Integrating the Courses in Electrical and Mechanical Engineering Technologies to Fulfill the Need of Energy Professionals

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Abstract

There is an increased demand for graduates who understand how energy is created, used, controlled, and wasted in residential, commercial, and industrial settings. Students in Electrical Engineering Technology learn electrical power generation, distribution, and control while students from Mechanical Engineering Technology learn how other forms of energy are generated, distributed, and controlled. Both groups learn engineering economics principles. The missing component is to bring these three fields together while integrating other developing technologies to solve the challenges in the field of energy management.

This paper discusses how the engineering technology programs can contribute in this endeavor. The topics include 1) what skills are required by today's energy professionals, 2) what subordinate skills are needed, 3) how energy audits can be used as cost effective hands-on experiences, 4) a list of equipment for energy audits, and 5) potential of applied research and outreach opportunities.

Introduction

The National Energy Policy Development Group, headed by Vice President Dick Cheney, submitted its final report to President George W. Bush. The group made very specific recommendations to address the energy challenges of the nation. Some of the highlights include expansion of federally funded programs to improve energy efficiency of residential users, expansion of research funding for energy efficient improvements, strengthening of public education programs relating to energy efficiency, expansion of the appliance standards program of the Department of Energy (DOE), increased fuel economy standards for automotive industry, continued commitment by the administration to the Department of Transportation's (DOT) fuel-cell-powered transit bus program, and incentives to residential solar energy integration.[1] These ideas, programs, and initiatives are not new. However, this time they come as a part of the National Energy Policy so that needed funds will be allocated at the highest level. Coupled with the need created by deregulation of the utility industry, these initiatives increase the need for professionals with an energy background.

The Association of Energy Engineers (AEE) has been trying to fulfill this need via professional seminars and workshops. The task is so vast that there is a room for every level of the education system when it comes to preparing energy professionals. Traditional Electrical Engineering

Technology (EET) and Mechanical Engineering Technology (MET) programs teach some of the skills required by energy professionals. An upper level undergraduate or a graduate course can be developed to teach the other required skills.

Energy Management?

One definition is "The judicious and effective use of energy to maximize profits (minimize costs) and enhance competitive positions." [2] The definition may vary from one society to another depending on how the environmental concerns and economic benefits are valued. However, there are many common aspects to any energy management program. 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.

Energy Management has been practiced in facilities management at some level for many years. Since the 1973 oil embargo, the view of energy as an inexpensive abundant commodity has changed. The Energy Policy Act of 1992 brought new life to the field of energy management.

Benefits

Traditionally, industrial engineering programs offered courses in energy management. Graduates with a knowledge of energy management will benefit no matter in what field or what sector they are employed. The skills learned in energy management can be used in designing devices and equipment, purchasing energy equipment, formulating energy policies, developing alternative energy systems, and marketing. Federal and state buildings are required to meet energy efficiency standard mandated by the Energy Policy Act of 1992. Implementation of these standards requires energy professionals. Any energy management program in industry has to rely on employees with energy management skills. EET and MET graduates will be able to increase their marketability by taking an energy management course.

According to a current survey[3], the employment opportunities for energy professionals are not restricted to industrial facilities. Energy traders, consulting firms, utility energy suppliers, and consumer groups have shown great interest in energy professionals in recent years. The average salary reported for 2000 was $70,459 and the average bonus for the same period was $6895. Seventy-five percent of those surveyed had a four-year degree. Fifty-five percent felt that they were receiving higher visibility in their organizations, while 25 percent received significantly higher compensation since they had assumed energy responsibilities.

Required Skills

As mentioned earlier, energy management has many aspects. It is not possible to master all of them in a sixteen-week course. What matters is to introduce the basic concepts in an interesting manner so that students will have the desire to learn and apply these concepts as a life-long endeavor. Students will find great interest in the subject matter when they experience the direct

application of the learned concepts. 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 skills requires a series of subordinate skills. Some of them can be considered as prerequisites skills gained through traditional EET or MET programs. Energy management is revolved around electrical and mechanical systems. Even though the prior knowledge of EET and MET students are not similar, students can work as teams allowing peer-to-peer learning. Figure 1 summarizes subordinate skill analysis where highlighted items can be considered as prior knowledge or knowledge that may require minimum coverage. The number inside the boxes on top corresponds to the numbers of the above list of skills.

Instructional Resources

There are several well-accepted textbooks and reference materials for in-class use.[2, 4] A complete list of published resources are available through the online store of AEE (www.aeecenter.org.) The website of U.S. department of Energy has many links to a wealth of information and valuable simulation software programs. Some of these simulation packages are free and the others can be purchased for a minimal cost.[5,6] Motor Master™ motor management software distributed through area utility companies is a very good tool for calculating energy saving where electric motors are used. The software is upgraded periodically to include new developments in energy efficient electric motors. If for some reason hands-on activities described below are not possible, these simulation software can be used as an alternative.

Hands On Experiences

Hands on activities related to real world energy management can be developed around energy audits. The energy auditing process and report writing requires almost all the concepts learned in class. The process begins with collecting and analyzing preliminary energy consumption data (pre-site work) for a building or a process. Then the auditors visit the facility and perform an on-site audit that includes investigating actual processes and/or facilities, interviewing employees who are in charge of energy matters, and taking pictures and necessary measurements. Students may have to visit the facility several times; during which students can investigate the mechanical and/or electrical processes learned in class and learn about new processes, equipment, and applications never seen before. Finally, a report is generated describing the energy saving opportunities. A typical audit report includes the identified problems, possible solutions, and economic analysis of the proposed solutions. The process resembles all the activities performed in a traditional lab environment.

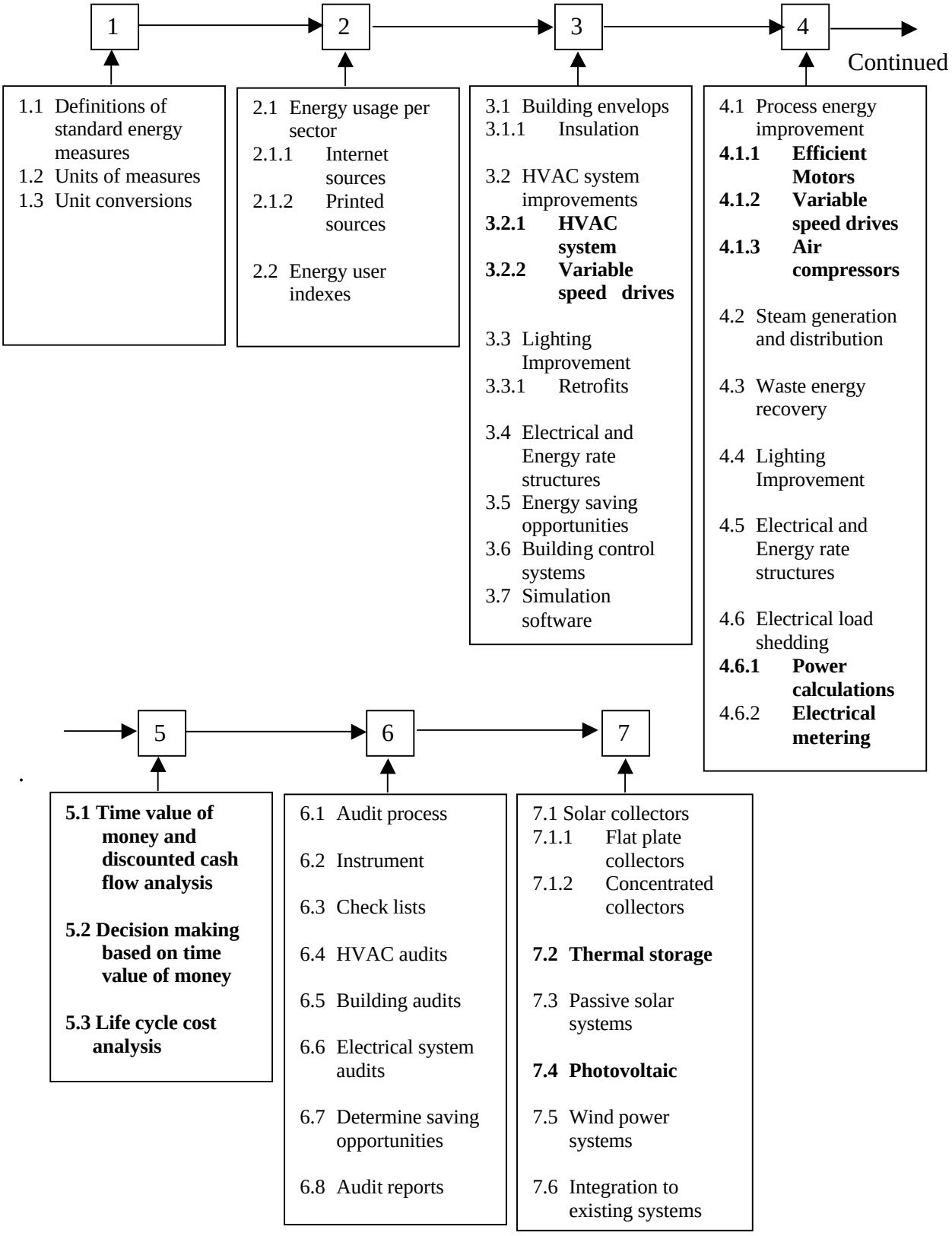

Figure 1. Major and Subordinate Skills for an Energy Professional

College campuses can be considered as a real world lab environment. Every college or university has a division of facilities management. Some schools generate their own power, completely or partially. State colleges and universities are mandated by the state to cut down the energy usage. All these create a learning environment that is waiting to be used. There is no need for a dedicated lab in the traditional sense. It is already there if academics and facility managers are willing to work together. When you count the number of stand alone buildings and the number of floors on multi-story buildings on campus, there are enough for several semesters. Although there are other ways to provide hands on experiences, construction of labs can be quite expensive.

Equipment

If one chooses energy audits as the mechanism to deliver hands on experience, the following equipment is needed to conduct basic energy audits. Some of this equipment may be already available in departments or campus facilities maintenance shops. They include a clip-on type ammeter with true RMS current capabilities, a wattmeter or a power Factor meter, a combustion analyzer, an airflow meter, a light meter, a blower door attachment, a smoke generator, a digital camera, several types of thermometers, and tape measures (25-foot and 100-foot.) There are, however, other more expensive equipment such as a Fluke 41B Harmonics Analyzer and Omega's Energy Conservation and Plant Maintenance kit which would make the audit process and data collection much easier.

Applied Research Opportunities

By its nature, energy management is an applied field. In energy management, electrical engineering, mechanical engineering, and economic principles are directly applied to solve existing problems or to enhance existing systems. As engineers and scientists introduce new technologies, engineering technologists have the opportunity to integrate them into existing systems. For example, increased air quality standards may require bringing in more outside air to a building, which means that the capacity of existing HVAC system must be increased or external heating must be supplied if it is in the winter. One option would be to experiment with flat plate solar collectors to supplement additional thermal energy. In another situation, students may explore the opportunities to develop microcontroller based blower units to provide more localize temperature control to specific area. Many utilities are still interested in demand-side management projects to distribute the demand profile, which prevent the construction of new generating facilities. Students may even get funding for developing electronic devices that may provide consumers the status of an electrical power grid so that consumers can be educated to use large residential appliances when there is a low power demand in the grid.

Outreach Efforts

One of the by-products of using energy audits as hands on activities is that they can be designed to help communities. Instead of conducting on campus projects, students may choose to help reducing the energy consumption of residences around the campus. Since there is interest in incorporating solar energy to residential users at the federal level, external funding opportunities may arise in the future. There is a political aspect to this approach as well because more and

more public universities are asked to engage in the larger society in which they exist. Many universities emphasize "engagement" as a high priority in boosting their public image. Ultimately, departments will be accountable to produce the results. Therefore, an energy management course with energy audit projects has the potentials to make win-win situation for students, faculty, department, and taxpayers.

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