AC 2007-2267: THE DEVELOPMENT AND PROMOTION OF INTERACTIVE ENERGY MANAGEMENT TOOLS FOR INDUSTRIAL ENERGY USERS

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The Development and Promotion of Interactive Energy Management Tool for Industrial Energy Users

Abstract

Despite the opportunity for increased energy efficiency, many industrial companies still face significant obstacles in that regard. To benefit small and medium industries located in Arkansas (and nationally), the Engineering Technology Department at the University of Arkansas at Little Rock (UALR) developed an Interactive Energy Management Tool (IEMT) for Arkansas Companies, with funding from the Arkansas Energy Office (AEO). This tool is a web-based software resource, which can be accessed from any remote web-browser. The IEMT is capable of providing users (industries) with customized recommendations with regard to energy conservation based on their specific inputs (data) to the software. The energy topics available for consideration are: lighting, motors, motor drives, fans and blowers, pumps, heaters and ovens, boilers, furnaces, steam and steam leaks, and compressed air. However, the utility of the IEMT is directly linked to the number of industries that utilize it. The overall success of IEMT depends upon the promotion and evaluation of the tool among a variety of companies. The promotion of the IEMT involved visiting and making presentations to nine industrial companies. It also involved a one-day workshop involving in-depth training with tutorials, using examples from actual industrial systems. The goal of this paper is to provide an overview of the IEMT, and to present the details of how the IEMT was promoted by means of onsite visits to various industrial companies. The structure and educational philosophy of the one-day workshops will also be presented. In this regard the methodology applied should have general applicability to other educational endeavors.

Introduction

The Department of Energy and other analysts of energy have projected a continued increase in energy use, especially in manufacturing and industrial sectors to maintain the current life styles of Americans. The article on Annual Energy Outlook 2004[1] with Projections to 2025, presents a critical review of the energy use of USA in the residential, commercial, industrial, and transportation sectors for the period of 1970 through 2025. The trends clearly indicate the increase in energy consumption by the industrial sector. A similar pattern for energy consumption is observed in the state of Arkansas. According to the report[2] released by the Arkansas Energy Office in 2000, the industrial sector is responsible for 43% of Arkansas' total energy consumption. The state's industrial sector consumed 465.6 trillion Btu and ranks at 24th among the 50 states. This large energy consumption makes manufacturing an attractive sector to focus on, because a small reduction in energy consumption through utilization of energy efficient equipment and practices could result in significant savings. The report (2001) of the National Energy Policy Development group (NEPD) led by Vice-president Cheney named six industries that consume three-quarters of all industrial energy[3]. They are lumber and paper; chemicals; petroleum refining; primary metals; food processing; and stone, clay, and glass. Improved energy efficiency in these energy-intensive industries yields even larger improvements in overall productivity, product quality, safety, and pollution prevention. Manufacturing companies generally obtain their largest savings from improved efficiency of motors (motors account for 54 percent of electricity use in manufacturing) and from improved steam and hot-water systems.

Many companies can reduce energy operating costs further by co-generating their electricity using heat from steam.

Many manufacturing operations are highly specialized, and they need specific information on energy-saving opportunities to effectively respond to process needs, energy price signals and supply problems. The existing sources of information usually provide data on power consumption and efficiency, but don't guide a user through a cost analysis and selection process. There is no comprehensive single source that can guide someone through a process of examining all facets of a company's energy usage and provide specific recommendations for different types of technology equipment. To fill this void, the Engineering Technology Department at UALR developed an Interactive Energy Management Tool (IEMT) for Arkansas Companies, with funding from the Arkansas Energy Office (AEO). This tool is a web-based software resource, which can be accessed from any remote web-browser. The goal of the IEMT is to provide users (industries) with customized recommendations with regard to energy conservation based on their specific inputs (data) to the software. The user can also use the IEMT in an interview mode. In the interview mode the software will guide the user through a set of queries, in response to which the IEMT will make specific recommendations for energy savings, complete with cost analysis for implementation.

Interactive Energy Management Tool - Development

The online interactive energy management site resides on UALR's web site[4] and may be accessed directly or via a link from the Department of Engineering Technology's/AEO's web page. The online energy management tool guides the user in the following ways:

(i) An interview style format: The user will respond to a series of questions relating to their use of equipment and energy. Based on the responses given, the software will prompt for specific information to be entered. The user will then be provided with a recommendation to improve energy efficiency and a cost analysis.

(ii) The user may bypass the interview process and select directly from a list of equipment/facilities. Again after entering data the user will be provided with specific recommendations.

When a user brings up the Interactive Energy Management Tool via a web browser a home page will be displayed. The home page will describe the purpose of the site, explain how to use it, and acknowledge the funding agency, ADED State Energy Office. The user will then be directed to use the site by way of the interview process or to choose specific areas of energy concern. The covered energy topics are lighting, motors, motor drives, fans and blowers, pumps, heaters and ovens, boilers, furnaces, steam and steam leaks, and compressed air.

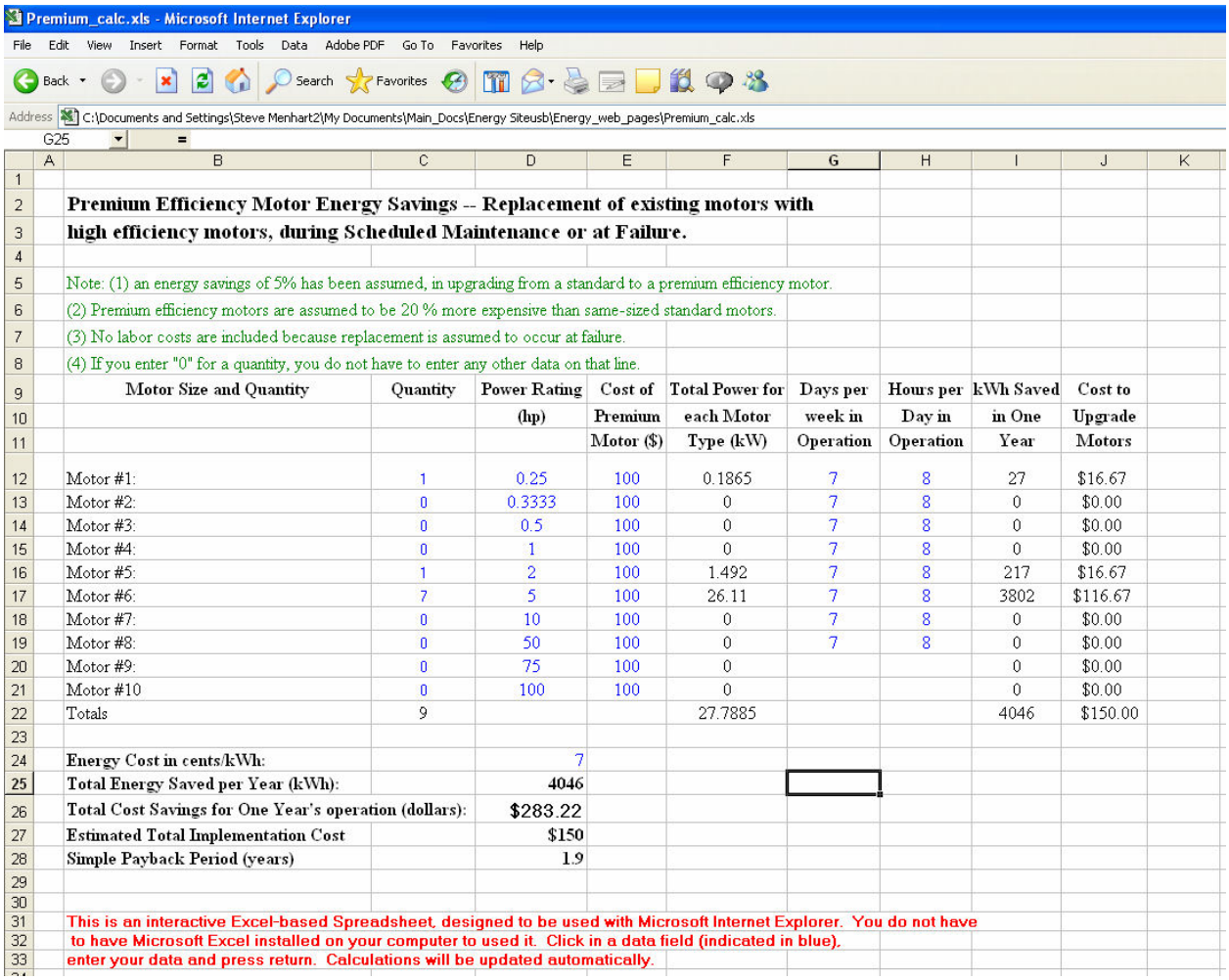
If the user chooses to select specific areas, clicking on any of these would provide an overview of that topic (with links to in-depth information) and definitions of all terminology. When ready, the user will click "begin energy analysis". This will cause a preprogrammed window or interactive Microsoft Excel spreadsheet to open. Detailed instructions on how to use this window will be provided. The user will be prompted to enter data in descriptive fields. After

completion of this phase the user will be provided with a practical solution to reduce energy costs in that area (if feasible) and also be provided with a complete cost analysis. The user may save and print this information, and then continue to another area of interest.

The user may also choose to use the web site in the interview mode. It is a powerful technique that will educate the user. That is, the user does not have to know in what areas they may improve energy efficiency and hence reduce costs; the web site will allow them to discover them. Based upon the user's answers, the software will direct the user to enter information. (A good analogy for this method is the interview process used by tax preparation software such as TurboTax.) In this way a comprehensive energy audit will be performed relating to equipment and facilities. At the end of the interview a thorough report will be generated. The report will contain specific detailed recommendations.

The site was developed using Microsoft Office FrontPage, which permits embedded coding, i.e., a user can run small programs via the web page, without downloading and installing the software. The interview mode required extensive coding in JavaScript.

As an example of using the IEMT, consider the topic of induction motors. Two ways of reducing the energy usage of motors are programmed into the IEMT. The first is the replacement of standard efficiency motors with premium efficiency motors, and the second is to replace standard v-belt drives with notched v-belts. These upgrades are straightforward in concept and implementation. Both upgrades are implemented in Excel spreadsheets and also in the interview mode. As an example, consider the upgrade to premium efficiency motors. By clicking on “motors” and following the appropriate links the following Excel spreadsheet will open, as shown in figure 1. The sheet has been preprogrammed to determine the dollar and energy savings that may be realized by upgrading from standard to premium efficiency motors. All of the fields are editable by the user, but typically a user would only need to edit the blue fields (number of motors, hp of each type, cost of a premium motor of that size, and the number of hours per year in operation). Up to ten different sizes of induction motors may be analyzed simultaneously, although the user may choose to consider fewer motors by placing a zero in the quantity fields of undesired motor sizes. To keep the analysis straightforward so as not to burden the user with determining parameters from manufacturers, certain “rules of thumb” have been assumed. It is assumed that users making this upgrade could save 5% of their current energy use. The 5% value represents a typical value. It is also assumed that premium efficiency motors cost 20 % more than standard efficiency motors. Again, this represents a typical value. The sheet also assumes that the upgrade is made at failure, or during scheduled maintenance.



Premium_calc.xls - Microsoft Internet Explorer

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Premium Efficiency Motor Energy Savings -- Replacement of existing motors with high efficiency motors, during Scheduled Maintenance or at Failure.

Note: (1) an energy savings of 5% has been assumed, in upgrading from a standard to a premium efficiency motor.
(2) Premium efficiency motors are assumed to be 20 % more expensive than same-sized standard motors.
(3) No labor costs are included because replacement is assumed to occur at failure.
(4) If you enter "0" for a quantity, you do not have to enter any other data on that line.

Motor Size and Quantity	Quantity	Power Rating (hp)	Cost of Premium Motor ($)	Total Power for each Motor Type (kW)	Days per week in Operation	Hours per Day in Operation	kWh Saved in One Year	Cost to Upgrade Motors
Motor #1:	1	0.25	100	0.1865	7	8	27	$16.67
Motor #2:	0	0.3333	100	0	7	8	0	$0.00
Motor #3:	0	0.5	100	0	7	8	0	$0.00
Motor #4:	0	1	100	0	7	8	0	$0.00
Motor #5:	1	2	100	1.492	7	8	217	$16.67
Motor #6:	7	5	100	26.11	7	8	3802	$116.67
Motor #7:	0	10	100	0	7	8	0	$0.00
Motor #8:	0	50	100	0	7	8	0	$0.00
Motor #9:	0	75	100	0			0	$0.00
Motor #10	0	100	100	0			0	$0.00
Totals	9			27.7885			4046	$150.00

Energy Cost in cents/kWh:	7
Total Energy Saved per Year (kWh):	4046
Total Cost Savings for One Year's operation (dollars):	$283.22
Estimated Total Implementation Cost	$150
Simple Payback Period (years)	1.9

This is an interactive Excel-based Spreadsheet, designed to be used with Microsoft Internet Explorer. You do not have to have Microsoft Excel installed on your computer to used it. Click in a data field (indicated in blue), enter your data and press return. Calculations will be updated automatically.

Figure 1: A Screen Shot of the Excel Spreadsheet for Upgrading to Premium Efficiency Motors

All spreadsheets in the IEMT use a consistent theme, in which the required user fields are displayed in blue. This sheet shows one of the simpler analyses that the IEMT can perform. This particular analysis is also available in the "interview mode", albeit in a more user friendly, interactive way using drop down question boxes and text fields.

Interactive Energy Management Tool - Promotion

The success of the Interactive Energy Management Tool is dependent upon its potential end-users (various industries) being aware of its existence. Furthermore, the usefulness of the IEMT must be demonstrated to industry. The IEMT was designed to be user-friendly, so that mastering the software should require a very minimal learning curve. Confidence in the software will also play an important role in the effective use of this energy management tool. An additional benefit to be stressed in promoting the tool is that it is less invasive and less costly than traditional assessment methods (on-site visits). A cogent promotional strategy is crucial to

the overall success of the IEMT. The promotion of the IEMT was carried out using a three-prong approach, which is described below.

In the first mode of promotion, the IEMT was taken directly to a variety of companies throughout the State of Arkansas and presented to them. Eight industrial companies were selected for this purpose. The IEMT was subsequently updated to incorporate the user feed-back from all of these companies. Table 1 presents the cost savings realized by analyzing various systems for the selected companies. The analysis for these companies involved touring their plants and collecting data from their systems. This data was then inputted into the IEMT to determine energy and cost savings. The names of the companies are not revealed to protect their confidentiality; however their industrial classifications are shown in the table. All of these companies were asked to provide their assessment of the IEMT. This feedback from all of these companies was analyzed and incorporated into the software. This resulted in an improved tool, and involved fixing some minor errors, changing some formats, adding notes, and making modifications that resulted in the software being more user-friendly. One specific suggestion that was implemented was to enable certain data fields to be entered automatically rather than to have a user extract them from a table and enter them into the software. (For example, in the Excel steam trap spreadsheet once the user enters the steam trap orifice diameter and the steam discharge rate, the steam pressure is entered automatically from a programmed table.) This is very useful not only from the point of user-friendliness, but also from the point of accuracy. The IEMT was extremely well received by these companies.

Equipment Analyzed using IEMT for energy savings	Wood products	Wire and wire related products	Food - food products	Electrical systems – hydraulic valves	Foods
	Dollars saved through energy analysis				
Motors	33701	78,205	22810	4562	22, 810
V-notch belts	6512	15,641	4561	912	4,562
Compressed air	21403	12,230	34,215	36,495	12,230
Steam & boilers systems	N/A	739,669	27,081	N/A	8465

Table 1: Energy analysis using Interactive Energy Management Tool

The second mode of promotion of the tool was carried out by conducting a training session at UALR, lasting one full day. This one day workshop began with an overview of the IEMT, followed by an in-depth tutorial using examples from actual industrial systems. Participants were also invited to use the IEMT during the training sessions. In the final mode of promotion, project personnel participated in a day-long workshop ("Energy Management Essentials in Commercial and Industrial Facilities"), sponsored by Entergy and held June 14th, 2006, at Alltel Arena, in Little Rock. Project personnel had a table setup outside of the main conference room, with two notebook computers. The IEMT was demonstrated interactively to workshop participants. A flyer/broacher was also available for any interested parties. This

workshop was attended by hundreds of participants. There appeared to be considerable interest in the IEMT, and this venue proved to be especially effective for the promotion of the software tool.

Conclusion

An interactive energy management tool was developed and promoted. The tool is user friendly and will allow industrial users to closely scrutinize all aspects of their energy usage from a single web site interface. After using the tool, users should be able to determine whether energy reduction is possible at their plants, and also specifically how those reductions may be achieved. In some instances, if the user has the necessary background, the information provided by the IEMT could be utilized to allow a user to progress to a DOE tool to select specific equipment from vendors. In future, it is planed to introduce this tool to students as a module of thermal systems design course.

The promotional strategies described in this paper are applicable to other programs or tools developed for use by the public. The developers of the tool noted that despite being offered free of charge, the one-day short course was poorly attended. It appears that for some individuals the value or utility of a product is directly linked to its cost. Given that the IEMT is available free of charge some individuals will under estimate its capabilities.

References

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