Striving for Cost-effective Energy Information Solutions: Emerging Web-based Technologies Provide Hope!

John M. Duff, CEM
VESTAR, a Cinergy Company

ABSTRACT

The internet is providing a cost-effective method of providing energy users with valuable information that enables them to better control their energy usage. The days of relying solely on systems that are on-site to provide this information have passed. The ability of off-site energy managers to collect, process, and disseminate this information using internet based e-mail and web pages accessible by the end user's standard internet browser has become a much more attractive option.

While centrally monitored energy management is not new, it has been used primarily by high-end users with dedicated staff to perform the gathering and analysis functions. With low-cost internet communications available, this service can now be provided to a much broader market. This market, consisting of K-12 school corporations, municipalities, medium-sized commercial office buildings, and modest-sized retail chains has been under-served by the energy management community, except in regions with high-cost energy rates. While energy retrofit activities have provided a significant amount of energy savings to much of this market, there are more savings to be had in the operational and system maintenance areas.

The only information that many of these under-served markets have is monthly energy bills. They are generally used for billing only, though some energy cost savings can be achieved by analyzing them for mistakes or for rate change recommendations. When one tries to

detect the cause of excess energy usage using monthly bills, inadequate results often happen because these bills are time-late and lack energy usage profile information needed to identify the cause of excess energy usage.

This article provides information regarding the information systems necessary to manage a facility's energy usage. It demonstrates the need for better, near real-time energy usage information for energy engineers and facility managers. In providing useful, timely energy usage information, the energy engineer and facility manager are better able to manage the energy usage in the facilities.

INTRODUCTION

Energy management has been around in one form or another for over four decades. This article is written primarily for facility managers and the energy service industry to motivate the development of affordable energy management systems to provide near real-time energy usage information to the end user so that they can more effectively manage their energy usage.

Interviews with facility operators rarely uncover anyone who is provided routine information regarding energy usage, especially if the only source of information is monthly bills. Since these are time-late, their value for detecting and solving problems is quite low. If the month's usage has been deemed excessive, any of several reasons can be given. Was it the weather? Did we operate the facility differently last month? Was there construction going on? Without profile data, the source of a demand spike may go undetected for months or years, perhaps never being discovered. The excess usage may have occurred from a setpoint change or equipment problems.

It is difficult to create positive change unless there is accountability for under-performance. Facility operators and tenants make decisions every day that affect operations that impact energy usage. Maintenance personnel perform repairs and adjustments that often increase energy usage in excess of what is needed to correct a comfort problem. None of this is done maliciously, but is the result of a lack of knowledge of the impact of their actions and a lack of accountability that could be remedied by appropriate energy information feedback on the results of their actions.

Take, for example, a technician who receives a "hot call,"— a space temperature that is too high, in the summer on a constant volume reheat system. To remedy this situation, the technician may reduce the chilled water delivery temperature, thus "solving" the problem. If the cause of the problem was a leaky reheat valve, not only is the space affected using excess heating and cooling energy, but the other space's reheats have to open up more to compensate for the lower chilled water temperature. All of this is on top of the chiller load increase to deliver the reduced chill water temperature. This phenomenon contributes to what is called 'energy creep': the slowly rising energy usage of systems that drift out of adjustment over time. If these actions can be detected and the proper personnel informed, better facility use practices can result in lower energy costs. A perfectly commissioned building may start with a low energy cost per square foot, but the actions of facility operators and tenants over the years, as well as undetected efficiency and setpoint changes, can go unnoticed for years. If properly analyzed, even poor commissioning of buildings can be detected and remedied.

There are similarities between energy management and business management. To manage any endeavor requires expertise, motivation, and information. If one is managing a business, one must have knowledge of the business, a profit or other motive, and information on how the business is doing. The information might consist of sales, revenue, and profits. The information usually comes from an accounting department, which provides the information in a format that is useful to managers and executives running the business. Without this information, the business is operating in the dark.

Energy management requires the same principles. The expertise may come from a dedicated on-site energy manager, a corporate energy manager, handling many facilities, or an off-site energy manager. The motivation may be reducing operating costs to help the bottom line, reducing peak loads on over-loaded circuits, better customer relations by being a more responsible user of energy, or any of a number of benefits. The information required to accomplish the job might include the energy budget, the utility rate structure, the energy use profile—both historic and real time, and knowledge of the facility loads and their controllability. The quality of these three essential elements will determine the success of any energy management effort.

DATA OR INFORMATION?

There must be a clear understanding of the difference between data and information. While the data may hold the answers needed to solve a problem, until it is turned into information, it is often of little use. An example is the gathering of a year's worth of energy bills. Unless there is some standard to compare the information to, the only information that may be available is whether or not you are over or under budget. Normalizing the data using weather and operational data can provide year to year comparison information, but may not indicate whether or not less energy could be used to achieve the same outcome. If an expected energy usage could be constructed from a knowledge of the facility equipment and operations, plotting this against the actual usage profile provides valuable information and highlights possible deviations. These deviations can fall into three categories:

1. Random events that change energy usage.
2. Detectable excess energy usage.
3. Problems with the energy usage model.

The need for more detailed energy profile information has resulted from the advent of competitive energy sources and real-time pricing. Many utility companies offer this service, sometimes in conjunction with beneficial rate options. It may come in the form of 15-minute electrical usage data that can be presented graphically. An experienced energy manager can determine quite a lot of information from this data, but the manager is the person who must review the data, make the determination of what is and is not significant, and provide results or opinions on how to reduce the energy usage. The key here is that an experienced person needs to look for problems in the data. If these data were to be analyzed in a manner that alerts the manager to the problem areas, more time could be devoted to solving problems and less time to searching for them.

ENERGY MONITORING BACKGROUND

In the 1970s, energy shortages and available technology brought an increase in the usage of energy monitoring equipment. These consisted

primarily of sub-metering plant equipment and runtime analysis to prevent excessive electric demand charges. Demand-limiting technologies, consisting of start-up controls and timing, allows industrial plants to better control their energy usage. Nearly all of these efforts were performed on-site.

Beginning in the 1980s, computer-based energy management systems became popular. The increased use of computer modems allowed the energy management function to be located off-site. Companies, such as Wal-Mart, made good use of this technology to monitor not only the base usage of their stores, but also the timing of the usage. A store manager who left his lights on after store closing hours would soon receive a call to explain the increased usage. Soon all store managers became very sensitive to energy usage issues, and this resulted in more competitive retail operations. This is an example of proper management generating accountability, thus motivating the operational changes that are desired.

The 1980s also saw the introduction of complex front-end building automation systems that were designed to operate in a stand-alone mode, capable of controlling the operation of more complex HVAC systems, such as direct digital control (DDC) systems. This added control allowed for better matching of system heating and cooling capacity to existing loads. These systems were able to record equipment usage, and in some cases recorded equipment energy usage. Few of these systems, however, were actually used to monitor the energy usage in a manner that allowed consumption to be managed. Demand thresholds were able to be set so that a dedicated system manager could be alerted to energy spikes, and could take corrective action. This is expensive in that someone had to monitor the system in order for it to be effective. Eventually, demand control strategies were able to be implemented that offered less hands-on control, but these were primarily used for the larger energy users. Little was done to monitor the routine usage, such as lighting, ventilation fans, and other controllable loads. The reasoning was that the loads were so small that the cost of monitoring them was not deemed to generate sufficient benefits.

As the internet became more widely used, the economics of remote monitoring changed. Based on independent research, there appear to be two schools of thought on this. One school seeks to monitor smaller and smaller loads, so as to generate large amounts of detailed data that can be analyzed to detect excess energy usage. The other school of thought

seeks to monitor key energy circuits and use system information and expected usage profiles to detect excess usage. This requires a detailed knowledge of the system, or a significant amount of usage history and the appropriate variables, such as weather, production numbers, and demographics in order to detect excess usage. The primary benefits of the second method are that the number of sensors is smaller, reducing installation costs, and that the data communications requirements were less expensive. The drawback is that, unless sufficient facility and operational information was available, such as energy audits and facility operational data, results can be less than adequate for the effort. Each method has its usefulness, depending on the type of facility that is to be monitored.

IN SEARCH OF WEB-BASED TECHNOLOGIES

The 21st century has seen an explosion in the number of internet-based information systems. In researching the systems designed to provide energy information for the purpose of energy management, VESTAR found that either the existing systems were too costly, or did not provide the functionality needed to deliver adequate energy savings. The criterion was to find a system that would routinely provide benefits that were two to three times the cost for groups of facilities that average 50,000 to 100,000 square feet, such as K-12 school corporations. After several months of research, no existing systems were found that would adequately provide this service to our customer base in a cost effective manner. The target was to find a way of generating 5 to 10 percent energy savings with a cost of 2 to 3 percent of their energy cost so that we could provide a reliable return on the customer's investment in the monitoring system. Many excellent systems with powerful graphics capabilities were available, but they were geared for large commercial and industrial markets.

GATHERING THE DATA

Several energy service providers are currently offering information delivery products with varying levels of analysis capabilities. Most services focus on month-end reporting of interval meter data only. Few

others are able to acquire facility information such as temperature, operating status or alarms. The provider names have been omitted to prevent the release of potentially proprietary information.

As you can see from Table 1, most of the providers offer hourly interval meter data. The average cost for providing data-only service is $60 per meter. The big variable is the setup cost, which can run from $1,200 per meter to $3,000 per site. This cost includes installation of any special metering, connection to the data server, and data delivery to the customer. Many of these installations use dial-up phone lines to modems or other labor-intensive setups. New technologies are currently being developed to reduce these costs.

SHOW ME THE MONEY!

A number of papers have been written that indicate savings from proper energy management can be 5 to 10 percent from equipment control modifications and facility operational changes. Savings from proper demand control can be even higher.

Taking an average of $60 per meter monthly service fee, and amortizing the setup cost over three years, the average monthly cost is approximately $185. If we assume a 50,000 square foot building on one electric meter with annual energy costs of $1.50 per square foot, the annual energy cost is $75,000. Therefore the monthly cost is $6,250. In order to pay for the $185 per month monitoring costs, the system would need to generate 3 percent in energy savings. What is missing in this information, however, is the cost of the analysis and generation of recommendations needed to accomplish the savings. For this example, let's assume that monthly monitoring is adequate to generate sufficient savings. Assuming that an off-site energy manager can analyze 500 meters per month, and that his time costs $120,000, with benefits, software and systems costs, this adds $20 to the monthly cost. This increases the monthly cost to $205 increasing the required savings to just 3.3 percent, still below the 5 to 10 percent in savings potential. There are many cases when one electric meter serves well over 50,000 square feet, resulting in improved economics. If one used the above information on a 25,000 square foot building, the savings rate would have to be 6.6 percent to break even. See Figure 1 for more examples.

Table 1. Internet-based Energy Monitoring Pricing

Service Provider	*Service Description*	*Pricing*
Provider A	Dial-up hourly interval meter data (monthly)	$20/meter/month
	Dial-up hourly interval meter data (daily)	$50/meter/month
	Dial-up hourly interval meter data (hourly)	$150/meter/month
Provider B	Dial-up interval meter data	$1200 + $45/meter/month
Provider C	Dial-up interval meter data	$200/mo for up to 4 meters
Provider D	Installation	$1500/site up to 3 meter pts
	Dial-up hourly interval meter data (monthly)	$100-150/mo up to 3 meter pts
Provider E	Installation	$1200/meter pt
	Dial-up hourly interval meter data (monthly)	$30-$80/mo (varies by pt type)
Provider F	Display hourly interval meter data (monthly)	$45/mo/meter pt (software only)
Provider G	Installation	$3,000 per building, includes monitoring panel
	Dial or cellular hourly interval meter data (monthly)	$75/meter/month
	Forecasting	$40-60/meter/mo
	Facility points	$20-40/pt/mo
Provider H	Installation	$1800/site
	Dial-up hourly interval meter data (monthly)	$75-150/meter/mo based on term
Provider I	Dial-up hourly interval meter data (daily)	$50/meter/month + service contract
Provider J	Dial-up hourly interval meter data (daily)	$46/meter/mo meter data only
	Must put in new meters, 3-yr term	+$30/meter/mo adds bill payment
	Access single meter at a time and download	+15/meter/mo adds Power Quality
Provider K	Dial-up hourly interval meter data (daily)	$75/meter set-up
	1 yr min term	$125/meter/mo

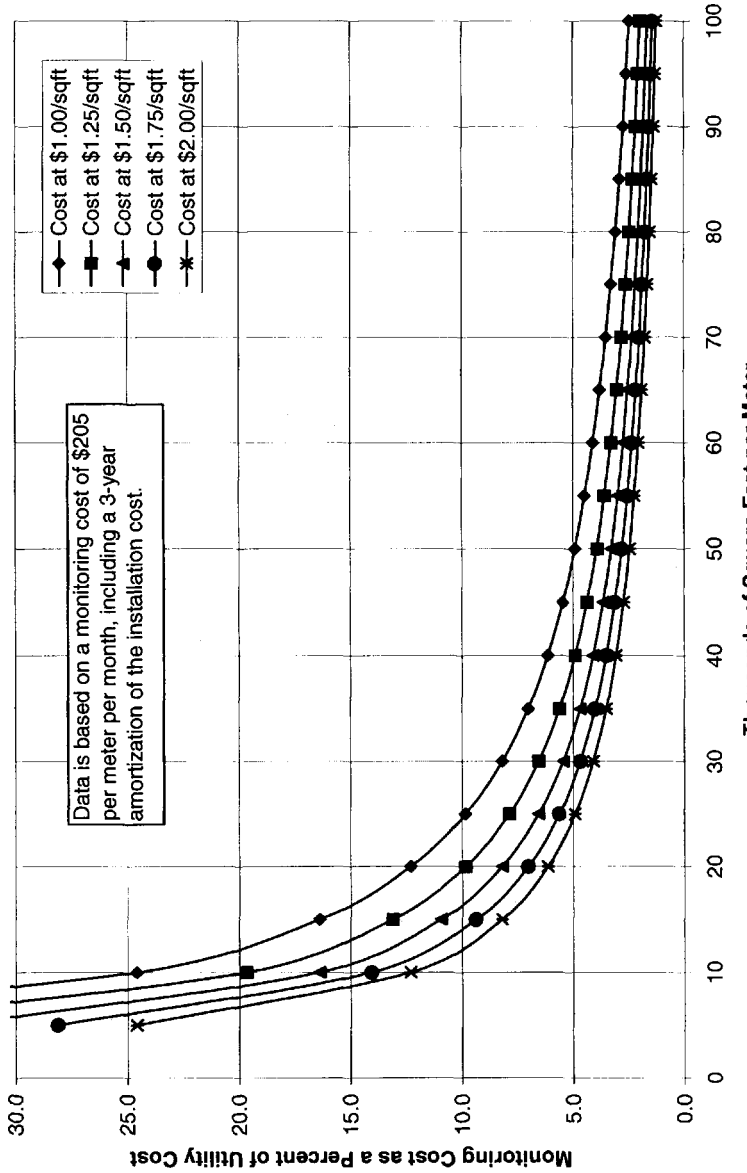

Figure 1. Monitoring Cost as a Percentage of Utility Cost

Since most of the meter data providers in Table 1 specify hourly interval meter data, they are evidently targeting customers that are interested in time-of-use information to take advantage of real-time pricing and load shedding. Most of these efforts are geared to hourly data, rather than 15-minute data. The benefit of 15-minute data is that it provides much better load profile information, and it corresponds to the demand charge time interval used by most utility companies. It is this interval that is of use to most energy managers, given the much greater cost of reduced intervals, such as 1-minute data. The electronic meters used by the majority of utility companies are set up to measure 15-minute data. Energy managers who analyze 15-minute data are interested in detecting improper or excessive system operation and to check the results of demand reduction efforts.

MOTIVATING THE MARKET

With such desirable benefits available, it would seem that this method of energy management would be quite widespread, but with less than 10 percent of the US market using some form of automatic meter reading [1], the initial setup costs can be quite a barrier to expanding the market into the medium and small sized customers. What is needed is a strong value proposition to justify the expense of installing the monitoring system.

Figure 1 shows the monitoring cost as a percentage of utility cost for five levels of energy usage from $1.00 per square foot to $2.00 per square foot and for meters that monitor up to 100,000 square feet. It is based on a monitoring cost of $205 per meter, including the amortization of the setup costs. By examining Figure 1, one can readily see that when the energy usage is greater than $1.00 per square foot and when the meter is monitoring at least 50,000 square feet, the monitoring cost is less than 5 percent of the utility cost. When the meter monitors only 25,000 square feet, the energy usage must exceed $2.00 per square foot for the monitoring cost to be less than 5 percent of the utility cost. One can see from Figure 1 why the larger facilities have been mostly served by the energy management industry.

UTILITY COMPANIES JOIN THE EFFORT

Many utility companies are utilizing new technologies to gather

customer meter data and provide other services. Deregulation has pushed many of these companies to reduce operating costs. Automatic meter reading technologies have proven beneficial in lowering the cost of obtaining meter data, and are widely used. Some utility companies are using the data for other uses, as well.

Cinergy Corp. (www.cinergy.com), an Ohio-based gas and electric utility, is embarking on a new venture with Current Technologies, LLC by deploying a Current Technologies (TM) Powerline Communications (PLC) solution to 100 homes in the state of Ohio. The test will focus on utilization of distribution powerlines for broadband internet access, automatic meter reading, outage detection, and substation monitoring. [2] Bundling meter reading with other services should lower the cost of remotely available meter data. This endeavor will add to Cinergy's already mature portfolio of energy management services, such as Energy Merchant, that it provides to its customers.

Duquesne Light, Co. (www.duquesnelight.com), serving the Pittsburgh area, takes over 400,000 daily meter readings on a fixed network, nearly 46,000 readings using telephone-based modules, and 80,000 monthly readings using mobile units for outlying areas. Duquesne's initial goal was to achieve improved meter reading and customer service, improve load forecasting, and outage management. [3]

As the number of utilities that implement automatic meter reading grows, the cost of implementing this technology in lower energy cost areas and smaller customers should decline. These efforts are further motivated by the utility's desire to manage load curtailment during peak hours.

TECHNOLOGIES ON THE HORIZON

Applications of new wireless technologies, such as Bluetooth, Shared Wireless Access Protocol (SWAP), and Wi-Fi [4] offer the hope that installation and communication costs of meter data gathering equipment will continue to drop. The low cost of many of these systems enable the installation of the necessary equipment with little cabling required. Inexpensive iButtons, small portable devices that utilize a 1-Wire® protocol for communications, offer many potential opportunities for use in energy management, including data logging and reporting, as well as event detection, such as when loads start and stop. [5]

CONCLUSIONS

The time to provide better energy management services to small to medium-sized energy users is here. Technologies are coming on-line to reduce the cost of remotely available interval meter data. The use of internet-based information data gathering and information delivery systems is making the operational cost of these systems able to provide enough value to justify use in markets that have been largely underserved. History has shown that as new technologies become more widely used, the cost goes down.

What the market seems to be requesting is a low-cost method to turn this data into the information needed to accomplish effective energy management for small to mid-sized energy users. One of Cinergy Corp.'s non-regulated subsidiaries, VESTAR (www.vestar.net), is developing a web-based solution called CheckPoint and envisions that CheckPoint will become the energy management software application of choice for facility and energy managers. A key feature of CheckPoint is the use of an automated analysis process. This lowers the monitoring costs by automatically detecting the most common sources of excess energy usage, thereby reducing the requirement to have a person search for problems. This allows the service to be offered to K-12 schools and other small to mid-sized energy users.

Facility managers can team with energy managers via web-based systems, and can play a vital role in reducing the cost of energy management systems by providing quality facility system and operational information to the energy managers, thus allowing them to use interval meter data to diagnose and remedy excess energy usage. Perhaps with better tools, facility managers can play a more active role in energy management, adding their expertise to the energy management team.

References

1. *Energy Engineering*, Vol. 99 No. 5, 2002, pg. 8
2. PR Newswire June 24, 2002, Financial News section
3. *Transmission & Distribution World*, February 2000
4. See http://www.howstuffworks.com/wireless-network.htm for more information
5. See http://www.ibutton.com/ibuttons/index.html for more information

ABOUT THE AUTHOR:

John M. Duff, CEM, is the regional energy manager for VESTAR, a non-regulated subsidiary of Cinergy Corp., an Ohio-based gas and electric utility. He has worked in the area of energy engineering for over nine years, including electronic ballast design, manufacture, testing, and marketing. He has managed dozens of energy saving contracts in the role of measurement and verification specialist. He spent four years generating energy and operational savings, including the establishment of a new work order system, at a large regional hospital, achieving over 150 percent of targeted savings. He is currently involved in the development and marketing of CheckPoint, an energy information system designed to be affordable to the vast number of small to medium sized buildings for which previous solutions were too expensive.

John received his BS degree in electrical engineering from Purdue University, an MS in electrical engineering and an MS in systems engineering from the Naval Postgraduate School, Monterey, CA. He is a graduate of the Naval Nuclear Power School, served for 12 years on nuclear submarines, and was qualified Engineer Officer of Naval Nuclear Propulsion Plants and for Command of Nuclear Submarines. His last position in the navy was as an engineering associate in the High Power Laser Department at Lawrence Livermore National Laboratory. He retired from the navy after serving for 21 years.

VESTAR, 1000 East Main Street, Plainfield, IN 46168; ph. 317-838-1443; fax 317-838-2986;jduff@vestar.net