# USE OF AN ENTERPRISE ENERGY MONITORING SYSTEM TO SUPPORT BUILDING COMMISSIONING AND OVERALL ENERGY EFFICIENCY BY THE HYATT HOTELS CORPORATION

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## ABSTRACT

This paper describes the corporate-wide energy management program implemented by the Hyatt Hotels Corporation. Components of this program include efforts to promote energy awareness and efficient energy consumption, an enterprise-wide energy tracking, reporting and benchmarking system and the ongoing installation of an automated network of utility monitoring and control systems in all their hotels in North America. The utility monitoring systems are used to support the energy tracking, reporting and benchmarking system and to facilitate building commissioning and re-commissioning, operation and maintenance problem identification and ultimately demand-response programs. Initial data analysis suggests that the program has achieved over $5 million in cumulative savings since January 1, 2003.

## BACKGROUND AND INTRODUCTION

Hyatt Hotels Corporation manages approximately 120 hotels throughout North America. Their annual utility costs are in excess of $100 million and many individual hotels have annual utility costs in excess of $1,000,000. Energy and water costs are key elements in their cost structure and a focus of management.

The Hyatt Hotels Corporation has embarked on a major energy management program. To facilitate better access to energy information and promote energy-efficiency, Hyatt Hotels Corporation is in the process of implementing an enterprise-wide automated Energy Information and Utility Monitoring System (UMS). New Horizon Technologies and eComponents Technology have teamed to provide an integrated solution that will ultimately include all of their hotels in North America. As part of the corporate-wide energy management program, all of the hotels participate in a monthly web-based utility benchmarking and hotel engineering reporting system. For hotels with automated Utility Monitoring Systems (UMS) installed, energy and water consumption data along with local weather data are automatically summarized in the web reports. Hotels without the UMS enter monthly utility and weather data manually at the website. The hotels also enter certain attributes such as occupancy rates and meals served into the system manually.

The base automated UMS consists of electric, gas and domestic water consumption interval metering and local temperature and relative humidity measurements. The UMS is one of the first enterprise-wide systems to include domestic water metering. Many hotels also elect to install additional sub-metering for major loads or end uses such as chillers, kitchens and laundries.

The local hotel UMS consists of a data acquisition system capable of displaying real-time meter data that also logs 15-minute interval data. The system transfers interval data daily, to a data center and also transfers interval data hourly, via a Local Area Network, to an on-site workstation with a local database. The local workstation permits users to have real-time alarming capability, access to easy-to-use data visualization and analysis tools, and the ability to generate both customized and standard daily and monthly reports. Report writing and utility cost software are used to generate daily and month-to-date cost reports. Bill estimation software uses actual utility rate tariff models to create estimates of utility costs for any custom defined period.

Data resident in the data center is accessible to the individual hotels using a web browser. Supervisory Senior Engineers with authorization can access data for all hotels under their span of control. The corporate energy director and senior management have access to all data in the data center. Hotel benchmarking data is also available through a similar browser-based system with a permission hierarchy.

The initial pilot installation was completed at the Park Hyatt San Francisco in the summer of 2000. Full-scale corporate-wide implementation began in the fall of 2000 and to date approximately 60 hotels in the Hyatt system have installed the UMS.

This paper will describe the design and implementation of the UMS in detail, review how the

system is currently being used by hotel personnel, discuss potential future applications and provide an initial look at UMS system-wide data, including preliminary utility cost savings estimates.

**SYSTEM DESCRIPTION**

The UMS is an enterprise-level solution, but many of the major components of the UMS are installed at the local hotel. An overall schematic drawing of the Hyatt utility monitoring system is shown in Figure 1. The central element of the local UMS is a "thin server." The thin server, typically an EnFlex MG 200 Control Server, in essence, is a single-board computer with an embedded Linux operating system; pulse counting capability and several communications ports. These communications ports support 10baseT Ethernet as well as RS-232 and RS-485 communications. The system includes telephone-based modem communication and supports a complete implementation of TCP/IP networking.

Each thin server can support up to 35 channels of data collection. The current UMS base monitoring system includes service entrance electricity, natural gas, domestic water and outdoor temperature monitoring at each hotel site. Sub-metering of major equipment or end uses such as chillers, laundries and restaurants is encouraged and included at many sites (1). Currently, the largest single monitoring site collects data from a total of 19 meters and sensors.

The thin server transfers data hourly to a local workstation that operates EnerTel® software (2). This software provides real-time data display, alarming capability, the ability to track and model energy costs on a daily or month-to-date cumulative basis using actual utility tariffs, data visualization, extensive reporting and data analysis capability including the ability to build virtual channels that represent multiple metering points, and the ability to develop and produce custom reports.

The thin server also transfers data daily to the eComponents Technology Enterprise Data Center. The data center is an integrated proprietary database management system on a Microsoft SQL Server® platform. The data center employs data validation and verification routines to screen every data point from every meter and sensor imported from the thin servers at each hotel daily. These automated routines inspect data for missing, duplicate and out-of-sequence data points, compliance with range limits, on/off load conditions and abnormal load shapes. Verification exceptions (test failures) for individual meters and sensors at all hotel sites are summarized daily in an automatically generated report. The report is reviewed further by data analysts to screen for false positives and forwarded to program engineers to provide "proactive" system maintenance and follow-up with the local hotel as necessary.

This daily screening and verification process adds enormous value to the utility monitoring system. Sensor failures and modifications (utility pulse constant changes) are detected immediately. Even more important, out of range conditions are used to detect operations and maintenance issues such as Energy Management and Control System failures, water leaks and malfunctioning equipment. The current automated data verification process is the first step in an evolving process that will eventually lead to automated failure mode alarming.

The data center also provides internet-based data access to staff throughout the Corporation via a WebActive™ Server and browser client (3). Senior Engineers with appropriate permission can access data for all hotels within their span of management authority. They can compare consumption and load shapes among their various hotels, build virtual consumption channels that combine several hotels and create customized views of data for recurring analysis and reporting. The Corporate Energy Director and other senior management personnel have access to data from all of the hotels with Utility Management Systems installed.

Hyatt Hotels Corporation has also implemented a web-based energy benchmarking and engineering reporting service to replace a manually operated system. The custom reporting service collects utility consumption data and hotel information such as the number of guest nights, occupied rooms, food covers served as well as information for preventive maintenance and room smoke detector checks via web forms. For the UMS hotels, utility consumption and weather-related data are automatically extracted from the enterprise data center and entered into the monthly web forms. Hotels without a UMS enter data manually. The web form data is submitted monthly, automatically generating on-line reports for: Energy Benchmarks with BTUs of energy and gallons of water consumed per square foot and per guest night, Consumption Predicted versus Actual based on multiple regression models for each hotel, Comparative Data for all utility types for the current.

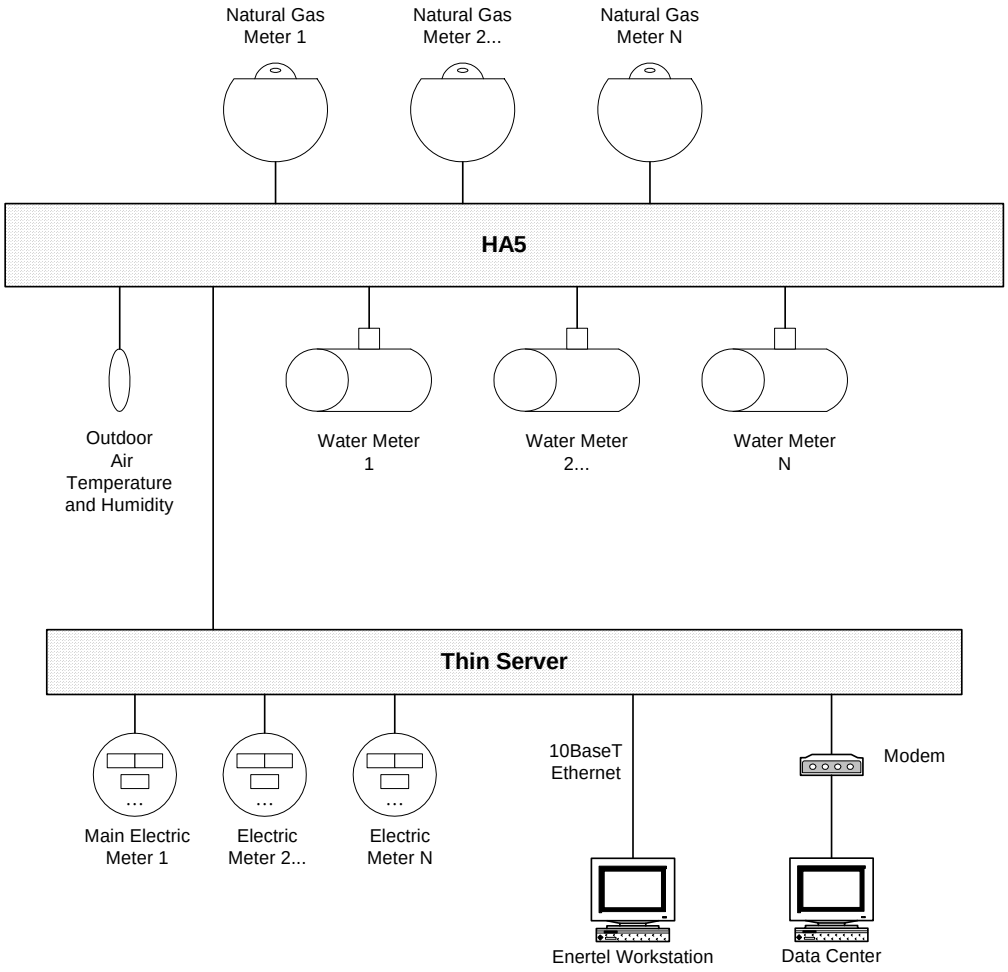


**Figure 1: Generic Hyatt Hotel Installation**

and previous year, and Preventive Maintenance and Room Smoke Detector Check reports for each hotel

Historic benchmark data is accessible through the data center. A security authorization hierarchy is in place so that appropriate management personnel can access data for multiple sites or the entire hotel system. Monthly energy and water benchmark comparison reports and engineering compliance reports for preventive maintenance and smoke detector checks are distributed across the Corporation to Senior Engineers and management and are metrics used to evaluate hotel operation.

## OPERATIONAL EXPERIENCE

Utility Monitoring Systems have been in place for over four years in many Hyatt hotels and substantial operating experience has been obtained. The systems have been used in a broad range of applications, some of which are described in this paper.

### Load Shape Analysis

One of the most common applications of the UMS is load shape analysis. Load shapes are evaluated as part of the data center automated verification process. Anomalous load shapes are flagged and noted in the exceptions report. New Horizon Technologies engineers evaluate the exception reports and determine if the anomaly is related to a meter or sensor failure or a hotel operations and maintenance issue. Unusual chiller cycling, water leaks and malfunctioning Energy Management and Control Systems have all been detected in this fashion. The corporate energy manager, hotel engineering directors, corporate engineers, and consultants use the UMS to identify periods of peak consumption, to understand when

and by inference why periods of high and low consumption occur, and to see if unusual or unexplained consumption is occurring. Daily and monthly loads shapes provide a valuable tool for building engineers to manage their buildings and manage their patterns of operation. Load shape information is also useful in the energy procurement process because many hotels participate in the deregulated energy marketplace.

**Energy Conservation Opportunity Identification**

Once hotel engineers become familiar with their building load shapes, they can begin to identify energy consumption patterns that suggest energy waste or inefficiency and can lead to opportunities to improve energy efficiency. For example, the Director of Engineering at a large Hyatt property identified an unusual natural gas consumption pattern in the middle of the night. The unusual consumption was traced to the kitchen and ultimately to kitchen cleaning practices. Cleaning personnel were turning on kitchen appliances as part of the cleaning process, contrary to standard hotel practices. This same cleaning practice was later discovered in other properties. In another instance, unusual chiller operating patterns at a property were verified and corrected by local hotel engineering personnel based on an unusual load shape flagged by the UMS automated data verification process.

**Operations and Maintenance Problem Identification**

Load shape analysis can also be used to identify operations and maintenance problems. One engineer with a large ballroom used the UMS to verify the operation of some components of his energy management and control system, particularly his ballroom lighting control system. The load shapes from the UMS pinpoint the time the ballroom lights are turned out and thus when modifications to the lighting control system have been made or the system overridden.

**Daily and Monthly Energy Reports**

The UMS automatically generates daily and monthly energy reports either to the desktop or as a printed report each morning for the Director of Engineering (DOE). Reports can also be generated and emailed automatically from the eComponents data center for DOEs who prefer this method of report delivery. The reports include previous day, month-to-date and/or previous month versus current month energy consumption and cost information. This automated reporting feature is highly valued by engineering personnel who are frequently very busy and often lack the time to generate, let alone study and act on, manual reports.

Each hotel uses the reports differently; approximately half of the hotels submit a daily energy report to their general manager and controller and the other half submits a month end report only.

Month end reports are used extensively by the corporate Energy Director to reveal operational issues. While this is a reactive method of energy management, it has provided value in two ways. First, the hotel engineering directors are cognizant that their energy consuming operations are being reviewed and hence pay closer attention to how they use energy. Also, the monthly report review by the Corporate Energy Manager from time to time discloses energy issues that need further follow-up by the local hotel that have not previously been identified. It is a case where a second review provides additional value.

These daily and monthly energy reports can also be used to track natural gas nominations under bulk purchase and “take or pay” natural gas contracts. Each day cumulative month-to-date natural gas consumption can be reported and compared to estimated quantities on a percentage of monthly/daily average consumption basis so that Hotel engineering directors can track their consumption and act proactively if the market price is above/below the contract price or to adjust budget estimates if weather or occupancy are creating consumption anomalies.

**Utility Bill Verification**

The UMS is also used for detailed energy bill verification. As energy markets become deregulated, billing becomes more complex and more difficult to understand. Engineers and controllers use the UMS to confirm both utility consumption and costs. The local UMS stores Utility rate tariffs and has the ability to replicate utility bills over any given time period. Several meter-related billing issues have been identified through the UMS. The hotels use their UMS to routinely monitor their energy consumption and check their utility bills. As part of the UMS service, analysts at eComponents and New Horizon Technologies formally verify all UMS billing meters against hotel utility bills every six months and a report is issued to the DOE. The vast majority of UMS meter verification tests agree very closely with utility readings. The standard UMS system tolerance

(acceptable variance) is 1% for electricity, 2% for natural gas and 5% for water meter readings. Occasionally, however there are discrepancies. Program engineers track down these discrepancies and the actual consumption verified. When billing errors are identified, this application can have substantial monetary value to the hotels. In a recent case, a billing error identified through the verification and rate tariff review process resulted in a correction of more than $23,000 to the hotel's gas bill for a month.

**Energy Consumption Threshold Alarming**

The UMS can display and operate on real-time data from all meters in the system. This means that in addition to tracking consumption in real-time, threshold consumption alarms can be set. These alarms can be set to notify engineering personnel when certain consumption levels are approached or reached. These alarms are particularly useful with time-of-use rate structures since engineering personnel can be notified in advance to take actions to control loads and reduce energy costs.

Future implementations of the UMS will include the capability to send an alarm-based digital control signal to an energy management system to further automate the alarm functionality. This functionality will be particularly important as demand-response programs begin to proliferate. The UMS Thin Server also has the ability to serve as an Energy Management and Control System gateway. Drivers for server popular energy management systems are available for the Thin Server

**Commissioning**

Hyatt is currently launching a program to offer re-commissioning and continuous commissioning services to hotels with UMS installed. New Horizon Technologies will provide a team of subcontractors to analyze UMS data, conduct a detailed on-site inspection and provide recommendations and proposed system modifications to participating Hyatt hotels. The pilot inspection for this new program was conducted at the Hyatt Regency San Antonio in February 2005. The program will be available to all hotels late in 2005.

**WATER METERING**

The metering of domestic water with the UMS is probably the most challenging of the metering technologies deployed. Electric and, to a lesser degree, gas utilities are familiar with customer requests for meter access or redundant metering to provide end-users with access to interval meter data. However, many Hyatt hotels are served by municipal or small local water utilities that are often less familiar with "pulse retrofits" or shared metering technology. Furthermore, the automated meter reading technology employed by many water utilities is incompatible with certain pulse retrofit devices. The Hyatt UMS is one of the first corporate enterprise-scale monitoring systems to obtain extensive domestic water metering data. This has resulted in a "learning experience" for both Hyatt and New Horizon Technologies.

There are several different approaches to domestic water metering that are being used in the UMS project. Some hotels are retrofitting existing water meters with a pulse output. Other hotels are installing new water meters in a redundant metering approach.

The least-cost approach is to install a pulse output device on the hotel's existing utility water meter. In that way both the hotel and the utility are sharing the same meter signal. However, some water utilities will not permit such a device to be installed. New Horizon Technologies is now deploying a non-intrusive pulse retrofit device that is compatible with most water meters and automated meter reading systems. But permission to install the retrofit device is still required from the utility that owns the meter and the process of obtaining that permission can be cumbersome and time-consuming.

The alternative approach is to install a new, redundant water meter. Due to cost and the requirement for a water outage to install the new meter, insertion water meters are often the preferred alternative. Insertion meters are installed through a "wet tap" and an outage is not required.

However, the placement location of an insertion meter is critical. Five to ten pipe diameters of straight, unobstructed flow both before and after the meter are required for good accuracy. Also, care must be taken to install the insertion meter to the proper depth.

Water meters are typically most accurate over a relatively narrow flow range. Utilities often overcome this difficulty by installing a compound meter that essentially is a dual meter with one meter registering high flows and the other meter registering low flows. A drawback to insertion meters is that while they are normally scaled to be as accurate as possible over as wide a range as possible, they

generally do not record very low flows accurately and "cut out" or record zero flow while water is still flowing. The insertion flow meter used in the Hyatt UMS cuts out at about 0.17 feet per second. New Horizon Technologies tracks the accuracy of all of the insertion meters installed in the UMS and calculates and applies a correction factor to meters where the low flow variation is significant.

Another drawback with turbine-type insertion meters is that they can become clogged with debris and lose accuracy or fail entirely. This problem has been encountered at a few locations. New Horizon Technologies is currently testing an ultrasonic insertion meter in the UMS that will have no moving parts. This new technology should be a major step forward. In situations where higher accuracy is required and a shutdown can be accommodated, New Horizon Technologies deploys in-line turbine or compound-turbine flow meters.

## UMS MAINTENANCE AND TECHNICAL SUPPORT

The UMS includes a comprehensive software and hardware maintenance and technical support program. The maintenance is a Total Care Package and covers essentially everything, hardware as well as software. It includes the following:

- Toll-free Technical Support Hot-line staffed 8:00 AM to 5:00 PM Central Time, Monday through Friday excluding Holidays (New Years, Memorial Day, July 4, Labor Day, Thanksgiving Day and following Friday, Christmas Day).
- On-line Manuals, Technical Bulletins.
- On-site Computer Hardware Support – Premium next day service.
- On-site Meter and Communications Hardware Support.
- Extended parts warranty on major UMS Components (Computer, Thin Server & Modem).
- On-line UMS Software Support.
- Daily System Communications and Data Verification Checks.

### Software Upgrades

The maintenance program also provides for software version upgrades that incorporate major functionality improvements as well as routine software fixes. Hotels have all received the third Service Pack upgrade with the fourth Service Pack released to selected Hotels in the spring of 2005. While some of the software upgrades, such as the updated graphing and reporting capabilities are obvious, other changes are invisible yet critical including security issues related to the Windows operating system and the inclusion of database optimization and automated back-up tools. The Thin Server, the principal data acquisition component of the Utility Monitoring System has received one, and in many cases two software upgrades each year. One of those upgrades substantially improved the real-time data display.

### Software Upgrade Training Services

Additional training for software upgrades or "refresher" training for current installations is provided to Hotels upon request at no additional charge.

### Enterprise-Level Solution

The Utility Monitoring System is a complex network. Not only is there a local network at the hotel that provides hourly data updates, there is also a Hyatt-wide (enterprise-wide) network that collects and updates data from every UMS on a daily basis. The maintenance and technical support program includes data transmission to the enterprise data center as well. Essentially this enterprise data center provides redundancy (back-ups) for all the sites. If the local database or back-up tapes become corrupt, the historical data can be restored from the enterprise network.

## THE LEAST-COST SOLUTION

Maintenance is time consuming and expensive. But without maintenance and technical support any complex metering and monitoring system will degrade rapidly. Given the level of investment in the UMS, and with the amount of data that is generated, the level of information that is provided and the complexity of the overall system, the ongoing maintenance program is clearly the least-cost approach to quality information.

Given the everyday priorities of running a hotel, there is no way local personnel could give the UMS the priority it deserves. And with the data quality requirements of an enterprise-level system, comprehensive maintenance support is required.

## RESULTS AND COST-EFFECTIVENESS

Hyatt has implemented their enterprise Energy Information and Utility Monitoring System against a background of rising energy costs. Corporate-wide electricity costs have increased 7% since January 1, 2002. Natural gas costs have increased 19% during

the same period. Electricity consumption has increased 1.85% during the period and natural gas consumption has increased 0.1%. During the same period overall hotel occupancy (guest nights) increased by 7.7%

The Hyatt Hotels Corporation has undertaken an initial evaluation of their enterprise-wide Energy Information and Utility Monitoring System by looking at the program as a stand-alone energy conservation tool. However, the system is also being used to replace a manual energy benchmarking system that has been in place for a number of years. This automation is an added benefit that has greatly benefited data accessibility and accuracy. A description of the Hyatt energy-benchmarking program follows.

**Benchmarking**

Hyatt Hotels Corporation has implemented an extensive energy benchmarking system. All of the individual hotels in the corporation are benchmarked against one another. They are also benchmarked by geographic region and by hotel type. Ultimately, the benchmarking will be implemented entirely by the UMS. Currently, benchmarking is implemented through a combination of UMS and manually entered data. Summary total energy consumption and cost benchmarking data for 2004 are shown in Table 1 as an example of the types of data collected. Hyatt has at least three years of benchmark data accessible for every hotel in their system.

**Table 1. Hyatt Hotel Energy Benchmarking**

| January - December 2004 Hotel Type | BTU/S.F | $/S.F. |
|---|---|---|
| Resort | 131,392 | $3.01 |
| Large Business | 110,803 | $2.00 |
| "Park" Hotels | 141,574 | $2.13 |
| Primary Convention | 112,124 | $1.70 |
| Secondary Convention | 111,907 | $1.58 |
| Small Business | 110,518 | $1.78 |
| Average | 116,009 | $1.98 |

For 2004 the average Hotel (111 hotels) total energy consumption was 116,000 BTUs per square foot per year. This results in an average energy cost of $1.98 per square foot per year. The consumption ranged from 63,054 BTUs per square foot to 220,252 BTUs per square foot and costs ranged from $0.94 to $5.66 per square foot. With the exception of the "Park" hotels and resorts, the average energy consumption of the various hotel market segments was nearly identical at approximately 111,000 BTUs per square foot. The fact that large business and primary convention hotels had higher energy costs per square foot than their counterpart secondary convention and small business hotels is probably a function of location. The large and primary hotels are all in very large cities with typically higher utility rates. "Park" hotels, with their higher per square foot energy costs, are generally small, luxury facilities. The anomalously high energy costs of the resort hotels reflect their locations in prime vacation spots such as Hawaii and the Caribbean.

Hyatt uses a multiple linear regression model to forecast energy consumption at each of their hotels. Independent variables include guest nights, occupied rooms, food covers, cooling degree-days and heating degree-days. The regression models generally provide reasonable accuracy. Only 11 of the 111 hotels currently modeled have predicted versus actual energy cost variance greater than +/- 10%.

Return-on-Investment

In 2003 some preliminary cost-effectiveness analysis of the UMS was conducted. Electricity consumption (not demand) for the Eastern and Southern Hotel Regions was analyzed. For the combined Eastern and Southern Regions there are 37 hotels with data available for analysis. Four additional hotels had missing data and 3 had data questions. Fourteen hotels had UMS; 23 did not. The UMS were typically installed in the late fall of 2000 or early in the winter/spring of 2001. The change in electricity consumption per guest night between 2000 and 2002 was calculated. The data was not weather normalized since no discernable weather related patterns were observed in the data. Of the 14 UMS hotels, 10 (71%) reduced electricity consumption per guest night between 2000 and 2002. Of the 23 non-UMS hotels, 9 (39%) reduced electricity consumption per guest night. The cumulative savings for the UMS hotels for the year 2002 was $446,564. The cumulative savings for the non-UMS hotels was (-$69,028). The average 2002 electricity cost savings for the 14 UMS hotels was $ 31,897. The average for the 23 non-UMS hotels was (-$3,001).

While the analysis should not be viewed as definitive, these results do suggest that the UMS hotels analyzed are reducing their electricity consumption and that a quick return-on-investment appears to be likely in many cases.

Further analysis was recently conducted to evaluate the cost-effectiveness of the Enterprise Energy Information and Utility Monitoring System. All of the participating hotels that were in existence from 2002 through 2004 (111) were included regardless of whether they had a UMS. The evaluation premise was to assess the overall effectiveness of the corporate energy management program by comparing the actual corporate energy cost for 2003 and 2004 with what the cost would have been if the program were not present. This is a standard technique used in the evaluation of energy conservation retrofits (4). The results were normalized for occupancy and heating degree-days.

For 2003, actual energy corporate energy cost for these 111 hotels was $2.99 million less than the predicted energy consumption. For 2004, actual energy consumption was $2.18 million less than predicted consumption. Combined savings for the two years represents over $5.17 million and approximately 2.5% of actual corporate energy expenditures.

**FUTURE EXPANSION**

Hyatt Hotels Corporation plans to complete the installation of their UMS over the next few years. There will also be a major focus on encouraging use of the system by hotel personnel and in developing additional applications. It has become clear that increasing the automation of the system will be a high priority. Pattern recognition software in the data verification routines will be a future priority as will be expanding the automated links between the hotel UMS and energy management systems.

There will also be a priority placed on using the system to identify energy conservation opportunities. Again, database analysis software for pattern recognition will help in this regard, but an even more important energy conservation opportunity will be the use of the UMS to support building re-commissioning. The vast majority of Hyatt hotels have been in operation long enough to be good candidates for re-commissioning. Use of UMS data for re-commissioning may be the single most cost-effective application of the UMS and Hyatt has recently initiated a program to capitalize on this.

**SUMMARY AND CONCLUSION**

The Hyatt UMS is still a work-in-progress. The system has been implemented in only about 50% of the corporation's hotels due to individual hotel owner's capital expenditure restrictions. Nevertheless, the results to date are very encouraging and suggest that the implementation will be highly cost-effective. Implementation of the system in the remaining hotels is being strongly encouraged and additional priority is being placed on energy efficiency at the most senior levels of the company.

**REFERENCES**

1. W. Dan Turner, John R. McBride, "Energy Submetering: The Key to Cost-Effective Conservation," Facility Manager, November – December 1999, pp 45-51, Association of Higher Education Facility Officers, Alexandria, Virginia, 1999.

2. EnerTel ® software was developed by eComponents Technology and New Horizon Technologies.

3. WebActive ™ software was developed by eComponents Technology.

4. "IPMVP Volume 1: Concepts and Options for Determining Energy and Water Savings," International Performance Monitoring and Verification Protocol, Inc., Washington, D.C., 2001.