1 INTRODUCTION

In response to the growth of managed care, advances in medical technology that reduce hospital stays, reductions in reimbursement rates, and the increasing number of uninsured patients, the healthcare industry continues to experience intense financial strain. Continual pressure to cut costs together with the trend for consolidation are driving healthcare providers to thoroughly scrutinize their services and expenditures, including energy usage.

Nationally, hospitals and healthcare facilities generally spend approximately $6 billion annually on energy-related items, including electricity, natural gas, and fuel oil; equipment operations, and infrastructure financing. Energy performance of hospitals can be improved and significant cost savings realized through better operations and maintenance (O&M) of existing systems, by purchasing more energy-efficient technologies, or a combination of the two. Oftentimes, lack of knowledge has barred adoption of best management practices or certain technologies since the gain in energy performance is unsubstantiated or difficult to predict, especially given different building types and climate region. In pursuit of cost reduction and improved operating efficiency, hospitals are seeking to bridge information gaps. The market knowledge presented in this guidebook is designed to fill some of these gaps and shed light on many aspects of the hospital market that could translate into an increase in energy performance and significant energy cost savings.

Energy Costs in the Healthcare Market

According to the Environmental Protection Agency (EPA), healthcare is one of the most energy intensive industries in the U.S. Hospitals use more than twice as much energy per square foot as office buildings; however, cost increases cannot be offset, as they would in other industries, because healthcare facilities have set reimbursement rates. Healthcare organizations face significant revenue gaps created by shrinking budgets, declining tax bases, aging facilities, and growing energy costs. These facilities are constantly challenged to reduce costs, elevate the quality of care, and compete in the market place. By improving energy efficiency, hospitals can generate a new source of capital for investment in facilities, for expansion, or to increase the bottom-line.

Background

This Healthcare Energy Guidebook is the result of a collaborative effort among the American Society for Healthcare Engineering (ASHE) of the American Hospital Association (AHA), the Health Research and Educational Trust (HRET), Environmental & Energy Conservation for Healthcare Organization (EECHO), and ProWrite Inc. It was made possible through a United States Environmental Protection Agency (EPA) grant.

The guidebook is designed to provide decision makers with knowledge about improving energy efficiency. The data presented profiles the U. S. hospital market on size and energy-related characteristics and provides energy benchmarking information that can be used to make meaningful comparisons among healthcare facilities. This guidebook will enable managers to gain a better understanding of the key characteristics of energy-related issues within the healthcare market and to assess how well their facilities are performing relative to hospitals with similar energy equipment.

Uses of Hospital Facility Data

The data presented in this guidebook were gathered through a comprehensive survey and facility benchmarking using the EPA's ENERGY STAR® Portfolio Manager benchmarking tool. Surveys were completed by 121 healthcare facilities representing all types of climate region. Energy management practices were compared between the top and bottom performing quartiles.

Goals and Objectives

The primary goal of the Healthcare Energy Project is to provide healthcare engineers technical guidance to increase the energy performance of their buildings. The scope of this guidance covers technology upgrades and operations and maintenance (O&M) practices (including preventive maintenance plans) of lighting, HVAC load reductions, fan systems, and HVAC plant operations.

To achieve this goal, the following objectives were accomplished:

Determine benchmarking scores for at least 120 hospitals—Benchmarking surveys were completed by hospitals geographically distributed across the country to obtain an even distribution across all major climate regions, as outlined in the Commercial Building Energy Consumption Survey (CBECS), coordinated by the Energy Information Administration of the U.S. Department of Energy. The survey results have been benchmarked using the EPA benchmark algorithm at www.epa.gov.

Create comprehensive surveys—The comprehensive survey provided detailed information on technologies and current O&M practices. It focused on obtaining information about what differentiates high-performing and low-performing hospitals.

Compare management practices within and among each quartile—The hypothesis of HEP is that high-performing hospitals will employ more technologies that are energy-efficient and institute more aggressive best management O&M practices than low-performing hospitals.

Compile a best practices guidebook—A best energy management practices guidebook has been compiled that details the differences between respondents whose benchmarking scores are in the top quartile from those in the bottom quartile and the respondents as a whole.

Approach

HEP involved a phased approach to accomplish the goals and objectives of this effort. The first phase involved obtaining benchmarking scores and completed comprehensive surveys from 121 hospitals. Next, the data were analyzed and management practices within and among each quartile were compared. The final phase involved compiling the data and reporting the study findings in this best energy management practices guidebook.

Results

Although there were many areas such as types of fuel used, that showed little difference between top performers and bottom performers, other areas showed significant differences.

Top Performers

The strongest common characteristics of top performers included

- The greater use of a variety of lighting sources, especially halogen bulbs and installing more lighting conservation features
- Working with ESCOs
- Using EMCS/BAS that cover a large number of areas
- Having twice as many O&M energy conservation strategies
- Installing insulation within the last five years
- Using more O&M procedures for laundry equipment

Other characteristics of top performers included

- Using recently-installed EMCS/BASs—or none at all
- Installing HVAC maintenance conservation features in the last five years
- Using single-duct or multi-zoned variable volume or multi-zoned constant volume air handling
- Having air-cooled chillers, district chilled water, or evaporative or desiccant cooling
- Having larger cooling sources
- Using air balancing, filter replacement, and piping insulation in their O&M procedures for their HVAC systems

- Using chemical treatment of closed-loop system and descaling of boilers for their hot water systems
- Using passive solar energy heating
- Using the following lighting types: compact florescent, electronic ballast florescent, high-pressure sodium, parabolic aluminized reflectors, standard incandescent, low-pressure sodium, and, as mentioned above, halogen
- Installing lighting conservation features within the last five years including dimmers, electronic ballasts, occupancy sensors, photocells, relamping, and timers
- Cleaning lighting fixtures and conducting lighting zone maintenance daily checks
- Performing annual roof inspections and caulking inspections
- Installing seals and roofing within the last five years
- Having a preventive maintenance program for cooking equipment
- Replacing cooking or laundry equipment in the last five years
- Checking laundry equipment including checking the ironer temperatures, daily monitoring of kWhs and water usage, recovery of heat from wastewater, and reuse of wastewater—or outsourcing their laundry
- Performing energy audits internally
- Working with ESCOs to finance and install energy-efficient equipment

Bottom Performers

Respondents in the bottom quartile also shared some common characteristics which could result in

- Consuming more energy
- Making less energy improvements than other measures
- Keeping other more-effective measures from being implemented

This study did not attempt to determine which of the above was the cause of low performance.

The strongest common characteristics of bottom performers included

- Participating in supply side management
- Replacing air-handling equipment in the last five years

Other characteristics of bottom performers included

- Using contracted lighting replacement
- Using mercury vapor lighting
- Using single- or dual-duct constant volume or dual-duct variable cooling air handling system

- Using an air-handler economizer cycle (although the vast majority of all facilities use an economizer cycle)
- Using the following O&M procedures for their HVAC systems: chemical treatment of closed-loop system, coil cleaning and maintenance, monitor operating conditions, steam trap inspection program for boilers, and water treatment for boilers as well as performing fewer total procedures than top performers
- Using fuel oil #2 for heating
- Replacing their hot water heating system or replacing no main equipment in the last five years in addition to replacing their air handling equipment mentioned previously
- Using the following O&M procedures for their cooling towers: ozonation and organizing the motors as cells as well as performing more total procedures than top performers
- Using a water-cooled chiller as the primary cooling source
- Using a combination of distributed and centralized primary domestic water heating system
- Not cogenerating or not recovering waste heat
- Installing an EMCS or making no HVAC energy conservation improvements in the last five years
- Installing their last EMCS/BAS before 1997
- Having a laundry (using electricity)
- Not working with ESCOs
- Performing their last energy audit before 1997 and using a consultant to perform it
- Participating in rate review and consumption auditing
- Installing multi-paned windows or doors or installing no building shell conservation features in the last five years
- Using vendor contracted O&M on cooking equipment and refrigerators
- Using the following O&M procedures for laundry equipment: flame testing of dryer burners and outsourcing chemical treatment of water

Because operating a healthcare facility and achieving good energy efficiency is a complex operation, any conclusions from this study should be made by examining the study as a whole.

Guidebook Organization

The Healthcare Energy Guidebook is organized in the following chapters:

Overview of the Hospital Market—A summary of general market characteristics, including locations of hospitals in the U.S., ownership, size, and operating expenses.

Energy Use in the Healthcare Industry—An overview of typical energy use for hospitals in the U.S. healthcare industry, including electricity, natural gas, fuel oil, and other types of energy.

Healthcare Energy Project Survey Results—The results obtained through the HEP survey, which was completed by engineering and facilities management professionals at 121 hospitals. Results examined include

- Census Division
- Annual Inpatient Days
- Fuels
- Heating and Cooling Sources and Systems
- Energy Use
- Management
- Equipment and Conservation Features
- Operations and Maintenance
- Energy Audits

This chapter also presents data analysis and conclusions, including the method of data analysis, an overview of the benchmarking scores, and conclusions about best energy management practices.

Best Practices—A summary of the best energy practices including the results of interviews with the top 10 percent of high performers and a preventive maintenance checklist.

Appendix A, Summary Statistics—A compilation of the numerical data collected using the HEP survey, analyzed by top quartile, bottom quartile, and all respondents.

Appendix B, Survey Tool—A printed version of the survey tool completed by HEP participants.

Appendix C, Spreadsheet Benchmarking Tool—A printed version of the spreadsheet benchmarking tool completed by HEP participants for submission of data to the EPA's ENERGY STAR® benchmarking program.

Appendix D, Glossary—Definitions of the terms used in the surveys and this report.

Appendix E, Highlighted Summary Statistics—A version of the Summary Statistics with the most significant findings highlighted as well as comments.

Appendix F, Qualitative Data— A compilation of the qualitative data collected using the HEP survey, analyzed by top quartile, bottom quartile, and all respondents. Included are all the responses to "Other."

Appendix G, Summary Statistics by Region—Similar to Appendix E and F but compared by the different regions.

Appendix H, Statistical Significance—Statistical significance of key findings determined using statistical techniques such as *t*-tests.

Data Sources

The profiling information for the overview of the healthcare market and energy usage was drawn from two EPRI reports, *Energy Market Profiles: Hospital Buildings, Equipment, and Energy Use* and B*ackground, Trends, Issues, and Opportunities in Healthcare*. The Healthcare Cost and Utilization Project (HCUP) is a family of administrative longitudinal databases, web-based products, and software tools developed and maintained by the Agency for Healthcare Research and Quality (AHRQ) as part of a Federal-State-Industry partnership to build a standardized, multi-state health data system. HCUP is the primary source for the hospital market statistics.