American Society for Healthcare Engineering
of the American Hospital Association

Healthcare Energy Guidebook

Results of the
Healthcare Energy Project
November 2001 through December 2003

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American Society for Healthcare Engineering (ASHE) of the
American Hospital Association
Health Research and Education Trust (HRET)
Environmental & Energy Conservation for Healthcare Organization
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FOREWORD

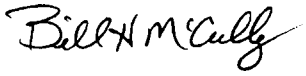
Hospitals are large users of both electrical and thermal energy on a continuous basis. Their operation is year-round and 24 hours per day, and they are highly energy intensive.

This basic assessment, from the National Accounts Sector—Energy Profile, says it all. Hospitals are energy intensive. Daily challenges include providing patients with a safe and comfortable environment, coping with dwindling staffing and financial resources, and compliance with a myriad of codes and standards. Among the daily challenges is the challenge we all face of reducing operating costs—the largest being energy consumption.

With these challenges comes the opportunity to design in energy-efficient equipment, operations, and controls. But energy savings opportunities do not only come with capital dollars. Facility managers and engineers may increase the energy performance of their buildings through improved operations and maintenance. These often overlooked best management practices are based on fundamental principles of equipment preventive maintenance and effective operational control.

In 2003 ASHE was awarded the Environmental Protection Agency (EPA) Energy Star Partner of the Year Award for Excellence in Business Outreach. We are both proud of this honor, and mindful that we as a healthcare community can do more. That "more" starts with sharing best practices, lessons learned, and proven energy savings solutions among our profession. This guidebook is a first step in the sharing of this information, and a call for continued work to identify practices, techniques, and technologies that we can all leverage to conserve our precious energy resources.

Michael Kuechenmeister
2003 Chairman
ASHE Facilities Management Committee



Bill McCully
2003 President
ASHE

ACKNOWLEDGEMENTS

This guidebook could not have been completed without the help of the ASHE members who participated in this project. They took their valuable time to share their knowledge and data by completing both the EPA benchmarking survey and the HEP comprehensive survey. Top performers also provided valuable information through a series of phone interviews. All ASHE members owe the participants their appreciation. In addition, the following organizations made this guidebook possible.

American Society for Healthcare Engineering (ASHE) has initiated programs for the coming years to educate, train, and promote energy conservation and efficiency practices. ASHE spearheaded the HEP project by promoting it to its members, gathering feedback and data from its members, and working with AHA and HRET to distribute the findings of the study.

Health Research and Educational Trust (HRET) is a 501C3 non-profit corporation providing research and educational services for AHA divisions. HRET's mission is "transforming health care through research and education through people, communities, and those who serve them working together to improve health." HRET supports the Healthcare Energy Project (HEP), which has resulted in this guidebook for all AHA and ASHE members across the country.

Environmental & Energy Conservation for Healthcare Organization (EECHO) is involved in energy conservation and efficiency for hospitals nationwide. It explores technologies and practices that will assist hospitals in controlling energy costs. EECHO was instrumental in initiating this project.

ProWrite Inc. is a full-service technical communications company that specializes in communicating technical information to broad audiences. ProWrite developed the comprehensive study, gathered and analyzed the data, and designed, wrote, and produced the guidebook.

United States Environmental Protection Agency (EPA)

This research was made possible through a United States Environmental Protection Agency (EPA) grant.

Disclaimer

Although the research described in this report has been funded wholly or in part by the United States Environmental Protection Agency through EPA Assistance Agreement # X-82934101-0 to the Healthcare Education Research Trust, it has not been subjected to the Agency's required peer and policy review and therefore does not necessarily reflect the views of the Agency and no official endorsement should be inferred.

EXECUTIVE SUMMARY

Healthcare Energy Project

This guidebook profiles the U.S. healthcare market on size and energy-related characteristics and provides energy benchmarking data that can be used to make meaningful comparisons between healthcare facilities. The intent of the guidebook is to provide assessment of practices, methodologies, and technologies being applied for the purpose of improving energy efficiency in hospitals.

This guidebook will enable managers to gain a better understanding of the key characteristics of healthcare facilities that have lower energy usage and those that have higher energy usage. Managers can also look at practices that seem to make little or no difference. When future projects are considered, they may want to promote the projects that are characteristic of top performers and re-evaluate those that are characteristic of low performers or seem to make little difference.

Background

This guidebook on the healthcare/hospital market is the result of the Healthcare Energy Project (HEP), which is a cooperative effort of the American Society for Healthcare Engineering (ASHE) of the American Hospital Association, 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.

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.

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.

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

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.

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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.

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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.

2 BACKGROUND: OVERVIEW OF THE HOSPITAL MARKET

This chapter provides an overview of the national hospital market. This overview was developed from the analysis of statistical data obtained from The Healthcare Cost and Utilization Project (HCUP). HCUP is based on weighted national estimates from a HCUP Nationwide Inpatient Sample completed for the year 2000 using data collected and provided to the Agency for Healthcare Research and Quality (AHRQ) by individual States.

Summary of General Market Characteristics

National hospital market characteristics summarized in this chapter include:

- Location of hospitals in the U.S.
- Hospital ownership
- Hospital classification
- Hospital size
- Operating expenses and profit margins

Location of Hospitals in the U.S.

Hospitals are located throughout the U.S. generally in proportion to the nation's population, with the heaviest concentrations occurring in the East North Central (primarily in Michigan, Ohio, and Illinois), South Atlantic (primarily in Georgia and Florida), West North Central (Kansas, Missouri, Iowa, and Minnesota), and West South Central (Louisiana and Texas) regions.

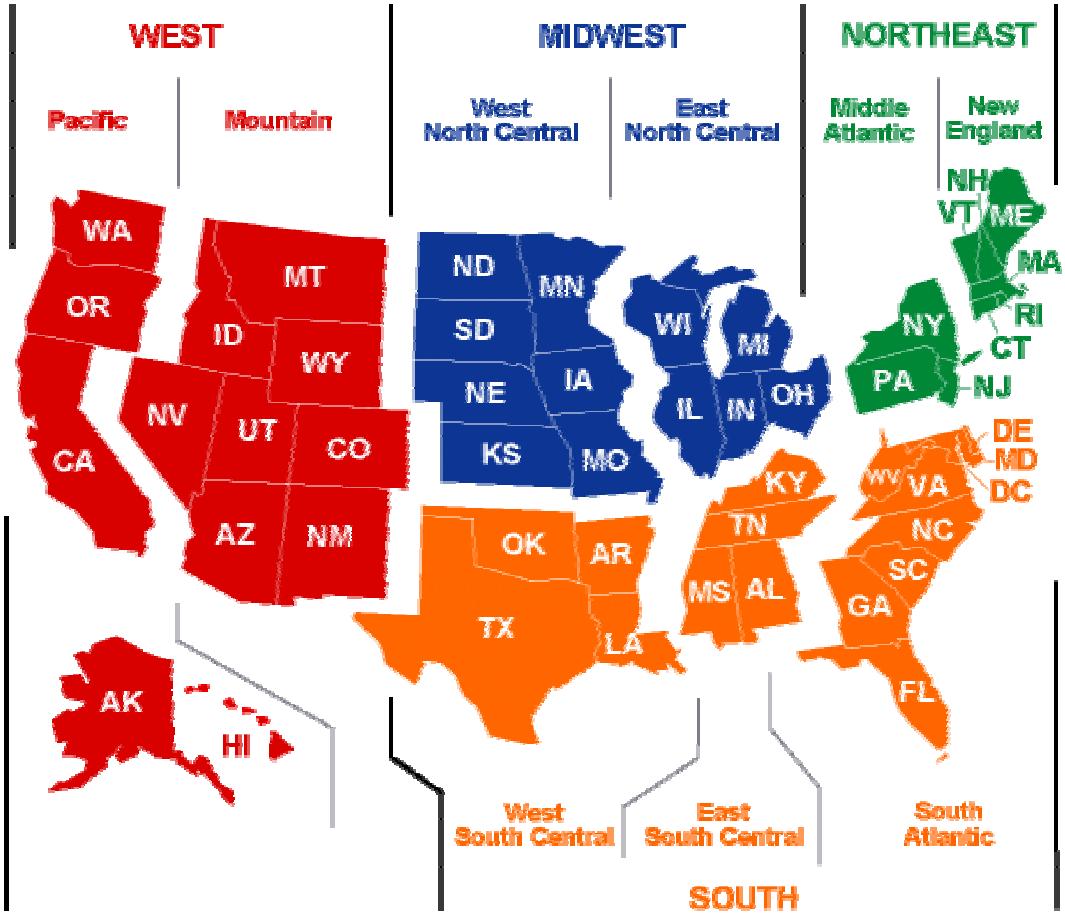
Table 2-1 shows a breakdown of total U.S. hospitals by Census Division. Figure 2-1 shows states in the Census Division and Regions. Figure 2-2 shows the percentage of hospitals by Census Division. Figure 2-3 shows how the surveyed hospitals compare with the national distribution of hospitals.

Table 2-1: Total Hospitals by Census Divisions

Census Division	National Count	Percent of Total
East North Central	761	15
East South Central	432	9
Middle Atlantic	504	10
Mountain	353	7
New England	206	4
Pacific	609	12
South Atlantic	751	15
West North Central	699	14
West South Central	702	14

Source: *Federal Register*, July 31, 1998 edition (Table 4, pp. 41116–17).

Figure 2-1: Census Divisions and Regions



Source: Energy Information Administration, U.S. Department of Energy, June 14, 2000
http://www.eia.doe.gov/emeu/reps/maps/us_census.html

Figure 2-2: Percentage of Hospitals by Census Division

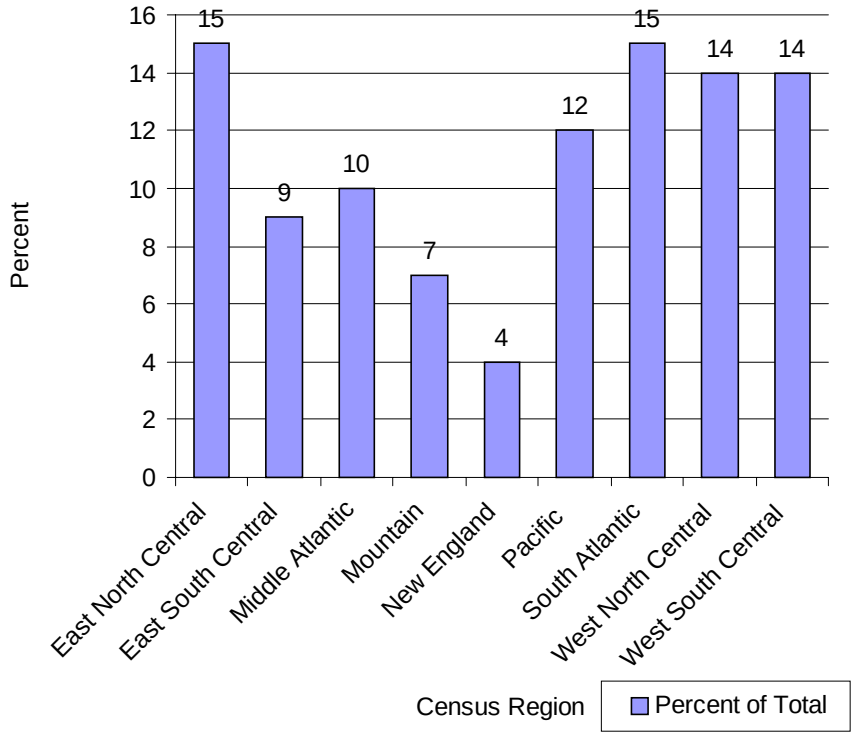
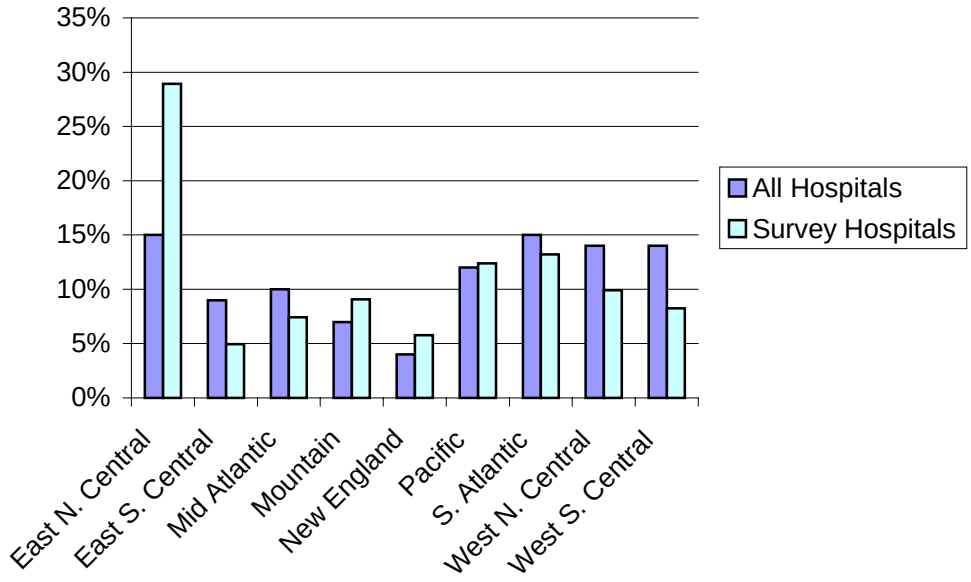


Figure 2-3: All Versus Surveyed Hospitals by Census Division



In general survey respondents reflected the national distribution except for a greater representation in the East North Central region.

Hospital Ownership

Hospital ownership and control generally falls into three categories as defined by the AHA Annual Survey of Hospitals and as used by the EPA for ENERGY STAR benchmarking. These types of hospitals tend to have different missions and different responses to government regulations and policies. Hospital ownership categories are as follow:

- **Non-Profit**—Hospitals that are operated by a church or other non-profit organization
- **For-Profit**—Hospitals that are operated for profit by individuals, partnerships, or organizations
- **Governmental**—Hospitals that are operated by the federal government

Classification of Hospitals

Hospitals are generally classified by type of service, ownership, size in terms of number of beds, and length of stay.

During the data collection phase of the HEP study, the EPA ENERGY STAR benchmarking tool required that at least 50 percent of a hospital's floor area consist of the primary space uses associated with acute care or children's hospitals only. Since only acute care and children's hospitals could be benchmarked, these types of facilities only were eligible to participate in the HEP study. These are facilities that typically provide a variety of services within the same building or among multiple buildings on a campus, including:

- Emergency medical care
- Physician's office services
- Diagnostic care
- Ambulatory care
- Surgical care

Hospital Size

Hospital size can be defined by the number of licensed care beds and the total floor area as follows:

Number of licensed beds—The number of licensed care beds, which are defined as beds that are set up and staffed for use by inpatients and licensed by a state or local government agency. The AHA licensed bed count is the average number of beds, cribs, and pediatric bassinets for use by inpatients during a reporting period.

Total floor area—The total floor space from all buildings within a campus.

For multiple-building hospitals (campuses), the sum of the square footage and energy usage of all buildings were included in the ENERGY STAR benchmarking tool.

Operating Expenses and Profit Margins

Hospital profit margins have steadily declined since 1998 due to increased operating expenses that cannot be offset by the industry because of constraints related to set reimbursement rates. Table 2-2 summarizes projected average hospital profit margins by census division through the year 2003.

Table 2-2: Projected Average Hospital Profit Margins

Census Division	1998	2000	2003
Nationwide	6.5%	5.5%	5.2%
New England	4.2%	2.7%	2.4%
Mid-Atlantic	4.2%	4.0%	2.3%
South-Atlantic	7.5%	6.0%	5.1%
East North Central	6.4%	5.4%	5.0%
East South Central	7.2%	6.6%	6.3%
West North Central	6.0%	5.3%	6.1%
West South Central	8.2%	7.0%	6.7%
Mountain	7.0%	5.5%	5.9%
Pacific	5.8%	5.0%	4.3%

Source: *U.S. Hospitals and the Future of Health Care*, seventh edition, Deloitte & Touche, 1998.

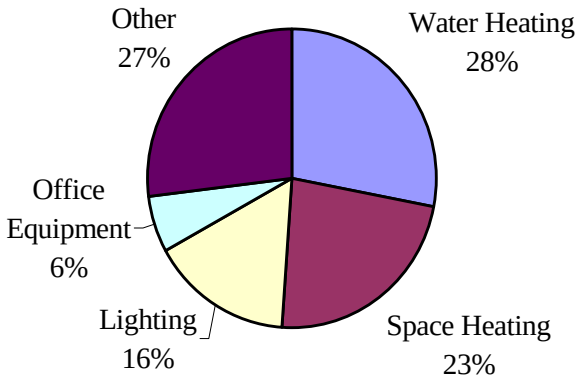
3 ENERGY USE IN THE HEALTHCARE INDUSTRY

Energy is a critical element essential to the delivery of quality healthcare services. According to the EPA, healthcare organizations spend over $6 billion on energy each year to meet patient needs. The upsurge in the use of technology in healthcare has increased energy demand within hospitals. At the same time, energy costs have been on the rise, due to increased demand, aging energy infrastructure, and deregulation of energy markets.

Typical Energy Use for Hospitals

In a typical hospital, water heating, space heating, and lighting account for 61–79 percent of total energy use, depending on the climate relative to the number of cooling- and heating-degree days. Figure 3-1 shows the estimated annual energy consumption of all U.S. healthcare buildings, including inpatient and outpatient facilities and nursing homes.

Figure 3-1: Estimated Annual Energy Use in Healthcare Buildings



Source: Energy Information Administration, U.S. Department of Energy, July 1998.

Table 3-1 lists average energy usage data for healthcare buildings as established by the Commercial Buildings Energy Consumption Survey released in 1998 by the U.S. Department of Energy, Energy Information Administration.

Table 3-1: Average Annual Energy Usage of Healthcare Buildings

End Energy Use	Consumption (Total Btu)
Space Heating	153.98
Space Cooling	29.98
Ventilation	18.18
Water Heating	189.64
Lighting	107.42
Cooking	34.56
Office Equipment	39.06
Refrigeration	13.09
Miscellaneous	86.98
Total	**672.89**

Source: Energy Information Administration, U.S. Department of Energy, July 1998.

Strategies for Energy Cost Controls

Energy is a significant factor in the growing percentage of healthcare operating costs, which are increasing at a rate that cannot be offset by increases in reimbursement rates. In order to survive, healthcare facilities must aggressively control costs. Strategies for energy cost controls have led to a trend of dealing with energy supply costs, reliability, and quality as managed risks.

Approaches to handling ever-increasing energy requirements can include:

Demand-side management—A management approach that involves ways to reduce the need for energy.

Supply-side management—A management approach that seeks the most cost-effective ways to procure and distribute the needed energy supply.

Other considerations for energy use in the healthcare industry include:

- Power Sources
- Deregulation
- Outsourcing Energy Management

Demand-Side Management

The key in demand-side management is conservation through system-wide energy conservation programs. These types of programs identify cost-effective procedures that reduce energy consumption and develop systematic programs of energy system efficiency improvements.

Healthcare facilities examine and analyze energy use to determine where it could be possible to cut back. When planning new construction, the most energy-efficient systems are considered. Older buildings are targeted for energy use reductions including:

- Modification of light fixtures
- Alteration of heating and cooling systems from constant volume to variable drive applications
- Addition or upgrade of process instrumentation
- Changeover of equipment
- Controls improvements

Supply-Side Management

Supply-side management focuses on cost-effectiveness in the procurement and distribution of energy. Supply-side management typically includes:

- Load profiling or understanding existing loads
- Load aggregation, which combines the loads of multiple buildings, campuses, or companies
- On-site generation alternatives such as cogeneration
- New procurement strategies such as purchasing energy from suppliers other than the local utility company
- Electrical system upgrades to remove old, inefficient equipment
- Peak shaving opportunities where alternate energy sources are used to reduce the maximum amount of energy used and the demand charges on invoices

Power Sources

Healthcare facilities must be designed to ensure that secure sources of power are available at all times. Regulations mandate emergency power supplies to ensure that critical functions will remain operational during power interruptions. Hospitals typically employ several approaches to meeting this requirement including:

- Diesel-fueled emergency generators
- Electricity distribution systems
- Diversified power sources

Diesel-Fueled Emergency Generators

Diesel-fueled emergency generators are frequently installed on site to maintain the power supply during an outage. Drawbacks include air quality issues related to burning diesel fuel, and the time constraints defined by the amount of fuel available to keep these generators operating.

Distribution Systems

Distribution systems employ two separate utility feeds into the facility so that one automatically takes over the power feed if the other one goes out of service. Local utility companies determine the availability of a second service. Each utility feed should be isolated to a separate sub-station for improved reliability.

Diversified Power Sources

An example of diversified power sources is using natural gas to generate electricity on site. Cogeneration, or using the waste energy from the generation process to supplement or take over load requirements also falls under this category. Diversified power sources often make good sense economically since the facility does not have to pay for the energy that would have been required to address load requirements, which significantly reduces operating costs.

On-site generation and cogeneration enable hospital facilities to maintain greater control of energy supplies and can provide revenue opportunities if excess power is generated that can be sold back to the grid.

Deregulation

Deregulation has split energy companies into generation, transmission and distribution, and services. Transmission and distribution is still regulated, while generation and services are deregulated in many states. Service providers might be independents or spin-offs of an existing energy utility. Energy Service Companies (ESCOs) from other territories can now enter an existing utility's area and offer services. The deregulated electricity market enables healthcare facilities to select services from a wide range of energy suppliers. Facilities can hold competitive bidding for energy supply contracts, which can cut costs by as much as five percent.

Another alternative is to establish long-term supply contracts with energy service providers (ESPs), which function as energy brokers by operating power plants on their own and/or accessing groups of other generators. As brokers for a large number of customers, ESPs have leverage to negotiate for better prices. ESP power supply contracts secure certain amounts of energy at fixed rates over specific periods of time, which guarantees savings.

Outsourcing Energy Management

An increasing number of hospitals today outsource energy management and procurement. Outsourcing means that energy issues are handled by organizations that specialize in energy management. While outsourcing operations, a facility can sell any normal power generating capability, boiler capacity, chilled water capacity, emergency power generating capacity, and other generated power sources to a facilities management company that takes over operations and sells the power back to the facility.

Another outsourcing alternative is to contract with a firm that funds conservation measures and new generating capacity needed for expansion. The hospital can have a power plant designed, built, and operated by a third-party company and then can directly purchase the power generated.

4 HEALTHCARE ENERGY PROJECT SURVEY RESULTS

This chapter summarizes the results derived from the HEP Survey Instrument and EPA ENERGY STAR benchmarking tool. Data Analysis and conclusions are also provided. Chapter 5 and the appendices provide additional detail:

- Chapter 5 contains the best practices found to be used by top-performing hospitals
- Appendix A contains a compilation of the numerical data collected using the HEP survey
- Appendix B contains a copy of the survey tool completed by HEP participants
- Appendix C contains a copy of the energy use spreadsheet for benchmarking completed by HEP participants
- Appendix D contains the glossary
- Appendix E is the same as Appendix A except results are highlighted and comments are added
- Appendix F contains qualitative data such as responses to open-ended questions and respondent answers to the "Other" option
- Appendix G contains the same data but broken out by region
- Appendix H discusses the statistical significance of selected findings

Graphs

Most graphs display data of those whose benchmarking scores were in the top quartile (top performers), all responses, and those whose benchmarking scores were in the bottom quartile (bottom performers). Note that because responses were reported as a percentage of the total number of responses

- When participants provided more than one response (such as for types of fuel used), the percentages total more than 100 percent.
- When not all participants provided a response (such as for use of energy performing contracts), the percentages total less than 100 percent.

At times the answer "None" was eliminated and the remaining responses tallied so that the total number using various technologies or procedures could be determined. Any differences between top and bottom performers could also be more clearly identified.

Method of Data Analysis

Data was collected from most respondents using a Word survey form that was then imported into an Excel spreadsheet. Data was summarized and results compared.

One of the primary purposes of this study was to determine how participants who had benchmarking scores in the top quartile differed from those in the bottom quartile and all participants. Therefore, charts were used that compared the three groups.

All survey data was self-reported, so there was great variation in how the respondents interpreted and answered questions. However, enough data was collected to give a picture of how healthcare facilities use energy and what practices are more common among top performers than bottom performers.

It is important to note that this guidebook contains data as close to the original submissions as possible. Little editing was done so that experienced healthcare engineers can study the data and select the information that applies to their situation and that affects their decision making.

Benchmarking Performance

Participants in the HEP study had two options for establishing benchmarking scores:

1. Provide a current ENERGY STAR benchmarking score by entering energy use information online and then printing and forwarding the established benchmarking score by FAX.
2. Complete an Excel spreadsheet with all necessary energy use and related information and return it to the HEP staff for downloading online to establish a benchmarking score.

In either case, it is important to note that benchmarking scores are impacted by

- Accuracy of energy consumption readings
- Inclusion of (or failure to include) all energy use
- Accuracy of the data provided regarding hospital characteristics
- Provision of enough energy use data to establish a benchmarking score that is normalized for weather

The ENERGY STAR benchmarking tool provides no means for verifying the accuracy and validity of the data entered, unless the facility that is benchmarking is seeking the ENERGY STAR label, which requires a Statement of Energy Performance approved by a licensed professional engineer.

HEP survey participants had benchmarking scores that ranged from 2 to 100 with an average benchmarking score of 55. Based on the range of scores, the following performance quartiles were established:

Quartile	Range
Top	78–100
Second	56–77
Third	34–54
Bottom	2–33
All	2–100

Results

This is a preliminary study, so further analysis will undoubtedly find nuances and conclusions not presented here. However, looking at the overall picture, the present data reveals the differences between top and bottom performers.

Top performers

- Take energy conservation seriously by performing a greater number of energy conservation measures such as utilizing more types of lighting fixtures and implementing a greater number of O&M procedures.
- Prefer being self-reliant rather than relying on consultants or outsourcing engineering functions. However, they do prefer to outsource laundry.
- Focus on fundamentals such as daily monitoring of water and electrical usage, lighting, and caulking.

Bottom performers

- Depend more on the advice of consultants and are more willing to outsource engineering functions. Perhaps these facilities perform poorly on efficient energy usage because they lack the expertise to adequately perform energy management tasks themselves.
- Focus more on supply-side management rather than energy conservation.

The survey questions and results follow. The numbers listed in parentheses by each question correspond to the comprehensive survey question numbers as shown on the copy of the survey tool located in Appendix B.

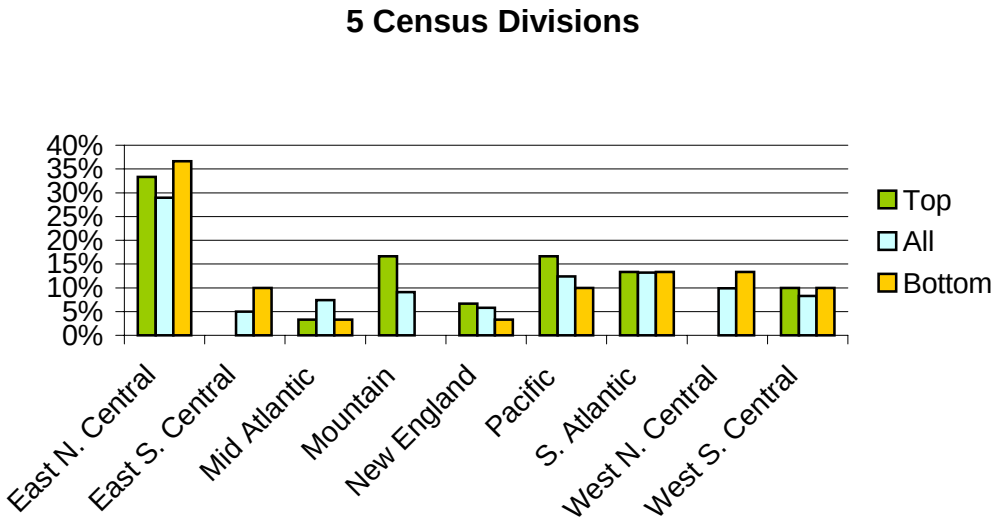
Census Division (5)

Table 4-1 and Figure 4-1 provide a breakdown of the representation of the census divisions of the survey participants.

Table 4-1: Percent of HEP Survey Participants by Census Division

Census Division	Percent of Survey Participants
East North Central (Illinois, Indiana, Michigan, Ohio, Wisconsin)	28.9%
East South Central (Alabama, Kentucky, Mississippi, Tennessee)	5.0%
Mid Atlantic (New York, New Jersey, Pennsylvania)	7.4%
Mountain (Arizona, Colorado, Idaho, Montana, New Mexico, Nevada, Wyoming)	9.1%
New England (Connecticut, Massachusetts, Maine, New Hampshire, Rhode Island, Vermont)	5.8%
Pacific (Alaska, California, Hawaii, Oregon, Washington)	12.4%
South Atlantic (Delaware, Washington, D.C., Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, West Virginia)	13.2%
West North Central (Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, South Dakota)	9.9%
West South Central (Arkansas, Louisiana, Oklahoma, Texas)	8.3%

Figure 4-1: Distribution of Survey Participants by Census Division



*Note: The "5" refers to Question 5 in the Comprehensive survey.

The data was combined into Census Regions (Table 4-2, Figure 4-2, and Figure 4-3) for statistical analysis. Then the facilities with benchmarking scores in the top quartile were compared to those in the bottom quartile and to all respondents to determine what characteristics differentiated the top quartile from the bottom quartile.

A simple and straightforward analysis was performed laying the groundwork for additional studies.

Table 4-2: Percent of HEP Survey Participants by Census Region

Census Regions	Percent of Survey Participants
NORTHEAST: Mid Atlantic (New York, New Jersey, Pennsylvania) and **New England** (Connecticut, Massachusetts, Maine, New Hampshire, Rhode Island, Vermont)	13.2%
MIDWEST: East North Central (Illinois, Indiana, Michigan, Ohio, Wisconsin) and **West North Central** (Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, South Dakota)	38.8%
SOUTH: East South Central (Alabama, Kentucky, Mississippi, Tennessee), **South Atlantic** (Delaware, Washington, D.C., Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, West Virginia), and **West South Central** (Arkansas, Louisiana, Oklahoma, Texas)	25.6%
WEST: Mountain (Arizona, Colorado, Idaho, Montana, New Mexico, Nevada, Wyoming) and **Pacific** (Alaska, California, Hawaii, Oregon, Washington)	22.3%

Figure 4-2: Census Region Representation

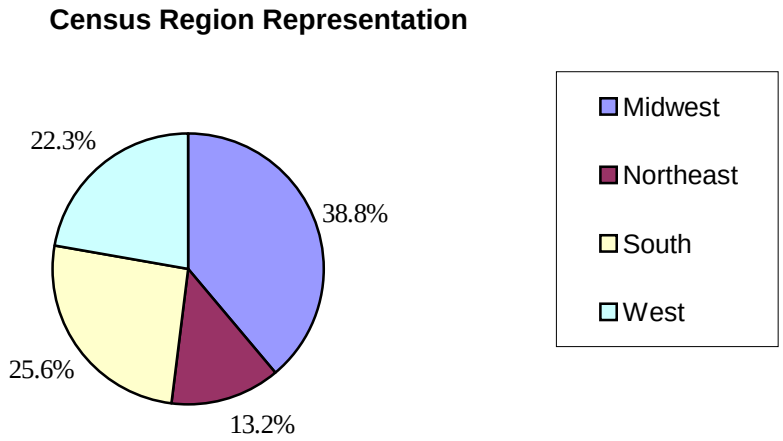
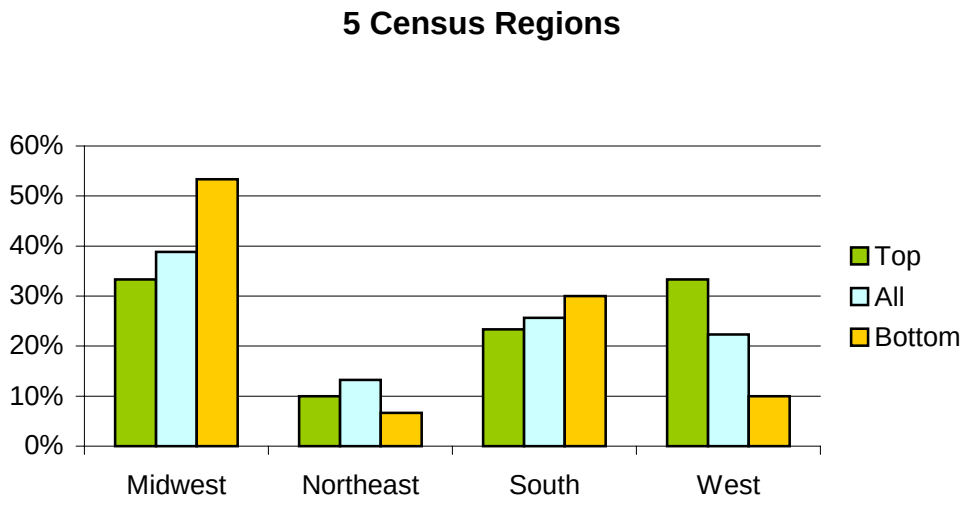


Figure 4-3: Representation of Census Regions of Survey Participants



The West and Midwest census regions had the highest percentage of high performers while the Midwest and South had the highest percentage of low performers.

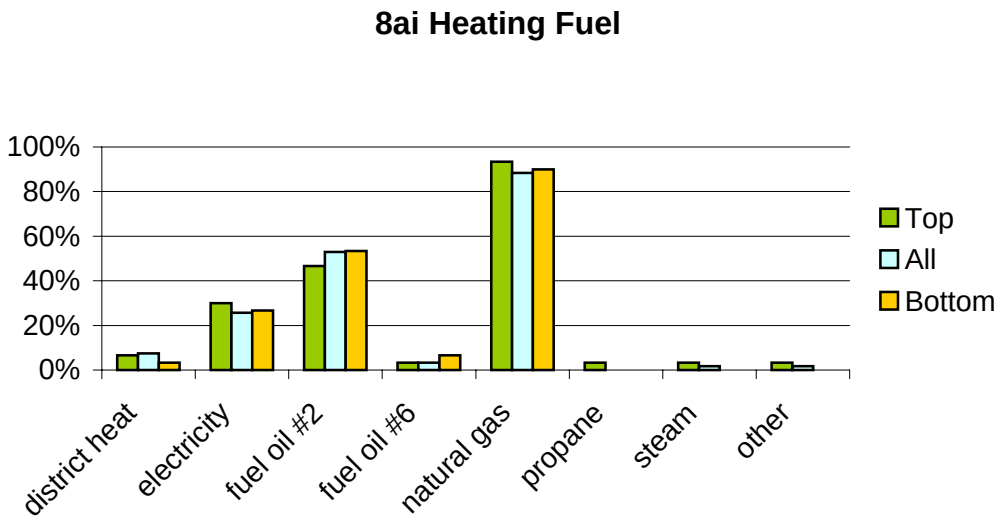
Annual Adjusted Patient Days (6)

The annual adjusted patient days reported ranged from 450 to 660,626. The average adjusted patient days for all survey participants is 86,835 while top performers averaged 77,929 and the bottom quartile averaged 83,986. From the data reported it seems that top performers had slightly fewer patient days but many respondents had trouble obtaining this data.

Heating Fuels (8ai)

Natural gas is by far the most commonly used fuel for heating, followed by number 2 fuel oil and electricity. Figure 4-4 illustrates the breakdown of heating fuels used by survey participants.

Figure 4-4: Heating Fuels Used by Survey Participants

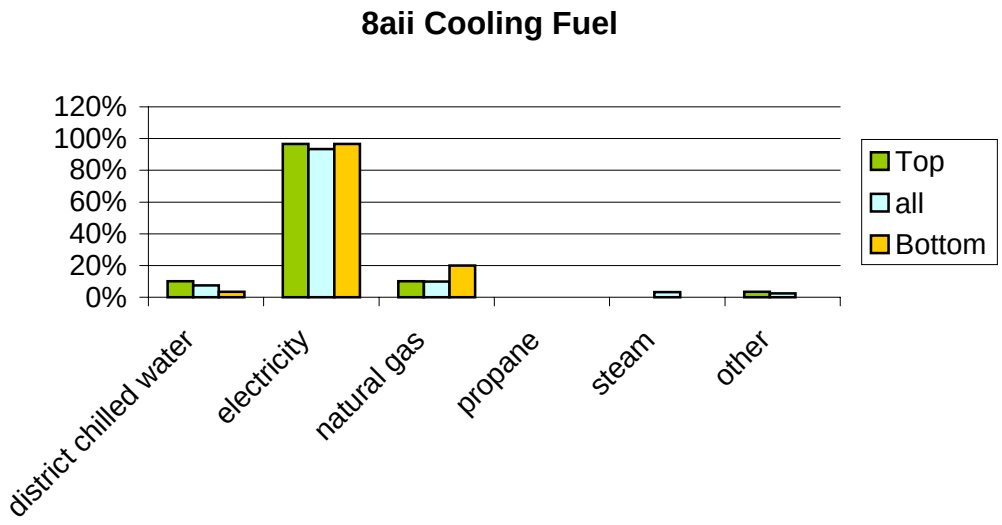


The use of number 2 fuel oil was more common among the bottom performers than the top performers or all respondents. No other significant differences were apparent.

Cooling Fuels (8ii)

Electricity is by far the most commonly used fuel for cooling, followed by natural gas and district chilled water. No survey participants used propane. Figure 4-5 illustrates the breakdown of cooling fuels used by survey participants.

Figure 4-5: Cooling Fuels Used by Survey Participants

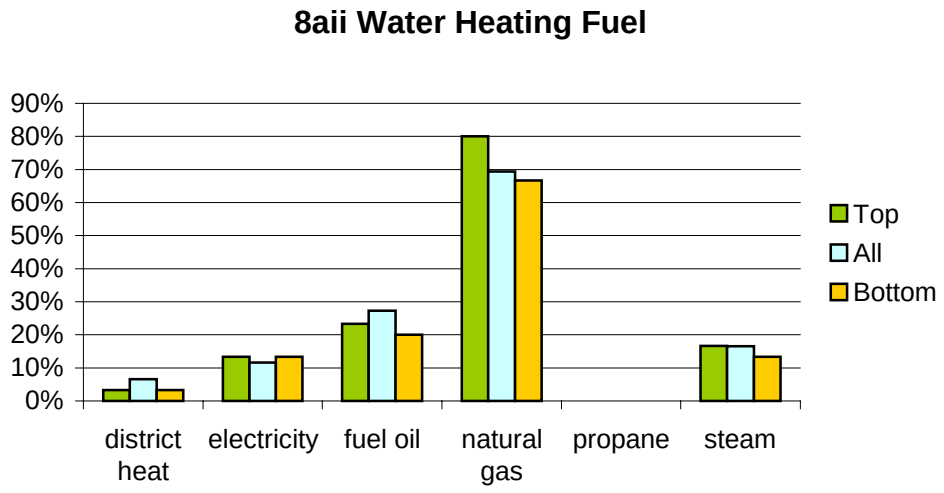


No significant differences between groups were apparent.

Water Heating Fuels (8aiii)

Natural gas is the most commonly used fuel for water heating, followed by fuel oil and steam. Figure 4-6 illustrates the breakdown of water heating fuels used by survey participants.

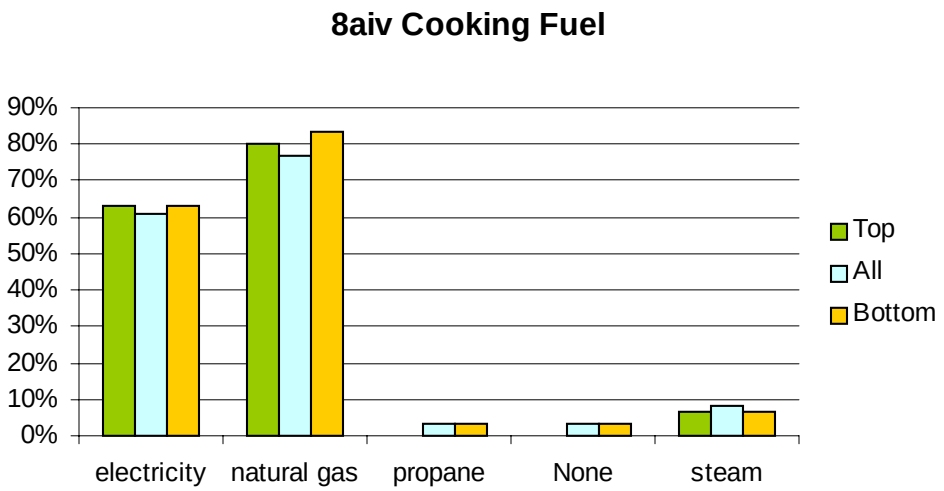
Figure 4-6: Water Heating Fuels Used by Survey Participants



Cooking Fuels (8aiv)

Natural gas is the most commonly used fuel for cooking, followed by electricity and steam. Figure 4-7 illustrates the breakdown of cooking fuels used by survey participants.

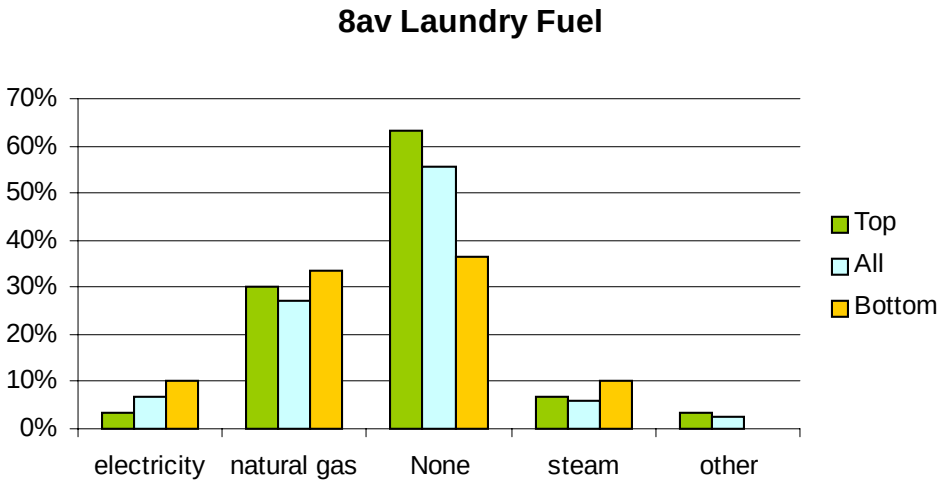
Figure 4-7: Cooking Fuels Used by Survey Participants



Laundry Fuels (8av)

Most survey participants did not have laundries, especially ones with high benchmarking scores. Natural gas is the most commonly used fuel for laundry drying and any additional water heating, followed by steam and electricity. Figure 4-8 illustrates the breakdown of laundry fuels used by survey participants.

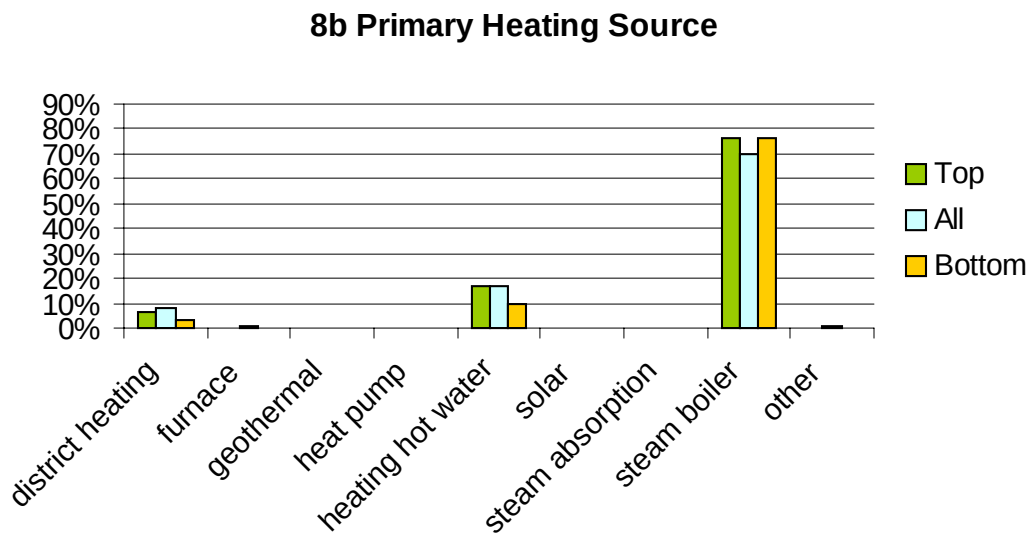
Figure 4-8: Laundry Fuels Used by Survey Participants



Primary Heating Source (8b)

Steam boilers are most often used as a primary heating source, followed by heating hot water and district heating. Figure 4-9 illustrates the breakdown of primary heating source use by survey participants.

Figure 4-9: Primary Heating Sources Used by Survey Participants



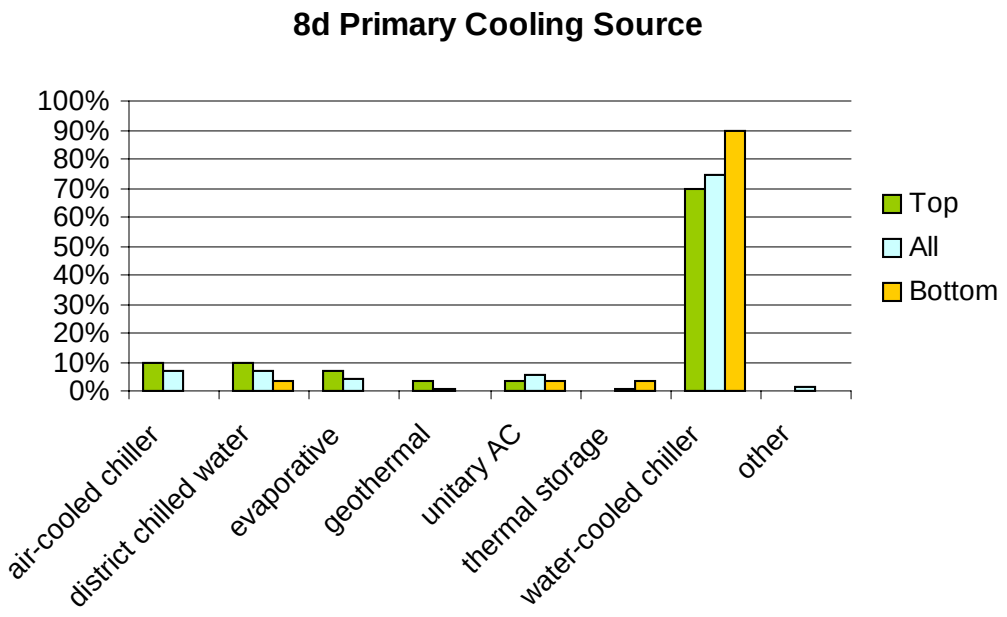
Size of Heating Source (8c)

Respondents used a variety of notations to express the size of their heating source so the values were not combined. See Appendix F for the responses to this question.

Primary Cooling Source (8d)

Water-cooled chillers are most often used as primary cooling sources, followed by district chilled water and air-cooled chillers. Figure 4-10 illustrates the breakdown of primary cooling sources used by survey participants.

Figure 4-10: Primary Cooling Sources Used by Survey Participants



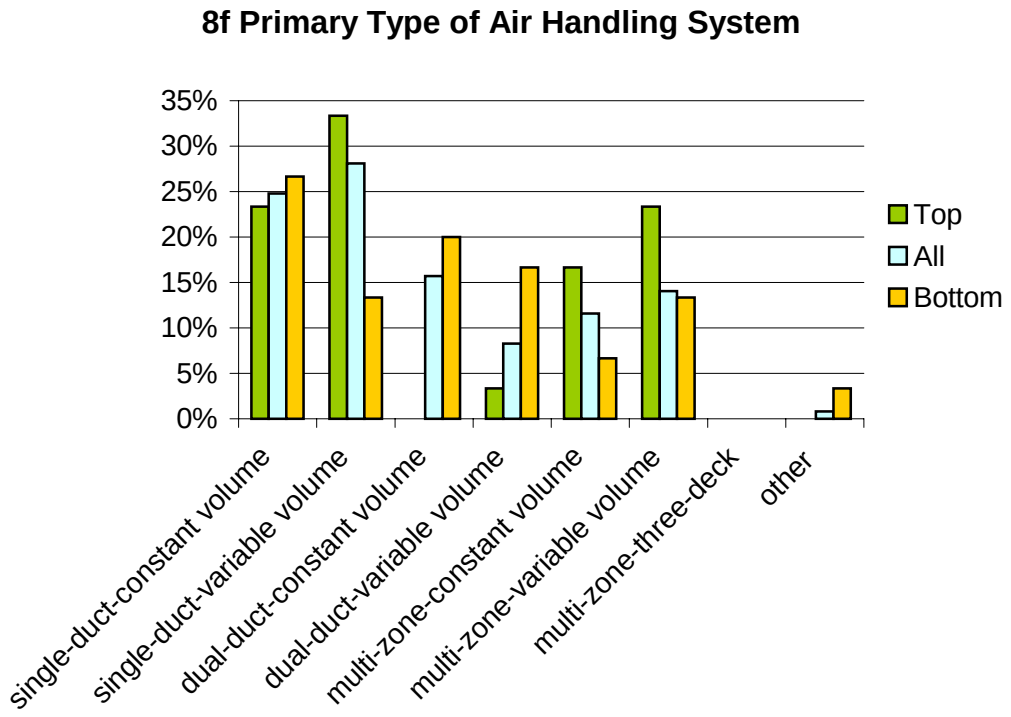
Capacity of Cooling Source (8e)

The average cooling source capacity is 4,575.5 tons. Top performers averaged 2,171.8 tons while bottom performers averaged 2,623.9 tons.

Primary Air Handling System (8f)

Single-duct variable volume air handling systems are most often used, especially by top performers. Also in common use were single-duct-constant volume systems, which were the most popular among bottom performers. Figure 4-11 illustrates the breakdown of primary air handling systems used by survey participants.

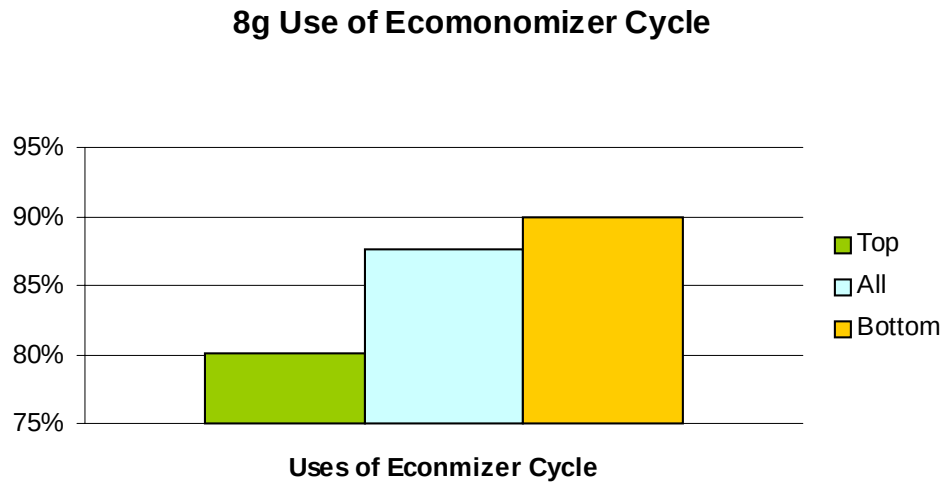
Figure 4-11: Primary Air Handling Systems Used by Survey Participants



Use of Economizer Cycle (8g)

Most facilities use economizer cycles but they are most popular with bottom performers. Figure 4-12 illustrates the use of economizer cycles.

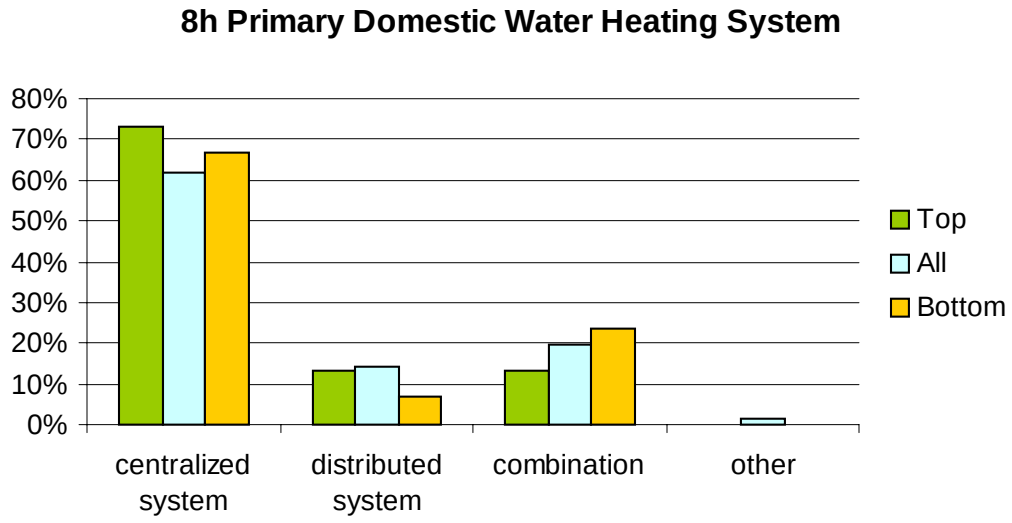
Figure 4-12: Use of Economizer Cycles



Primary Domestic Water Heating System (8h)

Centralized domestic water heating systems are most often used, followed by combinations and distributed systems. Figure 4-13 illustrates the breakdown of primary domestic water heating systems used by survey participants.

Figure 4-13: Primary Domestic Water Heating Systems Used by Survey Participants



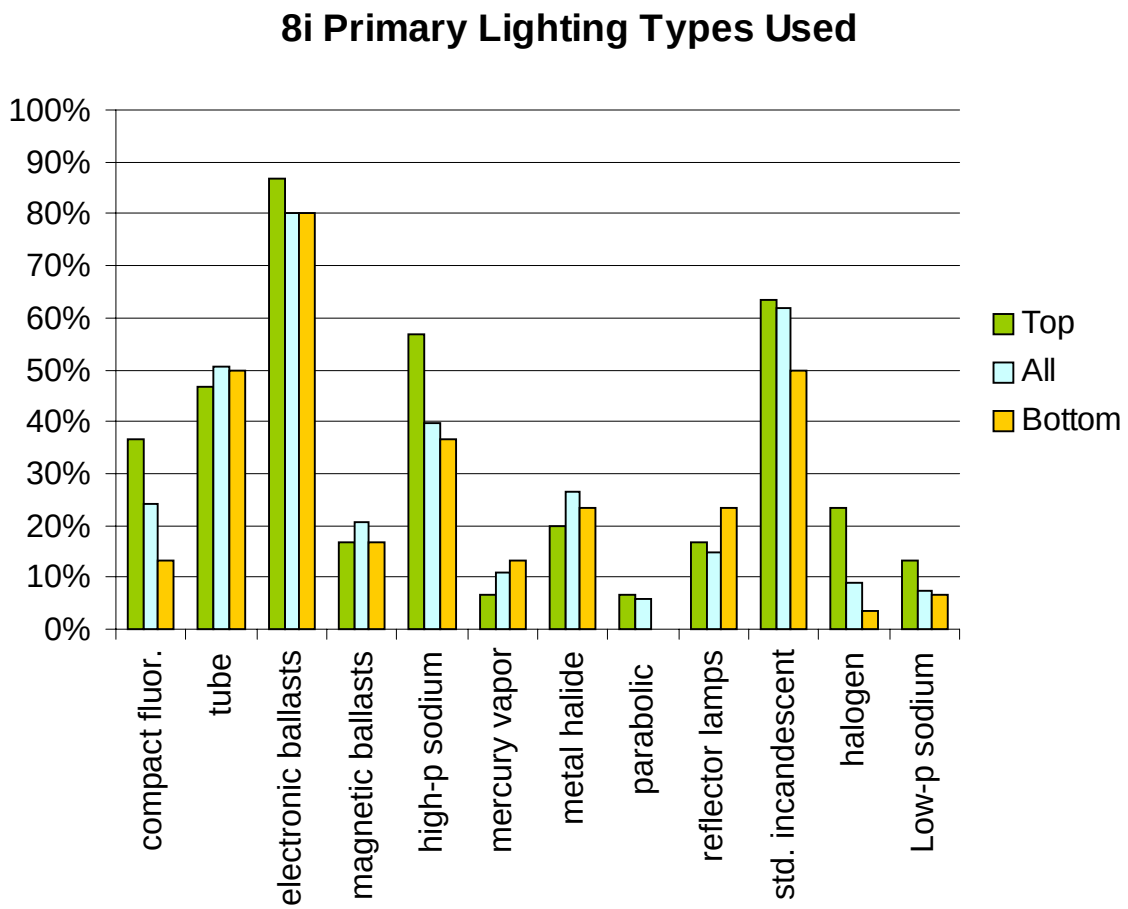
Primary Lighting Types (8i)

Electronic ballast fluorescent lights are used most often for primary lighting (> 10 percent), followed by standard incandescent, fluorescent tube, and high-pressure sodium. In general, top performers used more different types of lighting and favored:

- Compact fluorescent
- Electronic ballasts
- Mercury vapor
- Parabolic aluminized reflectors
- Reflector lamps
- Standard incandescent
- Halogen
- Low-pressure sodium

Halogen lights especially were found in 23 percent of the high-performing facilities but only 3 percent of the bottom performing facilities. Likewise bottom performers favored mercury vapor lights twice as often as did high performers. Figure 4-14 illustrates the breakdown of primary lighting types used by survey participants.

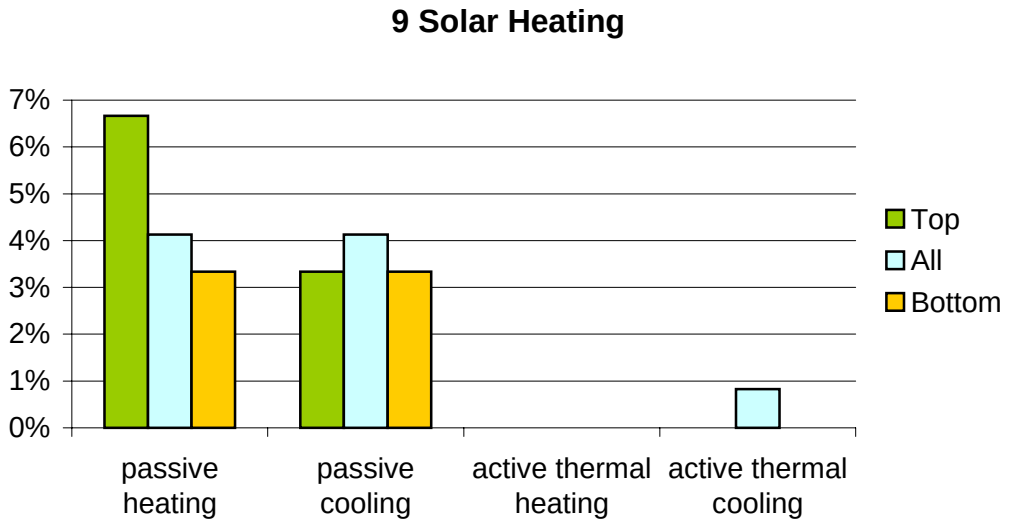
Figure 4-14: Primary Lighting Types Used by Survey Participants



Solar Energy (9)

Passive solar heating is used most often at high performing facilities, but only 10 percent of all facilities use solar energy. No one reported using ventilation pre-heating or active thermal heating. Solar energy use is categorized in Figure 4-15.

Figure 4-15: Solar Energy Use by Survey Participants



Energy Service Companies and Energy Savings Performance Contracts (10,11)

An energy savings performance contract is an agreement between an energy services company (ESCO) and a building owner. The owner uses the energy cost savings to reimburse the ESCO and to pay off the loan that financed the energy conservation projects. Agreements with ESCOs are typically five- to seven-year agreements. The ESCO provides an array of services:

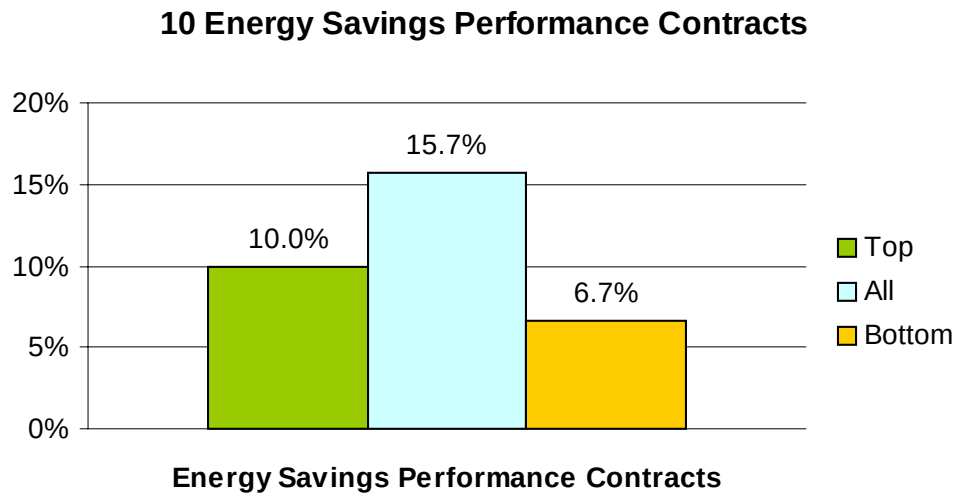
- Conducts a facility energy study
- Identifies cost-effective projects
- Designs all aspects of the selected projects
- Finances the project
- Hires subcontractors
- Manages the project installation

If an owner chooses, the ESCO:

- Guarantees savings
- Provides maintenance services

Energy savings performance contracts are in place at 16 percent of the facilities surveyed. Interestingly, they were most favored by average performers. Appendix F lists the descriptions provided for the energy savings performance contracts.
Figure 4-16 illustrates usage of these contracts by participants.

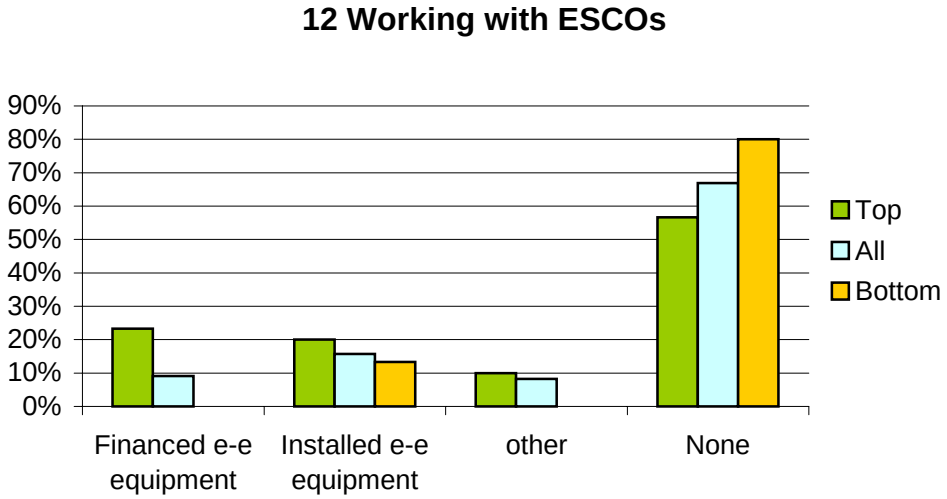
Figure 4-16: Energy Savings Performance Contracts



Working with Energy Service Companies (ESCOs)(12)

Top performers had significantly more involvement with ESCOs than did those that performed in the bottom quartile. Also they involved them with more activities, such as financing and installing energy efficient equipment and also for training, consulting, and auditing. Figure 4-17 illustrates how participants worked with ESCOs.

Figure 4-17: Working with ESCOs



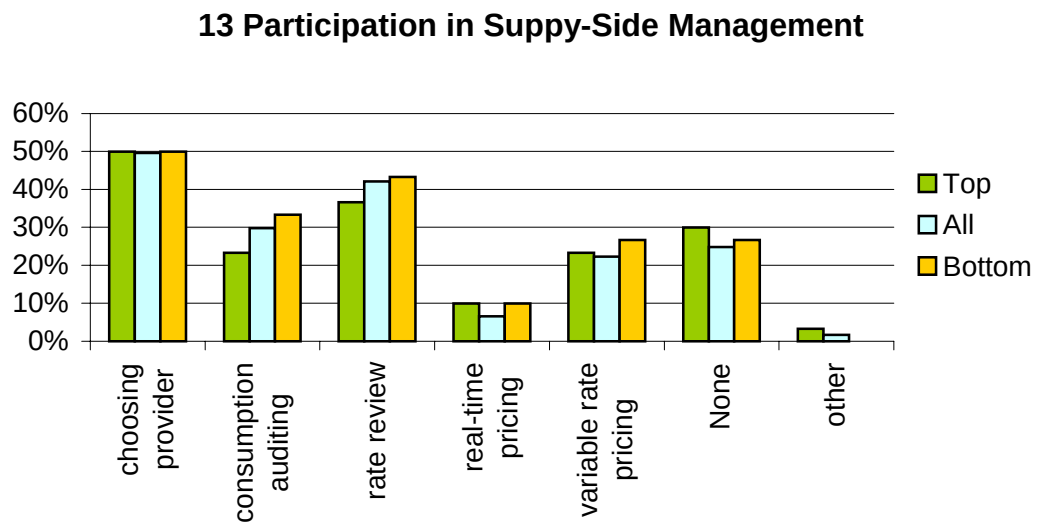
Supply-Side Management (13)

Supply-side management evaluates the cost of energy relative to the capacity required and the quality provided. This information is used to identify how much energy is required to eliminate shortages, determine the kind of energy that best meets demand, and select an appropriate supplier.

Participation in supply-side management proved to be less popular with top performers than bottom performers, especially when it came to consumption auditing, rate review, and variable rate pricing. Perhaps focusing on price reduced the focus on energy conservation. Pricing does not seem to reduce consumption. Facilities may pay less but use more.

The ways in which survey participants were involved in this type of energy management are as shown in Figure 4-18.

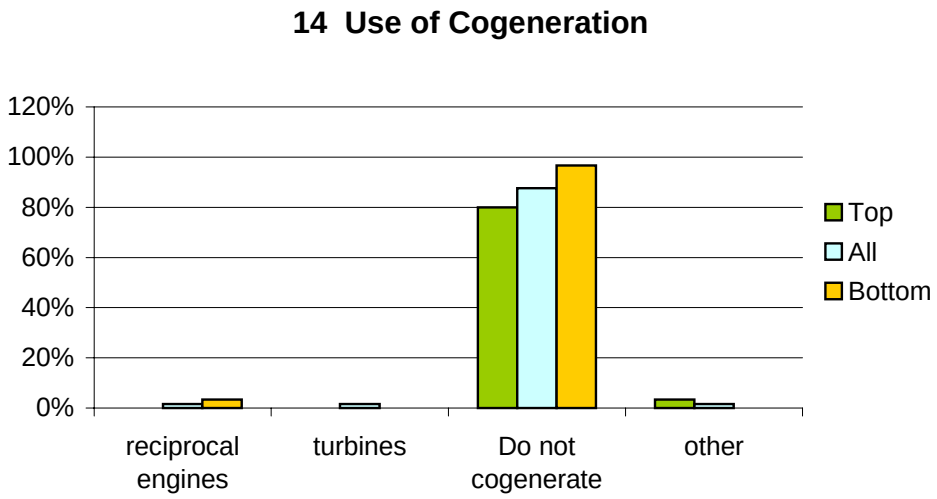
Figure 4-18: Supply-Side Management Used by Survey Participants



Cogeneration (14, 15, 16)

Cogeneration is used at fewer than 10 percent of the facilities participating in the survey. Only one of the top performers reported using cogeneration. Figure 4-18 shows the use of cogeneration among survey participants.

Figure 4-19: Use of Cogeneration



Of the people who cogenerate

- The waste heat is most frequently used to produce high-pressure steam (4 percent)
- Most continue to buy at least 75–95 percent of their energy.

Demand-Side Management (17)

Demand-side management involves reducing or more efficiently using energy in order to lower total consumption through conservation and energy efficiency, load management, cogeneration, and renewable energy technologies. About half of the hospitals surveyed have participated in demand-side management in the past five years. There was no significant difference between top and bottom performers.

Energy Management and Control System/ Building Automation System (18, 19)

An Energy Management Control System (EMCS) is an energy management feature that uses microcomputers, instrumentation, control equipment, and software to manage a building's use of energy for heating, ventilation, air conditioning, lighting, and/or business-related processes. These systems can also manage fire control, safety, and security. Not included as an EMCS feature are time-clock thermostats.

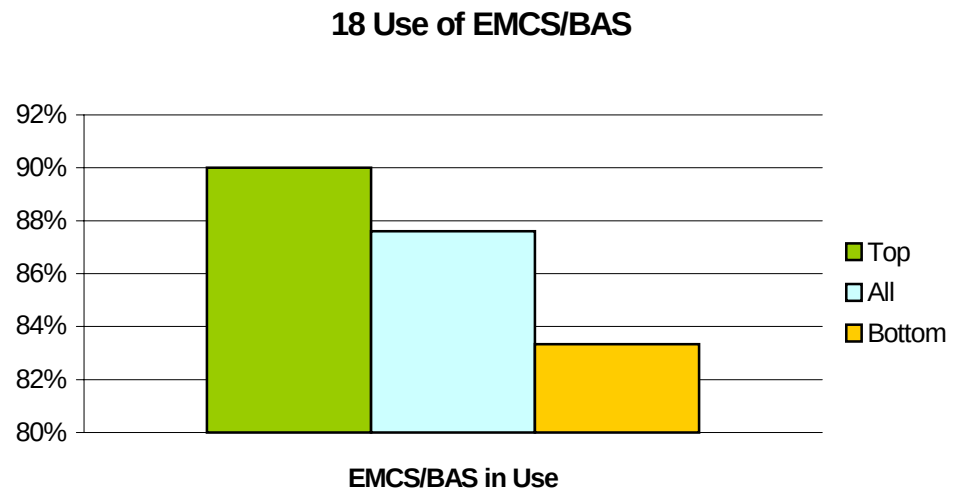
A Building Automation System (BAS) uses software and systems to monitor and control the functions of building equipment (such as HVAC and lighting systems).

The typical goals of a BAS include:

- Lowering the operating costs
- Providing more precise control
- Optimizing energy usage
- Increasing occupant comfort
- Providing more cost-effective overall facility management

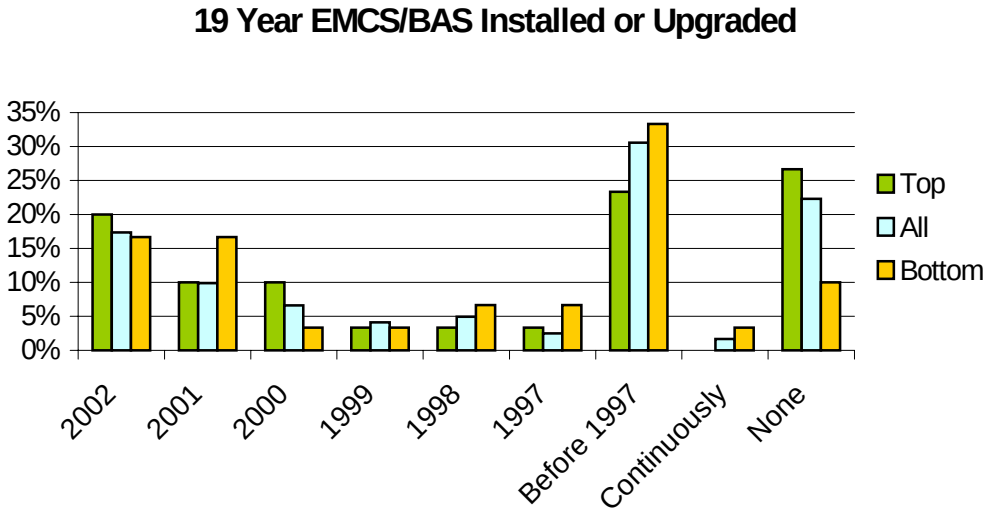
Of the hospitals surveyed, 88 percent are using EMCS/BAS, with a higher percentage of top performers using them than bottom performers. Figure 4-20 shows the usage of EMCS/BAS.

Figure 4-20: Use of EMCS/BAS



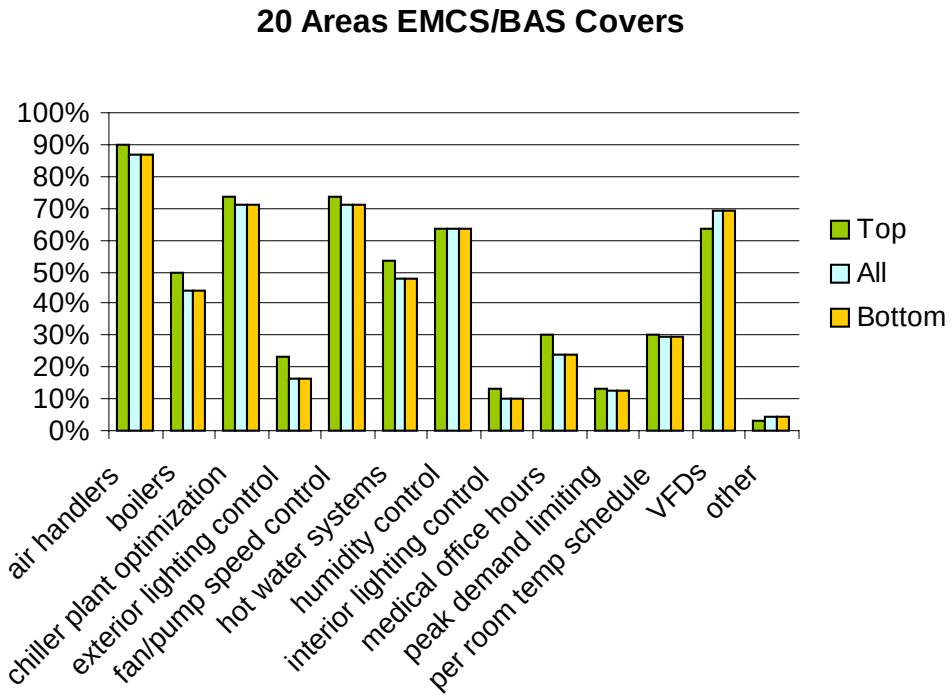
The systems were installed or upgraded as shown in Figure 4-21. Note that top performers tended to have more recent installations or upgrades.

Figure 4-21: Year EMCS/BAS Installed or Upgraded



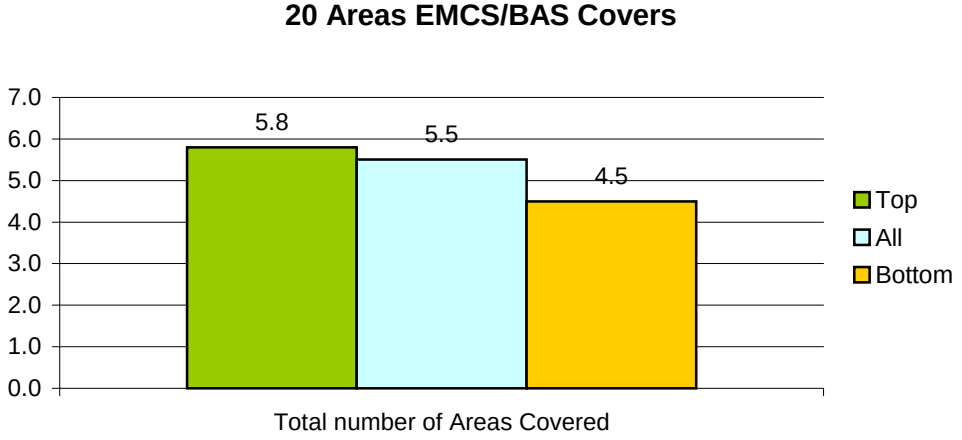
EMCS/BAS systems are most often used to control air handlers, chiller plants, and fan and pump speeds. A detailed breakdown of system uses is shown in Figure 4-22.

Figure 4-22: EMCS/BAS System Uses by Survey Participants



An interesting fact emerges when the total number of areas covered by EMCS/BAS systems are compared. Notice that the EMCS/BAS areas covered by top performers exceeds those of all respondents and bottom performers. Figure 4-23 shows the EMCS/BAS system areas covered by survey participants.

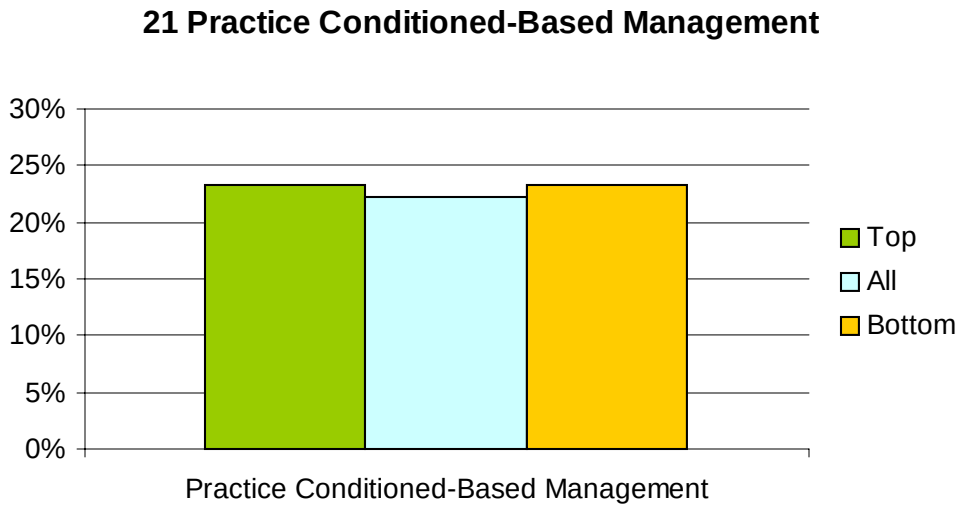
Figure 4-23: EMCS/BAS System Areas Covered by Survey Participants



Condition-Based Management (21)

Condition-based management involves monitoring equipment and operating conditions in real time and taking appropriate actions to achieve the desired results, such as energy efficiency, production level, or minimization of failure. About 22 percent of the hospitals surveyed participate in condition-based management, with no difference shown between top and bottom performers. A complete list of responses on how facilities use condition-based management is available in Appendix F. Survey participants that practice condition-based management are shown in Figure 4-24.

Figure 4-24: Survey Participants that Practice Condition-Based Management

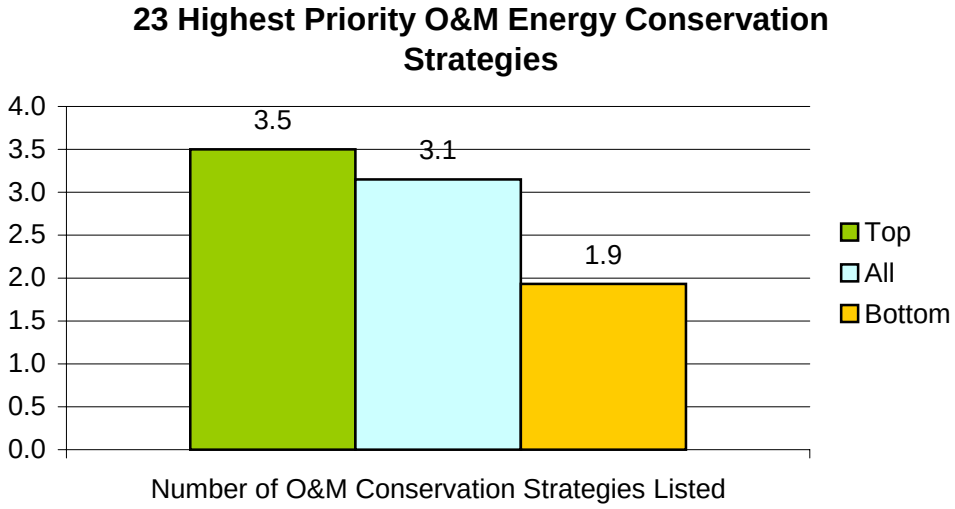


Operation and Maintenance Energy Conservation Strategies (23)

The highest-priority operation and maintenance (O&M) strategies implemented by survey respondents showed a wide variety of strategies, many of which were common among both top and bottom performers. What was striking was that the top performers responded with a great deal more strategies than the bottom performers as shown in Figure 4-25.

Chapter 5 discusses the responses to this question and includes a list of the top 100 O&M energy conservation strategies from top quartile performers. A complete list of responses on how facilities use condition-based management is available in Appendix F.

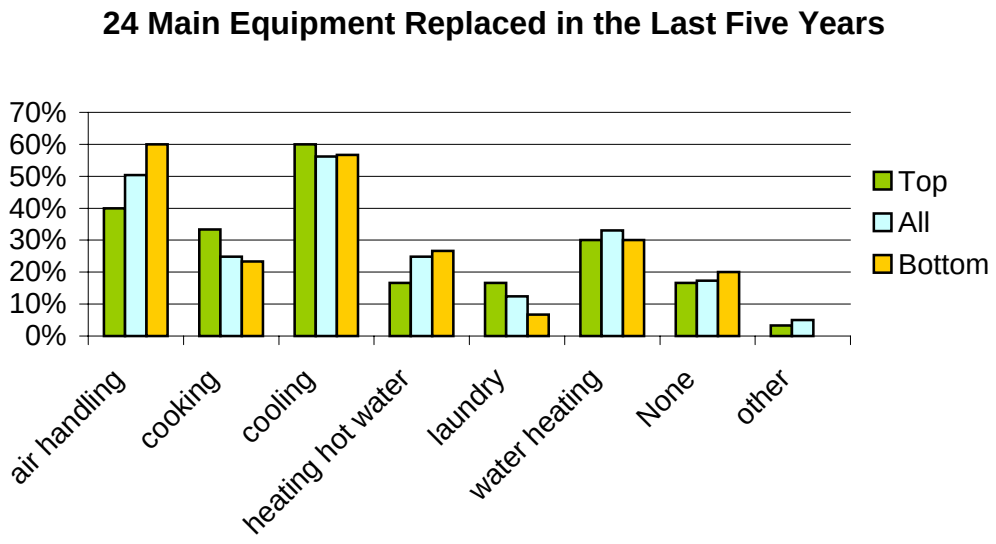
Figure 4-25: Number of Highest Priority O&M Energy Conservation Strategies



Equipment Replacement (24)

The percentage of hospitals surveyed that have replaced main equipment such as air handling, heating, and cooling equipment, in the last five years is shown in Figure 4-26.

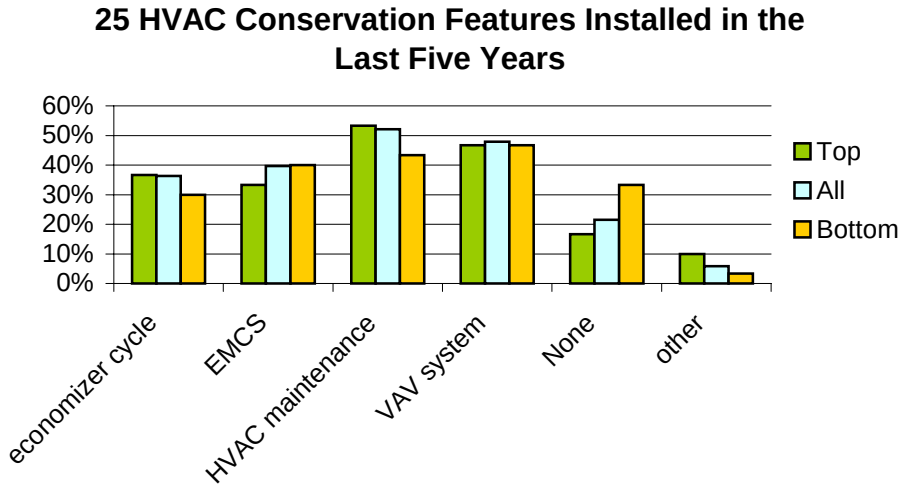
Figure 4-26: Main Equipment Replaced by Survey Participants in the Last Five Years



Conservation Features (25, 26, 27)

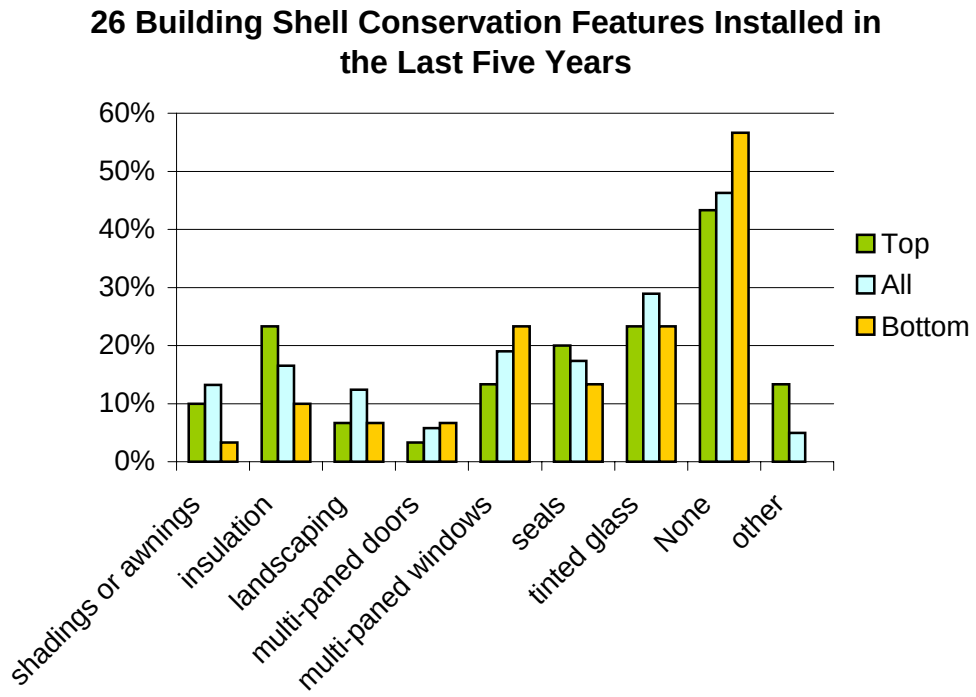
The percentage of hospitals that installed HVAC, building shell, and lighting conservation features within the last five years is shown in Figure 4-27 through Figure 4-29.

Figure 4-27: HVAC Conservation Features Installed by Survey Participants in the Last Five Years



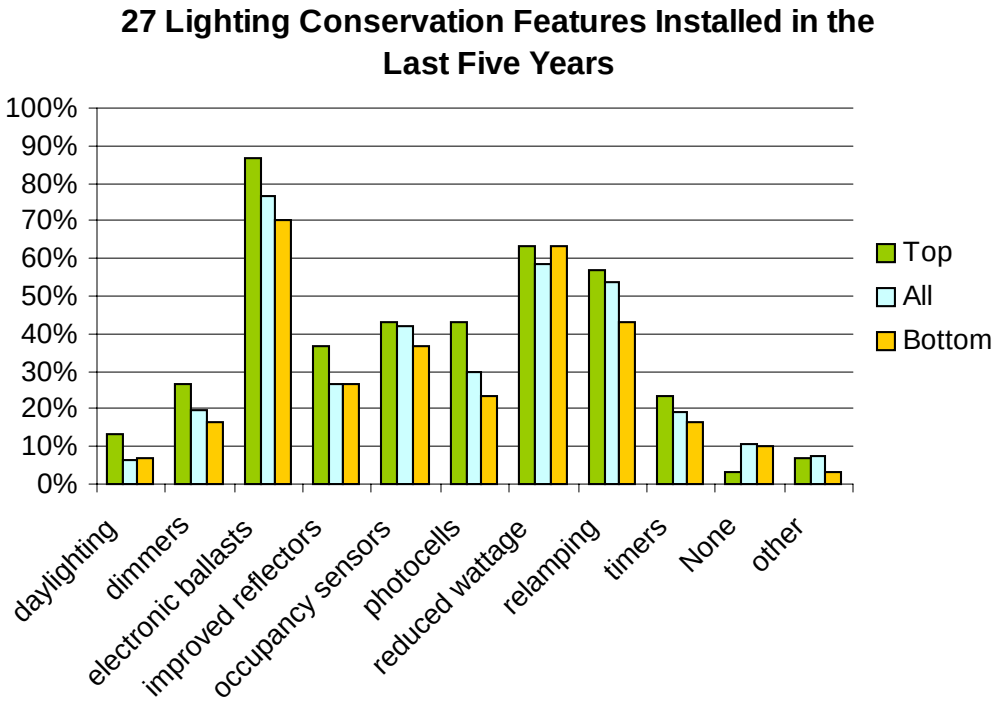
Top performers out-ranked others in installing HVAC maintenance features.

Figure 4-28: Building Shell Conservation Features Installed by Survey Participants in the Last Five Years



Poor performers had the fewest number of conservation features installed while top performers focused on insulation, seals, and other shell conservation features. Other answers of top performers included roof insulation and repairs (3) and building caulking (1).

Figure 4-29: Lighting Conservation Features Installed by Survey Participants in the Last Five Years



Top performers had more lighting conservation features installed than did all respondents or bottom performers.

HVAC Operation and Maintenance Procedures (28)

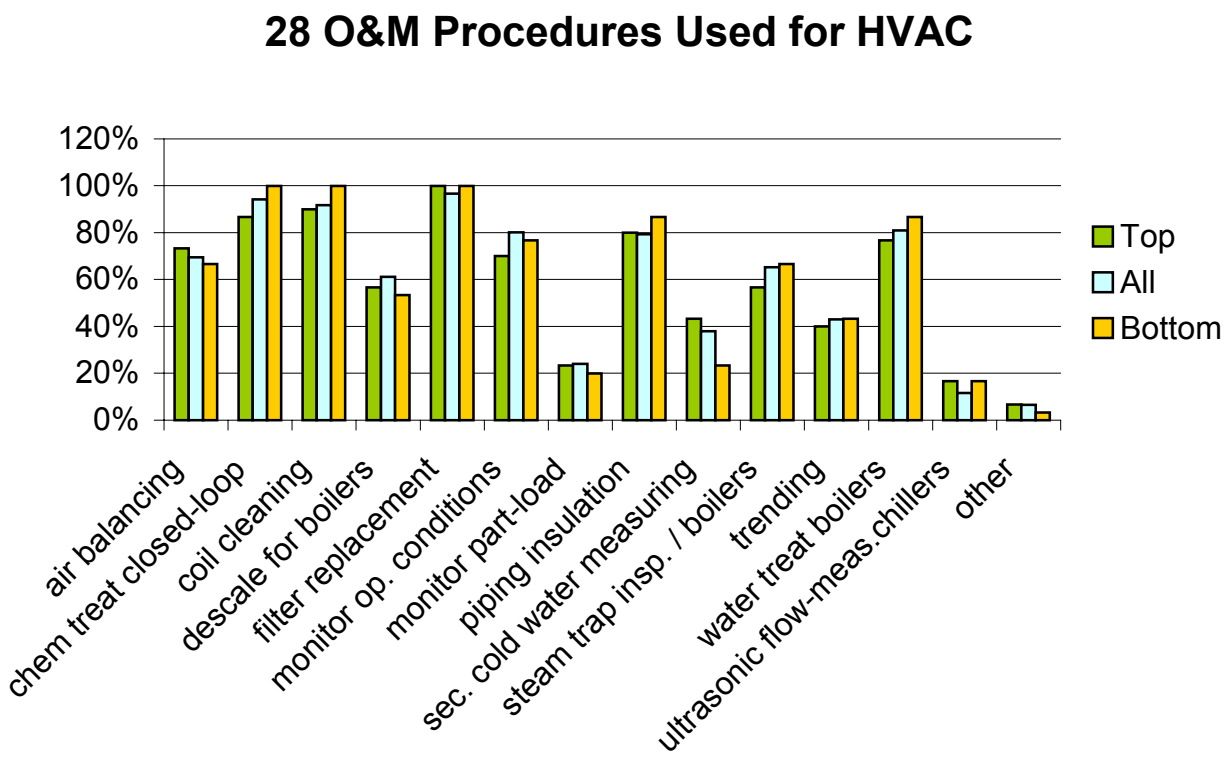
Table 4-3 lists HVAC operation and maintenance (O&M) procedures, the percentage of hospitals surveyed that implement each procedure, and the percentage of upper-quartile hospitals that implement each procedure.

Table 4-3: HVAC O&M Procedures in Use by Survey Participants

HVAC O&M Procedure	Percent of Hospitals That Implement Procedure	Percent of Upper-Quartile Hospitals That Implement Procedure
Air Balancing	69.4%	73.3%
Chemical Treatment of Closed-Loop System	94.2%	86.7%
Coil Cleaning and Maintenance	91.7%	90.0%
Descale for Boilers	61.2%	56.7%
Filter Replacement	96.7%	100.0%
Monitor Operating Conditions	80.2%	70.0%
Monitor Part-Load Performance	24.0%	23.3%
Secondary Chilled Water Loop Flow Measuring	79.3%	80.0%
Piping Insulation	38.0%	43.3%
Steam Trap Inspection Program for Boilers	65.3%	56.7%
Trending	43.0%	40.0%
Water Treatment for Boilers	81.0%	76.7%
Ultrasonic Flow-Measuring Device for Chillers	11.6%	16.7%
Other	6.6%	6.7%

Figure 4-30 contains O&M procedures used by survey participants for HVAC.

Figure 4-30: O&M Procedures Used For HVAC



Because the condition of the respondents' equipment was not known prior to the survey, performance ratings may not indicate cause and effect relationships between a given O&M procedure and performance, which may explain why there is little difference between the upper quartile and general population in implementing the given HVAC O&M procedures. However, the results suggest that air balancing, filter replacement, and piping insulation are practices employed more frequently by top performing facilities compared to others.

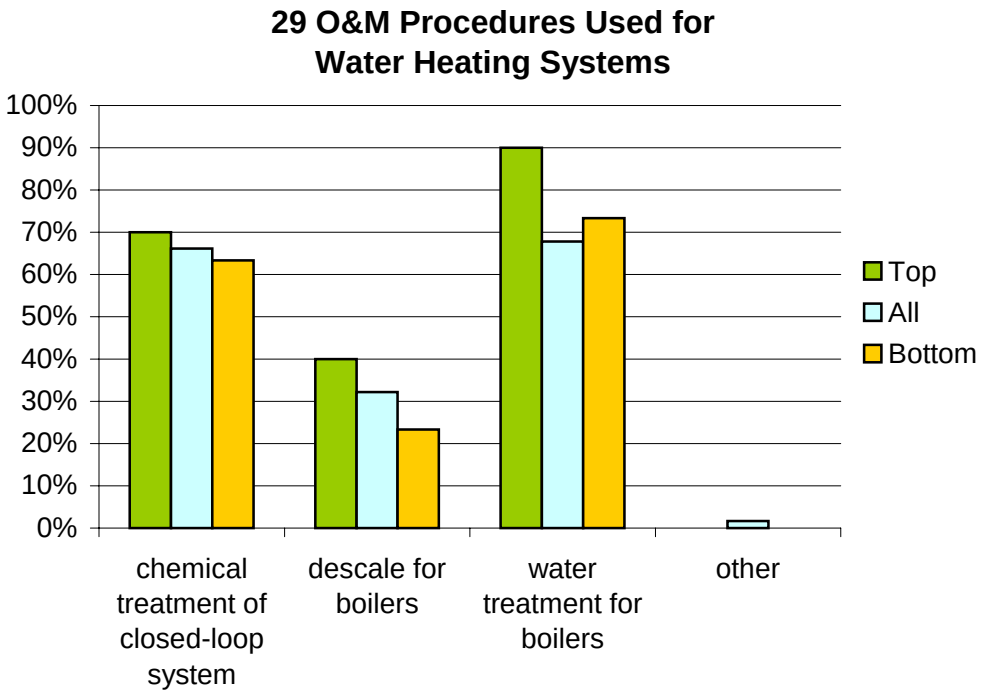
Other O&M Procedures (29, 30, 31, 32, 33, 34)

Other O&M procedures implemented by survey participants for

- Water heating systems
- Cooling towers
- Lighting
- The building envelope
- Cooking equipment
- Laundry equipment

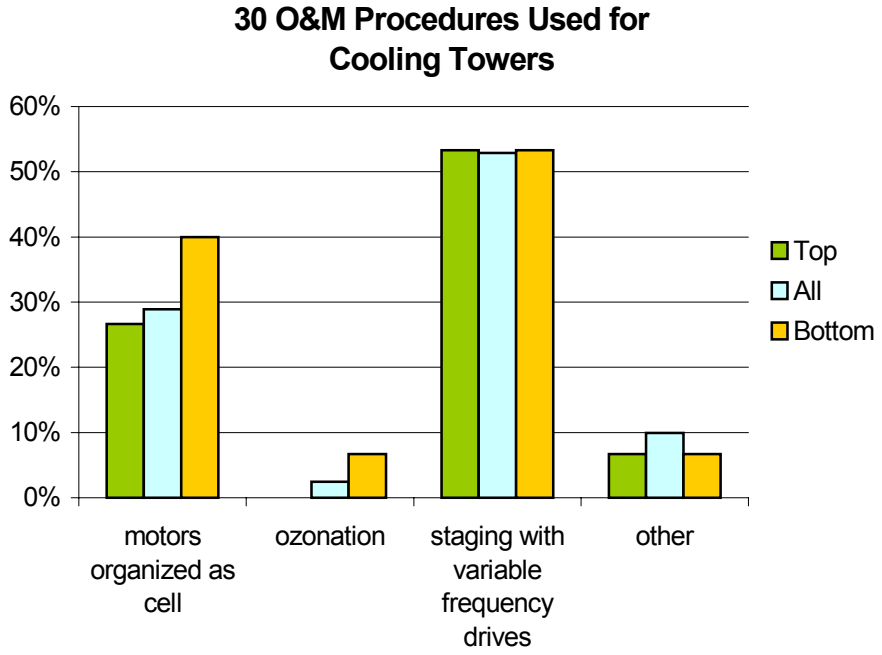
are shown in Figure 4-31 through Figure 4-37.

Figure 4-31: Water Heating System O&M Procedures Used by Survey Participants



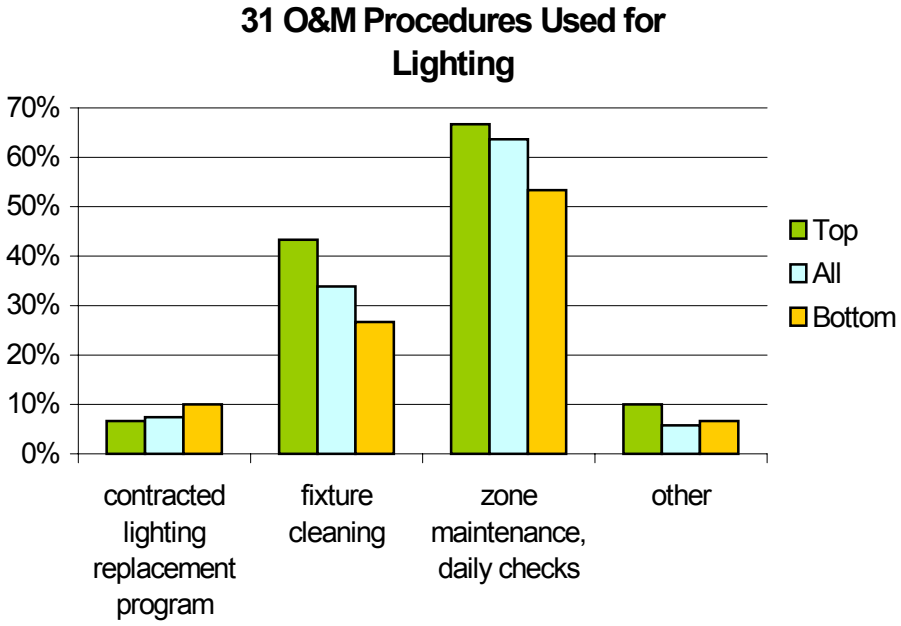
Top performers used more O&M procedures for their water heating systems than did all respondents or bottom performers.

Figure 4-32: Cooling Tower O&M Procedures Used by Survey Participants



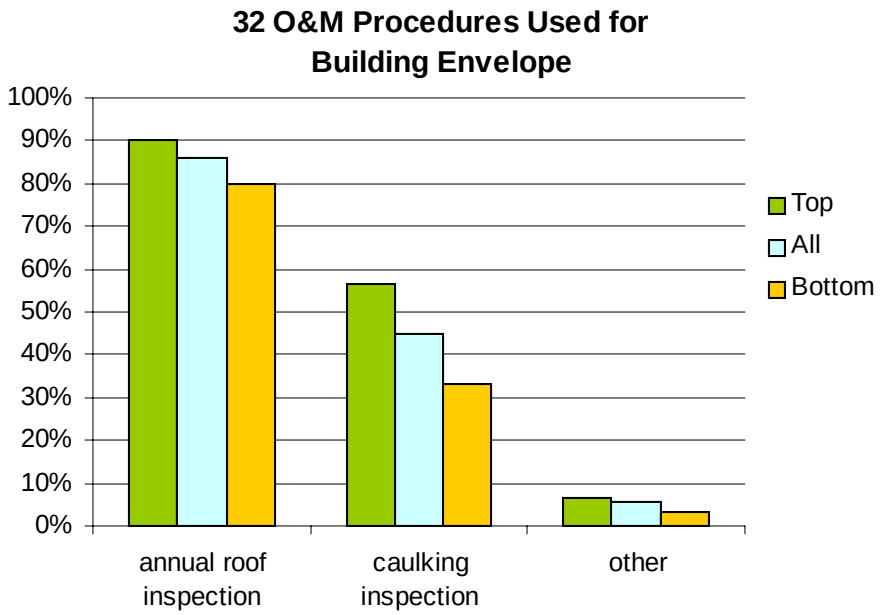
Top performers used fewer O&M procedures for their cooling towers than did all respondents or bottom performers. Fewer O&M procedures may indicate that top performing facilities may have simpler cooling tower designs, which require less maintenance than more complex designs.

Figure 4-33: Lighting O&M Procedures Used by Survey Participants



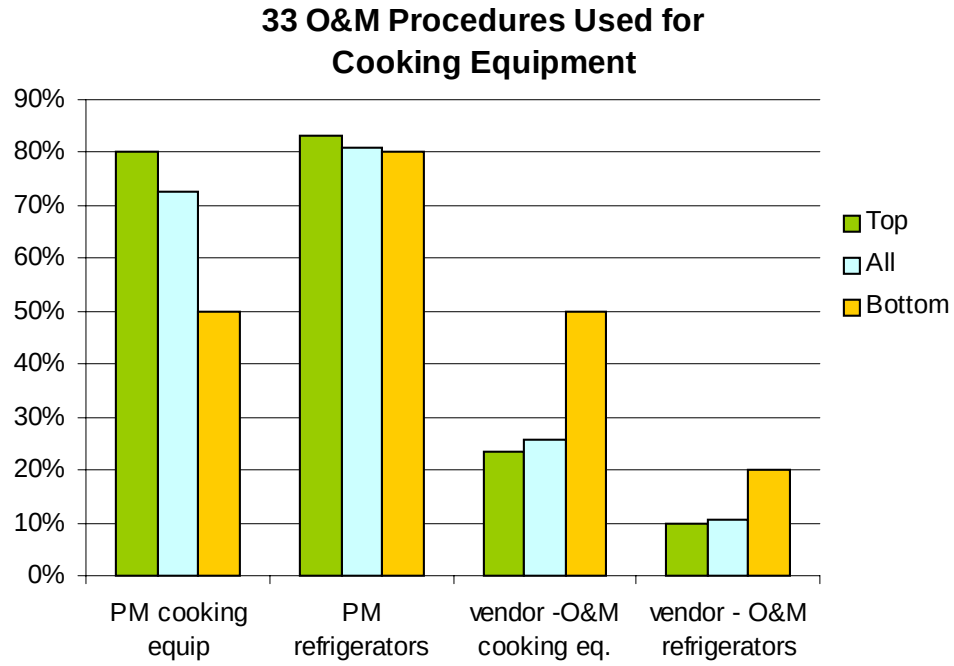
More top performers cleaned their lighting fixtures and performed zone maintenance daily checks than did bottom performers. Two of the top performers had in-house lamping replacement programs; bottom performers often contracted out their lighting replacement programs.

Figure 4-34: Building Envelope O&M Procedures Used by Survey Participants



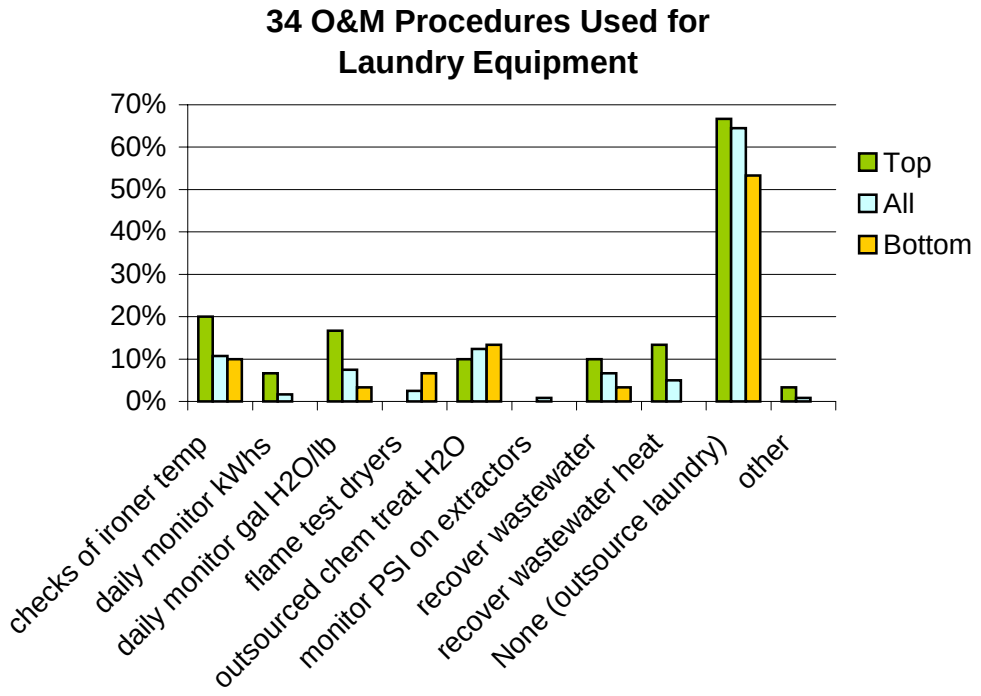
Top performers were more likely to conduct annual roof inspections and caulking inspections than all respondents or bottom performers.

Figure 4-35: Cooking Equipment O&M Procedures Used by Survey Participants



Top performers were more likely to conduct internal preventive maintenance on cooking equipment and refrigerators. Bottom performers were more likely to contract out preventive maintenance of cooking equipment and refrigerators.

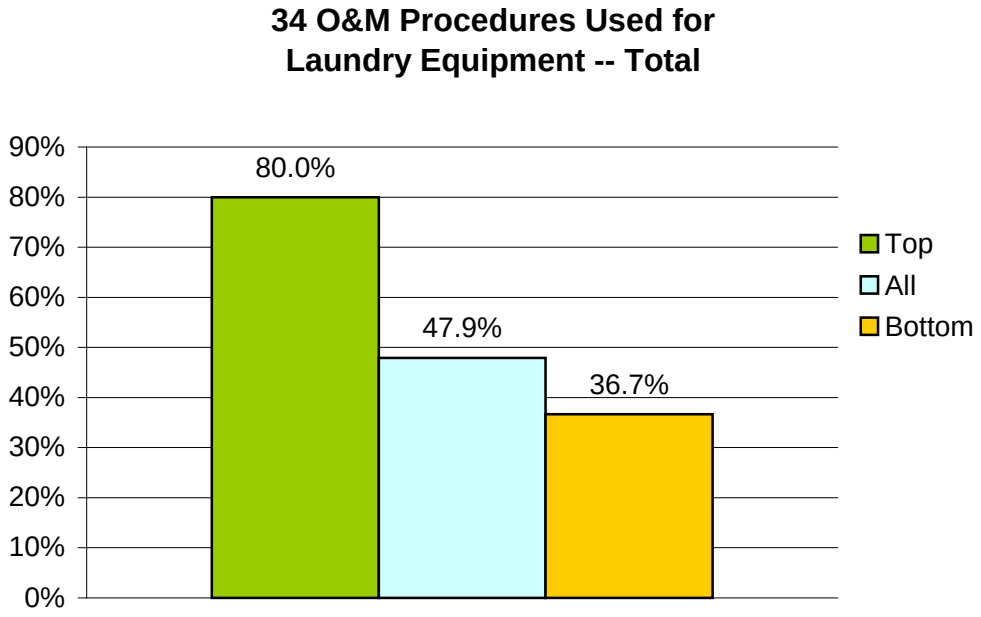
Figure 4-36: Laundry Equipment O&M Procedures Used by Survey Participants



Top performers were more likely to check ironer temperatures, daily monitor gallons of water per pound and kWh, and recover and reuse wastewater and its heat—or outsource the laundry altogether. Bottom performers were more likely to outsource the chemical treatment of water and flame test their dryer burners.

When none was eliminated (respondents who outsourced their laundry) and the number of O&M procedures were totaled, the result clearly indicated that top performers practiced many more O&M procedures than did bottom performers (see Figure 4-37).

Figure 4-37: Laundry Equipment O&M Procedures Used by Survey Participants—Total



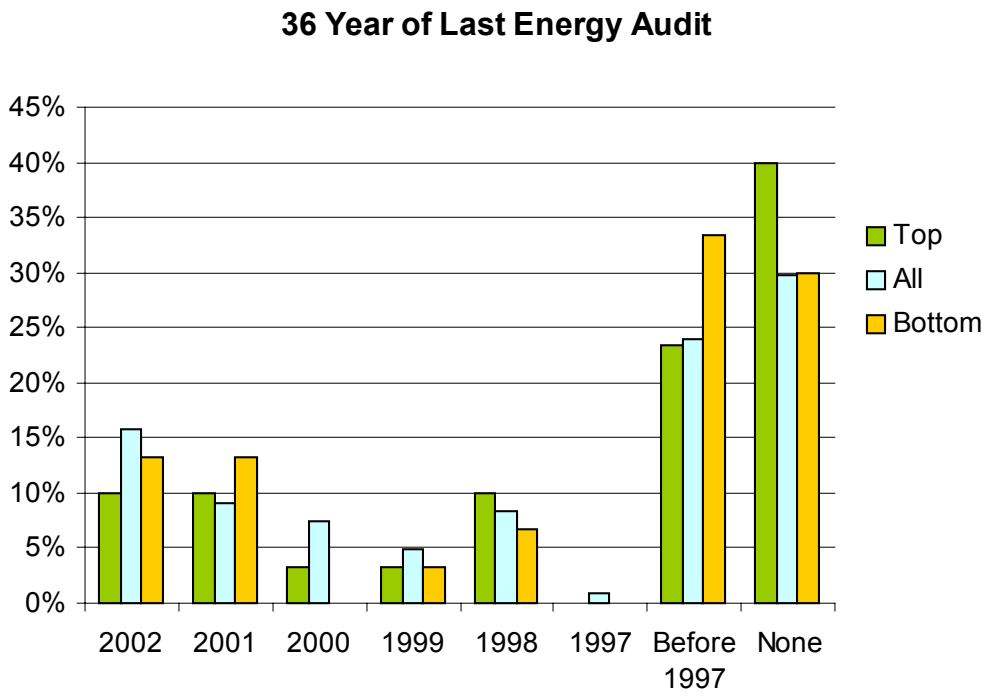
O&M Procedures Eliminated (35)

Only a few respondents listed O&M procedures that they had eliminated, but twice as many bottom performers as top performers had eliminated procedures. All responses are listed in Appendix F.

Energy Audits (36)

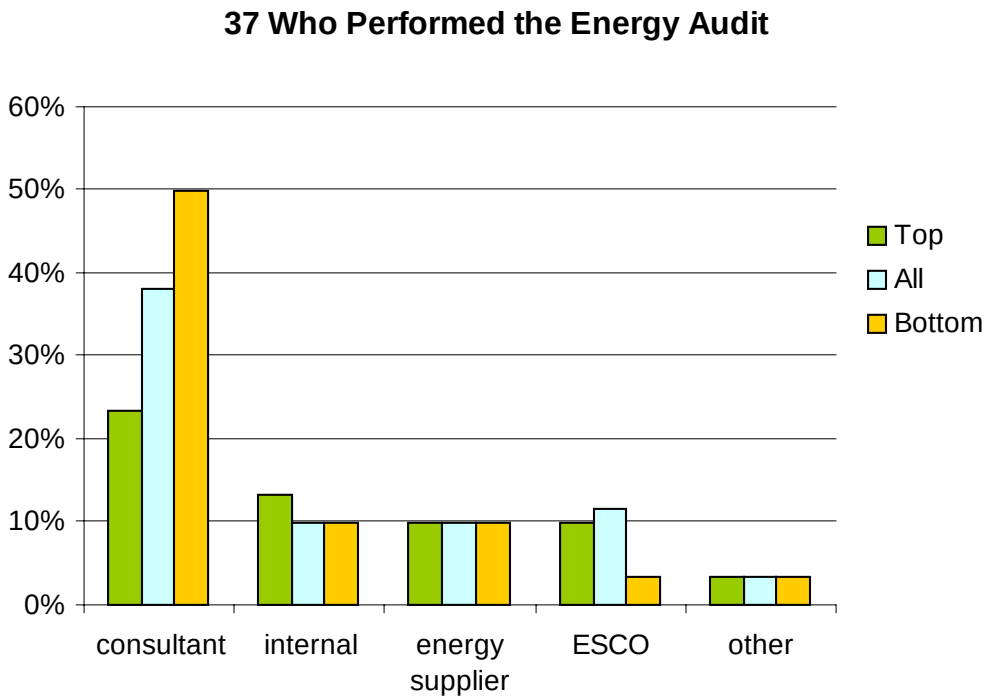
Energy audits have been performed at 70 percent of the hospitals surveyed. A breakdown of the most recent year that energy audits occurred is shown in Figure 4-38.

Figure 4-38: Year of Last Energy Audits by Survey Participants



This study found that top performers were less likely to have an energy audit than all respondents or bottom performers. This finding is actually contrary to EPA's "Class of Year" studies on top performing buildings, which found that ENERGY STAR labeled buildings were more likely to have had an energy audit within the last three years.

Figure 4-39: Who Performed the Energy Audits by Survey Participants



Energy audits performed by consultants were more likely to be found among bottom performers. Top performers showed a slight preference for conducting their own internal audits.

It could be, however, that energy efficiency improvements recommended by consultants were less likely to be implemented than those recommended by internal staff.

Measures Recommended by Energy Audits (38, 39)

Recommended measures that resulted from the energy audits covered a range of improvements and are listed in Appendix F.

Neither the number of facilities reporting recommendations nor the fact that recommendations were or were not implemented seem to have affected the benchmarking scores.

5 BEST PRACTICES

All healthcare facilities face complex challenges in designing and operating buildings efficiently. This study indicates that it is the consistent application of best practices and frequent monitoring of results that add up to energy efficiency.

This chapter presents information about the practices used by the facilities with the highest energy benchmarking scores. It contains

- A list of the top 100 O&M strategies from top quartile performers
- A discussion of the best practices of facilities whose benchmarking scores are in the top 10 percent
- A preventive maintenance checklist

Top 100 O&M Energy Conservation Strategies from Top and Bottom Quartile Performers

The information in the following table is based on the response given to Question 23, "What are the five highest O&M strategies that you practice?" by the top and bottom quartile performers. Raw data is provided in Appendix F. The right-hand columns give the number of top and bottom quartile performers that named the O&M strategies listed in the left-hand column.

"Are these strategies good or bad?" is a question that came up frequently by reviewers who looked at Table 5-1. Without further study, we are unable to answer this question. Because of the complex and interrelated nature of energy consumption within a healthcare facility—the various technologies, the types and sizes of equipment used, the O&M strategies used with each system, and how consistently each strategy is applied—it would be difficult to determine exactly what is the best O&M strategy to apply in a given situation.

So what does the data tell us? Table 5-1 shows that, for example, 18 out of 30 top performers stated they had Building Automation Systems (BAS) while only seven of the 30 bottom performers had them. This data would seem to indicate that BAS could save energy. It could also indicate that the seven bottom performers who used BAS might not be getting full advantage of them, perhaps for a variety of reasons such as

- They might not fully understand or use the data they get from it
- They might not maintain it properly

- Their BAS might not be as robust as those of top performers; for example, it might cover less of their building or control fewer parameters

Likewise, only one of the 30 top performers listed regulation of their hot water heaters as a top O&M strategy while four of the 30 bottom performers listed it. Does that mean that this strategy is bad? Probably not. But it could mean that by focusing on hot water regulation as a top strategy, bottom performers are missing other opportunities that might produce more energy savings. Or it could be that top performers performed hot water heating regulation as part of their integrated BAS while bottom performers treated it as a separate entity, perhaps reflecting a less-efficient approach to energy conservation.

Table 5-1. Top O&M Strategies Practiced by Top and Bottom Quartile Performers

Top O&M Strategies	Top Qtr	Btm Qtr
Operations		
BAS (Building Automation System) to optimize system performance including day/night schedules, chiller setpoints, chiller staging, and chiller plant peak demand limiting, reset schedules (AHU discharge air, hot water). Note: 90% of top performers utilize a BAS/EMCS system with significant differences from other performers in monitoring these areas: boilers, hot water systems, secondary chilled water loop flow, exterior lighting control, and temperature schedule per room	18	7
Economizer cycling on air handling units. Note: 37% of top performers use economizer cycle	5	1
Routine operations such as pre-heat and pre-cool building, exclude heating/cooling of unused spaces, turn off equipment	4	1
Water usage reduction and conservation	3	4
Education on energy practices and conservation	3	
Staging number of chillers and boilers to meet load demand	2	3
VAV operation	2	
Metering of electric usage and power factor, peak demand limiting	1	3
Hot water system regulation and instantaneous hot water heaters	1	4
Eliminating bleed water and chemical usage from cooling towers	1	
Maintenance		
Routine PM (for example boiler cleaning and water treatment, clean cooling towers to maximize condensor performance, chiller predictive maintenance). Note: 90% of top performers have water-treatment programs for boilers and 40% descale boilers, 90% perform annual roof inspections, and 57% perform caulking inspections, 80% PM cooking equipment, 67% utilize zone maintenance for daily checks on lighting, and 43% clean light fixtures.	7	6
Boiler efficiency testing and tuning	5	4
Thermostat calibration	1	
Filter changes	1	
Upgrades		
Lighting Retrofits including high efficiency fluorescent tubes (such as T8) and electronic ballasts (12) and LED exit signs (4). Note: 87% of top performers have installed electronic ballasts in last five years and 57% perform routine relamping.	16	11

Top O&M Strategies	Top Qtr	Btm Qtr
VFD—Variable Speed (frequency) Drives for example on pumps (chilled water and domestic hot water) and motors (air handlers and cooling towers)	13	4
Replacing aging and burnt/broken motors with high efficiency motors	2	1
Steam plant upgrade	1	
Tower upgrade	1	
Heat recovery on 100% outside air handling units	1	
Installing DDC	1	
Rehab all AHU, dampers, and filters	1	
Reflective window film	1	
Strategies and Long Range Planning		
Rate Negotiation for long-term contract below market rate and competitive source bidding	2	
Incorporate energy efficient building envelope design features	1	
Centralized utilities	1	1
Chiller source optimization (natural gas vs. electric)	1	2
Unique Projects/Upgrades		
Replace cooling tower with flat plate condensor/ground water	1	
Conversion of systems to ground water cooling	1	
Using well water for sprinkler system	1	
Waste heat is reclaimed from on-site incineration of medical and non-recycled combustible waste	1	
Ice storage to limit peak demand		1
Convert 3-way to 2-way valves		1
TOTALS	**100**	**52**

Managing Top Performing Facilities

The following observations were developed from interviews with the Facility Managers of the hospitals with the highest benchmarking scores (ranging from 91 to 100).

The First Priority—Meeting Indoor Climate Requirements

Hospitals are unique in design and size, and in the different specialized services they provide. Their plant operation systems must be designed and adjusted to meet the requirements of many different areas including surgical, clinical, laboratory, office, and patient care environments as well as space requirements found in large office buildings. These requirements are met through proper design and operation of the building and its technical systems such as moisture barriers, thermal insulation, heating, ventilation and air conditioning (HVAC), and lighting.

When considering energy-saving measures, the need to control the indoor climate is the top priority. Once indoor climatic requirements are established, energy efficiency in creation of the environment becomes an increasingly important secondary requirement. The facility manager is challenged to accomplish any energy savings while dealing with many complicating factors, including:

- Scheduled maintenance cannot interfere with the 24-hour, 7 days per week (24/7) operation of the facility
- Large amounts of outside air are needed to dilute odors
- Ventilation is still required, even when critical spaces are not in use, to maintain pressure relationships and control the spread of infection

Key Systems That Influence Energy Usage

The following systems have the most influence on energy usage:

- Temperature Control
- Thermal Insulation
- Ventilation
- Indoor Air Quality
- Lighting

Temperature Control

Most clinical areas require a consistent temperature throughout the year. To maintain comfort levels for patients, the indoor temperature in hospitals is usually two to eight degrees F higher than for other building types. A typical temperature for patients' rooms is 72 degrees F, but may be much warmer, for example 79 degrees F, due to heat given off from patient care equipment in the room.

Thermal Insulation

State and local building regulations typically establish maximum U-values (coefficients of thermal transmittance) for the entire building envelope, including walls, foundations, roof, and windows.

Ventilation

Hospital ventilation rates are established for infection control and comfort as compared to heat surplus (as in office and commercial buildings). Occupants and activities in the hospital contaminate indoor air so it must be renewed in order to eliminate odors, pollutants, and pathogens. Ventilation rates typically range from two to six air changes per hour (ACH) in patient rooms to 15 to 25 ACH in surgical suites.

Indoor Air Humidity Control

The comfort range covers relative humidities of 30–60 percent, at temperatures normal for hospitals (72–78 degrees F). Strict humidity control is often only applied in rooms where conditions are more critical, such as in surgical suites, intensive-care units, and computer-intensive areas. In other areas it is common practice to allow humidity levels to fall outside the comfort range due to expansive operating costs (humidification), and initial costs (dehumidification).

Lighting

Designs to realize the therapeutic impact of daylight often result in unwanted effects of glare and overheating. Having sunshades and blinds automatically controlled by sensors triggered by sunshine and wind best provides maximum utilization of daylight, but manual controls should always be available for individual adjustment. Hospitals also usually contain a substantial number of windowless rooms with artificial lighting as the only source of light.

Hospital Design and Renovation

The typical hospital building is designed for long-term use; frequently over 50 years. Often it is used for longer periods than its designers ever intended. During this period the building is retrofitted and renovated many times. This nearly constant state of change both challenges previous system designs and offers opportunities for system upgrades to address new and existing energy issues.

Energy-efficiency measures are implemented most cost effectively when they are installed during new construction or retrofitting/remodeling buildings, or when replacing old equipment. It is generally less expensive to introduce additional energy-saving measures when retrofitting work is already being carried out on a building than at times when the hospital is operating normally. By choosing installation times carefully, interference with normal hospital routines can be minimized, and capital expenditures may be substantially reduced. If an installation or item of equipment has to be replaced anyway, it is only the extra cost (the over-cost compared to a conventional system) that needs to be taken into consideration when calculating the payback period for a new, more energy-efficient installation. In calculating payback period it is important to recognize the thermodynamic linkage between retrofit projects, such as the less heat that high-efficiency lighting generates compared to older lighting technologies. For example, reducing the heat generated by lighting will reduce the need for cooling.

Facility managers should take advantage of these rare opportunities to carry out energy-saving measures.

Routine Operation and Maintenance

Although many technical methods exist for improving energy efficiency, facility managers should begin by considering the most fundamental measures. Often, improved maintenance and operation procedures, coupled with moderate investments, will provide immediate and continuing energy and cost savings. No-cost opportunities, such as switching off equipment like lights and heaters when rooms are unoccupied, are easy to identify and implement. Depending on the hospital's energy practices, a simple walkthrough inspection may reveal areas where lighting and equipment are left on when unattended, or where lighting, ventilation, or other service levels can be reduced without detriment to comfort or health care. Unused areas and rooms to be unoccupied for longer periods of time should be closed off with blinds or shades drawn and climate control air reduced or eliminated.

Storage rooms should not be heated unless it is necessary for protection of stored contents. A close observation of actual operations on loading docks should be made to determine ways to close off open dock doors from hallways and adjacent areas.

Other simple measures include:

- Cleaning lamps and reflectors regularly
- Replacing lamps and filters at the recommended time intervals
- Regularly checking for and repairing leaks
- Checking that thermostats and timers are accurate and correctly set
- Checking that automatic controls are functioning properly
- Keeping surfaces of radiators, convectors, baseboards, and finned-tube heaters clean for efficient operation

A basic maintenance function most facilities perform is a steam trap inspection program to prevent the escape of live steam from a distribution system. A leaking trap will allow steam to pass into the condensate system, wasting energy and creating noise. Often facilities trend steam production with outside air temperature to help flag a possible problem in system performance.

A good starting place is to perform a mechanical and electrical assessment. One assessment determined that the chemical treatment program for boiler feed water was not correct, resulting in sludge that diminished heat exchange efficiency. Improper chemical treatment shortens the life of the piping system and increases the frequency of trap failures that waste energy by bypassing steam or causing condensate to back up in the heat exchangers, which in turn reduces the capacity of the heating equipment. Additional investigation at that same hospital found a break in a steam line in a hot water tank; water was being dumped down as condensate.

Another facility assessment identified electrical back feeds from panel buss problems. Often a simple process of tracing and documenting systems will reveal problems. One facility found loads still on when documenting part of the electrical system: old lighting fixtures left in place where a new ceiling was installed were left on.

Preventive maintenance should be performed on electrical distribution equipment to assure minimum power loss from loose connections and/or contacts. See the Energy Savings PM checklist later in this chapter for details.

Use building commissioning to ensure that all systems work as designed. Use the operational staff to audit and assess problems. Start during the construction stage by having them tour the construction floor to observe access and installation problems as they occur, since the operational staff will have to live with the problems. Do not assume everything is installed correctly. Examples include

- A chiller with its return and supply lines switched
- A cooling tower installed at an improper height that causes it to overflow and thus require manual valving to balance the water flow

Conduct extensive training programs for hospital operational and maintenance staff whenever major equipment is installed. Discuss the new equipment's purpose and its specifications, schedules, operation, and maintenance requirements.

Lighting

Over the last ten years, nearly all facilities have moved from incandescent lighting to fluorescent and often to high-efficiency lighting including electronic ballast, T8 lamps, and compact fluorescent bulbs. In some cases grant money and interest-free loans from the state were used to fund lighting retrofits. The practice of installing high-efficiency lighting systems was continued in new construction often to ASHRAE or IES (Illuminating Engineering Society) recommendations. Facilities that had not obtained grant or rebate dollars, chose to install upgraded fixtures (T8 and electronic ballasts) with routine replacement and remodel common areas (not patient rooms). Another common project is replacement of incandescent and fluorescent exit signs with LED signs.

More recent strategies include taking advantage of load management options such as daylight harvesting, occupancy control, and manual dimming. Newer occupancy controls are on the market with microprocessors that analyze the occupancy activity and adjust to meet the needs of the area. Rather then controlling lighting as on/off, many controllers are set up for areas with a high-low illumination system. Although most hospital areas operate 24/7, lighting can be reduced in certain areas at certain times. For example, a doctor's building could shut down common areas and meeting rooms at 7 p.m. and main corridors at 9 p.m., leaving on only emergency lighting. Smaller areas can use room sensors for lights.

Most of the highest energy performers used zone mechanics and scheduled relamping of areas. Citing the highest expense of lamp replacement as "the hand that installs the bulb," relamping and wiping down reflectors in common areas, at one scheduled time, before the bulbs burn out or near their end of service life, improves customer satisfaction and effectively manages the maintenance costs of lighting.

Roof and Building Envelope Enhancements (Weatherization)

Weatherizaton enhancements include insulation, weather stripping, double-paned windows, and energy-efficient window films. These films reflect heat in the summer to reduce cooling needs, insulate the glass in the winter to reduce heating needs, and are especially effective on single pane and clear glass with southern or western exposure.

Use temperature-sensing equipment (IR or thermal scanning) to detect air leaks around windows and doors.

Seal in place operable windows. If they cannot be permanently sealed, ensure that operable windows have sealing gaskets and cam latches that are in proper working order.

Single pane windows with aluminum frames are a source of occupant discomfort and an energy hog. Although some facility managers reported they had replaced these through renovation and construction, it is worth evaluating the payback in upgrades to double-pane glass with a thermal break, for example phased over three years.

Develop a roof management program to trace the age and condition of each roof and to schedule when to refurbish and replace. Perform annual roof inspections to detect moisture infiltration and caulking inspections to determine breaches in the building envelope. Pay particular attention to roof/parapet/wall flashing, equipment and curb flashing, expansion joints, and the interface between concrete or stone slabs.

Similar to other energy saving measures, construction and renovation is a critical time to evaluate incorporation of current energy standards from ASHRAE and others in the building envelope systems through evaluation of the first cost addition verse the lifetime cost of ownership.

Additional proven strategies from facility managers include:

- Add vestibules at main entrances to eliminate infiltration through heavy traffic areas.
- Check elevator shaft louvers. These should be changed to operating louvers to prevent a stack effect from drawing negative pressure on the building.
- Be sure the total building is under positive pressure. Negative pressure in the building wastes energy from air infiltrating through open doors and cracks. In addition, moisture can come in that can damage the building and create conditions where mold and mildew can grow in wall cavities.

Boilers and Hot Water Systems

By monitoring multiple points on steam systems, facility managers can detect performance reductions that slowly occur over a period of years. Scale reduces the efficiency of the boiler and can lead to overheating and cracking of tube ends. Inspect boilers for scale deposits, accumulation of sediment, or boiler compounds on waterside surfaces.

Many engineering directors reported that good water treatment is essential to maintain peak performance and also extends boiler life and helps avoid costly repairs. A proper chemical treatment program ensures clean surfaces and good thermal exchange on boiler tubes. Make periodic inspections of burner adjustments to ensure the proper fuel-to-air mix. Observe the burners when the boilers shut down to determine if any solenoid valves leak.

Operating efficiency falls off significantly with decreasing load. Most boilers achieve maximum efficiency only when running at their rated output. It is important to evaluate part-load performance conditions. Evaluate boiler load characteristics to optimize operation for the staging and warm-up of boilers. Often boiler plants are over designed for the occasional worst-case conditions. Current designs incorporate modular boilers (small independent boilers) to stage on loads. Modular boiler system will increase seasonal efficiency as fluctuations of load are met by firing more or fewer boilers to come on in stages in order to make the operation energy efficient. Smaller boilers have low thermal inertia (low heat up and cool down losses) when running at maximum or off.

To increase energy efficiency of hot water systems, install a flue gas and air heat recovery system to preheat domestic hot water. Install instantaneous hot water heaters instead of storing hot water in tanks.

Chillers

Centrifugal chillers are the power monsters in the boiler room. The energy used by chillers is one of the largest operating costs in a facility. Energy efficiency of chillers has been improved significantly. All chiller manufactures have been working to increase the efficiency of their units, and the control technology has had a major impact. The new control systems are microprocessor-based and can perform control functions, which were not possible with electromechanical systems. Chiller controls can now be interfaced with energy management systems to match the chiller operation with building needs.

Operating efficiency falls off significantly with decreasing load. As with boilers, it is important to evaluate part-load performance conditions for chillers.

Most facility managers monitor the standard chiller points, but the actual performance for an individual chiller is seldom monitored. Monitoring actual flow through a chiller is essential to determining the performance of the unit. Flow can be monitored relatively inexpensively using an ultrasonic flow-measuring device. These devices are accurate when properly installed. When coupled with the entering and leaving temperatures and power consumption of the chiller, the actual performance can be continuously monitored. Also, accurate chiller efficiency could help determine optimum operating sequences for multiple chiller systems.

Another area where flow measurement should be monitored is in the secondary chilled water loop. Comparing this flow to outside conditions could help determine if a variable-speed pumping system is tracking with changes in outside air temperatures.

Numerous variable-speed pumping systems do not perform properly because pressure differential sensors that control the system are not located properly or functioning as designed. By monitoring the flow at different conditions, a facility manager can determine if the system is truly working as a variable system.

Chiller design and operational issues include:

- Designs should incorporate chiller usage to take advantage of the most favorable electrical rates
- Energy Management Systems should coordinate the operation of the chillers, pumps, and cooling towers
- Multiple chiller operation requires computer software to coordinate chilled water production
- Chillers should be operated by electric consumption (full-load rated amps)
- The electric operating curve needs to be programmed into a computer for efficient chiller operation
- Future chilled water loads need to be anticipated for size (tonnage) of chillers

One facility manager's chiller plant includes both natural gas (engine driven) and electrical chillers. Through precise logic control he is able to stage the loading to maximize the load on each chiller thereby controlling his demand charges. He says "Controlling demand is the name of the game." He is able to use his chiller plant and standby generators to compensate for rising peak demand on the electric grid and to minimize the high summer kW charges.

Facility managers reported additional measures including:

- Resetting chilled water temperature during intermediate seasons to reduce chiller energy consumption.
- Adding dedicated chillers for operating rooms and computer equipment rooms such as MRI and CT Scan. Often these areas require lower chilled water temperature (40 degrees F). By using dedicated chillers for these areas, the main chillers can be set so that chilled water has a higher leaving temperature.
- Using double-bundle heat exchangers for new chillers to preheat domestic hot water or to provide reheat hot water during intermediate and summer seasons.

Cooling Tower Operation Expenses

Cooling tower operating expenses can be as much as 40 percent of chilled water production costs. Evaluate the condenser needs of the chiller(s) to determine when (or if) the tower is needed. One facility manager needed to run the chiller throughout year. The manager was able to replace the tower with a flat plate collector and keep the tower as backup.

Other tips to consider are:

- Specify variable speed drives so cooling fans can cycle and run at speeds to match heat rejection
- Specify the water treatment program and equipment to reduce chemical and labor maintenance expenses
- Make sure the cooling tower is connected to a chiller management program for efficient operation

One hospital took advantage of regional conditions to run ground water (43–45 degree F water) through a closed loop system and then re-inject the water back into the well, which served as a heat sink. Another hospital has been able to nearly eliminate their chiller needs in the winter. It uses a smaller chiller or multiple DX units for equipment-intense areas with special cooling loads such as data processing, cardiac catheterization lab, MRI, and CT Scan through the use of winter air via the economizer mode on all ducted ventilation systems.

Another hospital developed a water-heat reclamation system from cooling tower water during cold weather. This hospital uses a plate-frame exchanger to produce chilled water for small air-handling units that serve interior spaces.

Variable Frequency Drives

A large energy cost savings is associated with controlling the fan speed on large air-handling units (AHUs) that typically operate 24/7. Often, internal temperature and humidity conditions within clinical areas are maintained by modulating the chilled water control valve on each AHU according to the highest demand for cooling as signaled by room temperature sensors. Reheat energy is provided to zones requiring less cooling in the form of hot water generated from steam. Typically, AHUs incorporate a humidity sensor in the return air stream to override the temperature sensors should the mean relative humidity rise. These conditions create a situation of over-cooling and re-heating.

Variable frequency drives (VFDs) vary the power delivered to a motor so that it runs only when needed and at the minimum speed required. Installing VFDs on each supply and return air fan motor (10 hp and greater) within each AHU reduces the air quantity over the cooling coil of each AHU. The sensible cooling load reduction on the space results in energy cost savings associated with the elimination of over-cooling and re-heating as well as significant electricity cost savings from the reduced electrical load of each supply and return air fan.

A direct digital control (DDC) package limits the AHU fan motor (for example to a minimum of 50 percent of full speed) and allows rolling starts and automatic restarts of fans after power failures. Temperature sensors in each zone and outside air-measuring devices are installed enabling the accurate measurement and control of fresh air to each AHU.

Specifying and installing VFDs designed for the highest possible load, on many of the AHUs, pumps, and cooling tower fan motors allow the motors to better match the load imposed upon them. Many engineering directors reported variable speed pumping projects on chilled water pumps (often 50 hp or greater), secondary chilled water pumps (often 200 hp or greater), and condenser water pumps (150 hp and greater). They reported that use of VFDs allowed them to replace many three-way valves with two-way valves to vary the total flow of water in circulation systems for heating and cooling systems. Two-way valves also help to compensate for imperfect balance between supply and return piping systems and are less likely to leak.

VFDs have been installed for induction system heating/cooling secondary pumps and for controlling air compressors with the speed of devices modulated to match the current load.

Energy Management Systems

Energy savings often occur as a result of changes to the operation of the steam and chilled-water generation systems, revised management practices for the steam and chilled-water distribution system, and modifications to building equipment operation schedules.

Energy Management Control Systems (EMCS), as part of a Building Automation System (BAS) or as a separate system, are installed to control energy-consuming equipment from a central location. These systems enable a facility engineer to schedule the hours of use of energy related services (such as HVAC), and make equipment adjustments, such as temperature control for different parts of a facility and for buildings that are spread over a large geographic area.

For many years this dedicated networking technology has allowed dynamic improvements in HVAC system operational efficiency to existing equipment. One facility manager stated that "Newer technologies such as direct digital controls and variable frequency drives, combined with improved design, commissioning, and operation, can decrease chiller plant energy consumption by more than 50 percent while improving reliability and helping the environment."

The efficiencies of centralized computer control allow engineering and maintenance staff to invest more time in troubleshooting and maintaining equipment, rather then performing manual equipment control. Use of an EMCS allowed changes to operating procedures, duty cycling, and the re-balancing of mechanical systems.

Examples of system control measures performed by the EMCS for improved equipment efficiency and control accuracy include:

- Equipment outside air lockout
- An enthalpy sensor to initiate an economizer cycle

- Supply air temperature reset
- Chilled water temperature reset
- Condenser water temperature reset
- Hot water temperature reset
- Scheduled start/stop for fans and pumps
- Chilled water plant optimization or staging of chiller compressors
- Electric preheat control
- Optimum start/stop
- Controlled warm-up
- Two-speed fans
- System time of day control
- Night setback
- Optimized start time for peak shaving

One engineering director reported that he was able to leverage the design of a replacement chiller plant to reap operational savings. They utilized data (for example ASHRAE BIN data) to analyze climatic conditions to not over design the plant by designing large units for maximum loads. The facility specified equipment with solid control packages on high-efficiency chillers and installed a new EMCS as part of a new chiller plant. They installed VFDs on water pumps and replaced existing three-way valves with two-way valves in the chilled water system. Through logic of design, equipment was staged to balance the load between the variable speed (primary) and the fixed speed chiller (secondary).

Another director emphasized that if absorption chillers are used, a coordinated effort is needed to operate all equipment (steam production and chilled water production) through the energy management system.

To continue to improve and refine his energy control, another director focused on development and customization of the BAS. By writing specific logic for control applications based on sliding windows of energy usage and climate targets, he has been able to achieve long-term, sustainable savings. This hands-on approach requires thorough knowledge of the hospital systems and specific applications to create the ladder logic and instructional sets for comprehensive energy management and control.

For control of equipment outside the power plant, many facility managers have upgraded from older style electric and pneumatic temperature control systems to Direct Digital Control (DDC) systems that can better control outside air mix, temperature, and pressures. Upgraded control packages enable the operating engineer to look at valve position and tighten up temperature band from a central or networked remote computer. This trend to upgrade was not universal, as one facility manager liked the reliability of the pneumatic controls and the ability of his staff to still manually control equipment if a controller failed.

Other EMCS applications cited were:

- Custom designed fan control sequences to maintain proper pressure relationship between patient rooms and corridors
- Control of the building electrical load to eliminate excessive peaks
- Zone temperature monitoring and improved control of zone dampers and VFDs
- Controls to alter set points, such as the use of outside air temperatures to reset hot water temperature

Ventilation

Nearly all facility managers reported that they had completed or were in the process of replacing old air handling units (AHU). Replacement was primarily due to unit age and increased needs for ventilation to support newer clinical procedures. As part of the replacement process, a review of the fresh air needs of the services supplied by the AHU is performed. Former clinical spaces requiring 100 percent outdoor air are often converted to office and administrative spaces. In these cases, facility managers can investigate converting the AHU to a re-circulation system with a new return air fan.

Facility managers have taken advantage of this replacement period to include an economizer mode in the specifications to take advantage of "free cooling" when outside air temperatures are below 50 degrees F. Most facility managers reported that they have incorporated an economizer mode into AHU retrofits or replacements. Through greater use of outside air (below 50 degrees F) they have been able to unload chillers and often close chilled water valves to AHUs. Many facility managers expressed caution on the need to understand the loss of dehumidification when raising chilled water temperature when using economizer mode or when raising discharge air temperatures above 55 degrees F. In dry climates or when the relative humidity outside is low (or if other forms of dehumidification are used) this may not be a problem, but it could be critical for moisture-sensitive areas such as operating rooms.

In addition to adding an economizer mode, specifications packages often included VFDs for areas that can be throttled back like office space and surgical suites. Several facilities use the energy management system to determine when the facility should switch the HVAC systems to an economizer cycle.

If an AHU replacement had not occurred, the need to perform cleaning and repairs to older AHUs was stressed, particularly to cooling coils, coil control valves, and air dampers, making existing AHU more efficient. These improvements not only reduce energy usage, but also improve performance from a user's standpoint. Most high-performing facilities had initiated or completed a program to replace older motors with high-efficiency motors that reduce motor losses by 25 to 30 percent through the reduction of magnetic, heating, friction, windage, and stray load losses.

Many facility managers indicated that their buildings utilized terminal reheat systems. In new construction they had specified the more energy efficient variable air volume (VAV) systems. These were typically installed with sophisticated digital controllers and PC-based,

graphic-intensive control software for improved reporting and visual indication of system performance. The VAV systems utilized variable vanes at the fan inlet to reduce airflow or VFDs to modulate the fan motor speed. Some facility managers expressed concern for maintaining the outside air requirements and potential indoor air quality (IAQ) issues from reduced ventilation.

A few engineering directors described in-house programs where HVAC mechanics replaced two-position controllers with proportional controllers. A common example is replacing room thermostats and valve controllers on hot water valves with radiant panels or reheat coils with a tight throttle range around the setpoint.

Excessive ventilation was a common theme expressed by nearly all facility managers. Strategies to combat this included:

- Investigate hours of operation of exhaust fans, cooking hood, laboratory hoods, and exhausts
- Install zone dampers and motion detectors to reduce airflow in unoccupied spaces
- Reduce airflow to nonessential areas during periods of low activity
- Mechanical retrofit ductwork in areas where 24-hour temperature monitoring and control is essential

One facility manager observed that in Southern states, dehumidification is a major factor especially for operating suites. Energy efficiency and comfort can present competing objectives, but both can be obtained if systems are monitored and controlled properly.

Additional proven strategies from facility managers include:

- Change filters more frequently to reduce total static pressure on air-handling systems.
- Provide interlocks between exhaust fans and laboratories, and kitchens with outside dampers to balance makeup air and exhaust air. Significant savings can be achieved by shutting down exhaust hoods when not in use with a corresponding reduction in outside makeup air.
- Provide untempered air to kitchen range hood exhaust to prevent conditioned air from being exhausted from other spaces in the building through the kitchen.
- Rework 100 percent of outside air systems to return air to the AHU. If this is not feasible, use a heat wheel to recover both sensible and latent heat if the exhaust and supply ducts are in close proximity to each other.
- On AHUs equipped with an outside air economizer, use enthalpy controllers rather than setting changeover at designated outside air temperature. Enthalpy controllers measure humidity and temperature of the return air and outside air so that changeover is based on the total energy content rather than temperature alone.

Miscellaneous

Although not cited as often, many facility managers have also focused on reducing domestic water use. Examples given include:

- Identify water-cooled condensers to upgrade to heat exchangers or air-cooled condensers.
- Trace the condensate path to ensure that there are return lines and that the condensate does not go down the drain. Condensate reuse reduces chemical usage.
- Identify liquid ring pumps and upgrade them to rotary vane vacuum pumps.
- Consider ground irrigation strategies such as irrigation of only presentation areas and the use of vegetation that requires little watering.
- Perform an audit of water (and related chemical treatment usage)—focus on high water-use areas.

On-site laundries have become less common over time. One facility manager whose hospital operated a laundry said their laundry operated on day shift only. They had looked at the load cycles to time down boilers and reduce the control air compressor use during the off shifts.

Likewise, on-site incinerators have become less common with the introduction of more stringent air emissions standards by EPA. One of the top performing hospitals was able offset the cost of scrubber technology and the data logging requirements through reclaiming waste heat to meet 33 percent of their high-pressure steam needs.

One facility manager said that the knowledge gained from energy savings was shared among system hospitals. They had formed a hospital system user group for group purchasing and to compare energy management strategies and techniques with the goal of all hospitals within the system receiving the EPA Energy Star award.

Preventive Maintenance Checklist

1. BUILDING ENVELOPE

Windows and Skylights

- ☐ Replace broken or cracked window panes.
- ☐ Replace worn weather stripping and caulking.
- ☐ Replace defective sealing gaskets and cam latches.

Doors

- ☐ Replace worn weather stripping and caulking.
- ☐ Check automatic door closers for proper operation.
- ☐ Replace defective gaskets on garage doors and other overhead doors.

Exterior Surfaces

- ☐ Replace worn weather stripping, caulking, and gaskets at exterior joints and at openings for electrical conduits, piping, through-the-wall units, and outside air louvers.

Stairwells and Shafts

- ☐ Replace worn seals and weather stripping in stairwells, on penthouse machine-room doors, in elevator shafts, in vertical service shafts, and on basement and roof equipment room doors when they are connected by a vertical shaft that serves the building.

2. HVAC—AIR CONDITIONING EQUIPMENT

Refrigerant Circuit and Controls

- ☐ Inspect the moisture-liquid indicator to ensure that no moisture is in the system.
- ☐ Check for and repair refrigerant and oil leaks around the shaft seal, sight glasses, valve bonnets, flanges, flare connections, and the condenser assembly relief valve.
- ☐ Check for and repair leaks at pipe joints on equipment, valves, and instrumentation.
- ☐ Check for and repair the source of oil spots on connections or under equipment.
- ☐ Inspect the liquid line leaving the strainer.
- ☐ Listen to the system operate for a few minutes and determine the cause of any unusual sounds.
- ☐ Check all gauges frequently to ensure that design conditions are being met.
- ☐ Inspect the tension and alignment of all belts and adjust as needed.
- ☐ Lubricate motor bearings and all moving parts.
- ☐ Inspect the insulation on suction and liquid lines and replace as necessary.

Compressor

- ☐ Check for unusual compressor operation, such as continuous running or frequent stopping and starting.
- ☐ Listen to the compressor operate for a few minutes and determine the cause of any unusual sounds.
- ☐ Check to see that the compressor and motor are securely fastened to the base.
- ☐ Check all compressor joints for leakage.
- ☐ Inspect instrumentation frequently to ensure that the operating oil pressure and temperature agree with manufacturer's specifications.

Air-Cooled Condenser

- ☐ Check the fan belt drive and motor to ensure that they are properly aligned and lubricated.
- ☐ Ensure that refrigerant piping connections to the condenser coil are tight. Check for leaks.
- ☐ Clean the face of the condenser coil.
- ☐ Determine if hot air is being bypassed from the fan outlet to the coil inlet.

Evaporative Condenser

- ☐ Inspect piping joints and check for leaks.
- ☐ Check for dirt on the coil surface.
- ☐ Inspect the air inlet screen, spray nozzles, water distribution hoses, and the pump screen.
- ☐ Check to see if the local water supply leaves surface deposits on the coil.
- ☐ Follow the manufacturer's guidelines for fan and pump maintenance.

Water-Cooled Condenser

- ☐ Clean condenser shells and tubes.

Chillers

- ☐ Inspect for clogging.
- ☐ Keep water-side tubing clean and the refrigerant-side free of noncondensables.

Absorption Equipment

- ☐ Clean the strainer and seal the tank regularly.
- ☐ Lubricate flow valves regularly.
- ☐ Follow the manufacturer's instructions for proper maintenance.

Cooling Towers

- ☐ Conduct a chemical analysis to determine if solid concentrations are being maintained at acceptable levels.
- ☐ Check the overflow pipe's clearance from the normal operating water level.
- ☐ Listen to the fan and determine the cause of any unusual noise or vibration.
- ☐ Inspect the V-belt and the alignment of the fan and motor.
- ☐ Follow the manufacturer's guidelines for fan maintenance.
- ☐ Check to see if the tower is clean.
- ☐ Check to see if the intake strainer is clean.
- ☐ Determine if air is bypassed from the tower outlet back to the inlet.
- ☐ Inspect spray-filled and gravity-distributed towers for proper nozzle performance. Ensure that the nozzles are clean.
- ☐ Inspect gravity-distributed towers for even water depth in the distribution basins.
- ☐ Monitor the effectiveness of any water-treatment programs.

Self-Contained Units (such as window and through-the-wall units and heat pumps)

- ☐ Clean evaporator and condenser coils.
- ☐ Clean air intake louvers, filters, and controls.
- ☐ Keep airflow from units unrestricted.
- ☐ Replace worn caulking in openings between the units and windows or wall frames.
- ☐ Check the voltage to ensure that the unit is operating at full power.
- ☐ Follow applicable maintenance guidelines for compressors, condensers, and fans.

3. HVAC—HEATING EQUIPMENT

Boilers

- ☐ Tune boilers at least annually.
- ☐ Inspect boilers for scale deposits, accumulation of sediment, or boiler compounds on water-side surfaces. The rear of the boiler is the area most susceptible to scale.
- ☐ Inspect the fire-side of the furnace and tubes for deposits of soot, flash, and slag. Pay particular attention to the fire-side refractory surface. Check the temperature at the gas outlet. Adjust the air-to-fuel ratio for a clean-burning fire.
- ☐ Replace door gaskets that do not provide a tight seal.

- ☐ Keep a daily log of pressure, temperature, firing rate, and other data. Look for variations as a way to determine the need for tube and nozzle cleaning, pressure or linkage adjustments, and related measures.
- ☐ Keep stacks free of haze. Adjust the burner if necessary.
- ☐ Tighten linkages when slippage or jerky movements are observed.
- ☐ Observe the fire when the unit shuts down. If the fire does not cut off immediately, the solenoid valve may need to be repaired or replaced.
- ☐ Clean nozzles or cutoffs on oil-fired units as necessary.
- ☐ Check the burner's firing period. If it is too long or too short, controls may be faulty.
- ☐ Check the boiler's stack temperature. If it is too high, clean the tubes and adjust the fuel burner.
- ☐ Inspect all boiler insulation, refractory, and brickwork and the boiler casing for hot spots and air leaks. Repair and seal as necessary.
- ☐ Replace all obsolete or little-used pressure vessels.
- ☐ Clean mineral or corrosion buildup on gas burners.

Central Furnaces, Make-Up Air Heaters, and Unit Heaters

- ☐ Clean all heat exchanger surfaces. Adjust the air-to-fuel ratio as necessary.
- ☐ Inspect burner couplings and linkages.
- ☐ Seal air links in casings as necessary.
- ☐ Repair or replace insulation as necessary.
- ☐ Follow the manufacturer's suggested guidelines for fan and motor maintenance.

Radiators, Convectors, and Baseboard and Finned Tube Units

- ☐ Remove obstructions in front of all units whenever possible. Ensure that air movement in and out of the connector unit is unrestricted.
- ☐ Be sure that air collected in the high points of hydropic units is vented to enable hot water to circulate freely throughout the system.
- ☐ Clean heat transfer surfaces in radiators, convectors, and baseboard and finned-tube units.

Electric Heating

- ☐ Keep the heat transfer surfaces of all electric heating units clean and unobstructed.
- ☐ Keep the air movement in and out of the units unobstructed.
- ☐ Periodically inspect heating elements, controls, and fans.
- ☐ Check reflectors on infrared heaters for cleanliness and proper beam direction.
- ☐ Determine if electric heating equipment is operating at the rated voltage.
- ☐ Check controls for proper operation.

4. HVAC—HUMIDIFICATION AND DEHUMIDIFICATION EQUIPMENT

- ☐ Remove lint and dust from air dampers, fan parts, the spray changers and diffusers, control starters, and eliminators.
- ☐ Check equipment for carryover. Maintain carryover by adjusting eliminator seal gaps, altering damper positions, or changing air velocities.
- ☐ Follow the manufacturer's suggested guidelines for fan and motor maintenance.

5. HVAC—AIR-HANDLING EQUIPMENT

- ☐ Seal leaks in ductwork by taping or caulking and repair or replace ductwork insulation as necessary.
- ☐ Check ductwork access openings for obstructions, such as loose hanging insulation (in lined ducts), loose turning vanes and accessories, and closed fire dampers. Adjust, repair, or replace as necessary.

- ☐ Inspect for buildup of water, condensation, or moisture on insulation and on equipment walls and floors of air handlers. Ensure drip pans and drains are kept clear and free running.
- ☐ Inspect damper blades and linkages. Clean, oil, and adjust regularly.
- ☐ Inspect air valves in dual-duct mixing boxes to ensure full seating and minimum air leakage.
- ☐ Inspect mixing dampers for proper operation.
- ☐ Clean or replace air filters regularly.
- ☐ Clean air heating, cooling, and dehumidification coils regularly.
- ☐ Seal leaks around the coils and casing.
- ☐ Keep all room air outlets and inlets (diffusers, registers, grills) clean and unobstructed.
- ☐ Inspect air washers and evaporative air-cooling equipment for proper operation. Clean damper blades and linkages. Inspect nozzles and clean as necessary.
- ☐ Check electronic air cleaners for excessive accumulations on the ionizing and grounding plate section. Replace filter media as necessary. Follow the manufacturer's instructions whenever adjustments or maintenance are required.
- ☐ Keep humidifier and dehumidifier air dampers, fan parts, spray changers, diffusers, controls, strainers, and eliminators free of dirt, lint, and other foreign particles.
- ☐ Adjust variable air volume boxes so they operate precisely to prevent overheating or overcooling.
- ☐ Follow the manufacturer's guidelines for fan maintenance.

6. MOTORS, FANS, PUMPS, ENGINES, AND TURBINES

Motors

- ☐ Check the alignment of the motor to the equipment it drives. Align and tighten as necessary.
- ☐ Check for and repair loose connections and bad contacts regularly.
- ☐ Determine the cause of excessive vibration and repair as necessary.
- ☐ Clean motors regularly.
- ☐ Lubricate the motor and drive bearings regularly.
- ☐ Replace worn bearings.
- ☐ Tighten belts and pulleys.
- ☐ Check for overheating. If overheating is present, check for functional problems or inadequate ventilation and repair as necessary.
- ☐ Balance three-phase power sources to motors.
- ☐ Check for overvoltage or low-voltage conditions and correct as necessary.

Fans

- ☐ Check for excessive noise and vibration and correct as necessary.
- ☐ Clean fan blades.
- ☐ Inspect and lubricate bearings regularly.
- ☐ Inspect drive belts for proper tension. Adjust or replace as necessary to ensure proper operation.
- ☐ Keep inlet and discharge screens on fans free of dirt and debris.

Pumps

- ☐ Check for packing wear and repack as necessary. Replace glandular packing with mechanical seals.
- ☐ Inspect bearings and drive belts for wear and binding. Adjust, repair, or replace as necessary.

Engines

- ☐ Follow the manufacturer's recommended maintenance procedures.
- ☐ Check fuel consumption and compare it with the designed fuel consumption. If fuel consumption seems to be excessive, determine the cause and correct.
- ☐ Record and check cooling-water temperatures daily. If they exceed the manufacturer's recommendations, check the temperature controls and correct as necessary.

Turbines

- ☐ Follow the manufacturer's recommended maintenance procedures.
- ☐ Record steam pressure and check turbine speed daily.
- ☐ Check the oil level, packing, and governor and throttle valve operation regularly and correct any problems as necessary.
- ☐ Record and check bearing temperatures and oil cooler temperatures. If they exceed the manufacturer's recommendations, check the temperature controls and correct as necessary.
- ☐ Check for vibration weekly and correct as necessary.

7. HOT- AND CHILLED-WATER PIPING

- ☐ Inspect and test all controls for proper operation and leakage at joints. Adjust, repair, or replace as necessary.
- ☐ Check flow measurement instrumentation for accuracy. Adjust, repair, or replace as necessary.
- ☐ Repair or replace insulation as necessary. Replace any insulation damaged by water. Determine the source of the water and correct.
- ☐ Clean strainers regularly.
- ☐ Inspect heating and cooling heat exchangers. Temperature differences may be an indication of air binding, clogged strainers, or excessive amounts of scale. Determine the cause of the condition and correct.
- ☐ Remove clogs from vents.

8. STEAM PIPING

- ☐ Repair or replace insulation on all mains, risers, and branches as well as economizers and condensate receiver tanks as necessary.
- ☐ Check the automatic temperature-control system and related control valves and accessory equipment to ensure they are regulating the system properly in the various zones.
- ☐ Inspect zone shutoff valves and shut off steam going into unoccupied spaces.
- ☐ Adjust, repair, or replace any faulty steam traps.
- ☐ Adjust, repair, or replace pressure-reducing and regulating valves and related equipment as necessary.
- ☐ Adjust, repair, or replace condensate tank vents as necessary.
- ☐ Check the accuracy of recording pressure gauges and thermometers.
- ☐ Inspect the pump for satisfactory operation, particularly for leakage at packing glands.
- ☐ Correct sluggish or uneven steam circulation.
- ☐ Correct any excessive noise in the system, particularly water hammer.
- ☐ Repair leaks in the vacuum return system.

9. PNEUMATIC AIR COMPRESSOR FOR CONTROLS

- ☐ Repair any air leaks, particularly at connections.
- ☐ Note compressor operation. If it seems to run excessively, there could be pressure loss at the controls or somewhere in the piping system. Determine the cause and correct.
- ☐ Inspect the air pressure in the supply tank and pressure-regulator adjustment in the supply line for proper limits.
- ☐ Check belt tension and alignment.
- ☐ Clean or replace air compressor-intake filter pads as necessary.
- ☐ Lubricate electric motor bearings according to the manufacturer's recommendations.

10. LIGHTING

- ☐ Wipe lamps clean at regular intervals. Lamps that are exposed to substantial amounts of dirt, dust, grease, or other contaminants should be cleaned more frequently than lamps in a relatively clean atmosphere.
- ☐ Maintain luminare efficiency by properly cleaning the reflecting surfaces and shielding media.
- ☐ Replace lens shielding that has yellowed or become hazy with a clear acrylic lens with good non-yellowing properties. A clear glass lens can be considered if it is compatible with the luminare and does not present a safety hazard.
- ☐ Clean ceilings, walls, and floors frequently to improve reflective qualities.
- ☐ If daylighting contributes to lighting, wash windows frequently to maintain illumination levels.
- ☐ Replace *all* lamps used for area illumination after they have been in service for a substantial portion (approximately 70 percent) of their rated life, instead of simply replacing lamps one at a time as they burn out.

11. DOMESTIC HOT WATER

- ☐ Inspect pipes and tanks frequently. Repair or replace loose or hanging insulation. If insulation is water-damaged, locate the source of the water, repair it, and install new insulation.
- ☐ Repair all leaking faucets.
- ☐ Flush the water heater during seasonal maintenance of the heating system.
- ☐ Repack circulating pump packing glands to reduce hot water leakage. Replace glandular packing with mechanical seals.
- ☐ In the case of oil- or gas-fired water heaters, routinely check for smoky exhaust, high-stack temperatures, and high levels of carbon dioxide. Adjust the air-to-fuel ratio to optimum levels (proper settings can be obtained from local utilities and suppliers.)
- ☐ Be sure that boiler water covers service hot water coils (if applicable).

12. COMMERCIAL REFRIGERATION

- ☐ Clean display fixtures and cooler coils regularly. Be sure to shut off refrigeration before using water for cleaning.
- ☐ Replace worn refrigeration seals.
- ☐ Check all electrical circuits for power leaking to the ground.
- ☐ Check all systems for the correct refrigerant charge to avoid excessive compressor operation. Shortages usually will show up during low ambient air conditions.
- ☐ Check all multi-shelf fixtures for inoperative fan motors.

13. ELECTRICAL SYSTEMS

Electrical Distribution System

- ☐ Conduct a load survey of the building's electrical distribution system. Check for low voltage conditions, overvoltage, loose connections and bad contacts, unbalanced voltages, and power leaks to ground.
- ☐ Check voltage at the terminals of power and lighting circuits regularly.

Electric Motors

- ☐ Lubricate the motor and drives regularly.
- ☐ Replace worn motor bearings.
- ☐ Keep motors clean.
- ☐ Check the alignment between the motor and the equipment it drives and adjust if necessary.
- ☐ Tighten belts and pulleys at regular intervals.

A SUMMARY STATISTICS

This appendix contains the summary of the data from the comprehensive surveys, with columns for the top performers, bottom performers, and all performers. See Appendix B for a copy of the actual survey tool. See Appendix E for a copy of this data that has been highlighted to show the differences between top and bottom performers.

SUMMARY STATISTICS			Top Quartile Count	n = 30 Average	Bottom Quartile Count	n = 30 Average	All Data Count	n = 121 Average
5. Census division								
	East N. Central		10	33.3%	11	36.7%	35	28.9%
	East S. Central		0	0.0%	3	10.0%	6	5.0%
	Mid Atlantic		1	3.3%	1	3.3%	9	7.4%
	Mountain		5	16.7%	0	0.0%	11	9.1%
	New England		2	6.7%	1	3.3%	7	5.8%
	Pacific		5	16.7%	3	10.0%	15	12.4%
	S. Atlantic		4	13.3%	4	13.3%	16	13.2%
	West N. Central		0	0.0%	4	13.3%	12	9.9%
	West S. Central		3	10.0%	3	10.0%	10	8.3%
	TOTAL		30	100.0%	30	100.0%	121	100.0%
5+. Census region								
	Midwest		10	33.3%	15	50.0%	47	38.8%
	Northeast		3	10.0%	2	6.7%	16	13.2%
	South		7	23.3%	10	33.3%	32	26.4%
	West		10	33.3%	3	10.0%	26	21.5%
	TOTAL		30	100.0%	30	100.0%	121	100.0%
6. Adjusted patient days				77928.7		83986.4667		86835.2975
8a. Fuel Used								
	8ai Heating							
		district heat	2	6.7%	1	3.3%	9	7.4%
		electricity	9	30.0%	8	26.7%	31	25.6%
		fuel oil #2	14	46.7%	16	53.3%	64	52.9%
		fuel oil #6	1	3.3%	2	6.7%	4	3.3%
		natural gas	28	93.3%	27	90.0%	107	88.4%
		propane	1	3.3%	0	0.0%	0	0.0%
		steam	1	3.3%	0	0.0%	2	1.7%
		other	1	3.3%	0	0.0%	2	1.7%
		TOTAL	57	190.0%	54	180.0%	219	181.0%
		Quantities total more than 100% because multiple values can occur						
	8aii Cooling							
		district chilled water	3	10.0%	1	3.3%	9	7.4%
		electricity	29	96.7%	29	96.7%	113	93.4%
		natural gas	3	10.0%	6	20.0%	12	9.9%
		propane	0	0.0%	0	0.0%	0	0.0%
		steam	0	0.0%	0	0.0%	4	3.3%
		other	1	3.3%	0	0.0%	3	2.5%
		TOTAL	36	120.0%	36	120.0%	141	116.5%

SUMMARY STATISTICS			Top Quartile Count	n = 30 Average	Bottom Quartile Count	n = 30 Average	All Data Count	n = 121 Average
	8aiii Water Heating							
		district heat	1	3.3%	1	3.3%	8	6.6%
		electricity	4	13.3%	4	13.3%	14	11.6%
		fuel oil	7	23.3%	6	20.0%	33	27.3%
		natural gas	24	80.0%	20	66.7%	84	69.4%
		propane	0	0.0%	0	0.0%	0	0.0%
		steam	5	16.7%	4	13.3%	20	16.5%
		other	0	0.0%	0	0.0%	0	0.0%
		TOTAL	41	136.7%	35	116.7%	159	131.4%
	8aiv Cooking							
		electricity	19	63.3%	19	63.3%	74	61.2%
		natural gas	24	80.0%	25	83.3%	93	76.9%
		propane	0	0.0%	1	3.3%	4	3.3%
		None	0	0.0%	1	3.3%	4	3.3%
		steam	2	6.7%	2	6.7%	10	8.3%
		other	0	0.0%	0	0.0%	0	0.0%
		TOTAL	45	150.0%	48	160.0%	185	152.9%
	8av Laundry							
		electricity	1	3.3%	3	10.0%	8	6.6%
		natural gas	9	30.0%	10	33.3%	33	27.3%
		None	19	63.3%	11	36.7%	67	55.4%
		steam	2	6.7%	2	6.7%	6	5.0%
		other	1	3.3%	0	0.0%	3	2.5%
		TOTAL	32	106.7%	26	86.7%	117	96.7%
8b.	*Primary Heating Source*							
		district heating	2	6.7%	1	3.3%	10	8.3%
		furnace	0	0.0%	0	0.0%	1	0.8%
		geothermal	0	0.0%	0	0.0%	0	0.0%
		heat pump	0	0.0%	0	0.0%	0	0.0%
		heating hot water	5	16.7%	3	10.0%	20	16.5%
		solar	0	0.0%	0	0.0%	0	0.0%
		steam absorption	0	0.0%	0	0.0%	0	0.0%
		steam boiler	23	76.7%	23	76.7%	85	70.2%
		other	0	0.0%	0	0.0%	1	0.8%
		TOTAL	30	100.0%	27	90.0%	117	96.7%
8c.	*Size of Heating System*							
		BTU/hr	8	12797037.5	12	11211900	34	8988941.2
		hp	17	993.8	18	2094.2	73	240.1
Note: Respondents used a variety of notations to express question 8c values so this data may not be accurate								

SUMMARY STATISTICS			Top Quartile n = 30		Bottom Quartile n = 30		All Data n = 121	
			Count	Average	Count	Average	Count	Average
8d.	*Primary Cooling Source*							
		air-cooled chiller	3	10.0%	0	0.0%	8	6.6%
		district chilled water	3	10.0%	1	3.3%	8	6.6%
		evaporative or desiccant cooling	2	6.7%	0	0.0%	5	4.1%
		geothermal (ground water)	1	3.3%	0	0.0%	1	0.8%
		unitary air conditioner (refrigera	1	3.3%	1	3.3%	7	5.8%
		thermal storage	0	0.0%	1	3.3%	1	0.8%
		water-cooled chiller	21	70.0%	27	90.0%	90	74.4%
		other	0	0.0%	0	0.0%	2	1.7%
		TOTAL	31	103.3%	30	100.0%	122	100.8%
8e	*Size of Cooling Source*							
		Tons	26	2375.7	28	2171.8	107	2002.0
8f.	*Primary Type of Air Handling System*							
		single-duct-constant volume	7	23.3%	8	26.7%	30	24.8%
		single-duct-variable volume	10	33.3%	4	13.3%	34	28.1%
		dual-duct-constant volume	0	0.0%	6	20.0%	19	15.7%
		dual-duct-variable volume	1	3.3%	5	16.7%	10	8.3%
		multi-zone-constant volume	5	16.7%	2	6.7%	14	11.6%
		multi-zone-variable volume	7	23.3%	4	13.3%	17	14.0%
		multi-zone-three-deck	0	0.0%	0	0.0%	0	0.0%
		other	0	0.0%	1	3.3%	1	0.8%
		TOTAL	30	100.0%	30	100.0%	125	103.3%
8g. Air-handling system economizer cycle in use?			24	80.0%	27	90.0%	106	87.6%
8h.	*Primary Domestic Water Heating System*							
		centralized system	22	73.3%	20	66.7%	75	62.0%
		distributed system	4	13.3%	2	6.7%	17	14.0%
		combination	4	13.3%	7	23.3%	24	19.8%
		other	0	0.0%	0	0.0%	2	1.7%
		Total	30	100.0%	29	96.7%	118	97.5%

SUMMARY STATISTICS			Top Quartile n = 30		Bottom Quartile n = 30		All Data n = 121	
			Count	Average	Count	Average	Count	Average
8i. Primary lighting types (>10%)								
	8i_i Fluorescent							
		compact fluorescent	11	36.7%	4	13.3%	29	24.0%
		tube	14	46.7%	15	50.0%	61	50.4%
		electronic ballasts	26	86.7%	24	80.0%	97	80.2%
		magnetic ballasts	5	16.7%	5	16.7%	25	20.7%
	8i_ii High Intensity Discharge							
		high-pressure sodium	17	56.7%	11	36.7%	48	39.7%
		mercury vapor	2	6.7%	4	13.3%	13	10.7%
		metal halide	6	20.0%	7	23.3%	32	26.4%
	8i_iii Incandescent Bulbs							
		parabolic aluminized reflectors	2	6.7%	0	0.0%	7	5.8%
		reflector lamps	5	16.7%	7	23.3%	18	14.9%
		standard incandescent	19	63.3%	15	50.0%	75	62.0%
		halogen	7	23.3%	1	3.3%	11	9.1%
	8i_iv Low-pressure sodium		4	13.3%	2	6.7%	9	7.4%
	8i_v Sulfur		0	0.0%	0	0.0%	0	0.0%
	Other		0	0.0%	0	0.0%	1	0.8%
	Total		118	393.3%	95	316.7%	426	352.1%
9. Solar energy used								
		passive heating	2	6.7%	1	3.3%	5	4.1%
		passive cooling	1	3.3%	1	3.3%	5	4.1%
		active thermal heating	0	0.0%	0	0.0%	0	0.0%
		active thermal cooling	0	0.0%	0	0.0%	1	0.8%
		ventilation preheating	0	0.0%	0	0.0%	0	0.0%
		None	27	90.0%	28	93.3%	109	90.1%
		other	0	0.0%	0	0.0%	0	0.0%
		Total	30	100.0%	30	100.0%	120	99.2%
10. Does facility have energy saving performance contracts			3	10.0%	2	6.7%	19	15.7%
12. In what capacity have you worked with ESCOs?								
		they financed energy-efficient eq	7	23.3%	0	0.0%	11	9.1%
		they installed energy-efficient eq	6	20.0%	4	13.3%	19	15.7%
		they staff, operate, and maintain	0	0.0%	0	0.0%	0	0.0%
		None	17	56.7%	24	80.0%	81	66.9%
		other	3	10.0%	0	0.0%	10	8.3%
		Total	33	110.0%	28	93.3%	121	100.0%

SUMMARY STATISTICS			Top Quartile n = 30		Bottom Quartile n = 30		All Data n = 121	
			Count	Average	Count	Average	Count	Average
13. Participation in supply-side management								
		choosing provider in a deregulat	15	50.0%	15	50.0%	60	49.6%
		consumption auditing	7	23.3%	10	33.3%	36	29.8%
		rate review	11	36.7%	13	43.3%	51	42.1%
		real-time pricing	3	10.0%	3	10.0%	8	6.6%
		variable rate pricing	7	23.3%	8	26.7%	27	22.3%
		None	9	30.0%	8	26.7%	30	24.8%
		other	1	3.3%	0	0.0%	2	1.7%
		Total	53	176.7%	57	190.0%	214	176.9%
14. Type of cogeneration used								
		reciprocal engines	0	0.0%	1	3.3%	2	1.7%
		turbines	0	0.0%	0	0.0%	2	1.7%
		Do not cogenerate	24	80.0%	29	96.7%	106	87.6%
		other	1	3.3%	0	0.0%	2	1.7%
		Total	25	83.3%	30	100.0%	112	92.6%
15. What are you doing with the waste heat?								
		absorption cooling	0	0.0%	0	0.0%	1	0.8%
		high-pressure steam	1	3.3%	0	0.0%	5	4.1%
		Do not cogenerate	20	66.7%	28	93.3%	96	79.3%
		other	0	0.0%	1	3.3%	1	0.8%
		Total	21	70.0%	29	96.7%	103	85.1%
16 Amount of energy you are generating and buying				Amt gen.		Amt gen.		Amt gen.
		generating	1	5%	1	21.5%	2	5.0%
			1	12%	2	25.0%	1	12.0%
					1	100.0%	1	15.0%
							2	25.0%
							1	98%
							2	100%
		other answers	0		2		3	
		buying	1	88%	2	75.0%	1	2%
			1	95%	1	78.5%	2	75.0%
			17	100%	20	100.0%	1	78.5%
							1	85%
							1	88%
							1	95%
							78	100%
		other answers	1		0		3	
17. Have you participated in demand-side management in			14	46.7%	12	40.0%	59	48.8%
18. Are EMCS/BAS in use?			27	90.0%	25	83.3%	106	87.6%

Note: Question 16 is formatted slightly differently because of the nature of the response. For example, in the top quartile one respondent said they generated 5 percent of their energy and another said they generated 12 percent and so on.

SUMMARY STATISTICS			Top Quartile n = 30		Bottom Quartile n = 30		All Data n = 121	
			Count	Average	Count	Average	Count	Average
19 Year EMCS/BAS installed or last upgraded.								
		2002	6	20.0%	5	16.7%	21	17.4%
		2001	3	10.0%	5	16.7%	12	9.9%
		2000	3	10.0%	1	3.3%	8	6.6%
		1999	1	3.3%	1	3.3%	5	4.1%
		1998	1	3.3%	2	6.7%	6	5.0%
		1997	1	3.3%	2	6.7%	3	2.5%
		Before 1997	7	23.3%	10	33.3%	37	30.6%
		Continuously	0	0.0%	1	3.3%	2	1.7%
		None	8	26.7%	3	10.0%	27	22.3%
		Total	30	100.0%	30	100.0%	121	100.0%
20. Areas your EMCS/BAS cover								
		air handlers	27	90.0%	24	80.0%	105	86.8%
		boilers	15	50.0%	10	33.3%	53	43.8%
		chiller plant optimization	22	73.3%	20	66.7%	86	71.1%
		exterior lighting control	7	23.3%	1	3.3%	20	16.5%
		fan/pump speed control	22	73.3%	20	66.7%	86	71.1%
		hot water systems	16	53.3%	10	33.3%	58	47.9%
		humidity control	19	63.3%	19	63.3%	77	63.6%
		interior lighting control	4	13.3%	2	6.7%	12	9.9%
		medical office hours	9	30.0%	3	10.0%	29	24.0%
		peak demand limiting	4	13.3%	3	10.0%	15	12.4%
		per room temp schedule	9	30.0%	5	16.7%	36	29.8%
		VFDs	19	63.3%	17	56.7%	84	69.4%
		other	1	3.3%	1	3.3%	5	4.1%
		Total	174	580.0%	135	450.0%	666	550.4%
21. Do you practice condition-based management?			7	23.3%	7	23.3%	27	22.3%
23. 5 highest Priority O&M Energy Conservation Strategies			105	350.0%	58	193.3%	381	314.9%
24. Main equipment replaced in the last five years								
		air handling	12	40.0%	18	60.0%	61	50.4%
		cooking	10	33.3%	7	23.3%	30	24.8%
		cooling	18	60.0%	17	56.7%	68	56.2%
		heating hot water	5	16.7%	8	26.7%	30	24.8%
		laundry	5	16.7%	2	6.7%	15	12.4%
		water heating	9	30.0%	9	30.0%	40	33.1%
		None	5	16.7%	6	20.0%	21	17.4%
		other	1	3.3%	0	0.0%	6	5.0%
		Total	65	216.7%	67	223.3%	271	224.0%

SUMMARY STATISTICS			Top Quartile n = 30		Bottom Quartile n = 30		All Data n = 121	
			Count	Average	Count	Average	Count	Average
25. Types of HVAC conservation features installed in the last five years								
		economizer cycle	11	36.7%	9	30.0%	44	36.4%
		EMCS	10	33.3%	12	40.0%	48	39.7%
		HVAC maintenance	16	53.3%	13	43.3%	63	52.1%
		VAV system	14	46.7%	14	46.7%	58	47.9%
		None	5	16.7%	10	33.3%	26	21.5%
		other	3	10.0%	1	3.3%	7	5.8%
		Total	59	196.7%	59	196.7%	246	203.3%
26. Types of building shell conservation features installed in the last five years								
		exterior/interior shadings or awn	3	10.0%	1	3.3%	16	13.2%
		insulation	7	23.3%	3	10.0%	20	16.5%
		landscaping	2	6.7%	2	6.7%	15	12.4%
		multi-paned doors	1	3.3%	2	6.7%	7	5.8%
		multi-paned windows	4	13.3%	7	23.3%	23	19.0%
		seals	6	20.0%	4	13.3%	21	17.4%
		tinted, reflective, shaded glass	7	23.3%	7	23.3%	35	28.9%
		None	13	43.3%	17	56.7%	56	46.3%
		other	4	13.3%	0	0.0%	6	5.0%
		Total	47	156.7%	43	143.3%	199	164.5%
27. Types of lighting conservation features installed in the last five years								
		daylighting	4	13.3%	2	6.7%	8	6.6%
		dimmers	8	26.7%	5	16.7%	24	19.8%
		electronic ballasts	26	86.7%	21	70.0%	93	76.9%
		improved reflectors	11	36.7%	8	26.7%	32	26.4%
		occupancy sensors	13	43.3%	11	36.7%	51	42.1%
		photocells	13	43.3%	7	23.3%	36	29.8%
		reduced wattage	19	63.3%	19	63.3%	71	58.7%
		relamping	17	56.7%	13	43.3%	65	53.7%
		timers	7	23.3%	5	16.7%	23	19.0%
		None	1	3.3%	3	10.0%	13	10.7%
		other	2	6.7%	1	3.3%	9	7.4%
		Total	121	403.3%	95	316.7%	425	351.2%

SUMMARY STATISTICS			Top Quartile n = 30		Bottom Quartile n = 30		All Data n = 121	
			Count	Average	Count	Average	Count	Average
28. What O&M procedures are used for HVAC system?								
		air balancing	22	73.3%	20	66.7%	84	69.4%
		chemical treatment of closed-loo	26	86.7%	30	100.0%	114	94.2%
		coil cleaning and maintenance	27	90.0%	30	100.0%	111	91.7%
		descale for boilers	17	56.7%	16	53.3%	74	61.2%
		filter replacement	30	100.0%	30	100.0%	117	96.7%
		monitor operating conditions	21	70.0%	23	76.7%	97	80.2%
		monitor part-load performance	7	23.3%	6	20.0%	29	24.0%
		piping insulation	24	80.0%	26	86.7%	96	79.3%
		secondary chilled water loop flo	13	43.3%	7	23.3%	46	38.0%
		steam trap inspection program fo	17	56.7%	20	66.7%	79	65.3%
		trending	12	40.0%	13	43.3%	52	43.0%
		water treatment for boilers	23	76.7%	26	86.7%	98	81.0%
		ultrasonic flow-measuring device	5	16.7%	5	16.7%	14	11.6%
		other	2	6.7%	1	3.3%	8	6.6%
		Total	246	820.0%	253	843.3%	1019	842.1%
29. What O&M procedures are used for water heating system?								
		chemical treatment of closed-loo	21	70.0%	19	63.3%	80	66.1%
		descale for boilers	12	40.0%	7	23.3%	39	32.2%
		water treatment for boilers	27	90.0%	22	73.3%	82	67.8%
		other	0	0.0%	0	0.0%	2	1.7%
		Total	60	200.0%	48	160.0%	203	167.8%
30. What O&M procedures are used for cooling towers?								
		motors organized as cell	8	26.7%	12	40.0%	35	28.9%
		ozonation	0	0.0%	2	6.7%	3	2.5%
		staging with variable frequency	16	53.3%	16	53.3%	64	52.9%
		other	2	6.7%	2	6.7%	12	9.9%
		Total	26	86.7%	32	106.7%	114	94.2%
31. What O&M procedures are used for lighting?								
		contracted lighting replacement	2	6.7%	3	10.0%	9	7.4%
		fixture cleaning	13	43.3%	8	26.7%	41	33.9%
		zone maintenance, daily checks	20	66.7%	16	53.3%	77	63.6%
		other	3	10.0%	2	6.7%	7	5.8%
		Total	38	126.7%	29	96.7%	134	110.7%
32. What O&M procedures are used for building envelope?								
		annual roof inspection	27	90.0%	24	80.0%	104	86.0%
		caulking inspection	17	56.7%	10	33.3%	54	44.6%
		other	2	6.7%	1	3.3%	7	5.8%
		Total	46	153.3%	35	116.7%	165	136.4%

SUMMARY STATISTICS			Top Quartile n = 30		Bottom Quartile n = 30		All Data n = 121	
			Count	Average	Count	Average	Count	Average
33. What O&M procedures are used for cooking equipment?								
		PM program for cooking equip	24	80.0%	15	50.0%	88	72.7%
		PM program fro refrigerators	25	83.3%	24	80.0%	98	81.0%
		vendor contract-O&M of cooking	7	23.3%	15	50.0%	31	25.6%
		vendor contract-O&M of refrigera	3	10.0%	6	20.0%	13	10.7%
		other	0	0.0%	0	0.0%	0	0.0%
		Total	59	196.7%	60	200.0%	230	190.1%
34. What O&M procedures are used for laundry equipment?								
		checks of ironer temp	6	20.0%	3	10.0%	13	10.7%
		daily monitoring of kWhs	2	6.7%	0	0.0%	2	1.7%
		daily monitoring of gallons of wa	5	16.7%	1	3.3%	9	7.4%
		flame testing of dryer burners	0	0.0%	2	6.7%	3	2.5%
		outsourced chemical treatment c	3	10.0%	4	13.3%	15	12.4%
		monitoring of PSI on extractors	0	0.0%	0	0.0%	1	0.8%
		recover/reuse wastewater	3	10.0%	1	3.3%	8	6.6%
		recover heat from wastewater	4	13.3%	0	0.0%	6	5.0%
		None (outsource laundry)	20	66.7%	16	53.3%	78	64.5%
		other	1	3.3%	0	0.0%	1	0.8%
		Total	44	146.7%	27	90.0%	136	112.4%
35 Number of facilities reporting O&M procedures eliminate			2	6.7%	4	13.3%	11	9.1%
36 Year of Last Energy Audit								
		2002	3	10.0%	4	13.3%	19	15.7%
		2001	3	10.0%	4	13.3%	11	9.1%
		2000	1	3.3%	0	0.0%	9	7.4%
		1999	1	3.3%	1	3.3%	6	5.0%
		1998	3	10.0%	2	6.7%	10	8.3%
		1997	0	0.0%	0	0.0%	1	0.8%
		Before 1997	7	23.3%	10	33.3%	29	24.0%
		None	12	40.0%	9	30.0%	36	29.8%
		Total	30	100.0%	30	100.0%	121	100.0%
37. Who performed audit?								
		consultant	7	23.3%	15	50.0%	46	38.0%
		internal	4	13.3%	3	10.0%	12	9.9%
		energy supplier	3	10.0%	3	10.0%	12	9.9%
		ESCO	3	10.0%	1	3.3%	14	11.6%
		other	1	3.3%	1	3.3%	4	3.3%
		Total	18	60.0%	23	76.7%	88	72.7%
38 Number of facilities reporting measure that were implemented and not implemented.								
		Recommended	41	136.7%	37	123.3%	232	191.7%
		Not implemented	5	16.7%	3	10.0%	35	28.9%
39 Number of facilites reporting that recommended measures not implemented								
			4	13.3%	5	16.7%	29	24.0%

B SURVEY TOOL

Healthcare Energy Project Survey Tool

The survey tool completed by participants in the Healthcare Energy Project (HEP) was provided as an electronic form in Microsoft Word format by e-mail. Participants completed the form and then returned it by e-mail. Another option for the survey tool was a hard-copy form that could be returned by FAX or mail.

The hard-copy version of the HEP survey tool follows. Appendix D contains the definitions that accompanied this survey.

Healthcare Energy Project (HEP) Code: HEP

Confidential Study

Please be sure to check all appropriate boxes and provide your best data available for the values requested. To clarify any question, refer to the accompanying definitions.

1. What is your mailing address? _____
2. What is your phone number?_____
3. What is your e-mail address? _____
4. What is your zip code? _____
5. What is your Census division? *(Check one)*

   ☐ New England (CT-MA-ME-NH-RI-VT) ☐ East S. Central (AL-KY-MI-TN)

   ☐ Mid Atlantic (NY-NJ-PA) ☐ West S. Central (AR-LA-OK-TX)

   ☐ East N. Central (IL-IN-MI-OH-WI) ☐ Mountain (AZ-CO-ID-MT-NM-NV-WY)

   ☐ West N. Central (IA-KS-MN-MO-NE-ND-SD)

   ☐ Pacific (AK-CA-HI-OR-WA)

   ☐ S. Atl. (DE-DC-FL-GA-MD-NC-SC-VA-WV)
6. What are your annual adjusted patient days? _____
7. What is the name of the building for this Study [must be identical to the name used in EPA Energy Star Survey (HEPXXXX.xls)]? _____

Note: For multiple buildings, please complete a separate HEP Study form for each building you would like to include. Use a different name for each building. For multiple campuses, prefix each building name with a C2 for the second campus, a C3 for the third campus, etc. (Example, the Lester Building on the second campus would become C2Lester).

8. For the building named above:

   a) Fuel used *(Check all that apply)*

      i. Heating fuel

      ☐ District heat ☐ Electricity ☐ Fuel oil – #2

      ☐ Fuel oil – #6 ☐ Natural gas ☐ Propane

      Other _____

      ii. Cooling fuel

      ☐ District chilled water ☐ Electricity ☐ Natural gas

      ☐ Propane Other _____

iii. Water Heating fuel

☐ District heat ☐ Electricity ☐ Fuel oil

☐ Natural gas ☐ Propane

Other _____

iv. Cooking fuel

☐ Electricity ☐ Natural gas ☐ Propane

☐ None Other _____

v. Laundry – fuel for drying and any additional water heating

☐ Electricity ☐ Natural gas

☐ None Other _____

b) Primary heating source? *(Check only one)*

☐ District heating ☐ Furnace ☐ Geothermal

☐ Heat pump ☐ Heating hot water ☐ Solar

☐ Steam absorption ☐ Steam boiler

Other _____

c) Size of heating system? _____ Btu/hr or _____ hp

d) Primary cooling source? *(Check only one primary source)*

☐ Air-cooled chiller ☐ District chilled water

☐ Evaporative or desiccant cooling ☐ Water-cooled chiller

☐ Geothermal (ground water) ☐ Thermal storage

☐ Unitary air conditioner (Refrigerant based)

Other _____

e) Total cooling source capacity in tons? _____

f) Primary type of air handling system? *(Check only one)*

☐ Single-duct – constant volume ☐ Single-duct – variable volume

☐ Dual-duct – constant volume ☐ Dual-duct – variable volume

☐ Multi-zone – constant volume ☐ Multi-zone – variable volume

☐ Multi-zone – three-deck Other _____

g) Does the air-handling system have an economizer cycle feature in use? *(Check one)*

☐ Yes ☐ No

h) Primary domestic water heating system for this building? *(Check only one)*

☐ Centralized system ☐ Distributed system

☐ Combination of centralized and distributed system

Other _____

i) Primary lighting types used in the building (>10%)

i. Fluorescent

☐ Compact fluorescent ☐ Tube

☐ Electronic ballasts ☐ Magnetic ballasts

ii. High intensity discharge

☐ High-pressure sodium ☐ Mercury vapor

☐ Metal halide

iii. Incandescent bulbs

☐ Parabolic aluminized reflectors ☐ Reflector lamps

☐ Standard incandescent ☐ Halogen

iv. ☐ Low-pressure sodium

v. ☐ Sulfur

vi. Other _____

9. What solar energy does your facility use*? (Check all that apply)*

☐ Passive heating ☐ Passive cooling

☐ Active thermal heating ☐ Active thermal cooling

☐ Ventilation preheating (transpired solar collectors)

☐ None Other _____

10. Does your facility have energy savings performance contracts? *(Check one)*

☐ Yes ☐ No (Skip to Question 10)

11. If yes, please describe briefly: _____

12. In what capacity have you worked with ESCOs? *(Check all that apply)*

☐ They financed energy-efficient equipment

☐ They installed energy-efficient equipment

☐ They staff, operate, and maintain facility

☐ None

Other _____

13. In what ways have you participated in supply-side management? *(Check all that apply)*

☐ Choosing provider in a deregulated market

☐ Consumption auditing ☐ Rate review

☐ Real-time pricing ☐ Variable rate pricing

☐ None Other _____

14. What type of cogeneration are you using? *(Check all that apply)*

☐ Reciprocal engines ☐ Turbines

☐ Do not cogenerate Other _____

15. What are you doing with the waste heat?

☐ Absorption cooling ☐ High-pressure steam

☐ Do not cogenerate Other _____

16. How much energy are you generating and buying?

Generating _____

Buying _____

17. Have you participated in demand-side management in the past 5 years? *(Check one)*

☐ Yes ☐ No (Skip to Question 19)

18. Are you using an energy management and control system/building automation system (EMCS/BAS)? *(Check one)*

☐ Yes ☐ No (Skip to Question 19)

19. When was your EMCS/BAS installed or upgraded? *(Check one)*

☐ 2002 ☐ 1999 ☐ Before 1997

☐ 2001 ☐ 1998

☐ 2000 ☐ 1997

20. What areas does your EMCS/BAS cover? *(Check all that apply)*

☐ Air handlers ☐ Boilers

☐ Chiller plant optimization ☐ Exterior lighting control

☐ Fan/pump speed control ☐ Hot water systems

☐ Humidity control ☐ Interior lighting control

☐ Medical offices hours ☐ Peak demand limiting

☐ Per room temperature scheduling ☐ VFDs

Other _____

21. Do you practice condition-based management? *(Check one)*

☐ Yes ☐ No (Skip to Question 21)

22. If Yes, describe briefly: _____

_____

23. What are the 5 highest-priority O&M Energy Conservation strategies that you practice for this building?

    a. _____

    b. _____

    c. _____

    d. _____

    e. _____

24. What main equipment have you replaced in the last 5 years? *(Check all that apply and describe briefly)*

    ☐ Air handling _____

    ☐ Cooking _____

    ☐ Cooling _____

    ☐ Heating _____

    ☐ Laundry _____

    ☐ Water heating _____

    ☐ None Other _____

25. What types of HVAC conservation features have you installed in the last 5 years? *(Check all that apply)*

    ☐ Economizer cycle ☐ EMCS

    ☐ HVAC maintenance ☐ VAV system

    ☐ None Other _____

26. What types of building shell conservation features have you installed in the last 5 years? *(Check all that apply)*

    ☐ Exterior/interior shadings or awnings ☐ Insulation

    ☐ Landscaping ☐ Multi-paned doors

    ☐ Multi-paned windows ☐ Seals

    ☐ Tinted, reflective, or shaded glass

    ☐ None Other _____

27. What types of lighting conservation features have you installed in the last 5 years? *(Check all that apply)*

    ☐ Daylighting ☐ Dimmers ☐ Electronic ballasts

    ☐ Improved reflectors ☐ Occupancy sensors ☐ Photocells

    ☐ Reduced wattage ☐ Relamping ☐ Timers

    ☐ None Other _____

28. For your HVAC system, what O&M procedures do you use? *(Check all that apply)*

- ☐ Air Balancing
- ☐ Chemical treatment of closed-loop system
- ☐ Coil cleaning and maintenance
- ☐ Descale for boilers
- ☐ Filter replacement
- ☐ Monitor operating conditions
- ☐ Monitor part-load performance
- ☐ Secondary chilled water loop flow measuring
- ☐ Piping insulation
- ☐ Steam trap inspection program for boilers
- ☐ Trending
- ☐ Water treatment for boilers
- ☐ Ultrasonic flow-measuring device for chillers

Other _____

29. For your water heating system, what O&M procedures do you use? *(Check all that apply)*

- ☐ Chemical treatment
- ☐ Descale
- ☐ Water treatment

Other _____

30. For your cooling towers, what O&M procedures do you use? *(Check all that apply)*

- ☐ Motors organized as cell
- ☐ Ozonation
- ☐ Staging with variable frequency drives

Other _____

31. For your lighting, what O&M procedures do you use? *(Check all that apply)*

- ☐ Contracted lighting replacement program
- ☐ Fixture cleaning
- ☐ Zone maintenance, daily checks

Other _____

32. For your building envelope, what O&M procedures do you use? *(Check all that apply)*

- ☐ Annual roof inspection
- ☐ Caulking inspection

Other _____

33. For your cooking equipment, what O&M procedures do you use? *(Check all that apply)*

- ☐ PM program for cooking equipment
- ☐ PM program for refrigerators
- ☐ Vendor contract for O&M of cooking equipment
- ☐ Vendor contract for O&M of refrigerators

Other _____

34. For your laundry equipment, what O&M procedures do you use? *(Check all that apply)*

- ☐ Checks of ironer temperatures
- ☐ Daily monitoring of gallons of water/pound
- ☐ Outsourced chemical treatment of water
- ☐ Recover/reuse wastewater
- ☐ None, laundry outsourced
- ☐ Daily monitoring of kWhs
- ☐ Flame testing of dryer burners
- ☐ Monitoring of PSI on extractors
- ☐ Recover heat from wastewater
- Other _____

35. In general, what O&M procedures have you eliminated from your schedule and why?

_____

_____

_____

36. In what year was your last energy audit? *(Check one)*

- ☐ 2002
- ☐ 2001
- ☐ 2000
- ☐ 1999
- ☐ 1998
- ☐ 1997
- ☐ Before 1997
- ☐ None (Skip to Question 38)

37. Who performed the audit? *(Check one)*

- ☐ Consultant
- ☐ Done internally
- ☐ Energy supplier
- ☐ ESCO
- Other _____

38. What measures were recommended and when were they implemented?

Measure	Year Implemented
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

39. What recommended measures were not implemented and why?

_____

_____

_____

_____

_____

40. If you have any additional comments, please add them below:

_____

_____

_____

_____

_____

Please retain a copy of the completed HEP study for your records. Mail the original completed form to:

ProWrite Inc.
Attn: HEP
7508 Slate Ridge Blvd
Reynoldsburg, OH 43068-8188

Or FAX the form to:

ProWrite Inc.
Attn: HEP
(614) 846-8129

Thank you for your help.

C SPREADSHEET BENCHMARKING TOOL

Healthcare Energy Project Benchmarking Tool

The Healthcare Energy Project (HEP) utilized the ENERGY STAR® benchmarking tool to establish benchmarking scores for participants.

Benchmarking energy consumption in buildings means comparing how much energy is used in a building to an average or theoretical standard. How much energy a building should use varies widely according to the local climate and weather, how the building is used, and how densely people and equipment are configured in the building. Additionally, how and to what extent buildings are conditioned can have a significant impact on target energy consumption. Whatever the case, energy performance of a building can be improved by benchmarking to track changes in energy performance over time and to compare the building to others.

ENERGY STAR

The US Environmental Protection Agency (EPA) introduced ENERGY STAR in 1991 as a voluntary labeling program designed to identify and promote energy-efficient products to reduce greenhouse gas emissions. In the late 1990s, the program expanded to a whole-building concept, to cover commercial and industrial buildings.

ENERGY STAR provides technical information and tools that help organizations choose energy-efficient solutions and best management practices, saving businesses, organizations, and consumers more than $5 billion a year. The program provides easy-to-use building assessment tools to enable building operations to function at greater efficiency and cost savings.

The benchmarking tool provided through the ENERGY STAR program is called the Portfolio Manager. This tool enables organizations to analyze the energy performance of their buildings, set goals for improvement, and track their progress. The Portfolio Manager rates a building's energy use on a scale of 1 to 100. The rating, or benchmarking score, reflects energy performance of a particular facility relative to other buildings of the same size, type, and operations. For example, a benchmarking score of 50 would be average, and a score of 70 would mean that the rated facility is performing better than 70 percent of other similar type facilities. A score of 75 or higher qualifies a facility to receive the ENERGY STAR label.

ENERGY STAR Use in HEP

If a participant already had a benchmarking score from the ENERGY STAR program, they were asked to FAX a copy of the ENERGY STAR Portfolio Manager Summary page from the ENERGY STAR web site to provide a verified copy of the score.

If the participant had not previously benchmarked through ENERGY STAR, a spreadsheet for ENERGY STAR data submission was provided in Excel format by e-mail. Participants completed the spreadsheet and then returned it by e-mail. All identifying information was removed, and, through a special arrangement between ASHE and the ENERGY STAR program, a Portfolio Manager account and benchmarking score were obtained for the participant anonymously. The participant then had the option of maintaining and using the ENERGY STAR account. If the benchmarking score was 75 or above, the participant was eligible to receive the ENERGY STAR label.

Benchmarking scores were used to divide survey participants into quartiles in order to identify energy conservation practices and procedures and trends among the different levels of performers.

A copy of the ENERGY STAR benchmarking tool spreadsheet follows.

Portfolio Manager Hospital Data Import Template

This data import template was designed to assist you in providing large sets of building data to be incorporated into EPA's Portfolio Manager software. It is intended as a one-time conversion from your data format into the Portfolio Manager. It is not designed for monthly updates of energy data for buildings that are already in the Portfolio Manager. Be sure to complete the information on all of the applicable tabs in this template. Items shown in **red** are required. Please review the notes associated with each item by placing the cursor over the red triangle in the column header. Sample data is included as grayed out text on each of the tabs. If you are copying energy data from another source, be sure to use the required formatting and valid options for energy type and units. Numeric values should not include any formatting, such as commas, dollar signs or percent signs. Please note that this is a campus benchmark, so all data should be entered in aggregate. Additionally, in order to be eligible to participate, 51% or more of the stand-alone or multiple-building campus square footage must be designated as Acute care or Children's hospital space. Please ask about other space types currently being developed for the healthcare sector and how you may be able to participate.

Instructions:

1. For the HEP Study, enter your HEP ID as your User Name on the **User** tab and proceed to the Buildings tab.
2. Enter the name and location information for each Campus on the **Buildings** tab. First column asks for a "Building Name"; please enter one name for each stand-alone or multiple-building Campus you wish to benchmark.
3. Provide characteristics of each Campus on the **Hospital Space** tab. The Campus names will be automatically filled based on the information entered on the Buildings tab.
4. Record energy consumption and optional energy cost data for the buildings on the **Energy** tab. Enter a row for each period of energy consumption for every meter in all buildings. You will likely have multiple rows associated with each building. It is critical that the Building Name exactly match the name entered on the Buildings tab. Be sure to enter **all** types of energy used each building and for all commercial-use meters on the campus, in order to represent the full energy consumption.
5. Provide characteristics of Garages on the **Garage Space** tab if you have any garage space associated with the buildings. This tab is optional.
6. Provide characteristics of high volume computer processing facilities on the **Data Center Space** tab if there are any spaces of this type associated with the buildings. This tab is optional.
7. After you have completed the template, please review your data for completeness and accuracy. For assistance, review the **Import Tips** tab prior to submitting the data to EPA. **Click here to view Import Tips**
8. Save your import template and send the completed spreadsheet to **heproject@aha.org**. Be sure to include the words "Portfolio Manager Import" in the subject of the e-mail. Your data will be reviewed and validated and you will be contacted within 5 business days of receipt if any problems are identified that require further clarification.

Instructions | User | Buildings | Hospital Space | Energy Use | Garage Space | Data Center Space | Import

User Tab

Is This An Existing Account ?	User Name	Password	Password Verification Question	Password Verification Answer	First Name	Last Name
No	HEP1001	onetwothree	What is your favorite restaurant?	Popeye's	Joe	Smith

Organization	Address	City	State	Zip	E-mail
ABC Hospital	1140 Health	Windsor	VA	22030	joes@ahosp.com

Which best describes your job title?	What is the primary business or	Indicate your organization's annual activity for each of the following:		
		Manage/Upgrade:	Own	Develop/Build:
Energy manager	Healthcare	1 to 5 million sq. ft.	Over 5 million sq. ft.	less than 100,000 sq. ft.

Instructions | **User** | Buildings | Hospital Space | Energy Use | Garage Space | Data Center Space | Import

Buildings Tab

Building Name	Street Address	City	State	ZIP Code	Year Built
Logan General	123 Flower Lane	Boston	MA	35959	1998
Smith Regional	349 Mountain Place	Tacoma	WA	69352	1959
RF Franklin Hospital for Children	4479 Monroe Street	Baltimore	MD	12345	1971

Instructions | User | **Buildings** | Hospital Space | Energy Use | Garage Space | Data Center Space

Hospital Space Tab

Building Name	Total Campus Floor Area	Hospital Type	Number Of Licensed Beds	Number Of Buildings	Max Number Of Floors	Ownership Status	Tertiary Care
Logan General	10002562	Acute Care Hospital	451	5	8	Non Profit	Yes
Smith Regional	1212225	Acute Care Hospital	258	3	8	Non Profit	Yes
RF Franklin Hospital for Children	50000	Children's Hospital	50	2	3	Non Profit	Yes

Laboratory	Laundry On Site
Yes	No
Yes	No
Yes	No

Instructions | User | Buildings | **Hospital Space** | Energy Use | Garage Space | Data Center Space | Import

Energy Use Tab

Building Name	Energy Meter ID	Energy Type	Energy Unit	Start Date	End Date	Energy Consumption	Energy Cost
Logan General	1234556687	Electricity	kWh	1/1/01	1/31/01	1357643	1357352
Logan General	1234556687	Electricity	kWh	2/1/01	2/28/01	1405157	1357352
Logan General	1234556687	Electricity	kWh	3/1/01	3/28/01	1486454	1357352
Logan General	1234556687	Electricity	kWh	4/1/01	4/30/01	1080137	1357352
Logan General	1234556687	Electricity	kWh	5/1/01	5/31/01	1032613	1357352
Logan General	1234556687	Electricity	kWh	6/1/01	6/30/01	1182042	1357352
Logan General	1234556687	Electricity	kWh	7/1/01	7/30/01	1100585	1357352
Logan General	1234556687	Electricity	kWh	8/1/01	8/30/01	1027725	1357352
Logan General	1234556687	Electricity	kWh	9/1/01	9/30/01	1068074	1357352
Logan General	1234556687	Electricity	kWh	10/1/01	10/31/01	1051594	1357352
Logan General	1234556687	Electricity	kWh	11/1/01	11/30/01	1048891	1357352
Logan General	1234556687	Electricity	kWh	12/1/01	12/31/01	1154362	1357352

Instructions | User | Buildings | Hospital Space | **Energy Use** | Garage Space | Data Center Space | Import

Garage Space Tab

Building Name	Floor Space	Operating Hours/Week	Number of Workers	Floors Above Ground	Floors Below Ground
Logan General	288101	168	3	6	2
Smith Regional	199632	168	4	5	1

Instructions | User | Buildings | Hospital Space | Energy Use | **Garage Space** | Data Center Space | Import

Data Center Space Tab

Building Name	Floor Area	Weekly Hours
Logan General	10000	168

Instructions | User | Buildings | Hospital Space | Energy Use | Garage Space | **Data Center Space**

D GLOSSARY

Acute Care	An acute care hospital provides short-term medical treatment for patients having an acute illness or injury or recovering from surgery. An acute care facility typically provides a variety of services within the same building or on a campus, including emergency medical care, physician's office services, diagnostic care, ambulatory care, and surgical care. Acute care hospitals are often the center of health services for a community.
Air-Handling Unit	Heating and/or cooling distribution equipment that channels warm or cool air to different parts of a building. This process of channeling the conditioned air often involves drawing air over heating or cooling coils and forcing it from a central location through ducts or air-handling units. Air-handling units are hidden in the walls or ceilings, where they use steam or hot water to heat or chill water to cool the air inside the ductwork.
Annual Adjusted Patient Days	Adjusted Patient Days = Total Patient Days × (Total Patient Revenue (Inpatient+Outpatient)) / Inpatient Revenue)
Building Automation System (BAS)	Software and systems used to monitor and control the functions of building equipment (such as HVAC and lighting systems) with typical goals of lowering the operating costs, providing more precise control, optimizing energy usage, increasing occupant comfort, and providing more cost-effective overall facility management.
Boiler	Space-heating equipment consisting of a vessel or tank where heat produced from the combustion of such fuels as natural gas, fuel oil, or coal is used to generate hot water or steam. Some buildings have their own boilers, while others have steam or hot water piped in from a central plant. For this survey, only boilers inside the building (or serving only that particular building) are counted as part of the building's heating system. Steam or hot water piped into a building from a central plant is considered district heat.
Building Shell (Envelope)	The thermal envelope of the building—the roof, exterior walls, and foundation that enclose conditioned space through which thermal energy may be transferred to or from the exterior.
Census Region and Division	A geographic area consisting of several states defined by the U.S. Department of Commerce, Bureau of the Census.

The states are grouped into four regions and nine divisions:

Region	Division	States
Northeast	New England	Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont
	Middle Atlantic	New Jersey, New York, and Pennsylvania
Midwest	East North Central	Illinois, Indiana, Michigan, Ohio, and Wisconsin
	West North Central	Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, and South Dakota
South	South Atlantic	Delaware, the District of Columbia, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, and West Virginia
	East South Central	Alabama, Kentucky, Mississippi, and Tennessee
	West South Central	Arkansas, Louisiana, Oklahoma, and Texas
West	Mountain	Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, and Wyoming
	Pacific	Alaska, California, Hawaii, Oregon, and Washington

Centralized Water-Heating System — Water-heating equipment that heats and stores water for purposes other than space heating. It provides hot water from a single location for distribution throughout a building.

Children's Hospital — Children's hospitals specialize in the treatment of infants and children. These hospitals provide a broad spectrum of pediatric services including acute care, cancer therapy, psychiatric, and rehabilitation. Other activities include research, diagnostics, and specialized surgical procedures.

Cogeneration — The sequential or simultaneous process in which useful heat/steam is generated, used in a variety of process applications, and then directed into a turbine to generate electricity and/or mechanical work from the useful thermal energy still available for use. This process of electric generation can be electrically interconnected with an electric utility and grid, to deliver electricity to the grid as well as receive it from the grid. Neither generation of electricity without use of the byproduct heat, nor waste-heat recovery from processes other than electricity generation is included in the definition of cogeneration.

Compact Fluorescent Light Bulb	A light bulb designed to replace screw-in incandescent light bulbs often found in table lamps, wall sconces, and hall and ceiling fixtures of commercial buildings with residential-type lights. They combine the efficiency of fluorescent lighting with the convenience of standard incandescent bulbs. Light is produced the same way as with other fluorescent lamps. Compact fluorescent bulbs have either electronic or magnetic ballasts.
Condition-Based Management	Condition-based management involves monitoring equipment and operating conditions in real time and taking appropriate actions to achieve the desired results, such as energy efficiency, production level, or minimization of failure.
Conservation Features	Features designed to reduce energy loss or gain. This category includes building shell, HVAC, and lighting conservation features incorporated by the building.
Cooking	The end-use of energy for institutional food preparation. It does not include employee lounge areas that are equipped with microwaves, other food preparation equipment, and/or vending machines.
Cooling	The end-use of energy for conditioning of air in a room for human comfort by a refrigeration unit (such as an air conditioner or heat pump) or by a central cooling or district cooling system that circulates chilled water. Excluded is the use of fans or blowers by themselves, without chilled air or water.
Demand-Side Management	Demand-side management involves reducing or more efficiently using energy in order to lower total consumption through conservation and energy efficiency, load management, cogeneration, and renewable energy technologies.
Distributed Water-Heating System	A type of system for heating water for purposes other than space-heating which is located at more than one place within a building. Often called a "point-of-use" water heating system, the water heater is located at the faucet and heats water only as required for immediate use. Because water is not heated until it is required, this equipment is more energy efficient.
District Chilled Water	Water chilled outside of the building in a central plant and piped into the building as an energy source for cooling. Chilled water can be purchased from a utility or provided by a central physical plant in a separate building that is part of the same multibuilding facility.
District Heat	Steam or hot water produced outside of the building in a central plant and piped into the building as an energy source for space heating or another end use. The district heat can be purchased from a utility or provided by a central physical plant in a separate building that is part of the same multibuilding facility. District heat includes district steam and/or district hot water.
EMCS	See Energy Management and Control System

Economizer Cycle	A HVAC conservation feature consisting of indoor and outdoor temperature and humidity sensors, dampers, motors, and motor controls for the ventilation system to reduce the air-conditioning load. Wherever the temperature and humidity of the outdoor air are more favorable (lower heat content) than the temperature and humidity of the return air, more outdoor air is brought into the building.
Electricity	Electric energy supplied to a building by a central utility via power lines or from a central physical plant in a separate building that is part of the same multibuilding facility. Electric power generated within a building for exclusive use in that building is specifically excluded from the definition of electricity as an energy source.
Electronic Ballasts	A lighting conservation feature consisting of an energy-efficient version of a conventional electromagnetic ballast. The ballast is the transformer for fluorescent and high-intensity discharge (HID) lamps and provides the necessary current, voltage, and wave-form conditions to operate the lamp. An energy-efficient ballast requires lower power input than a conventional ballast to operate HID and fluorescent lamps.
Energy Audit	An energy management practice consisting of an evaluation to provide information on the physical and operating characteristics of a building and its energy uses and processes. Trained auditors conduct the energy audit at the premise or facility. Audit services vary from simple walk-throughs to building management training programs and site-specific process and efficiency evaluations. Audits can be initiated or sponsored and performed by a local utility; a federal, state, or local government; a building owner; or an energy service contractor.
Energy Management and Control System (EMCS)	An energy management feature that uses microcomputers, instrumentation, control equipment, and software to manage a building's use of energy for heating, ventilation, air conditioning, lighting, and/or business-related processes. These systems can also manage fire control, safety, and security. Not included as an EMCS are time-clock thermostats.
Energy Source	A type of energy or fuel consumed in the building. Energy sources can include electricity, natural gas, fuel oil, district heat, district chilled water, propane, solar, geothermal, and others.
Energy Supplier	Fuel companies supplying electricity, natural gas, fuel oil, or other sources of energy to a building.
Envelope	See Building Shell

Energy Service Company (ESCO)	Deregulation has split energy companies into Generation, Transmission and Distribution (T&D), and Services. T&D is still regulated (wires), where generation and services are deregulated in many states. The services offered are as many and varied as are those who offer the services. Service providers may be independents or spin-offs of an existing energy utility. ESCOs from other territories may now enter an existing utility's area and offer services. In essence, in this deregulated market, a hospital may now shop for the services and company it wants.
ESCO	See Energy Services Company
Evaporative Cooler (Swamp Cooler)	A type of cooling equipment that turns air into moist, cool air by saturating the air with water vapor. It does not cool air by use of a refrigeration unit. This type of equipment is commonly used in warm, dry climates.
Exterior or Interior Shadings or Awnings	A building shell conservation feature designed to reduce the flow of light into a building. Exterior shadings or awnings include any type of shading (including architectural) or awning on the outside of the building designed to limit solar penetration. Interior shadings are drapes, horizontal or vertical shades, mini blinds, or any other means of covering a window from the inside to limit the amount of solar or thermal penetration.
Fluorescent Light Bulb	Usually a long, narrow, white tube made of glass coated on the inside with fluorescent material that is connected to an electric fixture at both ends of the light bulb. The tube can also be circular or U-shaped. The light bulb produces light by passing electricity through mercury vapor, causing the fluorescent coating to glow or fluoresce. Excluded are compact fluorescent light bulbs, which are listed as a separate category.
Fuel Oil	A liquid petroleum product used as an energy source that is less volatile than gasoline. Fuel oil includes distillate fuel oil (No. 1, 2, and 4), residual fuel oil (No. 5 and 6), and kerosene.
Furnace	Space-heating equipment with an enclosed chamber where fuel is burned or electrical resistance is used to heat air directly without steam or hot water. The heated air is then distributed throughout the building, typically by air ducts.
Geothermal Heat Pump	A renewable energy feature that uses the natural heat storage ability of the earth and/or the earth's groundwater to heat and/or cool a building. The earth has the ability to absorb and store heat energy from the sun. To use that stored energy, heat is extracted from the earth through a liquid medium (groundwater or an anti-freeze solution) and is pumped to the heat pump or heat exchanger. There, the heat is used to heat the building. In the summer, the process is reversed and indoor heat is extracted from the building and transferred to the earth through the liquid. The geothermal heat pump is more efficient than an air-source heat pump.

Halogen Light Bulb	An incandescent light bulb that lasts longer and is more efficient than a standard incandescent light bulb. The light bulb uses a halogen gas, usually iodine or bromine, which causes the evaporating tungsten to be redeposited on the filament, thus prolonging the life of the bulb.
Heat Pump	Heating and/or cooling equipment that draws heat into a building from outside and, during the cooling season, ejects heat from the building to the outside. Heat pumps are vapor-compression refrigeration systems whose indoor/outdoor coils are used reversibly as condensers or evaporators, depending on the need for heating or cooling.
Heating Equipment	The equipment used for heating ambient air in the building such as a heat pump, furnace, boiler, packaged heating unit, individual space heater, and district steam or hot water piped in from outside the building.
Heating, Ventilation, and Air Conditioning (HVAC)	The system or systems that condition air in a building.
High-Intensity Discharge (HID) Light Bulb	A lamp bulb that produces light by passing electricity through gas, causing the gas to glow. Examples of HID lamps are mercury vapor lamps, metal halide lamps, and high- and low-pressure sodium lamps. HID lamps have an extremely long life and emit many more lumens per fixture than do fluorescent lights.
HVAC	See Heating, Ventilation, and Air Conditioning
HVAC Maintenance	An HVAC conservation feature consisting of a program of routine inspection and service for heating and/or cooling equipment. The inspection is performed on a regular basis, even if there are no apparent problems.
Incandescent Light Bulb	A light bulb that produces a soft warm light by electrically heating a tungsten filament, causing it to glow. Because so much of the energy is lost as heat, these are highly inefficient sources of light. Included in this category are the familiar type of light bulbs which screw into sockets, as well as halogen bulbs, and energy-efficient incandescent bulbs such as Reflector or R-Lamps (accent and task lighting), Parabolic Aluminized Reflector (PAR) lamps (flood and spot lighting), and Ellipsoidal Reflector (ER) lamps (recessed lighting).
Insulation	A building shell conservation feature consisting of material placed between the interior of a building (in the roof below the waterproofing layer or in the ceiling of the top floor in the building or between the exterior and interior walls of a building) and the outdoor environment to reduce the rate of heat loss to the environment or heat gain from the environment. Examples include glass-wool fill and foam board.
Manual Dimmer Switches	A lighting conservation feature that changes the level of light in the building. These are like residential-style dimmer switches, which are not commonly used with fluorescent or HID lamps.

Multipaned Windows/Glass	A building shell conservation feature consisting of storm windows, storm doors, or double- or triple-pane glass that are placed on the exterior of the building to reduce the rate of heat loss. For Storm Doors, the feature consists of a second door installed outside or inside a prime door creating an insulating air space. Included are sliding glass doors made of double glass or of insulating glass, such as thermopane, double- or triple-pane glass as well as sliding glass doors with glass or plexiglas installed outside or inside of the door. For Storm Windows, the feature consists of a window or glazing material placed outside or inside a window creating an insulating air space. Windows with double glass or thermopanes are considered storm windows as well as windows with glass or plexiglas placed on the outside or inside of the window. Plastic material(s) over windows or doors are counted only if they can be used year after year.
Natural Gas	Hydrocarbon gas (mostly methane) supplied as an energy source to individual buildings by pipelines from a central utility company. Natural gas does not refer to liquefied petroleum gas (LPG) or to privately owned gas wells operated by a building owner.
Occupancy Sensors	A lighting conservation feature that uses motion or sound to switch lights on or off. Also known as ultrasonic switching. When movement is detected, the lights turn on and remain on as long as there is movement in the room. Occupancy sensors that detect sound work like ultrasonic switching; when sound is detected, the lights turn on. In this survey, occupancy sensors refer to detecting movement, not sound.
Operating Hours (Weekly)	The number of hours per week that a building is used, excluding hours when the building is occupied only by maintenance, security, or other support personnel. For buildings with a schedule that varied during the year, weekly operating hours refer to the total weekly hours for the schedule most often followed. If operating hours varied throughout a building, the usual operating hours of the largest business in the building (based on floor space) determined the operating hours for the building.
Passive Solar Features	A renewable energy feature utilized in a deliberate approach to building design that makes use of natural means for heating in winter and cooling in summer. No external mechanical power is used to move the collected solar heat. Passive solar design features include structuring the building on the lot so that large window areas face south to capture sunlight during the winter months; building overhangs on the south-facing windows to keep the sun from over heating the building during the summer; using certain types of building material to absorb heat during the day and release heat at night; and planting trees and vegetation to minimize heat gain in the building in the summer.

Photocells	A lighting conservation feature that takes advantage of sunlight to cut the amount of electric lighting used in a building by varying output of the lighting system in response to variations in available daylight. It is sometimes referred to as day lighting controls or natural lighting control sensors.
Principal Building Activity	The activity or function occupying the most floor space in a building.
Propane	A gaseous petroleum product that liquefies under pressure. Propane is the major component of liquefied petroleum gas (LPG).
Reflectors	A lighting conservation feature that is the mirror-like backing of a fluorescent lighting fixture specifically designed to reflect light into the room. The materials and shape of the reflector are designed to reduce absorption of light within the fixture, while delivering light in the desired angular pattern. The most common materials used are silver (highest reflectivity) and aluminum (lowest cost).
Solar Thermal Panels	A system that actively concentrates thermal energy from the sun by means of solar collector panels. The panels typically consist of flat, sun-oriented boxes with transparent covers, containing water tubes or air baffles under a blackened heat absorbent panel. The energy is usually used for space heating and water heating. Passive collection of solar thermal energy is not included in this definition.
Supply-Side Management	Supply-side management evaluates the cost of energy relative to the capacity required and the quality provided. This information is used to identify how much energy is required to eliminate shortages, determine the kind of energy that best meets that demand, and select an appropriate supplier.
Tertiary Care Facility	A hospital that provides a high level of specialized skills or services. This facility has staff to provide short-term, specialized medical treatment for patients with more severe illnesses and conditions. Tertiary hospitals can have specialty units such as coronary intensive care, shock trauma, or perinatal/neonatal intensive care centers.
Thermal Energy Storage	Thermal energy storage systems shift energy use to non-peak times. These systems store the energy chilled in the form of ice, water, or phase-changing material for use later to meet air-conditioning loads. The energy can also be stored in heated form using bricks or a furnace to meet heating requirements.
Timers (Time Clocks or Timed Switches)	A lighting conservation feature that has automatic controls to turn lights off and on at predetermined times.
Tinted or Reflective Glass, or Shading Film	A building shell conservation feature consisting of tinted or reflective glass or shading films installed on the exterior glazing of a building to reduce the rate of solar penetration into the building.

Transpired Solar Collectors	A solar heating system that utilizes perforated panels to absorb heat from the sun. Ventilation air is drawn in through the perforations and behind the panels where the air is heated prior to entering the building.
Unitary Air Conditioner	Cooling equipment installed in either walls or windows (with heat-radiating condensers exposed to the outdoor air). These self-contained units are characterized by a lack of pipes or duct work for distributing the cool air; the units condition only air in the room or areas where they are located.
Variable Air-Volume (VAV) System	An HVAC conservation feature that supplies varying quantities of conditioned (heated or cooled) air to different parts of a building according to the heating and cooling needs of those specific areas.
Ventilation	The circulation of air through a building to provide fresh air to the occupants and to deliver heating and cooling to the occupied spaces.
Water Heating	The end-use of energy to heat water for purposes other than space heating.
Water-Heating Equipment	Automatically-controlled, thermally-insulated equipment designed for heating water at temperatures less than 180° F for other than space heating purposes.
Year Constructed	The year in which the major part or the largest portion of a building was constructed.

E HIGHLIGHTED SUMMARY STATISTICS

This data is the same as Appendix A except that the data with either practical or statistically significant differences has been highlighted. When viewed in color, green signifies procedures or technologies that correlate with higher benchmarking scores while orange signifies those that correlate with lower benchmarking scores. Comments are in pink.

PRELIMINARY SUMMARY STATISTICS (Highlighted)			Top Quartile Count	n = 30 Average	Bottom Quartile Count	n = 30 Average	All Data Count	n = 121 Average
Notes: Highlighting was done using the following color codes.								
	Strongest Relationship	⇦		Look here for what to implement				
	Relationship (Top>Middle>Bottom)	⇦						
	Negative Relationship (Top<Middle<Bottom)	⇦						
	Strongest Negative Relationship	⇦		Look here for what to avoid				
	Comment	⇦		Comments/conclusions				
Frequently the "None" choice was eliminated from the total to better ascertain a relationship. For example, in Question 12, when the choice "None" was eliminated, the number of facilities working with ESCOs could be determined.								
5. Census division								
	East N. Central		10	33.3%	11	36.7%	35	28.9%
	East S. Central		0	0.0%	3	10.0%	6	5.0%
	Mid Atlantic		1	3.3%	1	3.3%	9	7.4%
	Mountain		5	16.7%	0	0.0%	11	9.1%
	New England		2	6.7%	1	3.3%	7	5.8%
	Pacific		5	16.7%	3	10.0%	15	12.4%
	S. Atlantic		4	13.3%	4	13.3%	16	13.2%
	West N. Central		0	0.0%	4	13.3%	12	9.9%
	West S. Central		3	10.0%	3	10.0%	10	8.3%
	TOTAL		30	100.0%	30	100.0%	121	100.0%
5+. Census region								
	Midwest		10	33.3%	16	53.3%	47	38.8%
	Northeast		3	10.0%	2	6.7%	16	13.2%
	South		7	23.3%	10	33.3%	32	26.4%
	West		10	33.3%	3	10.0%	26	21.5%
	TOTAL		30	100.0%	31	103.3%	121	100.0%
6. Adjusted patient days				77928.7		83986.47		86835.298
8a. Fuel Used								
	8ai Heating							
		district heat	2	6.7%	1	3.3%	9	7.4%
		electricity	9	30.0%	8	26.7%	31	25.6%
		fuel oil #2	14	46.7%	16	53.3%	64	52.9%
		fuel oil #6	1	3.3%	2	6.7%	4	3.3%
		natural gas	28	93.3%	27	90.0%	107	88.4%
		propane	1	3.3%	0	0.0%	0	0.0%
		steam	1	3.3%	0	0.0%	2	1.7%
		other	1	3.3%	0	0.0%	2	1.7%
		TOTAL	57	190.0%	54	180.0%	219	181.0%
	Comment: Quantities total more than 100% because multiple values can occur							

PRELIMINARY SUMMARY STATISTICS (Highlighted)			Top Quartile Count	n = 30 Average	Bottom Quartile Count	n = 30 Average	All Data Count	n = 121 Average
	8aii Cooling							
		district chilled water	3	10.0%	1	3.3%	9	7.4%
		electricity	29	96.7%	29	96.7%	113	93.4%
		natural gas	3	10.0%	6	20.0%	12	9.9%
		propane	0	0.0%	0	0.0%	0	0.0%
		steam	0	0.0%	0	0.0%	4	3.3%
		other	1	3.3%	0	0.0%	3	2.5%
		TOTAL	36	120.0%	36	120.0%	141	116.5%
	8aiii Water Heating							
		district heat	1	3.3%	1	3.3%	8	6.6%
		electricity	4	13.3%	4	13.3%	14	11.6%
		fuel oil	7	23.3%	6	20.0%	33	27.3%
		natural gas	24	80.0%	20	66.7%	84	69.4%
		propane	0	0.0%	0	0.0%	0	0.0%
		steam	5	16.7%	4	13.3%	20	16.5%
		other	0	0.0%	0	0.0%	0	0.0%
		TOTAL	41	136.7%	35	116.7%	159	131.4%
	8aiv Cooking							
		electricity	19	63.3%	19	63.3%	74	61.2%
		natural gas	24	80.0%	25	83.3%	93	76.9%
		propane	0	0.0%	1	3.3%	4	3.3%
		None	0	0.0%	1	3.3%	4	3.3%
		steam	2	6.7%	2	6.7%	10	8.3%
		other	0	0.0%	0	0.0%	0	0.0%
		TOTAL	45	150.0%	48	160.0%	185	152.9%
	8av Laundry							
		electricity	1	3.3%	3	10.0%	8	6.6%
		natural gas	9	30.0%	10	33.3%	33	27.3%
		None	19	63.3%	11	36.7%	67	55.4%
		steam	2	6.7%	3	10.0%	7	5.8%
		other	1	3.3%	0	0.0%	3	2.5%
		TOTAL	32	106.7%	27	90.0%	118	97.5%
		If None is eliminated	13	43.3%	16	53.3%	51	42.1%
	Comment: Facilities with laundries tend to have lower benchmarking scores							
8b.	*Primary Heating Source*							
		district heating	2	6.7%	1	3.3%	10	8.3%
		furnace	0	0.0%	0	0.0%	1	0.8%
		geothermal	0	0.0%	0	0.0%	0	0.0%
		heat pump	0	0.0%	0	0.0%	0	0.0%
		heating hot water	5	16.7%	3	10.0%	20	16.5%
		solar	0	0.0%	0	0.0%	0	0.0%
		steam absorption	0	0.0%	0	0.0%	0	0.0%
		steam boiler	23	76.7%	23	76.7%	85	70.2%
		other	0	0.0%	0	0.0%	1	0.8%
		TOTAL	30	100.0%	27	90.0%	117	96.7%

PRELIMINARY SUMMARY STATISTICS (Highlighted)			Top Quartile n = 30 Count	Top Quartile n = 30 Average	Bottom Quartile n = 30 Count	Bottom Quartile n = 30 Average	All Data n = 121 Count	All Data n = 121 Average
8c.	*Size of Heating System*							
		BTU/hr	8	12797038	12	11211900	34	8988941.2
		hp	17	993.8	18	2094.2	73	240.1
	Comment: Respondents used a variety of notations to express question 8c values so this data may not be accurate							
8d.	*Primary Cooling Source*							
		air-cooled chiller	3	10.0%	0	0.0%	8	6.6%
		district chilled water	3	10.0%	1	3.3%	8	6.6%
		evaporative or desiccant cooling	2	6.7%	0	0.0%	5	4.1%
		geothermal (ground water)	1	3.3%	0	0.0%	1	0.8%
		unitary air conditioner (refrigera	1	3.3%	1	3.3%	7	5.8%
		thermal storage	0	0.0%	1	3.3%	1	0.8%
		water-cooled chiller	21	70.0%	27	90.0%	90	74.4%
		other	0	0.0%	0	0.0%	2	1.7%
		TOTAL	31	103.3%	30	100.0%	122	100.8%
8e	*Size of Cooling Source*							
		Tons	26	2375.7	28	2171.8	107	2002.0
	Comment: Larger size units may be more efficient, but size may not be that important							
8f.	*Primary Type of Air Handling System*							
		single-duct-constant volume	7	23.3%	8	26.7%	30	24.8%
		single-duct-variable volume	10	33.3%	4	13.3%	34	28.1%
		dual-duct-constant volume	0	0.0%	6	20.0%	19	15.7%
		dual-duct-variable volume	1	3.3%	5	16.7%	10	8.3%
		multi-zone-constant volume	5	16.7%	2	6.7%	14	11.6%
		multi-zone-variable volume	7	23.3%	4	13.3%	17	14.0%
		multi-zone-three-deck	0	0.0%	0	0.0%	0	0.0%
		other	0	0.0%	1	3.3%	1	0.8%
		TOTAL	30	100.0%	30	100.0%	125	103.3%
8g. Air-handling system economizer cycle in use?			24	80.0%	27	90.0%	106	87.6%
8h.	*Primary Domestic Water Heating System*							
		centralized system	22	73.3%	20	66.7%	75	62.0%
		distributed system	4	13.3%	2	6.7%	17	14.0%
		combination	4	13.3%	7	23.3%	24	19.8%
		other	0	0.0%	0	0.0%	2	1.7%
		Total	30	100.0%	29	96.7%	118	97.5%

PRELIMINARY SUMMARY STATISTICS (Highlighted)			Top Quartile n = 30 Count	Top Quartile n = 30 Average	Bottom Quartile n = 30 Count	Bottom Quartile n = 30 Average	All Data n = 121 Count	All Data n = 121 Average
8i. Primary lighting types (>10%)								
	8i_i Fluorescent							
		compact fluorescent	11	36.7%	4	13.3%	29	24.0%
		tube	14	46.7%	15	50.0%	61	50.4%
		electronic ballasts	26	86.7%	24	80.0%	97	80.2%
		magnetic ballasts	5	16.7%	5	16.7%	25	20.7%
	8i_ii High Intensity Discharge							
		high-pressure sodium	17	56.7%	11	36.7%	48	39.7%
		mercury vapor	2	6.7%	4	13.3%	13	10.7%
		metal halide	6	20.0%	7	23.3%	32	26.4%
	8i_iii Incandescent Bulbs							
		parabolic aluminized reflectors	2	6.7%	0	0.0%	7	5.8%
		reflector lamps	5	16.7%	7	23.3%	18	14.9%
		standard incandescent	19	63.3%	15	50.0%	75	62.0%
		halogen	7	23.3%	1	3.3%	11	9.1%
	8i_iv Low-pressure sodium		4	13.3%	2	6.7%	9	7.4%
	8i_v Sulfur		0	0.0%	0	0.0%	0	0.0%
	Other		0	0.0%	0	0.0%	1	0.8%
	Total		118	393.3%	95	316.7%	426	352.1%
	Comment: Certain types of lighting seem to make a difference as well as the number of different types of lights used							
9. Solar energy used								
		passive heating	2	6.7%	1	3.3%	5	4.1%
		passive cooling	1	3.3%	1	3.3%	5	4.1%
		active thermal heating	0	0.0%	0	0.0%	0	0.0%
		active thermal cooling	0	0.0%	0	0.0%	1	0.8%
		ventilation preheating	0	0.0%	0	0.0%	0	0.0%
		None	27	90.0%	28	93.3%	109	90.1%
		other	0	0.0%	0	0.0%	0	0.0%
		Total	30	100.0%	30	100.0%	120	99.2%
10. Does facility have energy saving performance contracts?			3	10.0%	2	6.7%	19	15.7%
	Comment: If a facility has performance contracts, it tends to be average Contracts may be a good choice for poor performers							
12. In what capacity have you worked with ESCOs?								
		they financed energy-efficient equipment	7	23.3%	0	0.0%	11	9.1%
		they installed energy-efficient equipment	6	20.0%	4	13.3%	19	15.7%
		they staff, operate, and maintain facility	0	0.0%	0	0.0%	0	0.0%
		None	17	56.7%	24	80.0%	81	66.9%
		other	3	10.0%	0	0.0%	10	8.3%
		Total	33	110.0%	28	93.3%	121	100.0%
		If None is eliminated	16	53.3%	4	13.3%	40	33.1%
	Comment: If you work with ESCOs, it may be best to involve them in many capacities							

PRELIMINARY SUMMARY STATISTICS (Highlighted)		Top Quartile n = 30		Bottom Quartile n = 30		All Data n = 121	
		Count	Average	Count	Average	Count	Average
13. Participation in supply-side management							
	choosing provider in a deregulat	15	50.0%	15	50.0%	60	49.6%
	consumption auditing	7	23.3%	10	33.3%	36	29.8%
	rate review	11	36.7%	13	43.3%	51	42.1%
	real-time pricing	3	10.0%	3	10.0%	8	6.6%
	variable rate pricing	7	23.3%	8	26.7%	27	22.3%
	None	9	30.0%	8	26.7%	30	24.8%
	other	1	3.3%	0	0.0%	2	1.7%
	Total	53	176.7%	57	190.0%	214	176.9%
	If None is eliminated	44	146.7%	49	163.3%	184	152.1%
Comment: Pricing does not seem to reduce consumption. You may pay less but use more.							
14. Type of cogeneration used							
	reciprocal engines	0	0.0%	1	3.3%	2	1.7%
	turbines	0	0.0%	0	0.0%	2	1.7%
	Do not cogenerate	24	80.0%	29	96.7%	106	87.6%
	other	1	3.3%	0	0.0%	2	1.7%
	Total	25	83.3%	30	100.0%	112	92.6%
Comment: Cogeneration does not seem to improve benchmarking scores							
15. What are you doing with the waste heat?							
	absorption cooling	0	0.0%	0	0.0%	1	0.8%
	high-pressure steam	1	3.3%	0	0.0%	5	4.1%
	Do not cogenerate	20	66.7%	28	93.3%	96	79.3%
	other	0	0.0%	1	3.3%	1	0.8%
	Total	21	70.0%	29	96.7%	103	85.1%
16 Amount of energy you are generating and buying			Amt gen.		Amt gen.		Amt gen.
	generating	1	5%	1	21.5%	2	5.0%
		1	12%	2	25.0%	1	12.0%
				1	100.0%	1	15.0%
						2	25.0%
						1	98%
						2	100%
	other answers	0		2		3	
	buying	1	88%	2	75.0%	1	2%
		1	95%	1	78.5%	2	75.0%
		17	100%	20	100.0%	1	78.5%
						1	85%
						1	88%
						1	95%
						78	100%
	other answers	1		0		3	
Comment: Cogeneration does not seem to improve benchmarking scores							
17. Have you participated in demand-side management in past 5 yrs?							
		14	46.7%	12	40.0%	59	48.8%
18. Are EMCS/BAS in use?		27	90.0%	25	83.3%	106	87.6%

PRELIMINARY SUMMARY STATISTICS (Highlighted)	Top Quartile Count	n = 30 Average	Bottom Quartile Count	n = 30 Average	All Data Count	n = 121 Average
19. Year EMCS/BAS installed or last upgraded						
2002	6	20.0%	5	16.7%	21	17.4%
2001	3	10.0%	5	16.7%	12	9.9%
2000	3	10.0%	1	3.3%	8	6.6%
1999	1	3.3%	1	3.3%	5	4.1%
1998	1	3.3%	2	6.7%	6	5.0%
1997	1	3.3%	2	6.7%	3	2.5%
Before 1997	7	23.3%	10	33.3%	37	30.6%
Continuously	0	0.0%	1	3.3%	2	1.7%
None	8	26.7%	3	10.0%	27	22.3%
Total	30	100.0%	30	100.0%	121	100.0%
Comment: More recent installations or upgrades are slightly better.						
20. Areas your EMCS/BAS cover						
air handlers	27	90.0%	24	80.0%	105	86.8%
boilers	15	50.0%	10	33.3%	53	43.8%
chiller plant optimization	22	73.3%	20	66.7%	86	71.1%
exterior lighting control	7	23.3%	1	3.3%	20	16.5%
fan/pump speed control	22	73.3%	20	66.7%	86	71.1%
hot water systems	16	53.3%	10	33.3%	58	47.9%
humidity control	19	63.3%	19	63.3%	77	63.6%
interior lighting control	4	13.3%	2	6.7%	12	9.9%
medical office hours	9	30.0%	3	10.0%	29	24.0%
peak demand limiting	4	13.3%	3	10.0%	15	12.4%
per room temp schedule	9	30.0%	5	16.7%	36	29.8%
VFDs	19	63.3%	17	56.7%	84	69.4%
other	1	3.3%	1	3.3%	5	4.1%
Total	174	580.0%	135	450.0%	666	550.4%
Comment: EMCS/BAS seem to reduce energy usage, especially when used in many areas.						
21. Do you practice condition-based management?	7	23.3%	7	23.3%	27	22.3%
Comment: Condition-based management seems to make no difference						
23. 5 highest Priority O&M Energy Conservation Strategies	105	350.0%	58	193.3%	381	314.9%
Comment: Top performers used many more energy conservation strategies						
24. Main equipment replaced in the last five years						
air handling	12	40.0%	18	60.0%	61	50.4%
cooking	10	33.3%	7	23.3%	30	24.8%
cooling	18	60.0%	17	56.7%	68	56.2%
heating hot water	5	16.7%	8	26.7%	30	24.8%
laundry	5	16.7%	2	6.7%	15	12.4%
water heating	9	30.0%	9	30.0%	40	33.1%
None	5	16.7%	6	20.0%	21	17.4%
other	1	3.3%	0	0.0%	6	5.0%
Total	65	216.7%	67	223.3%	271	224.0%
If None is eliminated	60	200.0%	61	203.3%	250	206.6%
Comment: While equipment is on average 30% more efficient than 20 years ago, improper sizing of equipment, incorrect application of technology, limited labor, and insufficient training can all play a role in degrading expected energy performance.						

PRELIMINARY SUMMARY STATISTICS (Highlighted)	Top Quartile Count	n = 30 Average	Bottom Quartile Count	n = 30 Average	All Data Count	n = 121 Average
25. Types of HVAC conservation features installed in the last five years						
economizer cycle	11	36.7%	9	30.0%	44	36.4%
EMCS	10	33.3%	12	40.0%	48	39.7%
HVAC maintenance	16	53.3%	13	43.3%	63	52.1%
VAV system	14	46.7%	14	46.7%	58	47.9%
None	5	16.7%	10	33.3%	26	21.5%
other	3	10.0%	1	3.3%	7	5.8%
Total	59	196.7%	59	196.7%	246	203.3%
If None is deleted	54	180.0%	49	163.3%	220	181.8%
Comment: Installing HVAC maintenance features may help, especially HVAC maintenance.						
26. Types of building shell conservation features installed in the last five years						
exterior/interior shadings or awn	3	10.0%	1	3.3%	16	13.2%
insulation	7	23.3%	3	10.0%	20	16.5%
landscaping	2	6.7%	2	6.7%	15	12.4%
multi-paned doors	1	3.3%	2	6.7%	7	5.8%
multi-paned windows	4	13.3%	7	23.3%	23	19.0%
seals	6	20.0%	4	13.3%	21	17.4%
tinted, reflective, shaded glass	7	23.3%	7	23.3%	35	28.9%
None	13	43.3%	17	56.7%	56	46.3%
other	4	13.3%	0	0.0%	6	5.0%
Total	47	156.7%	43	143.3%	199	164.5%
If None is deleted	34	113.3%	26	86.7%	143	118.2%
Comment: Poor performers had the fewest number of conservation features installed. Insulation, seals and other seemed to make a difference. "Other" answers of top performers included roof insulation and repairs (3) and building caulking.						
27. Types of lighting conservation features installed in the last five years						
daylighting	4	13.3%	2	6.7%	8	6.6%
dimmers	8	26.7%	5	16.7%	24	19.8%
electronic ballasts	26	86.7%	21	70.0%	93	76.9%
improved reflectors	11	36.7%	8	26.7%	32	26.4%
occupancy sensors	13	43.3%	11	36.7%	51	42.1%
photocells	13	43.3%	7	23.3%	36	29.8%
reduced wattage	19	63.3%	19	63.3%	71	58.7%
relamping	17	56.7%	13	43.3%	65	53.7%
timers	7	23.3%	5	16.7%	23	19.0%
None	1	3.3%	3	10.0%	13	10.7%
other	2	6.7%	1	3.3%	9	7.4%
Total	121	403.3%	95	316.7%	425	351.2%
If None is deleted	120	400.0%	92	306.7%	412	340.5%
Comment: The total number of lighting conservation features installed seemed to make a difference.						

PRELIMINARY SUMMARY STATISTICS (Highlighted)	Top Quartile Count	n = 30 Average	Bottom Quartile Count	n = 30 Average	All Data Count	n = 121 Average
28. What O&M procedures are used for HVAC system?						
air balancing	22	73.3%	20	66.7%	84	69.4%
chemical treatment of closed-loo	26	86.7%	30	100.0%	114	94.2%
coil cleaning and maintenance	27	90.0%	30	100.0%	111	91.7%
descale for boilers	17	56.7%	16	53.3%	74	61.2%
filter replacement	30	100.0%	30	100.0%	117	96.7%
monitor operating conditions	21	70.0%	23	76.7%	97	80.2%
monitor part-load performance	7	23.3%	6	20.0%	29	24.0%
piping insulation	24	80.0%	26	86.7%	96	79.3%
secondary chilled water loop flo	13	43.3%	7	23.3%	46	38.0%
steam trap inspection program fo	17	56.7%	20	66.7%	79	65.3%
trending	12	40.0%	13	43.3%	52	43.0%
water treatment for boilers	23	76.7%	26	86.7%	98	81.0%
ultrasonic flow-measuring device	5	16.7%	5	16.7%	14	11.6%
other	2	6.7%	1	3.3%	8	6.6%
Total	246	820.0%	253	843.3%	1019	842.1%
Comment: Because the condition of the respondents' equipment was not known prior to the survey, performance ratings may not indicate cause and effect relationships between a given O&M procedure and performance, which may explain why there is little difference between the upper quartile and general population.						
29. What O&M procedures are used for water heating system?						
chemical treatment of closed-loo	21	70.0%	19	63.3%	80	66.1%
descale for boilers	12	40.0%	7	23.3%	39	32.2%
water treatment for boilers	27	90.0%	22	73.3%	82	67.8%
other	0	0.0%	0	0.0%	2	1.7%
Total	60	200.0%	48	160.0%	203	167.8%
Comment: O&M procedures for water heating systems seem to make a difference						
30. What O&M procedures are used for cooling towers?						
motors organized as cell	8	26.7%	12	40.0%	35	28.9%
ozonation	0	0.0%	2	6.7%	3	2.5%
staging with variable frequency	16	53.3%	16	53.3%	64	52.9%
other	2	6.7%	2	6.7%	12	9.9%
Total	26	86.7%	32	106.7%	114	94.2%
Comment: Top performers used fewer O&M procedures for their cooling towers.						
31. What O&M procedures are used for lighting?						
contracted lighting replacement	2	6.7%	3	10.0%	9	7.4%
fixture cleaning	13	43.3%	8	26.7%	41	33.9%
zone maintenance, daily checks	20	66.7%	16	53.3%	77	63.6%
other	3	10.0%	2	6.7%	7	5.8%
Total	38	126.7%	29	96.7%	134	110.7%
Comment: O&M procedures for cleaning, zone maintenance, and daily checks seem to improve benchmarking scores. Also two in the top (other) had inhouse lamping replacement programs						
32. What O&M procedures are used for building envelope?						
annual roof inspection	27	90.0%	24	80.0%	104	86.0%
caulking inspection	17	56.7%	10	33.3%	54	44.6%
other	2	6.7%	1	3.3%	7	5.8%
Total	46	153.3%	35	116.7%	165	136.4%
Comment: O&M procedures for the building envelope seem to improve benchmarking scores.						

PRELIMINARY SUMMARY STATISTICS (Highlighted)		Top Quartile n = 30		Bottom Quartile n = 30		All Data n = 121	
		Count	Average	Count	Average	Count	Average
33. What O&M procedures are used for cooking equipment?							
	PM program for cooking equip	24	80.0%	15	50.0%	88	72.7%
	PM program for refrigerators	25	83.3%	24	80.0%	98	81.0%
	vendor contract-O&M of cooking	7	23.3%	15	50.0%	31	25.6%
	vendor contract-O&M of refrigera	3	10.0%	6	20.0%	13	10.7%
	other	0	0.0%	0	0.0%	0	0.0%
	Total	59	196.7%	60	200.0%	230	190.1%
	Comment: Internal PM programs seem to get better results than vendor contracts						
34. What O&M procedures are used for laundry equipment?							
	check of ironer temp	6	20.0%	3	10.0%	13	10.7%
	daily monitoring of kWhs	2	6.7%	0	0.0%	2	1.7%
	daily monitoring of gallons of wa	5	16.7%	1	3.3%	9	7.4%
	flame testing of dryer burners	0	0.0%	2	6.7%	3	2.5%
	outsourced chemical treatment o	3	10.0%	4	13.3%	15	12.4%
	monitoring of PSI on extractors	0	0.0%	0	0.0%	1	0.8%
	recover/reuse wastewater	3	10.0%	1	3.3%	8	6.6%
	recover heat from wastewater	4	13.3%	0	0.0%	6	5.0%
	None (outsource laundry)	20	66.7%	16	53.3%	78	64.5%
	other	1	3.3%	0	0.0%	1	0.8%
	Total	44	146.7%	27	90.0%	136	112.4%
	If None is deleted	24	80.0%	11	36.7%	58	47.9%
	Comment: Checks and daily monitoring of electrical and water usage and reuse of wastewater and its recovery of its heat seem to make more of a difference than flame testing. Outsourcing chemical treatment of water gave negative results.						
36 Year of Last Energy Audit							
	2002	3	10.0%	4	13.3%	19	15.7%
	2001	3	10.0%	4	13.3%	11	9.1%
	2000	1	3.3%	0	0.0%	9	7.4%
	1999	1	3.3%	1	3.3%	6	5.0%
3	1998	3	10.0%	2	6.7%	10	8.3%
	1997	0	0.0%	0	0.0%	1	0.8

F QUALITATIVE DATA

This section includes qualitative data that was in "Other" or was different from the normal responses.

Note that this follows a slightly different format from that used in Chapter 4 and Appendix A, E, and G in that these show Top Quartile, two Middle Quartiles, and Bottom Quartile while they show Top Quartile, Bottom Quartile, and All (the sum of Top, Middle, and Bottom quartiles).

8ai. Heating Fuel (other)

Top Quartile	Middle Quartiles	Bottom Quartile
Fuel Oil #5		Fuel Oil- #1

8aii. Cooling Fuel (other)

Top Quartile	Middle Quartiles	Bottom Quartile
Ground Water	Steam absorption (2)	
	District Heating For Chilled Water Absorption	

8aiii. Water heating fuel and 8av cooking fuel did not have any "Other" responses

8av. Laundry Fuel (other)

Top Quartile	Middle Quartiles	Bottom Quartile
#2 Fuel Oil	#2 Fuel Oil	
	Propane	

8b. Primary Heating Source (other)

Top Quartile	Middle Quartiles	Bottom Quartile
	Electric Wall Units	

8c. Size of Heating System

Top Quartile	Middle Quartiles	Bottom Quartile
BTU/hr		
2–20,000lb/hr, 2–9,600lb/hr	2-6900 lbs/hr	3m
3-5 million	2@2400M	12.5MM
38m	3260M	22000
276M	20800	25000
5500 MBH	36000	33000
104000	38000	108000
18000000	50000	150000
74437500	2 ea 60,000 lb/hr boilers	276000
	104000	5000000
	115000 #/hr	5356000
	1120000	60000000
	4000000	89430000
	5230000	130000000
	5500000	
	2 x 7,000,000	
	10240000	
	20478000	
	21000000	
	53000000	
Hp		
(3) 150	Multiple units. Patient rooms have 1/2 ton through wall units X 29	200
150	(3)	200
200 hp 4 pass boilers	150	300
250	150	450
250	165	500
350	60 & 125	500
450	200	625
500	220	650
800	300	715
350 and 500	325	750
1066	400	800
1150	400	900
1500	400	900
1500	400	1300
1810	400	1690 Max

Top Quartile	Middle Quartiles	Bottom Quartile
Hp (cont.)		
1869 max	550	1800
3750	600	1800
	600	2400
	600	
	600	
	625	
	700	
	750	
	900	
	1000	
	1000	
	1050	
	1050	
	1100	
	1100	
	1500	
	1500	
	1500	
	1500	
	1800	
	1950	
	2000	
	3246	
	3300	
	3,480	

8d. Primary Cooling Source (other)

Top Quartile	Middle Quartiles	Bottom Quartile
	Steam absorption chiller (county steam)	
	District Heating For Chilled Water Absorption	

8e. Cooling Source Capacity (tons)

Top Quartile	Middle Quartiles	Bottom Quartile
180	120	200
260	160.5	280
360	270	320
400	300	350
450	341	430
500	350	680
500	430	750
750	450	868
800	460	870
833	464	900
1200	500	900
1200	588	1100
1600	700	1200
1645	710	1460
1721	800	1500
1920	850	1600
2100	950	1760
2150	1050	1800
2250	1050	1830
3500	1125	1972
3500	1175	2000
3600	1200	2040
3650	1200	2600
6000	1200	4000
6000	1245	5050
14700	1250	5700
	1440	8650
	1500	10000
	1500	
	1500	
	1540	
	1600	
	1700	
	1770	
	1800	
	1900	
	1910	

Top Quartile	Middle Quartiles	Bottom Quartile
	2000	
	2200	
	2300	
	2300	
	2300	
	2400	
	2550	
	3000	
	3000	
	3200	
	4590	
	4700	
	5000	
	5000	
	5000	
	5000	

8f. Primary Type of Air Handling System (other)

Top Quartile	Middle Quartiles	Bottom Quartile
		A mix of all systems

8h. Primary Domestic Water Heating System (other)

Top Quartile	Middle Quartiles	Bottom Quartile
	County Steam	
	4 each Centralized Systems	

8i. Primary lighting types (>10%) (other)

Top Quartile	Middle Quartiles	Bottom Quartile
	Cans	

9. Solar energy used—No "Other" responses

11. Does facility have energy saving performance contracts? If yes, describe

Top Quartile	Middle Quartiles	Bottom Quartile
Lighting Retrofit	10 Yr. Project W/Guaranteed Savings First 3 Years	Johnson Controls
Steam traps; steam condensate heat recovery system; DDC, VAV, etc.	7 Year Performance Contract Ended 5/31/03	Load Shedding/Peak Shaving
Trane Company PACT Agreement	Began Implementation Of A 10yr $4,200,000 Contract In 11-2002, Spread The Two Campuses. (2)	
	Chilled Water Optimization (Current Contract)	
	Contract With Sempra Energy To Add New Chiller, Replace Cooling Tower, Controls, Closed Steam Loop Etc.	
	Energy System	
	In Final Negotiation	
	JCI, 10 Yr. Agreement, 4 Years Left	
	Johnson Controls Installed New Chillers And Controls	
	Lighting Retrofit, Metered Orifice Steam Traps, Exhaust Heat Reclaim Coils, Water Conservation System, Water Flow Restrictors	
	Ppo-Electric, Gas-Broker Purchased Contracts	
	Rider #27 With Comed And Natural Gas Storage	
	Water Conservation Measures	

12. In what capacity have you worked with ESCOs (other)?

Top Quartile	Middle Quartiles	Bottom Quartile
Consultation	Detailed Energy Study Complete	
Grant Money	Education	
Trained staff to assume responsibility	Facility Audits (2)	
	Onsite Energy Specialist	
	Re-Negotiated Rate Under Deregulation (2)	

13. Participation in supply-side management (other)

Top Quartile	Middle Quartiles	Bottom Quartile
Pilot program participant	We Operate Own Co-Gen Plant	
	Web Based Monitoring (EPONLINE)	

14. Type of cogeneration used (other)

Top Quartile	Middle Quartiles	Bottom Quartile
Back Pressure Steam Turbines	Peak Shaving Only W/ Reciprocal	Back Pressure Steam Turbines

15. What are you doing with the waste heat (other)?

Top Quartile	Middle Quartiles	Bottom Quartile
		Heating Water System

16. Amount of energy you are generating and buying (other)

Top Quartile	Middle Quartiles	Bottom Quartile
Generating		
	Capable of 2160 KW for load shed	3,000,000 kWh /yr 18,000 mmbtu natural gas /yr.
	2500 kw standby generator plant	
Buying		
93,500,000 kWhs	1500 KW	
	840,000 therms/year 19,070,000 kwh/year	

20. Areas your EMCS/BAS cover (other)

Top Quartile	Middle Quartiles	Bottom Quartile
Chiller Plant Automation & Demand Control 2 Natural Gas Engine Chillers With 4 Electric Chillers, Heating/Cooling System Enable Control, Lawn Irrigation Optimization And Control, Soiled Linen And Trash Transport Systems Control, Incinerator/Scrubber Control And Data Logging.	Security	Cooling Tower Control
	System Is Currently Being Installed	

22. Do you practice condition-based management? If yes, describe.

Top Quartile	Middle Quartiles	Bottom Quartile
Building Automation System Is Programmed To Notify Maintenance Staff When Various Temperatures, Pressure Relationships Etc. Are Outside Of Normal Limits. In Addition, Notification Is Provided Before Chiller Starts Which Allows Engineering Staff To Make Final Decision (E.G. If Late In The Day Or Cooler Weather Predicted, The Additional Chiller Start May Be Over Ridden.	Daily Rounds	Adjust System Parameters To Optimize Energy Usage During Seasonal Changes.
Load Curtailment Policy In Place With Electrical Provider To Load Shed If Necessary For Energy Management Of State Grid. (Stage 2 And 3).	Energy management, maximizing efficiency through enthalpy and temperature optimization	As Equipment Or Unit Needs Become Non-Cost Effective.
PM's, Dailey Monitoring/Adjustment	Equipment Operation And Electrical Consumption Is Monitored In Real Time So Temperature Settings Can Be Adjusted For Efficiencies	CHW Set Point, Flow Rate; Boiler Steam Flow Rate
Preventative Maintenance Program; Operations Monitoring	Monitor And Maintain Equipment In Real Time And Weigh This Against Replacement /Repair Cost.	Make Rounds Twice A Day And Monitor Equipment

Top Quartile	Middle Quartiles	Bottom Quartile
The ECMS Is Constantly Monitored For Appropriate Conditions, Adjusted Manually If Needed.	Monitoring And Trending Of Heating And Cooling Set Points And Equipment For Peak Functionality	Monitor Equipment And Operation Conditions. Take Appropriate Action To Achieve Desired Results.
	Monitoring equipment and operating conditions in real time	Redundant Systems, Evaluate Failures Monthly, Make Suggested Improvements, Spare Parts
	Monitoring month to month and comparing the usage in units to the same month of the previous year and also taking in to consideration patient census during both years.	
	Monitoring Of Systems Through BAS. Established Alarm Parameters.	
	Monitoring Systems For Optimum Operations	
	Operators Are Able To Monitor And Control Systems For Optimal Comfort & Efficiency	
	Seimens Infocenter Suite Energy Data Management System	
	Utilize Info Through The Bas (2)	
	Daily Rounds	

23. Five highest-priority O&M energy conservation strategies

See Chapter 5 for the top 100 O&M strategies. The raw data is listed below.

Top Quartile	Middle Quartiles	Bottom Quartile
60 Ton Chiller Replacement	480 Volt motors	2-way Valves
Active Use/Monitoring Via Building Automation System	AHU Economizers	Adjust System Parameters To Optimize Energy Usage During Seasonal Changes.
AHU Discharge Air Reset	Air Handlers On VFDs In Control	Air and water Balancing
Air Handlers On VFDs In Control	Air Handler Discharge Reset	Air Handler Economizers
Bas (2)	Air Handler Economizing	As Equipment Or Unit Needs Become Non-Cost Effective.
Boiler Cleaning	Air Handling Cleaning And Disinfecting	Automation Systems
Boiler Efficiency	Annual Roof Inspection	Boiler Economizers
Boiler Efficiency Testing	Automation Upgrades	Boiler Maintenance And Tuning
Boiler O2 Trim	Bas Monitoring	Boiler Tune-Ups and Condensate Return Maintenance"
Boiler Tuning	Boiler O2 Trim	Central Cooling Plant/Process Cooling
Boiler Water Treatment	Boiler Operations	Chiller Maintenance
Building Automation System	Boiler Optimization (2)	Chiller Optimization
Centralized Utilities	Boiler Tune-up	Clean Chillers
Chilled Water Central Plant	Boiler Water Treatment	Condensate Return/Da Tank (Parallel)/Feedwater
Chilled Water Setpoint Optimization	Buy Utilities In The Market	Efficiency of Motors
Chiller control with BAS	Change Air Filters	Electronic Ballasts
Chiller Efficiency	Change To T8 Lamps	Equipment Preventive Maintenance To Operate At Maximum Efficiency
Chiller Optimization	Chilled Water Flow Optimization	Gas Absorption Cooling Variability
Chiller Plant Peak Demand Limiting	Chilled Water Reset (2)	High Efficiency Chillers With Optimizing Controls
Chiller Plant Staging	Chilled water reset control	Hot Water Temperature Regulation
Chiller Predictive And Preventive Maintenance	Chiller Management I.E. Shut Off One Before Starting Larger Unit	Install VFD On AHU
Chiller Source Optimization (Natural Gas Vs. Electric)	Chiller Operations - Shedding Peak Loading	Install VFD On Cooling Towers

Top Quartile	Middle Quartiles	Bottom Quartile
Competitive Source Bidding	Chiller Optimization (7)	Instantaneous Hot Water System
Conservation	Chiller Preventive Maintenance / Optimization	Instantaneous Steam Hot Water Heaters
Continual Conversion To More Efficient Lighting (Electronic Ballasts, LED Exit Signs)	Chiller Sequencing	LEDs
Continual Performance Improvement Of Installed Systems Though BAS Optimization	Chiller Staging	Light Consumption In Low Use Areas
Conversion Of Systems To Ground Water Cooling	Compact Fluorescents	Lighting Retrofits
Cooling Tower Temperature Control - VFD	Condensate Return	Lighting T8's
Day/night setback on boilers	Continuous Controls Commissioning	Load Shedding
Economization	Control Heating Bundles In Summers	Low Wattage Fluorescent Tubes
Economizer cycling on air handling units	Control Temperatures	Make Rounds Twice A Day And Monitor Equipment
Economizer/ Free Cooling Operation	Cooling	Manage Building Automation System To Minimize Energy Usage
Education On Energy Practices On House-Wide Basis (Share The Knowledge, Share The Responsibility)	Cooling Tower Maintenance	Metering
Eliminating Bleed Water And Chemical Usage From Cooling Towers	Descale Boilers	Monitor Power Factor And Electric Usage For Unusual Ranges
EMCS Programming To Exclude Heating/Cooling Of Unused Spaces	Discharge Air Temp Control	Monitor Water Usage And Determine Ways To Reduce Consumption
Energy Efficient Equipment For New Construction And Replacement Of Aging Equipment	Discharge Air, Hot & Cold Deck Temp Reset (2)	Night Set Backs
Energy Efficient Equipment Purchasing	Economizer Control	Number Of Chillers That Are Running For The Load Demand
Energy Management System	Economizer Controls	Number Of Heating Hot Water Boilers That Running For The Load Demand

Top Quartile	Middle Quartiles	Bottom Quartile
Energy Monitoring And Management Of Chief Consumers (Chillers And Boilers)	Economizer Cooling	Number Of Hot Water Heaters That Are Running For The Load Demand
Ensuring Efficient HVAC Operations	Efficient Lighting + Ext. Lighting Controls	Occupancy Sensors
Exit lighting	Efficient Lighting And Motors	Occupancy Sensors For Lighting Controls
FAFC	Electronic Ballasts (2)	Outside Air Resets
Fan /VFD Maintenance	Electronic Ballasts and T8 bulbs	Peak Demand Limiting Utilizing Thermal (Ice) Storage Plant
Filter Changes	Electronic Ballasts Replacement Program	Plate & Frame Co
Fluorescent Lights	EMCS Systems (2)	Preventative Maintenance
Heat recovery on 100% outside air handling units	Employee Participation In Conservation	Real Time Monitoring
Heating Hot Water Control - VFD	Energy Consumption Monitoring	Relamping
Heating Hot Water Reset	Energy Efficient Lighting	Replace Lighting With Energy Efficient Lamps And Ballasts
Heating/Cooling Reset Schedules	Energy Efficient Motors (2)	Scheduling Equipment Operation And Tracking Performance
High Efficiency HVAC Systems and Lighting	Energy management (Automated Logic Controls System)	Steam System Inspections And Optimization
Incandescent Light Replacement With Fluorescent	Energy Mgmt. Shutting Units Down In Evenings	T8's
Incorporate Energy Efficient Building Envelope Design Features	Energy Tracking	Tuned Boilers
Increase Efficiency Of Boilers	Enthalpy Control (2)	Upgrade Lighting To T-8
Installing DDC	Enthalpy Control Economizer (2)	Variable Speed Drives
Installing VFDs	Equipment Scheduling	VFDs On AHUs
Led Exit Lights	Exhaust Heat Reclaim	Water Conservation
Light Ballasts	Extended Economizer Cycles	Water Conservation Strategies
Lighting Control - T-8 W/ Electronic Ballast And Local Sensors	Exterior Lights On Timer	Water Temp Reset
Lighting levels, on/off	Exterior Wall Insulation	
Lighting Management	Fan Control Via BAS	

Top Quartile	Middle Quartiles	Bottom Quartile
Lighting Retrofit (2)	Filtration Maintenance	
Lighting Upgrade	Flat Plate Heat Exchanger	
Long-term electric contract at below market rate	Flue Gas Analyzing	
Maintain Energy Lights And Ballasts	Free Cooling using air handler coils	
Maintenance	Free Cooling/ Plate Heat Exchanger	
Manage Lighting On Times In Off Hours	Fuel Purchasing	
Maximize Condenser Performance (Clean Cooling Towers)	Global System Communication	
On Site Incineration Of Medical And Non-Recycled Combustible Waste. Waste Heat Is Reclaimed Producing 33% Of Annual 125 Psi Central Plant Steam Demand.	Green Lights	
PM system electrical/utility	Heat exchanger maintenance through tube cleaning and treatment (2)	
PM system mechanical/HVAC	Heating Hot Water Reset	
Pre-Cool	Heating Hot Water Temperature Reset Schedule Based On OA Temp.	
Pre-Heat	High Efficiency Chillers	
Preventive Maintenance	High Efficiency Motors And VFDs	
Primary/Secondary Chilled Water Distribution (VFD On Secondary	High Pressure Plant Integration To Low Pressure During Low Peak Periods	
Rate Negotiation	Hot Water Heat Instead Of Steam	
Recirculate	Hot Water Temperature Reset	
Reduction Of Domestic Water Use	HVAC - Shutdown Of Units In Non-Patient Areas After Hours	
Reflective Window Film	HVAC - VFD Reduction During Non-Surgery Hours	
Rehab All AHU, Dampers & Filters	HVAC Controls	
Replace Cooling Tower With Flat Plate Condenser / Ground Water	HVAC Filter Replacement	

Top Quartile	Middle Quartiles	Bottom Quartile
Replacing Burnt/Broken Motors With High Efficiency Motors	HVAC Night Setback	
Steam Plant Upgrade	HVAC PM Program	
Strategic Planning Involving Electrical And Mechanical Engineers As Well As Maintenance And Repair Staff For Continued Progress In Energy Management.	HVAC Preventive Maintenance (Coil Cleaning / Filter Replacement)	
Switching to electronic ballast and to lamps	HVAC, Unoccupied Mode	
Thermostat Calibration	Implement reset and cutback operation of equipment	
Tower Upgrade	Insulation (3)	
Turn Off Equipment When Not In Use	Insulation/ Thermopane Windows	
Upgrade Lighting And Electrical Distribution System	Latest control systems and strategies	
Use Of Economizers To Take Advantage Of Free Cooling	Lighting (4)	
Use Outdoor Air Scheduling Of Setpoints	Lighting - Electronic Ballast	
Use VFDs Where Appropriate	Lighting Controls (3)	
Using Well Water For Sprinkler System	Lighting Conversion	
Variable Speed Drive Utilization	Lighting Occupancy Sensors	
VAV Systems	Lighting Retrofit (3)	
VAV/VFD Operation	Lighting Retrofit and VFDs	
VFDs (2)	Lighting Setback	
VFDs on pumps and motors	Lighting Upgrades	
Water conservation	Load Shedding	
Water conservation contract	Load side real time monitoring	
We Developed Our Own BAS Using ICONCIS Genesis-32 Software To Maximize Effectiveness, Create Unique Strategies, And Have Total Control Of Programs, Logic, etc.	Maintain Energy Lights And Ballasts	
	Maintaining A Tight Envelope	
	Maintenance (2)	
	Maximize economizer (2)	

Top Quartile	Middle Quartiles	Bottom Quartile
	May replace single pane windows with insulated windows	
	Monitoring Delta T	
	Motion sensors	
	Night Set Back of Lighting (4)	
	O2 Trim Control	
	Occ/Unocc. Dom. H.W. Circ.	
	Occupancy Schedules	
	Operate Equipment At Efficient Loads	
	Optimum Boiler Efficiency	
	Optimum Chiller Efficiency	
	Osa Set Back	
	Outdoor Air Economizers On Air Handling Units	
	Outside Air Reset	
	Partial Auto Infrared Sensor On Sinks And Flushometers	
	Participate in benchmarking studies	
	Peak Demand Limiting (3)	
	Peak Shaving	
	Peak Shaving On Electrical	
	Phasing out of all incandescent bulbs	
	Plate and frame free cooling	
	Preheat hot water with condensate	
	Preventative Maintenance (3)	
	Preventive maintenance of HVAC system	
	Primary/Secondary Chilled Water Distribution (VFD On Secondary)	
	Purchase Energy Saving Equipment	
	Purchase Only Energy Efficient	
	Record and monitor consumption	
	Reduce Run Time	
	Regular Equipment Preventative Maintenance	

Top Quartile	Middle Quartiles	Bottom Quartile
	Regulate HVAC To Weather And Load	
	Replace W/ Efficient When Renovate	
	Replacing resistive heat with heat pumps or gas	
	Rider # 27	
	Schedule equipment	
	Schedule Walk-In Freezer Defrost Cycle During Off Hours	
	Scheduling	
	Shutdown of non-essential equipment (2)	
	Speed Control On Cooling Tower Motors	
	Stage Chillers To Control Demand	
	Steam Driven Absorption Chiller	
	Steam Production	
	Steam Trap Monitoring	
	Steam Trap Preventive Maintenance (2)	
	Steam Usage	
	Supplemental Canal Water Cooling / 300 Tons	
	Supply Air Temperature Reset Schedules Based On Outside Air Temp.	
	Supply Side Agreement On Natural Gas	
	Supply Side Agreement On Telecommunications	
	Supply Side Agreements On Electricity	
	Switch To Smaller Boiler During Warmer Season	
	T8 Ballast For Lighting	
	T-8 bulbs and ballasts	
	Task Lighting	
	Temp Control	
	Temp Set Points	
	Temp. Control Strategies	

Top Quartile	Middle Quartiles	Bottom Quartile
	Time Of Day Scheduling (2)	
	Tinted multi-pane windows (2)	
	Turn Off Lights During Off Hours	
	Unoccupied HVAC Settings	
	Unoccupied Space Schedules	
	Use T8's And Replace Magnetic Ballast	
	Variable Frequency/Speed Drives (6)	
	Variable rate domestic water heaters	
	Variable Speed Motors	
	Variable speed pumping for secondary hot water and chilled water loops	
	VAV (3)	
	VFDs On Pumps And Fans	
	Water Conservation (4)	
	Water Source Heat Pumps	
	Weather Dependent Optimization	

24. Describe Main equipment replaced in the last five years

Top Quartile	Middle Quartiles	Bottom Quartile
Air Handling		
1 each Air Handler	12500 cfm AHU	Have replaced some AHU
2 units have been replaced within the last year	3 units	New and upgraded units on nursing units in conjunction with remodeling
Air Handling System Replacements w/economizers to improve energy efficiency, VFD, VAV, and high efficiency motors.	7 major air handling units (12,000 cfm - 30,000 cfm)	New Motors and VFDs
One air handling system replaced as part of renovation project.	Added 2 new	Replaced 4 old units #s 1,2,3,and 4
Replaced components such as fans, coils, VAV boxes	At several locations in the building	Replaced old units
Replacement of a few units and addition of AHX for 3 main units.	New, larger, more efficient fans	
Two roof tops	Replace old air handlers and install VSD	
	Replaced 2 each 40 year old Air Handlers	
	Replaced inefficient cooling coils/ installed UV lighting to keep them clean	
	Replaced two constant volume with 1 VAV unit	
	Replacements with renovations	
	Two surgery units	
	VAV in new addition	
Cooking		
1 Stove,1 Reach-in,	Installed cook-chill system in Food & Nutrition	New construction
20% of equip	New cook chill system	New Equipment to replace 30 year old units
Gas Fryer	New coolers/refrigerators	Replaced steamer cooking unit
New fryers/ steamers	Steamer, deep fryer	
New Range and Dish Machine		
Retherm units		

Top Quartile	Middle Quartiles	Bottom Quartile
Cooling		
2 -.6kw/tn chillers	3 cooling towers	
2 chill water pumps, 120 ton chiller, 10 VAVs	50 ton chiller	
2 each 450 ton Chillers	710 tons	Central chiller w/ ice storage
25 year old absorption chiller replaced with electric centrifugal chiller	At several locations in the building	Coils, control valves
280 Ton Carrier Air Cooled Chiller	Chiller	Have added new chillers
Chiller Plant Replacement Centralization,VFD Pumping and Optimization	Installed new 1100 Ton chiller	New Chiller
Chillers	New Chiller	New construction
Chillers	New 1100 ton chiller	One chiller
Compressor valve plates	New 500 ton & 550 ton chillers	Replaced forty ton Trane recip unit with a forty ton scroll unit
Increase capacity of ground water system	New absorption chilling	
VFD Temperature Control for Cooling Tower	New chillers	
	New process air cooled chiller	
	Replaced 2 each 1000 ton Chillers	
	Replaced two 400 ton chillers with two 800 ton higher efficiency units	
	Replaced two 600 ton with two 770 ton high efficiency	
	VSD chiller	
Heating Hot Water		
Addition of pony boiler to operate full-time in summer months when demand is low.	125hp, 65hp boilers	200 hp superior boiler replaced a 1966 200hp cleaver brooks
Expansion tank heater	325 HP boiler	Coils, control valves
	At several locations in the building	Upgraded/replaced burners & control units in 2001
	Heating water convectors	
	New boilers	
	Overhauled two domestic Heating Hot water Heaters	
	Replaced two 600 HP with two 400 and one 300 HP for summer operation	

Top Quartile	Middle Quartiles	Bottom Quartile
Laundry		
2- 800lb washers	Installed new hot water boiler	Large capacity gas dryer
2 dryers, 2 Washer extractors, 1 Dryer	Laundry replacement project	
75 lb steam washing machine	New Tunnel Washer	
New laundry 3 years ago		
Water Heating		
500,000 Btu gas heat exchanger	180F hw heater	Coils, Control valve Rebuild kits
Centralized Hot Water Production and Instantaneous Hot Water Heaters	Boiler O2 Trim	New construction
Insta-heats	Changing from centralized to remote wtr htg	New inst heaters
Instantaneous	Instantaneous	New inst units
Re-located & replaced heat exchanger	New boilers	
	New semi-instantaneous water heaters	
	New steam heat exchangers	
Other		
Water softner	All New	
	Boiler Burners / Deareator	
	Installed New High Pressure Boilers For Sterilization	
	Medical Air And Medical Vacuum	
	Steam Driven Condensate Return Pumps	

25. What types of HVAC conservation features have you installed in the last 5 years (other)?

Top Quartile	Middle Quartiles	Bottom Quartile
Chiller /system heat recovery	Conversion of a system from steam to hot water heat	VFDs on Pumps
Energy Recovery Units	Energy coils/recovery	
Installed a water treatment system that uses no chemicals and requires no bleed water	New chiller, cooling tower	

26. What types of building shell conservation features have you installed in the last 5 years (other)?

Top Quartile	Middle Quartiles	Bottom Quartile
Add roof insulation when build or repair roofs	Reflective Roofing	
Building Caulking	Revolving Exterior Door	
Roof Insulation		
Roofing System Replacement		

27. What types of lighting conservation features have you installed in the last 5 years (other)?

Top Quartile	Middle Quartiles	Bottom Quartile
Conversion to LED Exit signs	Already did major upgrade	In process of relamping
Compact Fluorescents	Change incand to compact fluor	
	LED	
	LED Exit Lights (2)	
	Replaced 410 exit signs with LightPanel	

28. For your HVAC system, what O&M procedures did you use (other)?

Top Quartile	Middle Quartiles	Bottom Quartile
Steam trap inspeaction and repairs/replacement throughout system	Bearing vibration analysis	Flow measuring on chiller water
Efficiency combustion tests on boilers	Boiler tuning	
	Chiller load monitoring	
	Vibration Analysis for predictive Maint. (2)	

29. For your water heating system, what O&M procedures do you use (other)?

Top Quartile	Middle Quartiles	Bottom Quartile
	Soft water system	
	Water softeners	

30. For your cooling towers, what O&M procedures do you use (other)?

Top Quartile	Middle Quartiles	Bottom Quartile
Chemical Treatment	Annual Cleaning And Chemical Treatment	Chemical Inhibitiors
Temperature Optimization For Chilled Water Temperature Using Proprietary Program For Trane Chillers.	Fans staged by temp	Preventive Maintenance, BAS Control & Monitoring
	High Speed/ Low Speed Motors	
	Ionization Water Treatment	
	Periodic Cleaning	
	Staging with multispeed motors, water treatment	
	Two speed motors	
	Water Treatment And Annual Cleaning	

31. For your lighting, what O&M procedures do you use (other)?

Top Quartile	Middle Quartiles	Bottom Quartile
Lighting Inspections	In House Lighting Replacement	Zone Relamping
In-House Re-Lamping	Replace As Needed	Replacement By Request
Facility Lighting Replacement Program By Staff		

32. For your building envelope, what O&M procedures do you use (other)?

Top Quartile	Middle Quartiles	Bottom Quartile
Surface inspection - brick replacement	New Building	Roof Flashing And Visual Checks QTR
Roof Under Warranty, Inspections Made By Contractor As Needed	Waterproofing Brickwork	
	Replaced Roof In 2001	

33. For your cooking equipment, what O&M procedures do you use (other)? —No "Other" responses

34. For your laundry equipment, what O&M procedures do you use (other)?

Top Quartile	Middle Quartiles	Bottom Quartile
	Heat Recovery From Dryers	PM Of Dryers

35. In general, what O&M procedures have you eliminated from your schedule and why?

Top Quartile	Middle Quartiles	Bottom Quartile
Duct cleaning, lack of funding	Dropped PMs on low energy usage/non-critical equipment	Equipment that would not have anything done unless the equipment failed to function
Chemical treatment of cooling tower water due to installation of PowerPure system	HVAC PM because of the complexity	Room PM, Small HVAC units run to failure, off site in-house maintenance
	Relamping exit lights- retrofit to LEDs	Routine walk-thru inspections
	Single room fan coil PM. Inadequate staffing.	Too many to list due to funding and staffing
	Steam trap maintenance of F&T traps, constant light tube replacements due to ESPC.	

37. Who performed the audit?

Top Quartile	Middle Quartiles	Bottom Quartile
Performance Contractor	Performance Contractor	Johnson Controls, Inc

38. What measures were recommended and when were they implemented?

Top Quartile	Middle Quartiles	Bottom Quartile
BAS—1998 or earlier	480 volt systems—1998 or earlier	Added VFDs to AHUs—1999
Building Automation System—1998 or earlier	Add new 480 volt chillers—2001	Ballast—1998 or earlier
Chiller Plant Upgrade—1998 or earlier	Add new 70 screw chiller OR loop—2001	Central Chiller—1998 or earlier
Chiller replacement 2/210 ton .06kw/tn—2000	Add New Chiller & Replace Cooling Towers—2002	Chiller replacement—2002
Chiller replacement—Not implemented	Air handler scheduling—1998 or earlier	DDC added to air handlers—1998 or earlier
Cogeneration—Not implemented	Air Handler VFDs—2000	Due to funding no recommendation were implemented. All implementation is done during construction only—2002
Completed central chilled water distribution system—1998 or earlier	Automation upgrades—2002	Economizer cycle added to air handlers—1998 or earlier
Completed complete lighting retrofit—1998 or earlier	BACS installations—1998 or earlier	Electronic ballast retrofit of existing lighting fixtures—1998 or earlier
Converted heating water system to low temperature heating water—1998 or earlier	BAS System expansion—2002	Fan motor controls— Not implemented
Cooling Tower VFD—2000	Began replacing magnetic ballasts—2001	Install 34w tubes—1998 or earlier
Economizers—1998 or earlier	Boiler buners & controls—2000	Installed electronic ballasts—1998 or earlier
Heat wheel Replacements—1998 or earlier	Boiler economizers—1998 or earlier	Installed gas boiler—1998 or earlier
Heating Hot Water VFD—1998 or earlier	Boiler exhaust economizer—1998 or earlier	Installed lighting reflectors—1998 or earlier
High efficiency motors	Boiler Replacement—2002	Installed smaller chiller—1998 or earlier
High Efficiency Motors—1998 or earlier	Boilers—1998 or earlier	Installed thermal pane windows—1998 or earlier
Install energy efficient motors—2000	Building automation system—1998 or earlier	Lamp / ballast replacement—1998 or earlier
Installed a water source heat pump to reduce gas consumption—1998 or earlier	Canal water cooling—1998 or earlier	Lighting retrofit— Not implemented

Top Quartile	Middle Quartiles	Bottom Quartile
Lighting retrofit—2002	Chilled water flow control at coils—2002	Lighting Retrofits—2002
Lighting retro—1999	Chiller optimization—2000	Lighting—2002
Lighting retrofit	Chiller Plant Replacement—1998 or earlier	Motor over 5HP replaced—1998 or earlier
Lighting Retrofit—1998 or earlier (3)	Chiller replacement—2000	PE controls for site lighting—1999
Lighting retrofit—2000	Chiller replacement—2001	Power factor capacitors—Not implemented
Lower condenser water pressure—2000	Chiller retrofit	Relamp electronic ballast—Not implemented
New chiller plant—1998 or earlier	Chiller—1998 or earlier	Relamp—1998 or earlier
Occupancy Sensor—1998 or earlier	Cleaned all chillers—2002	Replace cooling tower—1998 or earlier
Phase 1 Chiller Plant Replacements/Optimization/Centralization—1998 or earlier	Closed Steam Loop—2002	Replace electric boiler with natural gas boiler—1998 or earlier
Phase 2 Chiller Plant Replacements/Optimization/Centralization—2000	Co Monitoring—Not implemented	Replace electric boiler with steam heat exchanger—1998 or earlier
Powers/staeffa controls—1998 or earlier	Compact fluorescent—Not implemented	Replace pneumatic temp controls with DDC—1999
Replaced 20 year old absorption chiller with an electrical Centrifugal Chiller—2000	Conversion from steam plant to hot water heating—1998 or earlier	Replace windows—1998 or earlier
Replaced a 100% Outdoor air handling system with a VAV system—2002	Conversion of Boilers to Natural Gas—1998 or earlier	Replaced most incandescent lighting with fluorescent—1998 or earlier
Replaced oversized boilers with more efficient units—1998 or earlier	Convert DX clg. to chilled water—1998 or earlier	Replaced steam absorption chiller with centrifugal chiller—1998 or earlier
Siemans ecms updated—1999	Convert lights from T-12s to T-8s—Not implemented	Retrofit lighting—1998 or earlier
T8 lamps and electric ballasts—2002	Cooling Tower VFD—2000	Roofs—2002
Thermal storage—Not implemented	Decentralize boilers to local hot water system— Not implemented	Steam Trap Audits—2001
Variable speed applications—Not implemented	Efficient chiller—Not implemented	Total upgrade of system to include VFD, Motors, lamps—2002
VAV Conversion—1998 or earlier	Efficient motors (Johnson Controls)— 1998 or earlier	VAVs

Top Quartile	Middle Quartiles	Bottom Quartile
VFD/ pumps, air handlers—1998 or earlier	Electronic ballast & t-8 lamps—2002	Windows—2002
Water conservation measures—Not implemented	Electronic Ballast— Not implemented	
Water reclaim system—2001	Elevator Control Upgrade—Not implemented	
	EME upgrade—1998 or earlier	
	EMS central plant and OR—2001	
	Energy efficient lamps and ballasts—1996	
	Energy Management System—1998 or earlier (2)	
	Exhaust heat reclaim—1998 or earlier (2)	
	Exhaust rework—Not implemented	
	Exit lite retrofit—1998 or earlier	
	Exit sign replacement—2001	
	Heat recovery coils—1998 or earlier	
	HHW Pump VFD—2000	
	High efficiency motors—1998 or earlier	
	Hot Water Pump Operations—1998 or earlier	
	Hot water reset—1998 or earlier	
	HVAC heat recovery / dedicated surgery fan—2000	
	HVAC/VFD retrofits—1998 or earlier	
	Identify and correct simultaneous heating & cooling— Not implemented	
	Implementing relamping in older sections of the hospital—2002	
	In progress	
	Install 80 Ton Independent System for OR—2001	
	Install DDC system— Not implemented	
	Install Flat Plate Heat Exchanger—2002	
	Install plate and frame heat	

Top Quartile	Middle Quartiles	Bottom Quartile
	exchanger— Not implemented	
	Install VFDs on towers, chillers— Not implemented	
	Install VFDs—1998 or earlier	
	Install VFDs—2002	
	Installation of New High Pressure Boilers—1998 or earlier	
	Installed compact fluorescent—2002	
	Installed motion sensors—2002	
	Installing electronic ballasts in older sections of the hospital—2002	
	Installing two way valves on the AHU cooling coils—1999	
	Kitchen pupler shut down—2002	
	Larger prefilter surface area to reduce pressure drop on two AHUs—2002	
	LED Exit Signs—2000	
	Lighting	
	Lighting (Phillips)— 1998 or earlier	
	Lighting Changes—1998 or earlier	
	Lighting controls—2002	
	Lighting Retro Fit—2002	
	Lighting retrofit to electronic ballasts—1998 or earlier	
	Lighting retrofit—1998 or earlier (4)	
	Lighting retrofit—2000	
	Lighting Retrofit—2002 (2)	
	Lighting upgrade—1998 or earlier (4)	
	Look for ways to increase use of outside economizers— Not implemented	
	Low flow flushometers—1998 or earlier	
	Low flow water devices— Not implemented	

Top Quartile	Middle Quartiles	Bottom Quartile
	Lowering Inside Air Temperature—1998 or earlier	
	Motors—1998 or earlier	
	MUA Adjustment—Not implemented	
	New Absorption Chiller—Not implemented	
	New Air Compressors—Not implemented	
	New boiler—2000	
	New Chiller—2000	
	New chillers—2001	
	New Cogeneration System—Not implemented	
	New Cooling Tower—Not implemented	
	New High Efficiency Centrifugal Chiller—2002	
	New Roof—1998 or earlier	
	New towers—2001	
	New VFD on Air Handlers—Not implemented	
	None recommended	
	O2 trim on boliers—1998 or earlier	
	Occupancy sensors—2002	
	Occupancy sensors—Not implemented	
	Outsource laundry—1999	
	Phase 1 water measures-low flow flushometers and sterilizer controls—2000	
	Phase 2 water measures-side stream filtration on chilled H2O—2002	
	Premium efficiency motors—Not implemented	
	Pump downsizing / replacement—2002	
	Recommissioning/air balancing—2002	
	Reduced Wattage on Egress Signage—1999	
	Replace Air Handler serving	

Top Quartile	Middle Quartiles	Bottom Quartile
	OR—2001	
	Replace and Enhance Control Systems—2002	
	Replace chillers— Not implemented	
	Replace cooling towers—2002	
	Replace Steam Traps—2001	
	Solar Heating— Not implemented	
	Steam Trap Repair & Insulation—2002 (2)	
	Steam trap replacement—1998 or earlier	
	Steam trap survey—2002	
	Steam Traps Replacement—1999	
	Steam traps—1998 or earlier	
	Sterilizer Conservation—2000	
	Storm Windows Replacement—1998 or earlier	
	Supply side negotiations on gas, electricity, telcom—2000	
	T8/Electric Ballast Upgrade—2000	
	Temperature Control System Modifications—1998 or earlier	
	Tuned boiler—2002	
	Upgrade Chiller Plant—2001	
	Variable chilled water flow modification— Not implemented	
	Variable frequency drives—1998 or earlier	
	VAV Air System—2000	
	VAV conversions—1998 or earlier	
	VAV upgrade—Not implemented	
	Verify controls system setpoints— Not implemented	
	VFD cooling towers and Chiller—2001	
	VFD installations—1998 or earlier	

Top Quartile	Middle Quartiles	Bottom Quartile
	VFDs installed on cooling Towers—1999	
	VSD—1998 or earlier	
	Water Chiller System Control—1998 or earlier	
	Water Conservation Flow Restrictors—2002 (2)	
	Water conservation measures—1998 or earlier (2)	
	Window replacement—2002	
	Windows—1998 or earlier	

39. What recommended measures were not implemented and why?

Top Quartile	Middle Quartiles	Bottom Quartile
Cogeneration and thermal storage; payback	Chiller vfd - not cost effective; chiller power factor correction - not completed yet due to other priorities.	AHU for upper floors
Contract pending	Economizer for Boiler - Capital cost	Change of leadership
Demand control. This was not implemented due to difficulty finding loads that could be shed.	Expanded Building automation system, Steam trap program, plate and frame cooling - not implemented due to cost and payback.	Lack of project funds
Steam and Chilled Water distribution to East Campus. Implementation pending outcome of long term site/building utilization planning and study for this part of the hospital campus.	In process - final negotiation with ESCO under DOE ESPC - Energy Savings Performance Contract	Reflectors on fluorescent fixtures - admin did like the idea
	Insufficient funds to do all proposed measures.	Same as above, no funding
	Lack of funding	
	Lack of funding	
	Lavatory Water Conservation. Poor return	
	Lighting Modifications, Converting Constant Volume AHUs to VAV, Converting Hot Water pumps to variable flow, Boiler Flue Gas Heat Recovery. Not implemented due to budget restraints.	
	Lighting Modifications, Converting constant volume AHUs to VAV, Boiler Flue Gas Heat Recovery. None implemented due to budget constraints.	
	Lighting Upgrade is in 2003 budget	
	Lighting with long paybacks	
	Many due to lack of funding	
	Planning to implement all measures as money becomes available	

Top Quartile	Middle Quartiles	Bottom Quartile
	Still Under Consideration	
	Summer Boiler, This was not cost effective because of VA requirements for boiler room staffing and gas prices at time of study were not sufficient to warrant DSM on its own.	
	VFDs on chillers - Cost	
	Vsd on cw, cdw pumps were not implemented due to budget	
	Window replacement and building exterior insulation, solar heating, and elevator controls upgrade. Payback period too long	

40. If you have any additional comments, please add them below.

Top Quartile	Middle Quartiles	Bottom Quartile
Indoor air quality issues and concerns take presidence over energy conservation	Building was occupied in early 2002	I am in the process of doing a lighting retrofit. Will begin this project within the next month. Will be going to all electronic ballasts with T-8 lamps
	Currently installing heat exchanger, new EMS with DDCs and VFDs, also retrofitting lighting to T-8. Planning upgrade of chillers and decentralization of boilers	I have only been in this position for less than one year so I don't know the answers to all the questions.
	Facility to be enlarged by 60% soon. Many measures will be accomplished with the addition.	Our Medical Center has chilled water thermal energy storage, did a lighting retrofit, has a 600 kW cogen engine, and has variable pumping. Most of these energy conservation measures were instituted 10 years ago. The EMS has been in operation since the mid 1970s with upgrades along the way. The last upgrade was started in 2002 and is in progress.
	It is important to note that the Laundry on this campus handles laundry for several other facilities. Also, please note that while we purchase steam from a district supplier, we also have our own boilers for backup, which we periodically run during supplier outages. Measures implemented under performance contract are scheduled to be completed April of 2003.	This survey does not address a normal hospital. Most of our hospitals have many system and many construction project under way at the same time.
	Limited information reference energy audits	
	Long time participant in utility-based energy rebate program, including lighting, exit light fixtures, VFD, Elec to ng conversion and other equipment upgrades.	
	Measures implemented under performance contract are scheduled to be completed April 2003	

Top Quartile	Middle Quartiles	Bottom Quartile
	New position of Energy Manager hired Feb of 2002.	
	We are currently under going a complete renovation of our inpatient facility including HVAC systems, which will include Heat wheels and VAV systems.	
	We currently started buying our Natural Gas from a third party source. I do not have enough information on this yet to help with this survey.	

G SUMMARY STATISTICS BY REGION

As part of this study, the survey included a question on Census Division in hopes that significant differences between hospitals in different geographical areas may be discovered. Because only 121 surveys were completed, the Census Divisions were aggregated into Census Regions. The table below shows how the respondents were combined when all data was combined into Census Regions.

5+. Census Region	Top	Quartile	Bottom	Quartile	All	Data
Midwest	10	33.3%	15	50.0%	47	38.8%
Northeast	3	10.0%	2	6.7%	16	13.2%
South	7	23.3%	10	33.3%	32	26.4%
West	10	33.3%	3	10.0%	26	21.5%
TOTAL	**30**	**100.0%**	**30**	**100.0%**	**121**	**100.0%**

The average benchmarking scores for the region are shown below:

Region	Mean/Score
Midwest	52.6
Northeast	53.0
South	49.5
West	68.0
TOTAL	**55.1**

Since analysis of all the data revealed only subtle differences between top and bottom performers, it seemed unlikely that strong differences would be evident when regional data was analyzed. However, there was the possibility that some differences would emerge.

Three questions that seemed most likely to be weather related and for which the overall data showed the strongest differences between top and bottom performers were chosen for analysis:

- 8d—Primary cooling source
- 8i—Primary lighting types
- 26—Types of building shell conservation features installed in the last five years

The same type of analysis was performed as that described in Chapter 4 but for each of the four regions:

- Midwest
- Northeast
- South
- West

Within each of the four regions, the top quartile and bottom quartile for that region were selected. The table below shows the benchmarking ranges for each region.

Region			Top Quartile		Bottom Quartile	
	Number	Range	Number	Range	Number	Range
Midwest	47	100-2	12	100-76	12	30-2
Northeast	16	92-15	4	92-73	4	40-15
South	32	90-5	8	90-73	8	28-5
West	26	100-18	6	100-90	6	49-18
TOTAL	**121**		**30**		**30**	

It soon became evident that a tremendous amount of comparisons and graphs could be made. However, the regional data reflects the same differences between top and bottom quartile performers, as does the data for the nation as a whole. Also, because the sample size was small, differences did not appear to be statistically significant.

Below are the data for the four questions that were examined in depth. Note that the category "Others" was deleted when analyzing data because there were too few data points to be meaningful.

Midwest

The Midwest had the greatest number of respondents (47) so that of all the regions, any differences should be the most significant.

SUMMARY STATISTICS			Top Quartile n = 12		Bottom Quartile n = 12		All Data n = 47	
			Count	Average	Count	Average	Count	Average
			MIDWEST					
8d.	*Primary Cooling Source*							
		air-cooled chiller	2	16.7%	0	0.0%	3	6.4%
		district chilled water	1	8.3%	0	0.0%	2	4.3%
		evaporative or desiccant cooling	1	8.3%	0	0.0%	2	4.3%
		geothermal (ground water)	0	0.0%	0	0.0%	0	0.0%
		unitary air conditioner (refrigera	1	8.3%	0	0.0%	3	6.4%
		thermal storage	0	0.0%	0	0.0%	0	0.0%
		water-cooled chiller	6	50.0%	12	100.0%	36	76.6%
		TOTAL	11	91.7%	12	100.0%	46	97.9%
8i. Primary lighting types (>10%)								
	8i_i Fluorescent							
		compact fluorescent	3	25.0%	1	8.3%	8	17.0%
		tube	5	41.7%	5	41.7%	21	44.7%
		electronic ballasts	6	50.0%	10	83.3%	35	74.5%
		magnetic ballasts	4	33.3%	1	8.3%	12	25.5%
	8i_ii High Intensity Discharge							
		high-pressure sodium	6	50.0%	7	58.3%	18	38.3%
		mercury vapor	0	0.0%	0	0.0%	2	4.3%
		metal halide	2	16.7%	3	25.0%	12	25.5%
	8i_iii Incandescent Bulbs							
		parabolic aluminized reflectors	0	0.0%	0	0.0%	2	4.3%
		reflector lamps	1	8.3%	1	8.3%	6	12.8%
		standard incandescent	8	66.7%	7	58.3%	32	68.1%
		halogen	2	16.7%	0	0.0%	3	6.4%
	8i_iv Low-pressure sodium		1	8.3%	1	8.3%	3	6.4%
	8i_v Sulfur		0	0.0%	0	0.0%	0	0.0%
	Total		38	316.7%	36	300.0%	154	327.7%
26. Types of building shell conservation features installed in the last five years								
		exterior/interior shadings or awn	2	16.7%	1	8.3%	5	10.6%
		insulation	3	25.0%	1	8.3%	8	17.0%
		landscaping	0	0.0%	1	8.3%	4	8.5%
		multi-paned doors	1	8.3%	1	8.3%	4	8.5%
		multi-paned windows	2	16.7%	4	33.3%	11	23.4%
		seals	1	8.3%	1	8.3%	5	10.6%
		tinted, reflective, shaded glass	2	16.7%	3	25.0%	12	25.5%
		None	3	25.0%	5	41.7%	20	42.6%
		Total	14	116.7%	17	141.7%	69	146.8%

Northeast

The Northeast had the fewest number of respondents (16) so there were only four respondents per quartile.

SUMMARY STATISTICS			Top Quartile n = 4 Count	Average	Bottom Quartile n = 4 Count	Average	All Data n = 16 Count	Average
			NORTHEAST					
8d.	*Primary Cooling Source*							
		air-cooled chiller	0	0.0%	1	25.0%	3	18.8%
		district chilled water	1	25.0%	1	25.0%	2	12.5%
		evaporative or desiccant cooling	0	0.0%	1	25.0%	1	6.3%
		geothermal (ground water)	0	0.0%	0	0.0%	0	0.0%
		unitary air conditioner (refrigera	0	0.0%	0	0.0%	2	12.5%
		thermal storage	0	0.0%	0	0.0%	0	0.0%
		water-cooled chiller	3	75.0%	2	50.0%	8	50.0%
		TOTAL	4	100.0%	5	125.0%	16	100.0%
8i. Primary lighting types (>10%)								
	8i_i Fluorescent							
		compact fluorescent	2	50.0%	1	25.0%	5	31.3%
		tube	3	75.0%	2	50.0%	9	56.3%
		electronic ballasts	4	100.0%	4	100.0%	13	81.3%
		magnetic ballasts	0	0.0%	0	0.0%	3	18.8%
	8i_ii High Intensity Discharge							
		high-pressure sodium	3	75.0%	2	50.0%	6	37.5%
		mercury vapor	0	0.0%	0	0.0%	0	0.0%
		metal halide	1	25.0%	1	25.0%	4	25.0%
	8i_iii Incandescent Bulbs							
		parabolic aluminized reflectors	0	0.0%	1	25.0%	1	6.3%
		reflector lamps	1	25.0%	2	50.0%	3	18.8%
		standard incandescent	1	25.0%	1	25.0%	6	37.5%
		halogen	0	0.0%	1	25.0%	2	12.5%
	8i_iv Low-pressure sodium		0	0.0%	1	25.0%	1	6.3%
	8i_v Sulfur		0	0.0%	0	0.0%	0	0.0%
	Total		15	375.0%	16	400.0%	53	331.3%
26. Types of building shell conservation features installed in the last five years								
		exterior/interior shadings or awn	1	25.0%	2	50.0%	4	25.0%
		insulation	2	50.0%	1	25.0%	5	31.3%
		landscaping	2	50.0%	2	50.0%	4	25.0%
		multi-paned doors	0	0.0%	1	25.0%	2	12.5%
		multi-paned windows	1	25.0%	3	75.0%	5	31.3%
		seals	2	50.0%	2	50.0%	6	37.5%
		tinted, reflective, shaded glass	0	0.0%	3	75.0%	6	37.5%
		None	0	0.0%	0	0.0%	3	18.8%
		Total	8	200.0%	14	350.0%	35	218.8%

South

The South had 32 respondents, which was 8 per quartile. The South had the lowest benchmarking scores (average 49.5).

SUMMARY STATISTICS			Top Quartile Count	n = 8 Average	Bottom Quartile Count	n = 8 Average	All Data Count	n = 32 Average
			SOUTH					
8d.	*Primary Cooling Source*							
		air-cooled chiller	1	12.5%	0	0.0%	2	6.3%
		district chilled water	1	12.5%	1	12.5%	2	6.3%
		evaporative or desiccant cooling	0	0.0%	0	0.0%	1	3.1%
		geothermal (ground water)	0	0.0%	0	0.0%	0	0.0%
		unitary air conditioner (refrigerat	0	0.0%	0	0.0%	1	3.1%
		thermal storage	0	0.0%	1	12.5%	1	3.1%
		water-cooled chiller	6	75.0%	6	75.0%	25	78.1%
		TOTAL	8	100.0%	8	100.0%	32	100.0%
8i. Primary lighting types (>10%)								
	8i_i Fluorescent							
		compact fluorescent	2	25.0%	1	12.5%	6	18.8%
		tube	2	25.0%	4	50.0%	15	46.9%
		electronic ballasts	8	100.0%	6	75.0%	25	78.1%
		magnetic ballasts	0	0.0%	2	25.0%	8	25.0%
	8i_ii High Intensity Discharge							
		high-pressure sodium	2	25.0%	2	25.0%	13	40.6%
		mercury vapor	1	12.5%	3	37.5%	6	18.8%
		metal halide	1	12.5%	1	12.5%	9	28.1%
	8i_iii Incandescent Bulbs							
		parabolic aluminized reflectors	1	12.5%	0	0.0%	3	9.4%
		reflector lamps	1	12.5%	3	37.5%	5	15.6%
		standard incandescent	6	75.0%	3	37.5%	24	75.0%
		halogen	0	0.0%	0	0.0%	0	0.0%
	8i_iv Low-pressure sodium		0	0.0%	1	12.5%	1	3.1%
	8i_v Sulfur		0	0.0%	0	0.0%	0	0.0%
	Total		24	300.0%	26	325.0%	115	359.4%
26. Types of building shell conservation features installed in the last five years								
		exterior/interior shadings or awn	0	0.0%	0	0.0%	3	9.4%
		insulation	1	12.5%	0	0.0%	4	12.5%
		landscaping	0	0.0%	0	0.0%	4	12.5%
		multi-paned doors	0	0.0%	0	0.0%	0	0.0%
		multi-paned windows	1	12.5%	0	0.0%	4	12.5%
		seals	0	0.0%	1	12.5%	3	9.4%
		tinted, reflective, shaded glass	3	37.5%	0	0.0%	9	28.1%
		None	5	62.5%	7	87.5%	18	56.3%
		Total	10	125.0%	8	100.0%	45	140.6%

West

The West had 26 respondents. The West had the highest benchmarking scores (average 68) and the greatest percentage of top performers (38%).

SUMMARY STATISTICS			Top Quartile n = 6		Bottom Quartile n = 6		All Data n = 26	
			Count	Average	Count	Average	Count	Average
			WEST					
8d.	*Primary Cooling Source*							
		air-cooled chiller	0	0.0%	0	0.0%	0	0.0%
		district chilled water	0	0.0%	0	0.0%	2	7.7%
		evaporative or desiccant cooling	1	16.7%	0	0.0%	1	3.8%
		geothermal (ground water)	1	16.7%	0	0.0%	1	3.8%
		unitary air conditioner (refrigera	0	0.0%	1	16.7%	1	3.8%
		thermal storage	0	0.0%	0	0.0%	0	0.0%
		water-cooled chiller	4	66.7%	5	83.3%	21	80.8%
		TOTAL	6	100.0%	6	100.0%	26	100.0%
8i. Primary lighting types (>10%)								
	8i_i Fluorescent							
		compact fluorescent	3	50.0%	0	0.0%	10	38.5%
		tube	2	33.3%	5	83.3%	16	61.5%
		electronic ballasts	6	100.0%	4	66.7%	24	92.3%
		magnetic ballasts	1	16.7%	0	0.0%	2	7.7%
	8i_ii High Intensity Discharge							
		high-pressure sodium	4	66.7%	1	16.7%	11	42.3%
		mercury vapor	0	0.0%	2	33.3%	5	19.2%
		metal halide	2	33.3%	1	16.7%	7	26.9%
	8i_iii Incandescent Bulbs							
		parabolic aluminized reflectors	1	16.7%	0	0.0%	1	3.8%
		reflector lamps	1	16.7%	0	0.0%	4	15.4%
		standard incandescent	3	50.0%	4	66.7%	13	50.0%
		halogen	4	66.7%	0	0.0%	6	23.1%
	8i_iv Low-pressure sodium		1	16.7%	0	0.0%	4	15.4%
	8i_v Sulfur		0	0.0%	0	0.0%	0	0.0%
	Total		28	466.7%	17	283.3%	103	396.2%
26. Types of building shell conservation features installed in the last five years								
		exterior/interior shadings or awn	1	16.7%	0	0.0%	4	15.4%
		insulation	2	33.3%	0	0.0%	3	11.5%
		landscaping	1	16.7%	0	0.0%	3	11.5%
		multi-paned doors	0	0.0%	0	0.0%	1	3.8%
		multi-paned windows	1	16.7%	0	0.0%	3	11.5%
		seals	4	66.7%	0	0.0%	7	26.9%
		tinted, reflective, shaded glass	2	33.3%	2	33.3%	8	30.8%
		None	2	33.3%	4	66.7%	15	57.7%
		Total	13	216.7%	6	100.0%	44	169.2%

H STATISTICAL SIGNIFICANCE

Appendix E contains the results of the survey with apparent stronger relationships highlighted. A *t*-test was used to determine if the differences shown between top and bottom performers are statistically significant.

t-Test

To determine the statistical significance of the relationship, a *t*-test was performed on the most promising and representative relationships. Because of the small sample size, only a few of the relationships showed significance at the 0.05 level of a one-tail *t*-test. Table H-1 shows the relationships that were found to be statistically significant. Negative correlations are noted in the Description column.

Table H-1: Relationships Showing Significance at the 0.05 Level

Question	Description	P(T≤t) one-tail
8av	Laundry Fuels, None	0.04
8d	Air-Cooled Chillers	0.04
	Water-Cooled Chillers—*Negative*	0.03
8i	Compact Fluorescent Lighting	0.02
	Halogen Lighting	0.01
8	Total Lighting Types Used	0.03
12	Working with ESCOs—Financing	0.002
	Working with ESCOs—No Involvement—*Negative*	0.03
14	Type of Cogeneration Used—No Cogeneration—*Negative*	0.02
20	Areas Your EMCS/BAS Cover—Exterior Lighting Control	0.01
	Areas Your EMCS/BAS Cover—Medical Office Hours	0.03
	Areas Your EMCS/BAS Cover—TOTAL	0.05

This is not to say that the relationships do not exist: they may have practical significance. Also, one must be careful not to assume causality where none may exist. For example, top performers were much more likely to use halogen incandescent bulbs at their facility. However, some could argue that the top performers in general were more energy-conservation savvy and would be more likely to be aware of the reported benefits of halogen bulbs and install some at their facility. Just because top performers used them does not prove that the bulbs improved energy efficiency resulting in a higher benchmarking score. It may be something else that the top performers are doing. Although the 121 facilities must be considered a self-selected sample and conclusions about such data are limited, it appears that hospitals employing halogen lighting appear to perform better than those that do not.

ANOVA

ANOVA was considered as a statistical analysis method originally but was better suited for comparing differences among the four quartiles. Since the goal was to determine any differences between top and bottom performers, a *t*-test was used.

Selected *t*-Test Results

The following questions were analyzed using a *t*-test and the results are shown below. The filled-in arrow (red if viewed or printed in color) indicates a statistically significant difference at the 0.05 level existed between top and bottom performers. The outline arrow indicates that the differences were not statistically significant at the 0.05 level.

- Statistically significant at the 0.05 level
- Not Statistically significant at the 0.05 level
- Variable 1 = top quartile performers
- Variable 2 = bottom quartile performers

8av Laundry—None

Top performers were less likely to have laundries.

8av Laundry - None		
t-Test: Two-Sample Assuming Equal Variances		
	Variable 1	*Variable 2*
Mean	0.6	0.366666667
Variance	0.248275862	0.240229885
Observations	30	30
Pooled Variance	0.244252874	
Hypothesized Mean Difference	0	
df	58	
t Stat	1.828532037	
P(T<=t) one-tail	0.036306615	
t Critical one-tail	1.671553491	
P(T<=t) two-tail	0.072613231	
t Critical two-tail	2.001715984	

8d–Primary Cooling Source—Air-Cooled and Water-Cooled Chillers

Top performers were significantly more likely to use air-cooled chillers and less likely to use water-cooled chillers. While more top performers used evaporative or desiccant cooling, the differences were not statistically significant at the 0.05 level.

8d - Primary Cooling Source - Air-Cooled Chillers		
t-Test: Two-Sample Assuming Equal Variances		
	Variable 1	*Variable 2*
Mean	0.1	0
Variance	0.093103448	0
Observations	30	30
Pooled Variance	0.046551724	
Hypothesized Mean Difference	0	
df	58	
t Stat	1.795054936	
P(T<=t) one-tail	0.038927875	
t Critical one-tail	1.671553491	
P(T<=t) two-tail	0.07785575	
t Critical two-tail	2.001715984	

8d - Primary Cooling - Water-Cooled Chillers		
t-Test: Two-Sample Assuming Equal Variances		
	Variable 1	*Variable 2*
Mean	0.7	0.9
Variance	0.217241379	0.093103448
Observations	30	30
Pooled Variance	0.155172414	
Hypothesized Mean Difference	0	
df	58	
t Stat	-1.966384161	
P(T<=t) one-tail	0.027022984	
t Critical one-tail	1.671553491	
P(T<=t) two-tail	0.054045968	
t Critical two-tail	2.001715984	

8d - Primary Cooling - Evaporative or Desiccant Cooling		
t-Test: Two-Sample Assuming Equal Variances		
	Variable 1	*Variable 2*
Mean	0.066666667	0
Variance	0.064367816	0
Observations	30	30
Pooled Variance	0.032183908	
Hypothesized Mean Difference	0	
df	58	
t Stat	1.439245834	
P(T<=t) one-tail	0.077728104	⇦
t Critical one-tail	1.671553491	
P(T<=t) two-tail	0.155456207	
t Critical two-tail	2.001715984	

8e—Capacity of Cooling Source

Any differences in the capacity of the cooling source are not statistically significant.

8e - Size of Cooling Source		
t-Test: Two-Sample Assuming Equal Variances		
	Variable 1	*Variable 2*
Mean	2375.730769	2171.785714
Variance	8960149.645	5908171.063
Observations	26	28
Pooled Variance	7375468.458	
Hypothesized Mean Difference	0	
df	52	
t Stat	0.275732008	
P(T<=t) one-tail	0.391923363	⇦
t Critical one-tail	1.674688974	
P(T<=t) two-tail	0.783846726	
t Critical two-tail	2.006645445	

8g—Air Handling System in Use

Using an air handling system is not statistically significant at the 0.05 level, but may be at a higher level.

8g-Air Handling Unit in Use		
t-Test: Two-Sample Assuming Equal Variances		
	Variable 1	*Variable 2*
Mean	0.733333333	0.533333333
Variance	0.202298851	0.257471264
Observations	30	30
Pooled Variance	0.229885057	
Hypothesized Mean Difference	0	
df	58	
t Stat	1.615549442	
P(T<=t) one-tail	0.055809516	⇦
t Critical one-tail	1.671553491	
P(T<=t) two-tail	0.111619033	
t Critical two-tail	2.001715984	

8i—Lighting in Use

Statistically significant differences were shown for the use of compact florescent lighting, halogen lighting, and the total number of different lighting types used but not for high-pressure sodium lighting.

8i-Compact Florescent Lighting		
t-Test: Two-Sample Assuming Equal Variances		
	Variable 1	*Variable 2*
Mean	0.366666667	0.133333333
Variance	0.240229885	0.11954023
Observations	30	30
Pooled Variance	0.179885057	
Hypothesized Mean Difference	0	
df	58	
t Stat	2.130712581	
P(T<=t) one-tail	0.018682098	⇦
t Critical one-tail	1.671553491	
P(T<=t) two-tail	0.037364196	
t Critical two-tail	2.001715984	

8i- High Pressure Sodium Lighting		
t-Test: Two-Sample Assuming Equal Variances		
	Variable 1	*Variable 2*
Mean	0.566666667	0.366666667
Variance	0.254022989	0.240229885
Observations	30	30
Pooled Variance	0.247126437	
Hypothesized Mean Difference	0	
df	58	
t Stat	1.558174245	
P(T<=t) one-tail	0.062316132	⇦
t Critical one-tail	1.671553491	
P(T<=t) two-tail	0.124632264	
t Critical two-tail	2.001715984	

8i- Halogen Lighting		
t-Test: Two-Sample Assuming Equal Variances		
	Variable 1	*Variable 2*
Mean	0.233333333	0.033333333
Variance	0.185057471	0.033333333
Observations	30	30
Pooled Variance	0.109195402	
Hypothesized Mean Difference	0	
df	58	
t Stat	2.344085502	
P(T<=t) one-tail	0.011260402	⇦
t Critical one-tail	1.671553491	
P(T<=t) two-tail	0.022520803	
t Critical two-tail	2.001715984	

8-Total Lighting Types Used		
t-Test: Two-Sample Assuming Equal Variances		
	Variable 1	*Variable 2*
Mean	3.933333333	3.166666667
Variance	3.512643678	1.385057471
Observations	30	30
Pooled Variance	2.448850575	
Hypothesized Mean Difference	0	
df	58	
t Stat	1.897453178	
P(T<=t) one-tail	0.031374891	⇦
t Critical one-tail	1.671553491	
P(T<=t) two-tail	0.062749782	
t Critical two-tail	2.001715984	

12—Working with ESCOs

Strong statistical significance was shown for having ESCOs finance projects and for facilities that worked with ESCOs. There was a markedly strong relationship between facilities that did not work with ESCOs and low benchmarking scores.

12-Working with ESCOs - Financing		
t-Test: Two-Sample Assuming Equal Variances		
	Variable 1	*Variable 2*
Mean	0.233333333	0
Variance	0.185057471	0
Observations	30	30
Pooled Variance	0.092528736	
Hypothesized Mean Difference	0	
df	58	
t Stat	2.970873097	
P(T<=t) one-tail	0.002157755	
t Critical one-tail	1.671553491	
P(T<=t) two-tail	0.00431551	
t Critical two-tail	2.001715984	

12-Working with ESCOs - Installation		
t-Test: Two-Sample Assuming Equal Variances		
	Variable 1	*Variable 2*
Mean	0.2	0.133333333
Variance	0.165517241	0.11954023
Observations	30	30
Pooled Variance	0.142528736	
Hypothesized Mean Difference	0	
df	58	
t Stat	0.683916614	
P(T<=t) one-tail	0.248375656	
t Critical one-tail	1.671553491	
P(T<=t) two-tail	0.496751312	
t Critical two-tail	2.001715984	

12-Working with ESCOs -No Involvement		
t-Test: Two-Sample Assuming Equal Variances		
	Variable 1	*Variable 2*
Mean	0.566666667	0.8
Variance	0.254022989	0.165517241
Observations	30	30
Pooled Variance	0.209770115	
Hypothesized Mean Difference	0	
df	58	
t Stat	-1.973106861	
P(T<=t) one-tail	0.02662762	
t Critical one-tail	1.671553491	
P(T<=t) two-tail	0.05325524	
t Critical two-tail	2.001715984	

13—Participation in Supply-Side Management

While not statistically significant, participation in supply-side management almost had an adverse affect on benchmarking scores.

13- Participation in supply-side management- Consumption audit		
t-Test: Two-Sample Assuming Equal Variances		
	Variable 1	*Variable 2*
Mean	0.233333333	0.333333333
Variance	0.185057471	0.229885057
Observations	30	30
Pooled Variance	0.207471264	
Hypothesized Mean Difference	0	
df	58	
t Stat	-0.85028918	
P(T<=t) one-tail	0.199330437	
t Critical one-tail	1.671553491	
P(T<=t) two-tail	0.398660875	
t Critical two-tail	2.001715984	

14—Cogeneration

It is statistically significant that facilities that do not cogenerate have higher benchmarking scores than those that do cogenerate.

14. Type of cogeneration used - Do not cogenerate		
t-Test: Two-Sample Assuming Equal Variances		
	Variable 1	*Variable 2*
Mean	0.8	0.966666667
Variance	0.165517241	0.033333333
Observations	30	30
Pooled Variance	0.099425287	
Hypothesized Mean Difference	0	
df	58	
t Stat	-2.047132493	
P(T<=t) one-tail	0.022592201	
t Critical one-tail	1.671553491	
P(T<=t) two-tail	0.045184401	
t Critical two-tail	2.001715984	

20—Areas Your EMCS/BAS Cover

Statistically significant differences were found when EMCS/BAS covered exterior lighting controls and medical office hours. Also significant were the total number of areas the EMCS/BAS covered. The positive relationships between top performers and their EMCS/BAS covering boilers and hot water systems were not significant at the 0.05 level.

20. Areas your EMCS/BAS cover - boilers		
t-Test: Two-Sample Assuming Equal Variances		
	Variable 1	*Variable 2*
Mean	0.5	0.333333333
Variance	0.25862069	0.229885057
Observations	30	30
Pooled Variance	0.244252874	
Hypothesized Mean Difference	0	
df	58	
t Stat	1.306094312	
P(T<=t) one-tail	0.098338384	
t Critical one-tail	1.671553491	
P(T<=t) two-tail	0.196676769	
t Critical two-tail	2.001715984	

20. Areas your EMCS/BAS cover - exterior lighting control		
t-Test: Two-Sample Assuming Equal Variances		
	Variable 1	*Variable 2*
Mean	0.233333333	0.033333333
Variance	0.185057471	0.033333333
Observations	30	30
Pooled Variance	0.109195402	
Hypothesized Mean Difference	0	
df	58	
t Stat	2.344085502	
P(T<=t) one-tail	0.011260402	
t Critical one-tail	1.671553491	
P(T<=t) two-tail	0.022520803	
t Critical two-tail	2.001715984	

20. Areas your EMCS/BAS cover - hot water systems		
t-Test: Two-Sample Assuming Equal Variances		
	Variable 1	*Variable 2*
Mean	0.533333333	0.333333333
Variance	0.257471264	0.229885057
Observations	30	30
Pooled Variance	0.243678161	
Hypothesized Mean Difference	0	
df	58	
t Stat	1.569160333	
P(T<=t) one-tail	0.061025307	
t Critical one-tail	1.671553491	
P(T<=t) two-tail	0.122050615	
t Critical two-tail	2.001715984	

20. Areas your EMCS/BAS cover - medical office hours		
t-Test: Two-Sample Assuming Equal Variances		
	Variable 1	*Variable 2*
Mean	0.3	0.1
Variance	0.217241379	0.093103448
Observations	30	30
Pooled Variance	0.155172414	
Hypothesized Mean Difference	0	
df	58	
t Stat	1.966384161	
P(T<=t) one-tail	0.027022984	
t Critical one-tail	1.671553491	
P(T<=t) two-tail	0.054045968	
t Critical two-tail	2.001715984	

20. Areas your EMCS/BAS cover - TOTAL		
t-Test: Two-Sample Assuming Equal Variances		
	Variable 1	*Variable 2*
Mean	5.766666667	4.466666667
Variance	9.495402299	8.602298851
Observations	30	30
Pooled Variance	9.048850575	
Hypothesized Mean Difference	0	
df	58	
t Stat	1.673756488	
P(T<=t) one-tail	0.04978191	
t Critical one-tail	1.671553491	
P(T<=t) two-tail	0.099563821	
t Critical two-tail	2.001715984	

24—Main Equipment Replaced in the Last Five Years

Replacing equipment does not make a statistically significant difference in energy efficiency at the 0.05 level.

24. Main equipment replaced in the last five years - air handling units		
t-Test: Two-Sample Assuming Equal Variances		
	Variable 1	*Variable 2*
Mean	0.4	0.6
Variance	0.248275862	0.248275862
Observations	30	30
Pooled Variance	0.248275862	
Hypothesized Mean Difference	0	
df	58	
t Stat	-1.554563176	
P(T<=t) one-tail	0.062745159	
t Critical one-tail	1.671553491	
P(T<=t) two-tail	0.125490318	
t Critical two-tail	2.001715984	

24. Main equipment replaced in the last five years - laundry		
t-Test: Two-Sample Assuming Equal Variances		
	Variable 1	*Variable 2*
Mean	0.166666667	0.066666667
Variance	0.143678161	0.064367816
Observations	30	30
Pooled Variance	0.104022989	
Hypothesized Mean Difference	0	
df	58	
t Stat	1.200828443	
P(T<=t) one-tail	0.117349497	⇦
t Critical one-tail	1.671553491	
P(T<=t) two-tail	0.234698993	
t Critical two-tail	2.001715984	

25—Types of HVAC Conservation Features Installed in the Last Five Years

Installing HVAC conservation features does not make a statistically significant difference in energy efficiency at the 0.05 level.

25. Types of HVAC conservation features installed in the last five years- None		
t-Test: Two-Sample Assuming Equal Variances		
	Variable 1	*Variable 2*
Mean	0.166666667	0.333333333
Variance	0.143678161	0.229885057
Observations	30	30
Pooled Variance	0.186781609	
Hypothesized Mean Difference	0	
df	58	
t Stat	-1.493575988	
P(T<=t) one-tail	0.070353499	⇦
t Critical one-tail	1.671553491	
P(T<=t) two-tail	0.140706998	
t Critical two-tail	2.001715984	

26—Types of Building Shell Conservation Features Installed in the Last Five Years

Installing HVAC conservation features does not make a statistically significant difference in energy efficiency at the 0.05 level.

26. Types of building shell conservation features installed in the last five years		
t-Test: Two-Sample Assuming Equal Variances		
	Variable 1	*Variable 2*
Mean	0.24137931	0.1
Variance	0.189655172	0.093103448
Observations	29	30
Pooled Variance	0.140532365	
Hypothesized Mean Difference	0	
df	57	
t Stat	1.448209197	
P(T<=t) one-tail	0.076518607	⇦
t Critical one-tail	1.672028702	
P(T<=t) two-tail	0.153037214	
t Critical two-tail	2.002466317	