Sector-based Approach to Energy Efficiency within Hospitals and Health Care Facilities in New York State

Final Report 08-14
June 2008

New York State
Energy Research and
Development Authority

NYSERDA

NYSERDA

The New York State Energy Research and Development Authority (NYSERDA) is a public benefit corporation created in 1975 by the New York State Legislature. NYSERDA's responsibilities include:

- Conducting a multifaceted energy and environmental research and development program to meet New York State's diverse economic needs.
- Administering the **New York Energy $mart℠** program, a Statewide public benefit R&D, energy efficiency, and environmental protection program.
- Making energy more affordable for residential and low-income households.
- Helping industries, schools, hospitals, municipalities, not-for-profits, and the residential sector, including low-income residents, implement energy-efficiency measures.
- Providing objective, credible, and useful energy analysis and planning to guide decisions made by major energy stakeholders in the private and public sectors.
- Managing the Western New York Nuclear Service Center at West Valley, including: (1) overseeing the State's interests and share of costs at the West Valley Demonstration Project, a federal/State radioactive waste clean-up effort, and (2) managing wastes and maintaining facilities at the shut-down State-Licensed Disposal Area.
- Coordinating the State's activities on energy emergencies and nuclear regulatory matters, and monitoring low-level radioactive waste generation and management in the State.
- Financing energy-related projects, reducing costs for ratepayers.

NYSERDA administers the **New York Energy $mart℠** program, which is designed to support certain public benefit programs during the transition to a more competitive electricity market. Some 2,700 projects in 40 programs are funded by a charge on the electricity transmitted and distributed by the State's investor-owned utilities. The **New York Energy $mart℠** program provides energy efficiency services, including those directed at the low-income sector, research and development, and environmental protection activities.

NYSERDA derives its basic research revenues from an assessment on the intrastate sales of New York State's investor-owned electric and gas utilities, and voluntary annual contributions by the New York Power Authority and the Long Island Power Authority. Additional research dollars come from limited corporate funds. Some 400 NYSERDA research projects help the State's businesses and municipalities with their energy and environmental problems. Since 1990, NYSERDA has successfully developed and brought into use more than 170 innovative, energy-efficient, and environmentally beneficial products, processes, and services. These contributions to the State's economic growth and environmental protection are made at a cost of about $.70 per New York resident per year.

Federally funded, the Energy Efficiency Services program is working with more than 540 businesses, schools, and municipalities to identify existing technologies and equipment to reduce their energy costs.

For more information, contact the Communications unit, NYSERDA, 17 Columbia Circle, Albany, New York 12203-6399; toll-free 1-866-NYSERDA, locally (518) 862-1090, ext. 3250; or on the web at www.nyserda.org

Sector-Based Approach to Energy Efficiency within Hospitals and Health Care Facilities in new York State

Final Report

Prepared for the

New York State Energy Research and Development Authority

Albany, NY
www.nyserda.org

Pierre Bull
Rachel Adams
Project Managers

Prepared by:

Ecology and Environment, Inc.

Lancaster, NY

and

Nexera Inc.

New York, NY

NYSERDA
Report 08-14

NYSERDA 9267

June 2008

Table of Contents

Table of Contents (cont.)

Page

Table of Contents (cont.)

Page

List of Table

Page

List of Tables (cont.)

Table **Page**

List of Figures

NOTICE

ABSTRACT

Hospitals represent a significant portion of institutional building space nationwide. The New York State Energy Research and Development Authority (NYSERDA) retained Ecology and Environment, Inc. (E & E) and its project partner, Nexera, Inc., to conduct an energy efficiency pilot program within the health care sector.

The first step of this project consisted of conducting a detailed energy survey of 10 pilot facilities. Following development of an electrical energy consumption baseline, E & E prepared a comprehensive, detailed inventory of electrical end-uses. Survey data were used to develop an energy profile for each building. The Environmental Protection Agency's (EPA) ENERGY STAR Portfolio Manager (ES-PM) tool was used to benchmark eligible pilot facilities against similar hospitals. Situations presenting energy conservation opportunities were identified during the survey and were used to develop energy conservation measures (ECMs).

Major electrical energy end-uses in the facilities were determined to be the heating, ventilating, and air conditioning (HVAC) system and lighting system. Use of energy reduction capabilities of the Building Automation System (BAS) proved to be critically important for reduction of energy used by HVAC systems.

In addition to the ECM development, an educational outreach program was developed and implemented to increase energy conservation awareness among members of the health care sector. Elements of the outreach program included educational seminars and development of an Energy Management Guidebook for Health Care Facilities.

Key Words

Hospitals, Health Care, Electricity Consumption, Electricity End Use, Electricity Demand, Energy Conservation Measure.

ACKNOWLEDGMENTS

Ecology & Environment, Inc. thanks the following individuals for their expertise and dedicated support of this energy reduction project:

- Mr. James Bortz, Millard Fillmore Suburban Hospital Facilities Director
- Mr. Greg Doerr, St. John's Riverside Hospital Facilities Director
- Mr. Paul Potenza, Community Hospital at Dobbs Ferry Director of Plant Operations
- Mr. Mark McConkey, St. Vincent's Hospital – Westchester Administrative Director, Facilities/Support Services
- Mr. Peter Murphy, Buffalo General Hospital Manager of Plant Operations
- Mr. Melvin Gonzalez, Waterfront Health Care Center Plant Operations Manager
- Mr. Ron Williams, Corporate Director of Facilities Management and Construction
- Mr. Farouk Abdool, Rivington House Health Care Facility Plant Operation and Maintenance Director
- Mr. Kenneth Sanchez, Village Nursing Home Director of Plant Operations
- Mr. Paul Fras, Center for Nursing and Rehabilitation Director of Plant Operations

We appreciate the assistance of facility staff in their current and future efforts to achieve the energy reduction goals of this project.

EXECUTIVE SUMMARY

Ecology and Environment, Inc. (E & E), in conjunction with our project partner Nexera, Inc. (Nexera), conducted an energy efficiency pilot program at 10 health care facilities in New York State. Major components of this program included comprehensive energy audits, development of building energy profiles, electricity consumption/demand analysis, energy analyses and benchmarking, energy conservation measure (ECM) development and implementation, and educational outreach. These components are described below.

Comprehensive Energy Audit. The initial phase of the project included performance of a detailed energy survey of each pilot facility (six hospitals and four long-term care facilities). Based on the results of the building survey, a reliable inventory of electricity end-uses was prepared. Using these data, electricity load/consumption profiles were developed for the building and each end-use group. These profiles are critically important in understanding how the building consumes energy and identifying high-energy equipment groups and functional areas. These profiles will greatly assist facility owners/operators in prioritizing their future energy reduction efforts and energy use-related capital investments. These profiles indicate that the major contributor to electricity load and consumption for each pilot building surveyed is the heating, ventilating, and air conditioning (HVAC) systems (37%-68%), followed by the lighting systems (13%-28%), and the remainder contributed by other equipment groups (e.g., process, medical, and office).

Electricity Consumption and Demand Trend Analysis. An analysis of electricity consumption and demand using at least 2 years of electricity data was performed for each pilot facility. Typically, at least three years of energy data would be required for a statistically valid building energy consumption/demand baseline profile; however, three years of data was not available from some of the facilities. On a monthly basis, this analysis generally revealed some abnormalities from the "normal" building consumption/demand profile, the elimination of which could reduce overall demand/consumption. This analysis should be part of a comprehensive energy tracking system.

Total Energy Analyses and Energy Benchmarking. Using baseline utility data from between 2004 and 2006, an analysis of total energy consumption, including electricity, natural gas, and fuel oil (if applicable), and accompanying cost was performed for each pilot facility. For the pilot program hospitals, electricity was found to contribute between 21% to 46% of total energy consumption (in terms of kBtu) and 54% to 77% of total utility cost. Natural gas contributes approximately 1% to 68% of total energy consumption and 1% to 37% of total cost. For those hospitals that use fuel oil, fuel oil was found to contribute between 14% to 78% of total energy consumption and 11% to 45% of total utility cost. For the long-term care facilities, electricity was found to contribute between 24% to 51% of total energy consumption (in terms of kBtu) and 61% to 83% of total utility cost. Natural gas contributes approximately 3% to 67% of total energy consumption and 1% to 39% of total cost. For those facilities that use fuel oil, fuel oil was found to contribute between 52% to 70% of total energy consumption and 29% to 35% of total utility cost.

The United States Environmental Protection Agency's (EPA's) ENERGY STAR® Portfolio Manager (PM) tool was used to benchmark eligible pilot facilities (i.e., acute and children's hospitals only). The PM benchmark for a given facility is based on the total energy consumption intensity metric ($kBtu/ft^2$) from all energy inputs into a given facility (e.g.., electricity, natural gas, fuel oil), and is then converted to a scale of 1 to 100 based on the percentile ranking against other hospitals around the country. The four hospitals in the pilot program that could be benchmarked in the PM tool had ratings between 40 and 78..

ECM Development. Based on building survey results and the energy analysis performed for each pilot facility, several ECMs were developed. These ECMs pertain primarily to HVAC and lighting system optimization. These ECMs generally have a low-cost implementation and a simple payback period (SPP) of less than three years. The recent trend of increasing utility rates will also make implementing the proposed ECMs economically viable.

Measurable energy savings could be achieved through the analyses of the Building Automation System (BAS) output data and optimization of operation. Additional savings also can be achieved through industry accepted measures (e.g., building retro-commissioning) and building staff awareness.

A summary of the statistics for the hospitals and long-term care facilities included in this project are provided in Tables ES-1 and ES-2, respectively.

Outreach Program. Following conclusion of the individual facility energy audits and ECM development, an educational outreach program aimed at increasing energy conservation awareness among the health care sector was initiated. Two half-day educational seminars were held for sector members, in addition to the development and distribution of an Energy Management Guidebook for Health Care Facilities.

Table ES-1 Summary Statistics for Hospitals in the Pilot Program

Parameter	Units	MFSH	BGH	St. John's Andrus Pavilion	Dobbs Ferry	St. John's Park Care Pavilion	St. Vincent's	Total
General								
Hospital Type		acute	acute	acute	acute	rehab	behavioral	
Building Area	sq.ft.	268,000	1,177,305	319,000	57,502	217,000	226,000	2,264,807
Number of Beds	-	201	501	262	50	129	133	1,276
Floor Space Per Bed	sq.ft./bed	1,333	2,350	1,218	1,150	1,682	1,699	
Medical Procedures	-	4,679	9,777	4,813	689	NA	NA	19,958
Medical Operations	-	7,242	33,200	6,677	1,642	NA	NA	48,761
Energy Use/Cost Intensities								
EUI (total)	kBtu/sq.ft.-yr	227	215	425	288	295	214	
ECI (total)	$/sq.ft.-yr	$4.2	$3.4	$7.5	$8.1	$5.4	$4.6	
ENERGY STAR Score	-	53	78	40	51	NA	NA	
ECM Summary								
Baseline Electricity Consumption	kWh/yr	8,335,420	26,963,994	9,080,748	1,891,200	4,015,356	4,543,200	54,829,918
Electricity Consumption Reduction	kWh/yr	497,863	1,424,030	713,070	114,423	394,980	323,500	3,467,866
	%	6%	5%	8%	6%	10%	7%	6%
Cost Savings	$/yr	$54,765	$142,403	$114,090	$18,307	$63,200	$45,300	$438,065

Key:

EUI = Energy Use Intensity.
ECI = Energy Cost Intensity.
NA = Not Applicable.

Table ES-2 Summary Statistics for Long-Term Care Facilities in the Pilot Program

Parameter	Units	CNR	WHCC	Rivington House	Village Nursing Home	Total
General						
Building Area	sq.ft.	141,151	80,000	120,000	56,800	397,951
Number of Beds	-	320	160	219	200	899
Floor Space Per Bed	sq.ft./bed	441	500	548	284	
Energy Use/Cost Intensities						
EUI (total)	kBtu/sq.ft.-yr	174	216	182	327	
ECI (total)	$/sq.ft.-yr	$5.3	$4.0	$5.7	$4.9	
ENERGY STAR Score	-	NA	NA	NA	NA	
ECM Summary						
Baseline Electricity Consumption	kWh/yr	3,664,017	1,688,918	2,902,435	1,110,560	9,365,930
Electricity Consumption Reduction	kWh/yr	154,460	130,127	139,760	80,543	504,890
	%	4%	8%	5%	6%	5%
Cost Savings	$/yr	$26,260	$15,619	$20,955	$12,688	$75,522

SECTION 1
INTRODUCTION

1.1 PURPOSE

Ecology and Environment, Inc. (E & E), was tasked by the New York State Energy Research and Development Authority (NYSERDA), under Agreement Number 9267 to develop a sector-based approach to energy efficiency within hospitals and health care facilities in New York State. This project was awarded and administered under the New York Energy $mart[SM] program. Nexera, Inc., a subsidiary of Greater New York Hospital Association (GNYHA) Ventures, was subcontracted by E & E under Agreement Number 9267 to facilitate communications with the GNYHA member facilities participating in the project.

Poor profitability is widespread among New York hospitals. According to the Annual Survey of Hospitals conducted by the American Hospital Association, the average profit margin for New York community hospitals was about 0.3% in 2003, by far the lowest among the 10 most populous states. As a result, many hospitals in New York suffer from poor cash flow, limited ability to meet current operating and capital obligations, and have an over-reliance on debt, rather than equity, to pay for capital improvements and upgrades. While large-scale projects to improve energy efficiency through capital investment have often been effective, "first cost" remains a key barrier to purchasing or installing energy conservation measures (ECMs) for most health care facilities. Therefore, the primary goal of this project was to identify areas of energy efficiency and ECMs for hospitals and health care institutions with minimal or no capital expenditures through performance of a focused pilot study within ten (10) New York State health care institutions. The realized and potential energy, economic, and environmental benefits attributable to the implementation of ECMs, while potentially modest in individual facilities, can have significant cumulative benefits when adopted in health care facilities statewide. The secondary goal of the project was therefore to develop and implement a health care energy efficiency educational outreach program.

1.2 PROJECT DESCRIPTION

The overall goal for this project was to reduce energy consumption and peak demand within the healthcare sector without sacrificing the level of service provided or without major capital expenditures, thereby reducing operating costs and allowing healthcare providers to address other areas where fiscal attention is greatly needed. Program mechanisms toward meeting this goal included whole building energy performance benchmarking and follow-up support to help healthcare organizations quantify their energy usage and costs, compare their usage and costs to similar facilities in New York and nationally, recognize energy savings opportunities, and implement projects that save energy and reduce peak electricity demand. Specific project activities included:

- Conduct detailed energy surveys at 10 pilot facilities with emphasis on existing and future operation, maintenance, and management and recordkeeping practices;

energy-use equipment replacement (only where warranted); and energy efficiency education and training.

- Enter utility data for each of the pilot facilities (four acute-care hospitals, one behavioral and one rehabilitation hospital and four long-term care facilities) and benchmark (four acute-care hospitals) participating in the pilot program using the United States Environmental Protection Agency's (EPA) ENERGY STAR® Portfolio Manager Tool.
- Prepare facility-specific reports that provide baseline energy data, detailed energy use profiles, recommended list of ECMs, plan for implementing recommendations that incorporates specific NYSERDA program information and opportunities.
- Analyze the results of the pilot program to create an outreach program for encouraging other hospitals and healthcare facilities in the state to implement energy efficiency and conservation measures highlighting both energy and non-energy benefits.

1.3 REPORT ORGANIZATION

The remainder of this report presents the results of the energy surveys and evaluations conducted at the 10 pilot facilities and the outreach program. Section 2 presents a discussion of the project methodology. Section 3 summarizes detailed information for each facility surveyed. Section 4 summarizes ECM development and Section 5 describes the elements of the outreach program.

SECTION 2
PROJECT METHODOLOGY

This section describes the specific methods that E & E used to conduct the facility energy evaluation surveys, analyze energy consumption data, and develop ECMs. The pilot facility selection process and the elements of the outreach program are also discussed.

2.1 PILOT FACILITY SELECTION

An announcement of the project and solicitation for pilot program participants was prepared and submitted via e-mail to all eligible GNYHA member facilities on June 12, 2006. Under the terms of the NYSERDA program, institutions eligible to participate are those that fall under the New York Energy $mart^SM Systems Benefits Charge (SBC) paid by electric distribution customers of Central Hudson, Con Edison, NYSEG, Niagara Mohawk (National Grid), Orange and Rockland, and Rochester Gas and Electric. This excludes customers of New York Power Authority (NYPA) and Long Island Power Authority (LIPA) as well as those members located outside of New York State.

As part of the project announcement, a questionnaire was included in an effort to obtain preliminary facility data to use in selecting a representative number of facilities based on type, location, age, size, and energy consumption. A copy of the facility questionnaire is included as Appendix A. A sincere interest and willingness to participate were also considered key selection factors. Based on the information collected from the questionnaire and follow-up telephone conversations with the facility managers, 10 facilities, including six acute care hospital facilities plus two alternates, and four long-term care facilities plus two alternates, were selected to participate in the pilot program. During the course of the project, two of the 10 original facilities were replaced due to issues surrounding potential closing. The list of final pilot facilities is presented in Table 2-1.

The facilities in each health care group were selected based on the following criteria:

- Climatological zones of New York State;
- Number of beds and floor space;
- Electricity annual consumption and intensity;
- Existence of EMCS; and
- Recent energy efficiency projects.

In addition, the following criteria were also considered: response time to questionnaires, interest level, and additional specific comments.

Hospitals – Recommended Pilot Facilities

- Number of facilities: six
- Year built: 1906 to 1984
- Number of beds per facility: 50 to 501
- Total group number of beds: 1,276

- Floor space per facility: 57,502 to 1,177,305 sq.ft.
- Total group floor space: 2,264,807 sq.ft.

- Electricity annual consumption per facility: 1,891,200 to 26,963,994 kWh/yr.
- Electricity Use Intensity: 18.5 to 32.9 kWh/sq.ft.-yr
- Total group annual electricity consumption: 54,829,918 kWh/yr
- Total group annual electricity cost: $6,202,453

Long-Term Care – Recommended Pilot Facilities

- Number of facilities: four
- Year built: 1975 to 1995 (Note: Year built data not available for Village Nursing Home)
- Number of beds per facility: 160 to 320
- Total group number of beds: 899
- Floor space per facility: 56,800 to 141,151 sq.ft.
- Total group floor space: 397,951 sq.ft.

- Electricity annual consumption per facility: 1,110,560 to 3,664,017 kWh/yr
- Electricity Use Intensity: 20 to 26 kWh/sq.ft.-yr
- Total group annual electricity consumption: 9,365,930 kWh/yr
- Total group annual electricity cost: $1,436,988

Table 2-1 Pilot Facilities List

Facility Name	Location
HOSPITALS	
Buffalo General Hospital	Buffalo
St. Vincent's Hospital Westchester	Harrison
St. John's Riverside Hospital-Andrus Pavilion	Yonkers
Millard Fillmore Suburban Hospital	Williamsville
St. John's Riverside Hospital-Park Care Pavilion	Yonkers
Community Hospital at Dobbs Ferry	Dobbs Ferry
LONG-TERM CARE FACILITIES	
Waterfront Health Care Center	Buffalo
Center for Nursing and Rehabilitation	Brooklyn
Village Nursing Home	New York
Rivington House Health Care Center	New York

2.2 FACILITY SURVEYS

An energy evaluation survey was performed at each of the 10 pilot facilities. The survey focused on analyzing the detailed load/consumption profile for the building functional areas and end-use groups. Activities included conducting a comprehensive equipment survey; collecting measurements on major HVAC equipment for amperage, power factor, and power draw; analyzing Building Automation System (BAS) output; and interviewing personnel for the purpose of identifying ECMs appropriate for the facility given its operating parameters.

Since HVAC and lighting systems are the largest contributors to electricity consumption in health care facilities, a detailed HVAC system and lighting evaluation became a main focus of evaluation and subsequent ECM development.

Lighting
Electricity consumption by the lighting end-use group was calculated based on power ratings of lighting equipment and respective operational schedules. A detailed inventory of lighting equipment and its power rating data was compiled during the facility survey. This portion of the facility's electrical energy consumption estimate is relatively accurate.

HVAC Equipment
Electricity consumption by this end-use group was calculated based on power ratings of HVAC equipment and respective operational schedules. A detailed HVAC equipment inventory and power rating data were compiled during the facility survey.

HVAC equipment was grouped in the following categories:

- Space cooling: chillers, cooling towers and associated pumps;
- Space heating: boilers and associated pumps;
- Ventilation: AHU supply and return/exhaust fans; and
- HVAC auxiliaries: water heating, miscellaneous pumps, and unitary equipment.

Load/consumption analysis for this group was performed building-wide. This portion of the facility's electrical energy consumption is relatively accurate.

Office Equipment
Office equipment includes personal computers (PCs), printers, copiers, and fax machines. Detailed office equipment inventory data were compiled during the field survey. Electricity consumption by this end-use group was calculated based on power ratings of equipment, respective operational schedules, and nationwide statistical data. This portion of the estimate for total electrical energy consumption is relatively accurate.

Computer/Network Equipment
Computer/network equipment includes non-personal computers and servers. Electricity demand/consumption was estimated based on power ratings of this equipment and its respective operational schedule (typically 24 hours per day). Load/consumption analysis for this group was performed building-wide. This portion of the estimate for total electrical energy consumption is relatively accurate.

Medical Equipment
Specialized medical equipment includes magnetic resonance imaging (MRI) and computed tomographic scan (CT scan) equipment. A detailed general medical/laboratory equipment inventory was obtained from the respective pilot facility Clinical Engineering Department during the site survey. Load/consumption analysis for this group was performed building-wide. This portion of the estimate for total electrical energy consumption is relatively accurate.

Process Equipment
Process equipment includes medical compressors, medical vacuum pumps and sterilizers, morgue refrigeration units, and building elevators. Load/consumption analysis for this group was performed building-wide. This portion of the estimate for total electrical energy consumption should be relatively accurate.

Kitchen/cafeteria equipment
Kitchen/cafeteria equipment includes ovens, fryers, steamers, griddles, broilers, and refrigerators. Kitchen/cafeteria equipment inventory data and power ratings were compiled during the facility survey. Electricity consumption by this end-use group was calculated based on power ratings of equipment and respective operational schedules. This portion of the total electrical energy consumption estimate is relatively accurate.

Laundry Equipment
Laundry equipment includes washers, dryers, and irons. Laundry equipment inventory data and power ratings were compiled during the facility survey. Electricity consumption by this end-use group will be calculated based on power ratings of equipment and respective operational schedules. This portion of the total electrical energy consumption estimate is anticipated to be relatively accurate.

Miscellaneous Equipment
Miscellaneous equipment consists of equipment not included in the previous six groups, including vending machines, water dispensers, and building elevators. Miscellaneous equipment inventory data and power ratings were compiled during the facility survey. Electricity consumption by this end-use group was calculated based on power ratings of equipment, respective operational schedules, and nationwide statistical data.

Load/consumption analysis for this group was performed for each specific functional area. This portion of the total electrical energy consumption estimate is anticipated to be least accurate.

2.3 ELECTRICITY END-USE ANALYSIS

Based on the results of the building survey, a reliable inventory of electricity end-uses was prepared. Using these data, electricity load/consumption profiles were developed for the building and each end-use group. These profiles are critically important in understanding how the building consumes energy and in identifying high energy equipment groups and functional areas. These profiles will greatly assist facility staff in prioritizing their future energy reduction efforts and energy use-related capital investments.

2.4 ELECTRICITY CONSUMPTION AND DEMAND TREND ANALYSIS

Electrical Rate Analysis
In general, electric delivery charges consist of costs associated with electricity consumption (per kilowatt-hour [kWh]) and demand (per kilowatt [kW]) charges. Typically, demand charges contribute to approximately 20 to 25% of a monthly electricity bill. The aggregate rate for each facility, including the consumption and demand portions, were estimated.

Energy Data Normalization
Energy data weather normalization followed guidelines of the International Performance Measurement and Verification Protocol (IPMVP). Actual electricity consumption for a given time period by HVAC equipment is affected by weather conditions during the time period. For the heating period, these conditions are represented by heating-degree days (HDD); and for the cooling period they are represented by cooling-degree days (CDD).

In order to present actual energy consumption recalculated for "normal" weather conditions, a "normalized" energy consumption profile was developed.

The brief analysis shown below indicates the importance of considering HDD and CDD based on two representative project locations: New York City and Central New York (Syracuse) for the period from 2002 to 2005.

Comparison of normal HDD and CDD for the two locations indicates the following:

Syracuse:	HDDn = 6,814; CDDn = 550;
New York City (NYC):	HDDn = 4,777; CDDn = 1,131.

Normal HDDn are approximately 40% higher and normal CDDn are almost 100% lower for Syracuse than for New York City.

Comparison of HDD and CDD, respectively, for the same location for different years (2002 to 2005) indicates the following:

Syracuse:	HDDa = 6,077 to 6,958 (deviation from normal HDDn ranged from -11% in 2002 to + 2% in 2003); CDDa = 461 to 905 (deviation from normal CDDn ranged from -16% in 2004 to +65% in 2005);

New York City (NYC):	HDDa = 4,308 to 5,048 (deviation from normal HDDn ranged from -10% in 2002 to + 6% in 2003); CDDa = 1,155 to 1,596 (deviation from normal CDDn ranged from 2% in 2003 to +41% in 2005).

For two health care facilities with exactly the same characteristics except their location, a facility located in Syracuse compared with New York City, electricity consumption portion associated with heating equipment (HDD) is expected to be higher, and the electricity consumption portion associated with cooling equipment (CDD) is expected to be lower.

Electricity consumption data weather normalization was performed using regression analysis.

Energy Baseline Development
The baseline energy consumption was developed as the benchmark against which the effectiveness of future energy conservation efforts will be evaluated. Building electricity consumption was evaluated as a function of normalized EUI, measured in kilowatt-hours per year per square foot (kWh-yr./sq.ft.) of floor area.

2.5 BUILDING ENERGY BENCHMARKING

EPA's ENERGY STAR Portfolio Manager (ES-PM) tool was used to enter building utility data for each pilot facility and benchmark eligible facilities against similar hospitals (Note: Only acute and children's hospitals can be benchmarked using ENERGY STAR). As part of the project, pilot facilities were requested to enter monthly utility data into its ES-PM account at least once per quarter for the duration of the project for utility data recordkeeping and tracking.

2.6 ENERGY CONSERVATION MEASURE (ECMS) DEVELOPMENT

ECMs are generally defined as managing existing equipment or building systems to operate more efficiently or replacing existing equipment with more efficient equipment. For the purposes of this project, all energy reduction recommendations identified were referred to as ECMs.

ECMs were generally divided into three categories: technical measures involving the replacement of existing equipment; operational measures; and training and awareness. Recommended ECMs were prioritized based on expected return on investment. Each ECM's equipment and labor costs, as well as the expected energy consumption and cost savings resulting from ECM implementation, were estimated. ECM development concentrated on low-cost implementation measures with a simple pay-back period (SPP) of less than three years.

2.7 OUTREACH PROGRAM IMPLEMENTATION

Two educational seminars were conducted to raise energy efficiency and conservation awareness among health care facilities. These half-day seminars included a variety of presentations on energy-related topics including benchmarking and energy curtailment, NYSERDA programs and incentives available to health care facilities, and case studies.

In addition, an Energy Management Guidebook for Health Care Facilities was developed and distributed to attendees at the second seminar. The Guidebook contains checklists and forms that will allow facilities to conduct their own energy surveys.

SECTION 3
FACILITY SURVEY RESULTS

3.1 MILLARD FILLMORE SUBURBAN HOSPITAL

3.1.1 Facility Description

The Millard Fillmore Suburban Hospital (MFSH) is a 201-bed community hospital located in Williamsville, New York. The MFSH building summary is presented in Table 3-1.

Table 3-1 Summary of Energy Consumption/Cost/Intensities for the MFSH Building

Parameter	Units	Parameter	Comment
General			
Year Built	-	1973	
Building Area	sq.ft.	268,000	
Number of Beds	-	201	
Number of Staff	person	940	
Major HVAC Equipment			
Primary Cooling	tons	680	Two Trane electric chillers (320 and 360 tons)
	sq.ft./ton	394	
Primary Heating	MBH	29,290	Two Cleaver-Brooks natural gas-fired boilers (14,645 MBH each)
Air Handling Units	hp	462	12 AHUs; 10 are VAV and two are CV;
	hp/1,000 sq.ft.	1.7	Six AHUs have VFDs
Pumps	hp	220	
	hp/1,000 sq.ft.	0.8	
Energy Consumption/Cost/Intensities (based on 2005 data)			
Electricity			
Consumption	kWh/yr	8,335,420	
Demand Range	kW	1,000 to 1,450	
EUI (el)	kWh/yr-sq.ft.	31.1	
Cost	$/yr	$867,146	
Unit Cost	$/kWh	$0.10	
ECI (el)	$/sq.ft.-yr	$3.24	
Natural Gas			
Consumption	Mcf	32,265	
EUI (n.g.)	kBtu/yr-sq.ft.	120	
Cost	$/yr	$259,131	
Unit Cost	$/Mcf	$8.03	
ECI (n.g.)	$/sq.ft.-yr	$0.97	
Total Energy			
Consumption	kBtu	60,713,788	
EUI (total)	kBtu/yr-sq.ft.	227	

Table 3-1 Summary of Energy Consumption/Cost/Intensities for the MFSH Building

Parameter	Units	Parameter	Comment
Total Cost	$/yr	$1,126,277	
ECI (total)	$/yr-sq.ft.	4.2	

Key:

CV = Constant volume.
ECI = Energy cost intensity.
EUI = Energy use intensity.
hp = Horsepower.
HVAC = Heating, ventilating, and air conditioning.
kBtu = Kilo British thermal unit.
MBH = Thousand BTUs per hour.
sq.ft. = Square feet.
VAV = Variable air volume.
VFD = Variable frequency drive.

The primary building cooling is performed by two Trane electric chillers (320 tons and 360 tons). The primary heating is performed by two Cleaver-Brooks gas-fired boilers (14,645 thousand British thermal units per hour [MBH] each). Combined installed capacity of air-handling units is 462 horsepower (hp). Combined installed capacity of the hydronic pumps is 220 hp. Major heating, ventilating, and air conditioning (HVAC) equipment is from 10 to 15 years old.

3.1.2 Electricity End-Use Profile Development

Electricity end-use profiles indicate that the major contributor to electricity load and consumption for the MFSH building is the HVAC systems (~55%), followed by lighting (~17%), and the remainder by other equipment groups that include process, medical, kitchen, office, and miscellaneous equipment. Summary of electric load and consumption by end-use category are presented in Table 3-2.

Table 3-2 Summary of Electric Load and Consumption By End-Use Category for the MFSH Building

End-Use Category	Electric Load			Electric Consumption		
	kW	kW/sq.ft.	%	kWh-yr	kWh-yr/sq.ft.	%
HVAC Equipment	836	3.3	52%	4,471,565	17.9	55%
Lighting	277	1.1	17%	1,354,298	5.4	17%
Office Equipment	67	0.3	4%	376,671	1.5	5%
Process Equipment	151	0.6	9%	311,132	1.2	4%
Medical Equipment	131	0.5	8%	867,212	3.5	11%
Kitchen Equipment	47	0.2	3%	237,902	1.0	3%
Computer/Network Equipment	6.4	0.026	0.4%	34,490	0.14	0.4%
Miscellaneous Equipment	86	0.3	5%	470,498	1.9	6%
Total	**1,600**	**6.4**	**100%**	**8,123,769**	**32**	**100%**

Note: W/sq.ft. and kWh-yr/sq.ft. are based on floor space of the whole building.

Key:

kW = Kilowatt.
kWh-yr = kilowatt hours per year.
sq.ft. = Square foot.

Figures 3-1 and 3-2 present end-use profiles of electric load and consumption for the MFSH building.

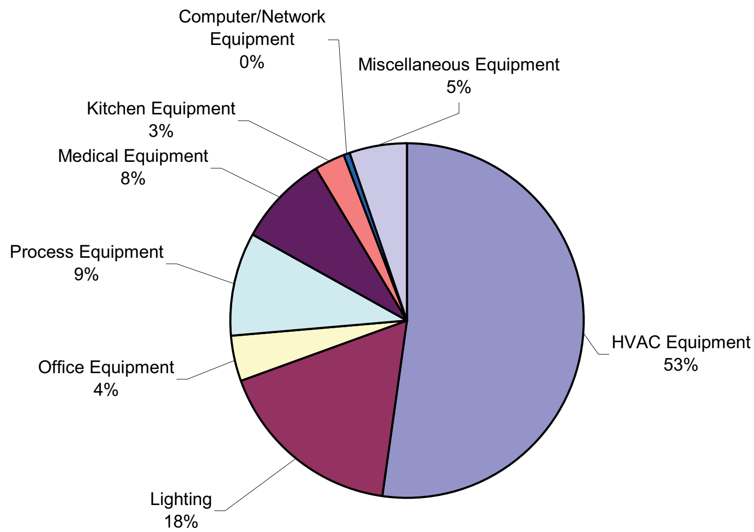

Figure 3-1 End-Use Profile of Electricity Load for the MFSH Building

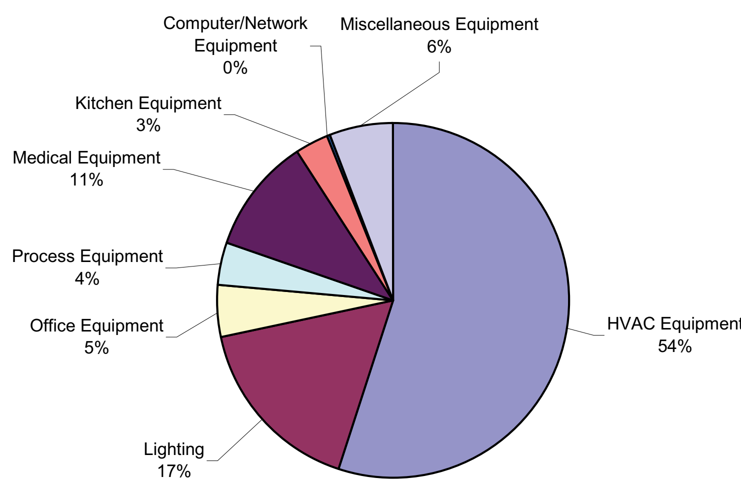

Figure 3-2 End-Use Profile of Electricity Consumption for the MFSH Building

3.1.3 Total Energy Analysis and Energy Benchmarking

Monthly natural gas consumption from MFSH changes from 1,800 million cubic feet per month (Mcf/mo) in summer to 3,000 to 4,000 Mcf/mo during the heating season. Base-load (non-heating) natural gas consumption is approximately 1,800 Mcf/mo.

Electricity was found to contribute approximately 46% of total energy consumption (in terms of kilo British thermal units [kBtu]) and 77% of total utility cost. Natural gas contributes approximately 54% of total energy consumption and 23% of total cost.

EPA's ENERGY STAR Portfolio Manager (ES-PM) tool was used to benchmark the MFSH building against similar hospitals. Analysis indicates, on a scale of 1 to 100, the MFSH building has a rating of 53 based on total annual energy use intensity (EUI = 225 kBtu/yr-sq.ft.), which is 20% to 30% higher than for ENERGY STAR labeled acute hospitals located in the same climatological zones.

3.1.4 Field Survey Findings

Overall, the MFSH building survey revealed that it is well maintained by a full compliment of in-house maintenance staff. The MFSH building uses an existing BAS based on the Tridium Niagara Framework platform. The BAS capabilities and its use by the MFSH staff are summarized in Table 3-3. Comprehensive testing, adjusting, and balancing (TAB) of HVAC systems for MFSH was performed in 1994. The most recent TAB effort pertinent to air change rates in operational rooms was undertaken in August of 2006.

Table 3-3 Building Automation System, Millard Fillmore Suburban Hospital, Williamsville, New York

End-Uses BAS Covers	Capable	Utilized
Equipment		
AHU	yes	yes
Boilers	yes	yes
Chiller Plant Optimization	yes	yes
Fan/pump Speed Control	yes	yes
VFDs	yes	yes
Hot Water System	yes	yes
Interior Lighting	no	no
Peak Demand Limiting	no	no
Energy Trending	no	no
Parameters		
Economizer Cycle (Enthalpy)	yes	yes
Air temperature reset	yes	yes
Chilled water temperature reset	yes	yes
Condenser water temperature reset	yes	yes
Hot water temperature reset	yes	yes
Scheduled start/stop for fans/pumps	yes	partially
Chilled water plant optimization or staging of chiller compressors	yes	yes
System time of day control	yes	yes
Night setback	yes	yes
Optimized start time for peak shaving	yes	no
Humidity Control	yes	yes
Peak Demand Limiting	yes	no
Energy Trending	yes	no

3.1.5 ECMs

Based on building survey results and the energy analysis performed for the MFSH building, several ECMs were developed. An estimate of implementation costs and expected savings for each recommended ECM was developed where possible. Table 3-4 lists the recommended ECMs in order of ease of implementation and simple payback calculations.

Table 3-4 Summary of ECMs for MFSH

ECM	Cost of Implementation		Savings		SPP (yr)
	Capital Cost ($)	Labor Cost($)	kWh-yr	Cost ($)	
Advanced Interval Metering	-	$2,184[a]	243,810	$26,817	0.1
BAS Scheduling	-	$546[b]	14,420	$1,590	0.3
Relamping	$312	$686	22,914	$2,521	0.5
Lighting Controls	$5,140	$2,827	33,648	$3,701	2.2
Higher Efficiency Equipment Purchase	NA	NA	121,657	$13,381	-
Awareness Program	$1,000[c]	$4,368[d]	61,414	$6,755	0.6
Total	**$6,452**	**$10,611**	**497,863**	**$54,765**	

Key:

SPP = Simple payback period.

Footnotes:

(a) Labor cost estimated at 1 hr/wk @ $42/hr (cost per labor-hour for electrician, 2006 RS Means)
(b) Labor cost estimated at 15 min/wk @ $42/hr
(c) Estimated cost for awareness program materials including posters, table top displays, signs, etc.
(d) Labor cost estimated at 2 hrs/wk @ $42/hr

3.2 BUFFALO GENERAL HOSPITAL

3.2.1 Facility Description

Buffalo General Hospital (BGH) is a 501-bed acute care hospital located in Buffalo, New York. The hospital is a member of Kaleida Health and is a teaching hospital affiliated with SUNY at Buffalo School of Medicine and Biomedical Sciences. The BGH building complex summary is presented in Table 3-5.

According to the NYSDOH, in 2006, BGH performed:

- 9,777 miscellaneous diagnostic and therapeutic procedures; and
- 33,206 operations, including 28,425 on the cardiovascular system.

Table 3-5 Summary Energy Consumption/Cost/Intensities for the BGH Building Complex

Parameter	Units	Parameter	Comment
General			
Year Built	-	1968	
Building Area	sq.ft.	1,177,305	BGH complex consists of seven buildings
Number of Beds	-	501	
Number of Staff	person	1,700	
HVAC Equipment			
Primary Cooling	tons	3,350	Three Trane electric centrifugal chillers (1,400; 650* and 1,500 tons)
	sq.ft./ton	351	
Primary Heating			Two Babcock & Wilcox (60,000 lbs/hr of steam each) and one Cleaver-Brooks Boiler (30,000 lbs/hr of steam)
Air Handling Units	hp	1,014	52 AHUs; five are VAV and 47 are CV; three AHUs have VFDs
	hp/1,000 sq.ft.	0.9	
Pumps	hp	932	
	hp/1,000 sq.ft.	0.8	
Energy Consumption/Cost/Intensities (based on 2006 data)			
Electricity			
Consumption	kWh/yr	26,963,994	
Demand Range	kW	3,474 to 5,688	
EUI (el)	kWh/sq.ft.-yr	23	
Cost	$/yr	$2,317,400	
Unit Cost	$/kWh	$0.09	
	$/sq.ft.-yr	$1.97	
Natural Gas			
Consumption	Mcf/yr	124,313	
EUI (n.g.)	kBtu/sq.ft.-yr	106	
Cost	$/yr	$1,267,190	
Unit Cost	$/Mcf	$10.19	
ECI (n.g.)	$/sq.ft.-yr	$1.08	
Fuel Oil No. 6			
Consumption	gal/yr	242,400	
EUI (f.o.)	kBtu/sq.ft.-yr	31	
Cost	$/yr	$461,456	
Unit Cost	$/gal	$1.90	
ECI (f.o.)	$/sq.ft.-yr	$0.39	
Total Energy			
Consumption	kBtu/yr	252,701,112	
EUI (total)	kBtu/sq.ft.-yr	215	
Total Cost	$/yr	$4,046,046	
ECI (total)	$/sq.ft.-yr	$3.4	

*Note: Chiller No. 2 (650-ton) was replaced by a new Trane 800-ton chiller in April 2007.

Key:

EUI = Energy Use Intensity.
ECI = Energy Cost Intensity.

Cooling of the primary building complex is performed by three electric centrifugal chillers. Primary heating is performed by three dual fuel boilers. The combined installed capacity of air-handling units is 1,014 horsepower (hp). The combined installed capacity of the hydronic pumps is 932 hp. The majority of air-handling systems are constant volume and all pumping systems are constant speed systems. Major heating, ventilating, and air conditioning (HVAC) equipment is from 10 to 35 years old.

3.2.2 Electricity End-Use Profile Development

Electricity end-use profiles indicate that the major contributor to electricity load and consumption for the BGH building complex is HVAC systems (~42%), followed by lighting (~18%), and the remainder by other equipment groups that include process, medical, kitchen, office, and miscellaneous equipment. Summary of electric load and consumption by end-use category are presented in Table 3-6.

Table 3-6 Summary of Electric Load and Consumption by End-Category, Buffalo General Hospital, Buffalo, New York

End-Use Category	Electric Load			Electric Consumption		
	kW	W/sq.ft.	%	kWh/yr	kWh/sq.ft.-yr	%
HVAC Equipment	2,793	2.4	47%	11,131,110	9.5	42%
Lighting	1,102	0.94	19%	4,948,715	4.2	18%
Office Equipment	212	0.2	4%	1,883,688	1.6	7%
Process Equipment	587	0.5	10%	1,661,858	1.4	6%
Medical Equipment	495	0.4	8%	2,962,709	2.5	11%
Kitchen Equipment	55	0.05	1%	425,492	0.4	2%
Computer/Network Equipment	183	0.2	3%	1,282,464	1.1	5%
Miscellaneous Equipment	506	0.4	9%	2,472,341	2.1	9%
Total	**5,933**	**5.0**	**100%**	**26,768,377**	**23**	**100%**

Note: W/sq.ft. and kWh/sq.ft. are based on floor space of the whole building

Figures 3-3 and 3-4 present end-use profiles of electric load and consumption for the BGH building complex.

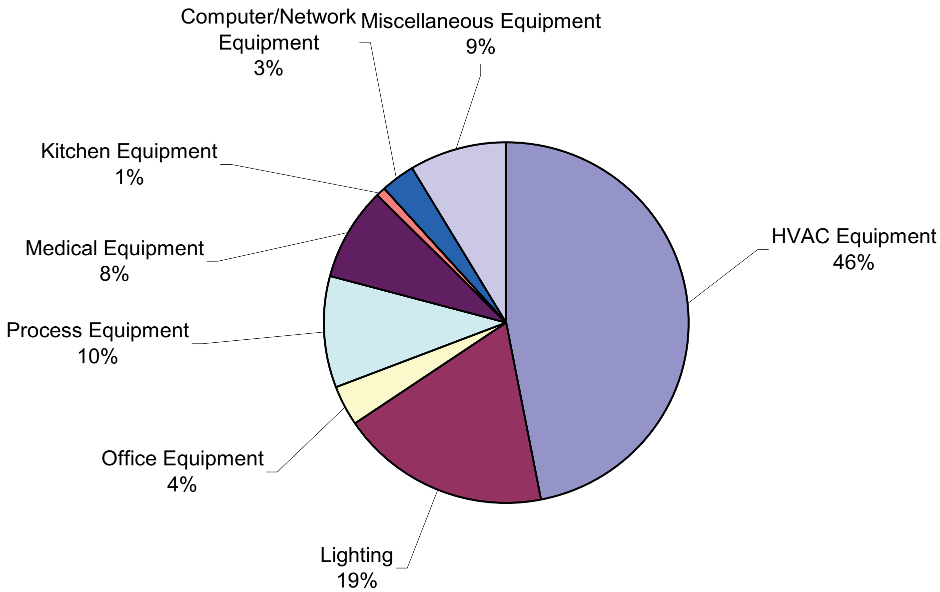

Figure 3-3 End-Use Profile of Electricity Load for the BGH Building Complex

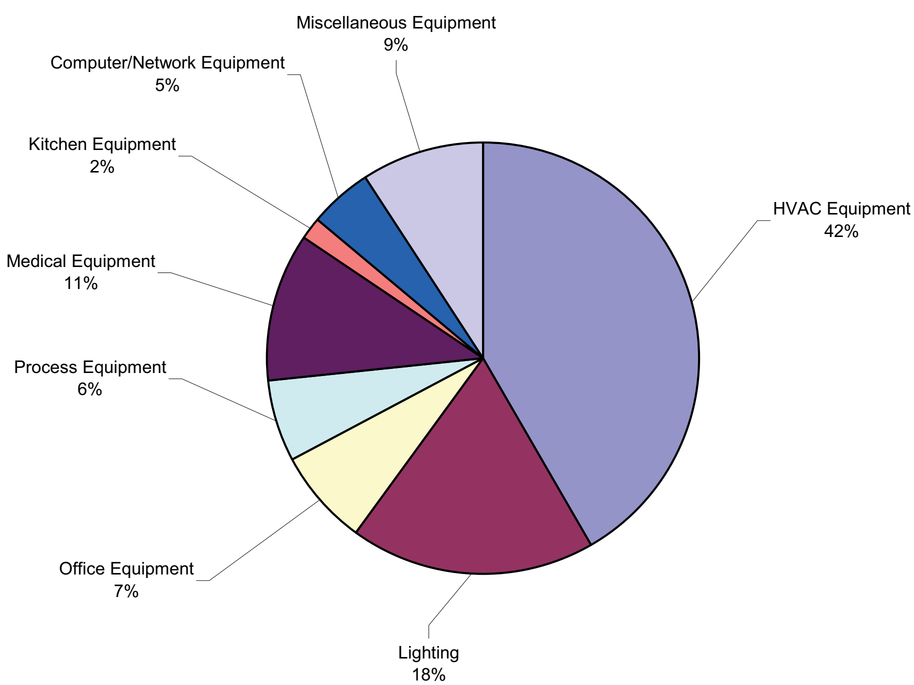

Figure 3-4 End-Use Profile of Electricity Consumption for the BGH Building Complex

3.2.3 Total Energy Analysis and Energy Benchmarking

The BGH building complex energy benchmarking is based on total energy consumption intensity including electricity, natural gas, and fuel oil. For 2006, natural gas contributed approximately 49% of total energy consumption and 31% of total energy cost. Fuel oil contributed approximately 14% of total energy consumption and 11% of total energy cost. Monthly thermal energy (natural gas and fuel oil) changes from a base-load (non-heating) consumption of 9,000 Mcf/mo to 16,000 to 20,000 Mcf/mo during the heating season. The steam generation trend for the BGH building complex is presented in Figure 7. Monthly steam generation changes from base-load (non-heating) to 8,000,000 lbs/mo to 16,000,000 to 18,000,000 lbs/mo during the heating season. Electricity contributed approximately 36% of total energy consumption (in terms of thousand British thermal units [kBtu]) and 57% of total energy cost.

ES-PM was used to benchmark the BGH building complex against similar hospitals. Analysis indicates that on a scale of 1 to 100, the BGH building complex has a rating of 76 based on total annual energy use intensity ($EUI_{(total)}$ = 210 kBtu/sq.ft.-yr).

3.2.4 Field Survey Findings

Overall, the BGH building complex survey revealed that it is well maintained by a full compliment of in-house maintenance staff. BGH uses an existing Siemens BAS. The BAS capabilities and its utilization by the BGH staff are summarized in Table 3-7. Comprehensive testing, adjusting, and balancing (TAB) of HVAC systems for BGH has not been performed. The most recent TAB effort pertinent to air change rates in operating, angio rooms, and several other specific areas, was undertaken in November 2006.

Table 3-7 Building Automation System, Buffalo General Hospital, Buffalo, New York

End-Uses BAS Covers	Capable	Utilized
Equipment		
AHU	yes	yes
Boilers	yes	yes
Chiller Plant Optimization	yes	yes
Fan/pump Speed Control	yes	yes
VFDs	yes	yes
Hot Water System	yes	yes
Interior Lighting	no	no
Parameters		
Economizer Cycle (Enthalpy)	yes	yes
Air temperature reset	yes	yes
Chilled water temperature reset	yes	yes
Condenser water temperature reset	yes	yes
Hot water temperature reset	yes	yes
Scheduled start/stop for fans/pumps	yes	partially
Chilled water plant optimization or	no	no
staging of chiller compressors		

Table 3-7 Building Automation System, Buffalo General Hospital, Buffalo, New York

End-Uses BAS Covers	Capable	Utilized
System time of day control	yes	yes
Night setback	yes	yes
Optimized start time for peak shaving	no	no
Humidity Control	yes	yes
Peak Demand Limiting	no	no
Energy Trending	no	no

3.2.5 ECMS

Based on building survey results and the energy analysis performed for the BGH building complex, several ECMs were developed. An estimate of implementation costs and expected savings for each recommended ECM was developed where possible. Table 3-8 lists the recommended ECMs in order of ease of implementation and simple payback calculations.

Table 3-8 Summary of ECMs for the BGH Building Complex

ECM	Cost of Implementation		Savings		SPP (yr)
	Capital Cost ($)	Labor Cost($)	kWh-yr	Cost ($)	
Advanced Interval Metering	-	$2,184[(a)]	269,640	$26,964	0.1
AHU Motor Replacement	$8,500	$5,485	120,362	$12,036	1.2
Additional HVAC Equipment Scheduling	-	$546[(b)]	62,254	$6,225	0.1
Relamping	$2,507	$2,127	32,348	$3,235	1.4
Lighting Controls	$11,120	$7,950	191,635	$19,164	1.0
Higher Efficiency Equipment Purchase	NA	NA	478,150	$47,815	-
Awareness Program	$1,000[(c)]	$4,368[(d)]	269,640	$26,964	0.2
Total	**$23,127**	**$22,660**	**1,424,030**	**$142,403**	

Key:

SPP = Simple payback period.

Footnotes:

(a) Labor cost estimated at 1 hr/wk @ $42/hr (cost per labor-hour for electrician, 2006 RS Means)
(b) Labor cost estimated at 15 min/wk @ $42/hr
(c) Estimated cost for awareness program materials including posters, table top displays, signs, etc.
(d) Labor cost estimated at 2 hrs/wk @ $42/hr

3.3 ST. JOHN'S RIVERSIDE HOSPITAL – ANDRUS PAVILION

3.3.1 Facility Description

St. John's Riverside Hospital – Andrus Pavilion (SJRH-AP) is a 268-bed community hospital located in Yonkers, New York. The SJRH-AP building summary is presented in Table 3-9. The SJRH-AP building, in addition to its own 268 beds, houses several functional areas that serve other facilities within the Riverside Hospital Healthcare System:

- Park Care Pavilion: 129 beds;
- Dobbs Ferry Community Hospital: 50 beds; and
- Milotz Skilled Nursing Pavilion: 50 beds.

These shared functional areas include laundry, kitchen, laboratory, and the computer center areas.

Table 3-9 Summary of Energy Consumption/Cost/Intensities for the SJRH-AP Building

Parameter	Units	Parameter	Comment
General			
Year Built	-	1962	
Building Area	sq.ft./ton	319,000	13 floors
Number of Beds	-	268	
Number of Staff	person	1,300	
HVAC Equipment			
Primary Cooling	tons	780	Two Techochill natural gas engine-driven chillers (340 tons each); one Carrier electric chiller (100 tons)
	sq.ft./ton	409	
Primary Heating	MBH	67,000	Three Cleaver - Brooks fuel oil-fired steam boilers (one 21,000 MBH and two 23,000 MBH each)
Air Handling Units	hp	460	15 constant volume AHUs
	hp/1,000 sq.ft.	1.4	
Hydronic Pumps	hp	215	
	hp/1,000 sq.ft.	0.7	
Energy Consumption/Cost/Intensities (based on 2005 data)			
Electricity			
Consumption	kWh/yr	9,080,748	
Demand Range	kW	1,250 to 1,700	
EUI (el)	kWh/sq.ft.-yr	28	
Cost	$/yr	$1,429,192	
Unit Cost	$/kWh	$0.16	
ECI (el)	$/sq.ft.-yr	$4.48	
Natural Gas			
Consumption	therms/yr	113,106	
EUI (n.g.)	kBtu/sq.ft.-yr	35	
Cost	$/yr	$157,623	
Unit Cost	$/therm	$1.39	
ECI (n.g.)	$/sq.ft.-yr	$0.49	
Fuel Oil No. 6			
Consumption	gal/yr	601,022	
EUI (f.o.)	kBtu/sq.ft.-yr	283	
Cost	$/yr	$807,555	
Unit Cost	$/gal	$1.34	
ECI (f.o..)	$/sq.ft.-yr	$2.53	

Table 3-9 Summary of Energy Consumption/Cost/Intensities for the SJRH-AP Building

Parameter	Units	Parameter	Comment
Total Energy			
Consumption	kBtu	135,461,635	
EUI (total)	kBtu/sq.ft.-yr	425	
Total Cost	$/yr	$2,394,370	
ECI (total)	$/sq.ft.-yr	$7.5	

The primary building cooling is performed by two Techochill natural gas engine-driven (340 tons each) chillers and one Carrier electric chiller. The primary heating is performed by three Cleaver-Brooks fuel oil-fired boilers. The combined installed capacity of air-handling units is 460 horsepower (hp). The combined installed capacity of the hydronic pumps is 215 hp. All air-handling systems are constant volume and all performing systems are constant speed systems. Major heating, ventilating, and air conditioning (HVAC) equipment is from 10 to 25 years old.

3.3.2 Electricity End-Use Profile Development

Electricity end-use profiles indicate that the major contributors to electricity load and consumption for the SJRH-AP building are the HVAC systems (~40%), followed by lighting (~16%), and the remainder by other equipment groups that include process, medical, kitchen, office, computer, and miscellaneous equipment. A summary of electric load and consumption by end-use category are presented in Table 3-10.

Table 3-10 Summary of Electric Load and Consumption By End-Use Category for the SJRH-AP Building

End-Use Category	Electric Load			Electric Consumption		
	kW	kW/sq.ft.	%	kWh-yr	kWh/sq.ft.-yr	%
HVAC Equipment	672	2.1	38	3,631,228	11	40
Lighting	277	1.0	16	1,431,393	4.5	16
Office Equipment	95	0.3	5	523,481	1.6	6
Process Equipment	145	0.5	8	388,044	1.2	4
Medical Equipment	143	0.4	8	971,751	2.9	11
Kitchen Equipment	115	0.4	7	641,604	2.0	7
Laundry Equipment	42	0.1	2	194,220	0.6	2
Computer/Network Equipment	88	0.3	5	770,880	2.4	9
Miscellaneous Equipment	186	0.6	11	464,283	1.5	5
Total	**1,762**	**5.7**	**100**	**9,016,884**	**28**	**100**

Note: W/sq.ft. and kWh/sq.ft.-yr are based on floor space of the whole building.

Key:
kW = Kilowatt.
kWh-yr = Kilowatt hours per year.
sq.ft. = Square foot.

Figures 3-5 and 3-6 present end-use profiles of electric load and consumption for the SJRH-AP building.

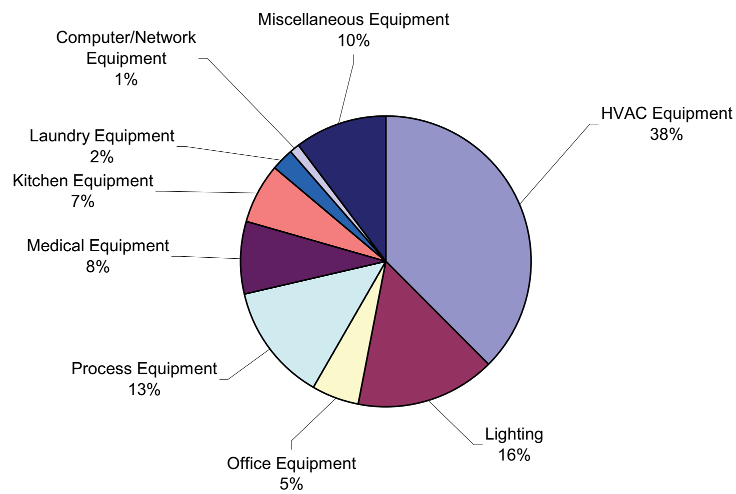

Figure 3-5 End-Use Profile of Electricity Load for the SJRH-AP Building

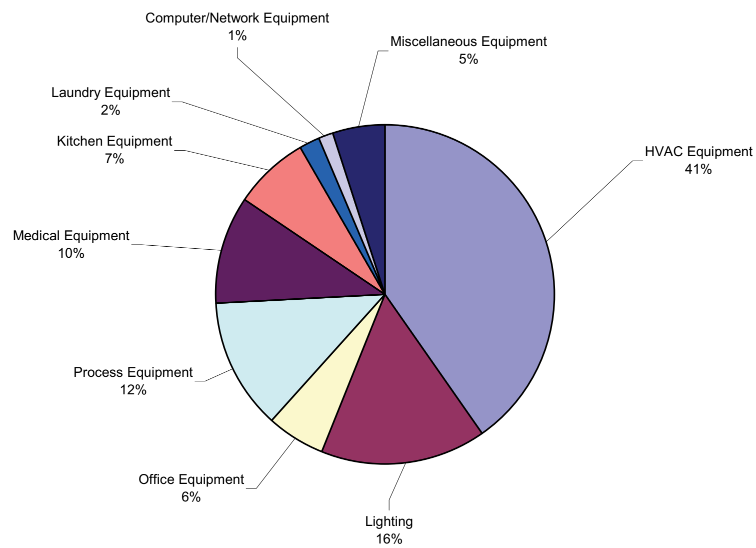

Figure 3-6 End-Use Profile of Electricity Consumption for the SJRH-AP Building

3.3.3 Total Energy Analysis and Energy Benchmarking

The SJRH-AP building energy benchmarking is based on total energy consumption intensity including electricity, natural gas, and fuel oil. Electricity contributes approximately 23% of total energy consumption (in terms of thousand British thermal units [kBtu]) and 60% of total utility cost. Monthly natural gas consumption changes from a base-load (non-cooling) consumption of 1,200 therms/mo to 25,000 to 30,000 therms/mo during the cooling season. Natural gas contributes approximately 8% of total energy consumption and total cost. The cooling portion of total natural gas consumption is approximately 90%. Monthly fuel oil consumption ranges from 30,000 gal/mo in summer to 60,000 to 90,000 gal/mo during the heating season. Fuel oil contributes approximately 70% of total energy consumption and 35% of total energy cost.

ES-PM was used to benchmark the SJRH-AP building against similar hospitals. Analysis indicates that on a scale of 1 to 100, the SJRH-AP building has a rating of 40 based on total annual energy use intensity ($EUI_{(total)}$ = 420 kBtu/sq.ft.-yr), which is 30% to 40% higher than for ENERGY STAR labeled acute hospitals located in the same climatological zones. The ENERGY STAR score for the SJRH-AP building should be carefully interpreted. The functional areas of the SJRH-AP building serving additional facilities are larger than those for a typical acute hospital. These areas contribute to approximately 20% of the SJRH-AP building's electricity consumption. In addition, a significant portion of fuel oil is used for laundry steam generation. Taking these factors into account, the ENERGY STAR score could be estimated closer to 50.

3.3.4 Field Survey Findings

Overall, the SJRH-AP building survey revealed that its total energy intensity is relatively high. This can be attributed to certain system inefficiencies. The SJRH-AP building uses an existing first generation BAS. This system does not have the functional capabilities of the latest generation BAS. Comprehensive testing, adjusting, and balancing (TAB) of HVAC systems for SJRH-AP has not been performed.

3.3.5 ECMs

Based on building survey results and the energy analysis performed for the SJRH-AP building, several ECMs were developed. An estimate of implementation costs and expected savings for each recommended ECM was developed where possible. Table 3-11 lists the recommended ECMs in order of ease of implementation and simple payback calculations.

Table 3-11 Summary of ECMs for the SJRH-AP Building

ECM	Cost of Implementation		Savings		SPP (yr)
	Capital Cost ($)	Labor Cost($)	kWh-yr	Cost ($)	
Advanced Interval Metering	-	$2,184[a]	180,780	$28,930	0.1
HVAC Equipment Scheduling	-	$546[b]	69,730	$11,160	0.1
Relamping	$22,497	$13,594	88,778	$14,204	2.5
Lighting Controls	$7,320	$5,234	74,258	$11,881	1.1
Higher Efficiency Equipment Purchase	NA	NA	209,125	$33,460	-
Awareness Program	$1,000[c]	$4,368[d]	90,390	$14,460	0.3
Total	**$30,817**	**$25,926**	**532,280**	**$85,165**	

Key:

SPP = Simple payback period.

Footnotes:

(a) Labor cost estimated at 1 hr/wk @ $42/hr (cost per labor-hour for electrician, 2006 RS Means)
(b) Labor cost estimated at 15 min/wk @ $42/hr
(c) Estimated cost for awareness program materials including posters, table top displays, signs, etc.
(d) Labor cost estimated at 2 hrs/wk @ $42/hr

3.4 ST. JOHN'S RIVERSIDE HOSPITAL – PARK CARE PAVILION

3.4.1 Facility Description

St. John's Riverside Hospital – Park Care Pavilion (SJRH-PCP) is a 128-bed rehabilitation health care facility located in Yonkers, New York. The SJRH-PCP building summary is presented in Table 3-12.

Table 3-12 Summary of Building and Energy Data for the SJRH-PCP Building

Parameter	Units	Parameter	Comment
General			
Year Built	-	1906 to 1974	
Building Area	sq.ft.	217,000	7 floors
Number of Beds	-	128	
Number of Staff	person	500	
HVAC Equipment			
Primary Cooling	tons	535	One steam absorption steam chiller (440 tons) and one absorption steam chiller (95 tons)
	sq.ft./ton	406	
Primary Heating	MBH	63,000	Three Cleaver-Brooks fuel oil-fired steam boilers (21,000 MBH each)
Air Handling Units	hp	162	Seven constant volume AHUs
	hp/1,000 sq.ft.	0.7	
Hydronic Pumps	hp	160	
	hp/1,000 sq.ft.	0.7	
Energy Consumption/Intensities (based on 2005 data)			
Electricity			
Consumption	kWh/yr	4,015,356	
Demand Range	kW	550 to 800	
$EUI_{(el)}$	kWh/sq.ft.-yr	18.5	
Cost	$/yr	$631,284	
Unit Cost	$/kWh	$0.16	
	$/sq.ft.-yr	$2.91	
Natural Gas			
Consumption	therms/yr	3,277	
$EUI_{(n.g.)}$	kBtu/sq.ft.-yr	1.51	
Cost	$/yr	$4,285	
Unit Cost	$/therm	$1.31	
	$/sq.ft.-yr	$0.02	
Fuel Oil No. 4			
Consumption	gal/yr	356,469	
$EUI_{(f.o.)}$	kBtu/sq.ft.-yr	230	
Cost	$/yr	$535,483	
Unit Cost	$/gal	$1.50	
	$/sq.ft.-yr	$2.47	

Table 3-12 Summary of Building and Energy Data for the SJRH-PCP Building

Parameter	Units	Parameter	Comment
Total Energy			
Consumption	kBtu/yr	63,937,770	
EUI (total)	kBtu/sq.ft.-yr	295	
Total Cost	$/yr	$1,171,052	
Unit Cost	$/sq.ft.-yr	$5.4	

Key:
EUI = Energy Use Intensity.
ECI = Energy Cost Intensity.

The primary building cooling is performed by two steam absorption chillers (440 tons and 95 tons). The primary heating is performed by three Cleaver-Brooks fuel oil-fired boilers. The combined installed capacity of air-handling units is 162 horsepower (hp). The combined installed capacity of the hydronic pumps is 160 hp. All air-handling systems are constant volume and all pumping systems are constant speed systems. Major heating, ventilating, and air conditioning (HVAC) equipment is from 10 to 25 years old.

3.4.2 Electricity End-Use Profile Development

Electricity end-use profiles indicate that the major contributor to electricity load and consumption for the SJRH-PCP building is the HVAC systems (~54%), followed by lighting (~23%), and the remainder by other equipment groups that include process, medical, kitchen, office, and miscellaneous equipment. Summary of electric load and consumption by end-use category are presented in Table 3-13.

Table 3-13 Summary of Electric Load and Consumption by End-Category, SJRH-PCP, Yonkers, New York

	Electric Load			Electric Consumption		
End-Use Category	kW	W/sq.ft.	%	kWh/yr	kWh/sq.ft.-yr	%
HVAC Equipment	382	1.8	42%	2,172,649	10	54%
Lighting	229	1.1	25%	910,010	4.3	23%
Office Equipment	57	0.3	6%	337,858	1.6	8%
Process Equipment	90	0.4	10%	83,360	0.4	2%
Kitchen/Cafeteria Equipment	45	0.2	5%	213,959	1.0	5%
Miscellaneous Equipment	117	0.6	13%	272,285	1.3	7%
Total	**919**	**4.3**	**100%**	**3,990,121**	**19**	**100%**

Note: W/sq.ft. and kWh/sq.ft. are based on floor space of the whole building

Figures 3-7 and 3-8 present end-use profiles of electric load and consumption for the SJRH-PCP building.

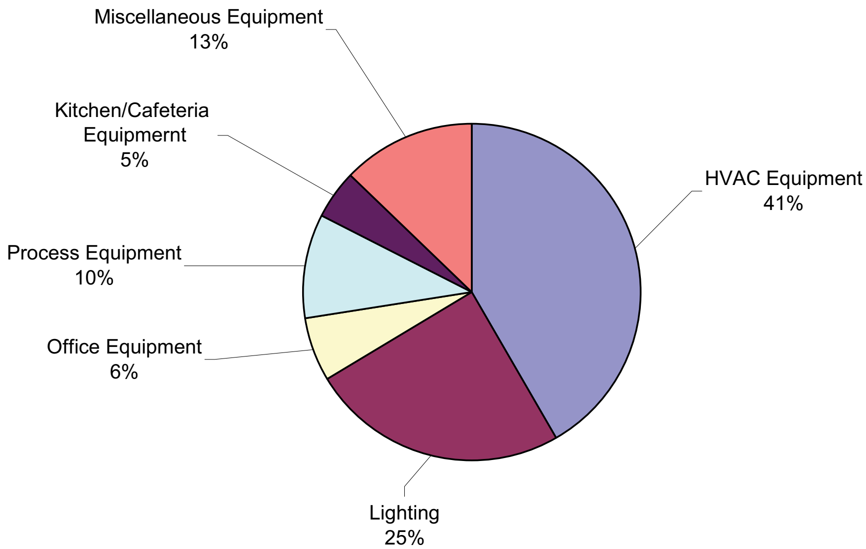

Figure 3-7 End-Use Profile of Electricity Load for the SJRH-PCP Building

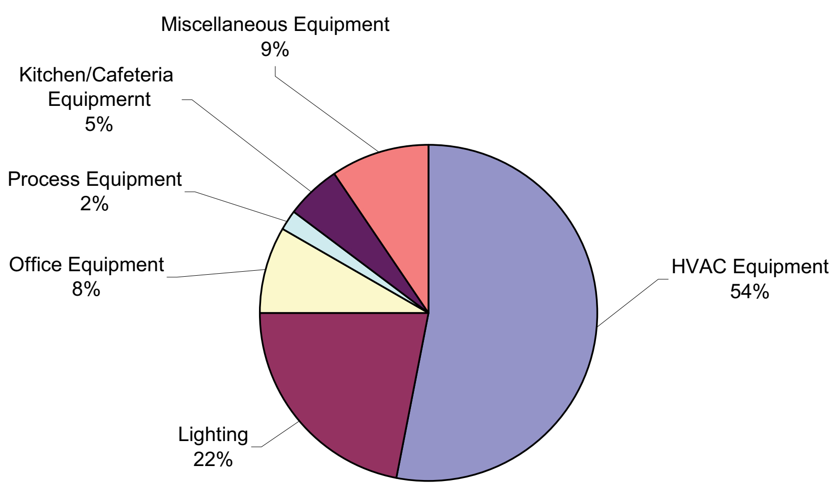

Figure 3-8 End-Use Profile of Electricity Consumption for the SJRH-PCP Building

3.4.3 Total Energy Analysis and Energy Benchmarking

The SJRH-PCP building energy benchmarking is based on total energy consumption intensity including electricity, natural gas, and fuel oil. Electricity contributes approximately 21% of total energy consumption and 54% of total utility cost. Natural gas contributes approximately 1% of total energy consumption and total cost. Monthly fuel oil consumption ranges from 20,000 to 35,000 gal/mo. Fuel oil contributes approximately 78% of total energy consumption and 45% of total energy cost.

ES-PM was used to enter the SJRH-PCP building utility data; however, ES-PM can benchmark acute and children's hospitals only and is not designed to benchmark rehabilitation health care facilities. Since U.S. benchmarking data for these types of facilities is not available, data available from studies conducted in Ontario, Canada

(Ontario Power Authority 2006) was used. Analysis indicates the SJRH-PCP building has a total annual energy use intensity $EUI_{(total)}$ = 295 kBtu/sq.ft.-yr, which is 40% to 50% higher than addiction/rehab health care facilities in Ontario, which have average $EUI_{(total)}$ = 190-210 kBtu/sq.ft.-yr.

3.4.4 Field Survey Findings

Overall, the SJRH-PCP building survey revealed that its total energy intensity is relatively high. This can be attributed to certain system inefficiencies. The SJRH-PCP building does not have a BAS. It is recommended to consider installing a BAS in the future. Comprehensive testing, adjusting, and balancing (TAB) of HVAC systems for SJRH-PCP has not been performed.

3.4.5 ECMs

Based on building survey results and the energy analysis performed for the SJRH-PCP building, several ECMs were developed. An estimate of implementation costs and expected savings for each recommended ECM was developed where possible. Table 3-14 lists the recommended ECMs in order of ease of implementation and simple payback calculations.

Table 3-14 Summary of ECMs for SJRH-PCP

ECM	Cost of Implementation		Savings		SPP (yr)
	Capital Cost ($)	Labor Cost($)	kWh-yr	Cost ($)	
Advanced Interval Metering	-	$2,184[(a)]	41,030	$6,565	0.3
HVAC Scheduling	-	$546[(b)]	16,530	$2,645	0.2
Relamping	$34,700	$20,240	144,000	$23,000	2.4
Lighting Controls	$6,880	$4,920	58,700	$9,390	1.3
Higher Efficiency Equipment Purchase	NA	NA	93,710	$15,000	-
Awareness Program	$1,000[(c)]	$4,370[(d)]	41,000	$6,570	0.3
Total	**$42,580**	**$32,260**	**394,980**	**$63,200**	

Key:
SPP = Simple payback period.

Footnotes:
(a) Labor cost estimated at 1 hr/wk @ $42/hr (cost per labor-hour for electrician, 2006 RS Means)
(b) Labor cost estimated at 15 min/wk @ $42/hr
(c) Estimated cost for awareness program materials including posters, table top displays, signs, etc.
(d) Labor cost estimated at 2 hrs/wk @ $42/hr

3.5 ST. VINCENT'S HOSPITAL

3.5.1 Facility Description

St. Vincent's Hospital (SVH) is a 133-bed behavioral health care facility located in Harrison, New York. The SVH building summary is presented in Table 3-15.

The primary building cooling is performed by three York electric chillers (45 tons each) and five McQuay rooftop units (51 to 81 tons). The primary heating is performed by three natural gas-fired boilers. The combined installed capacity of air-handling units is 253 horsepower (hp). AHU-2 through AHU-6 are VAV systems. The combined installed capacity of the hydronic pumps is 64 hp. Major heating, ventilating, and air conditioning (HVAC) equipment is from 10 to 25 years old.

Table 3-15 Summary of Building and Energy Data for the SVH Building

Parameter	Units	Parameter	Comment
General			
Year Built	-	1954 to 1990	
Building Area	sq.ft.	226,000	
Number of Beds	-	133	
Number of Staff	person	450	
HVAC Equipment			
Primary Cooling	tons	467	Three York electric chillers (45 tons each) and five McQuay rooftop units ranging from 51 to 81 tons.
	sq.ft./ton	484	
Primary Heating	MBH	30,081	Three boilers (8,936 MBH; 6,500 MBH and 14,645 MBH)
Air Handling Units	hp	253	Five Roof Pack packaged heating and cooling rooftop units (VAV) 10 CV AHUs
	hp/1,000 sq.ft.	1.1	
Hydronic Pumps	hp	64	
	hp/1,000 sq.ft.	0.3	
Energy Consumption/Intensities (based on 2005 and 2006 data)			
Electricity			
Consumption	kWh/yr	4,543,200	
Demand Range	kW	590 to 1238	
EUI (el)	kWh/sq.ft.-yr	20.1	
Cost	$/yr	$655,955	
Unit Cost	$/kWh	$0.14	
ECI (el)	$/sq.ft.-yr	$2.90	
Natural Gas			
Consumption	therms/yr	327,524	
EUI (n.g.)	kBtu/sq.ft.-yr	145	
Cost	$/yr	$391,994	
Unit Cost	$/therm	$1.20	
ECI (n.g.)	$/sq.ft.-yr	$1.73	
Total Energy			
Consumption	kBtu/yr	48,258,342	
EUI (total)	kBtu/sq.ft.-yr	214	
Total Cost	$/yr	$1,047,949	
ECI (total)	$/sq.ft.-yr	$4.6	

Key:

EUI = Energy use intensity.
ECI = Energy cost intensity.

3.5.2 Electricity End-Use Profile Development

Electricity end-use profiles indicate that the major contributor to electricity load and consumption for the SVH building is the HVAC systems (~60%), followed by lighting (~19%), and the remainder by other equipment groups that include process, medical, kitchen, office, and miscellaneous equipment. A summary of electric load and consumption by end-use category is presented in Table 3-16.

Table 3-16 Summary of Electric Load and Consumption by End-Category SVH, Harrison, New York

	Electric Load			Electric Consumption		
End-Use Category	**kW**	**W/sq.ft.**	**%**	**kWh/yr**	**kWh/sq.ft.-yr**	**%**
HVAC Equipment	406	1.8	45%	2,607,248	11.5	61%
Lighting	197	0.9	22%	822,620	3.6	19%
Office Equipment	52	0.2	6%	293,787	1.3	7%
Process Equipment	77	0.3	8%	77,750	0.3	2%
Medical Equipment	38	0.2	4%	114,698	0.5	3%
Kitchen Equipment	42	0.2	5%	188,362	0.8	4%
Miscellaneous Equipment	95	0.4	10%	155,899	0.7	4%
Total	**907**	**4.0**	**100%**	**4,260,364**	**19**	**100%**

Note: W/sq.ft. and kWh/sq.ft. are based on floor space of the whole building

Figures 3-9 and 3-10 present end-use profiles of electric load and consumption for the SVH building.

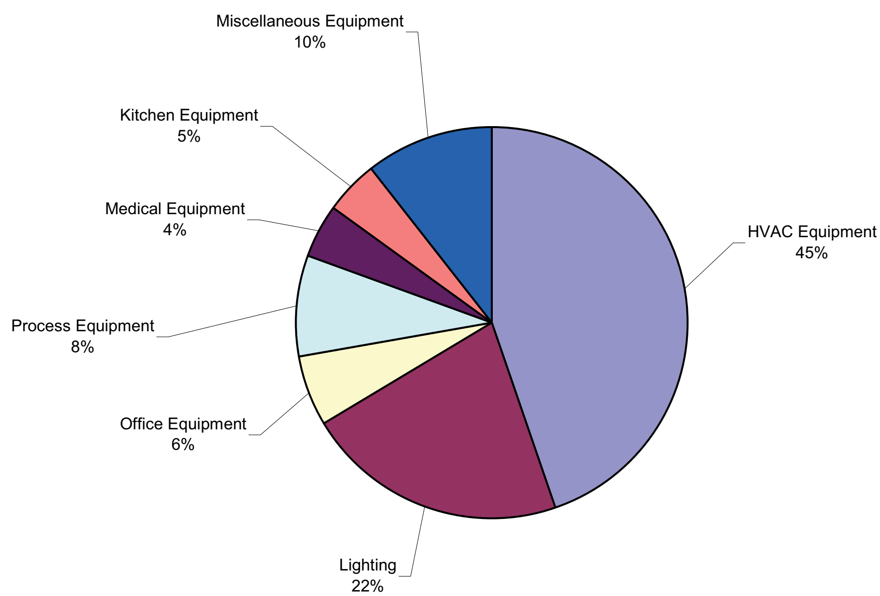

Figure 3-9 End-Use Profile of Electricity Load for the SVH Building

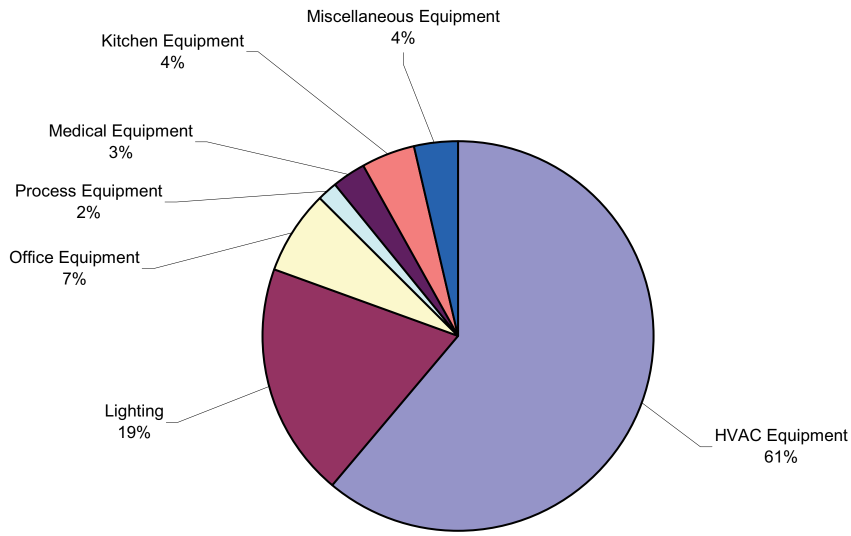

Figure 3-10 End-Use Profile of Electricity Consumption for the SVH Building

3.5.3 Total Energy Analysis and Energy Benchmarking

The SVH building energy benchmarking is based on total energy consumption intensity including electricity and natural gas. Electricity contributes approximately 32% of total energy consumption and 63% of total utility cost. Natural gas contributes approximately 68% of total energy consumption and 37% of total cost.

ES-PM was used to enter the SVH building utility data; however, ES-PM can benchmark acute and children's hospital only and is not designed to benchmark behavioral health care facilities. Since U.S. benchmarking data for these types of facilities is not available, data available from studies conducted in Ontario, Canada (Ontario Power Authority 2006) was used. Analysis indicates the SVH building has a total annual energy use intensity $EUI_{(total)}$ = 214 kBtu/sq.ft.-yr, which is comparable with behavioral health care facilities in Ontario, which have average $EUI_{(total)}$ = 210 kBtu/sq.ft.-yr.

3.5.4 Field Survey Findings

Overall, the SVH building survey revealed that it is well maintained by a full compliment of in-house maintenance staff. The SVH building uses existing Johnson Controls and Andover BAS. Routine analysis of BAS output is critically important for reducing energy consumption by the facility's HVAC system. This effort should be streamlined and BAS trending and demand reduction capabilities, which are currently not available should be added to BAS. Comprehensive testing, adjusting, and balancing (TAB) of HVAC systems for SVH has not been performed.

3.5.5 ECMs

Based on building survey results and the energy analysis performed for the SVH building, several ECMs were developed. An estimate of implementation costs and expected savings for each recommended ECM was developed where possible. Table 3-17 lists the recommended ECMs in order of ease of implementation and simple payback calculations.

Table 3-17 Summary of ECMs for SVH

ECM	Cost of Implementation		Savings		SPP (yr)
	Capital Cost ($)	Labor Cost($)	kWh-yr	Cost ($)	
Advanced Interval Metering	-	$2,184[(a)]	85,200	$11,910	0.2
HVAC Scheduling	-	$546[(b)]	13,140	$1,840	0.3
Relamping	$3,800	$2,740	21,800	$3,090	2.1
Lighting Controls	$10,200	$7,300	62,500	$8,750	2.0
Higher Efficiency Equipment Purchase	NA	NA	98,230	$13,750	-
Awareness Program	$1,000[(c)]	$4,370[(d)]	42,600	$5,960	0.9
Total	**$15,000**	**$17,140**	**323,500**	**$45,300**	

Key:
SPP = Simple payback period.

Footnotes:
(a) Labor cost estimated at 1 hr/wk @ $42/hr (cost per labor-hour for electrician, 2006 RS Means)
(b) Labor cost estimated at 15 min/wk @ $42/hr
(c) Estimated cost for awareness program materials including posters, table top displays, signs, etc.
(d) Labor cost estimated at 2 hrs/wk @ $42/hr

3.6 COMMUNITY HOSPITAL AT DOBBS FERRY

3.6.1 Facility Description

Community Hospital at Dobbs Ferry (CHDF) is a 50-bed community hospital located in Dobbs Ferry, New York. The CHDF building summary is presented in Table 3-18.

The primary building cooling is performed by a Trane electric (204 ton) chiller. The primary heating is performed by two Kewanee fuel oil-fired boilers. The combined installed capacity of air-handling units is 67 horsepower (hp). The combined installed capacity of the hydronic pumps is 44 hp. All air-handling systems are constant volume. Major heating, ventilating, and air conditioning (HVAC) equipment is from 10 to 20 years old, except for the chiller which is only a few years old.

Table 3-18 Summary of Building and Energy Data for the CHDF Building

Parameter	Units	Parameter	Comment
General			
Year Built	-	1984	
Building Area	sq.ft.	57,502	Three floors
Number of Beds	-	50	
Number of Staff	person	250	

Table 3-18 Summary of Building and Energy Data for the CHDF Building

Parameter	Units	Parameter	Comment
HVAC Equipment			
Primary Cooling	tons	204	One Trane electric chiller (204 tons)
	sq.ft./ton	282	
Primary Heating	MBH	8,500	Two Kewanee hot water boilers (4,250 MBH each)
Air Handling Units	hp	67	Four constant volume AHUs
	hp/1,000 sq.ft.	1.2	
Hydronic Pumps	hp	44	
	hp/1,000 sq.ft.	0.8	
Energy Consumption/Intensities/Cost (based on 2005 data)			
Electricity			
Consumption	kWh/yr	1,891,200	
Demand Range	kW	280 to 450	
EUI (el)	kWh/sq.ft.-yr	32.9	
Cost	$/yr	$301,476	
Unit Cost	$/kWh	$0.16	
ECI (el)	$/sq.ft.-yr	$5.24	
Natural Gas			
Consumption	therms/yr	480	
EUI (n.g.)	kBtu/sq.ft.-yr	0.8	
Cost	$/yr	$1,260	
Unit Cost	$/therm	$2.63	
ECI (n.g.)	$/sq.ft.-yr	$0.02	
Fuel Oil No.2			
Consumption	gal/yr	71,993	
EUI (f.o.)	kBtu/sq.ft.-yr	175	
Cost	$/yr	$164,864	
Unit Cost	$/gal	$2.29	
ECI (f.o.)	$/sq.ft.-yr	$2.87	
Total Energy			
Consumption	kBtu/yr	16,533,686	
EUI (total)	kBtu/sq.ft.-yr	288	
Total Cost	$/yr	$467,600	
ECI (total)	$/sq.ft.-yr	$8.1	

Key:

EUI = Energy use intensity.
ECI = Energy cost intensity.

3.6.2 Electricity End-Use Profile Development

Electricity end-use profiles indicate that the major contributors to electricity load and consumption for the CHDF building are the HVAC systems (~65%), followed by lighting (~13%), and the remainder by other equipment groups that include process, medical, kitchen, office, and miscellaneous equipment. A summary of electric load and consumption by end-use category are presented in Table 3-19.

Table 3-19 Summary of Electric Load and Consumption By End-Use Category for the CHDF Building

End-Use Category	Electric Load			Electric Consumption		
	kW	W/sq.ft.	%	kWh-yr	kWh/sq.ft.-yr	%
HVAC Equipment	211	3.7	43	1,200,948	21	66
Lighting	63	1.1	13	230,172	4.0	13
Office Equipment	18	0.3	4	107,132	1.9	6
Process Equipment[1]	146	2.5	30	92,620	1.6	5
Medical Equipment	15	0.3	3	56,876	1.0	3
Kitchen/Cafeteria Equipment	17	0.3	3	69,717	1.2	4
Miscellaneous Equipment	23	0.4	5	47,110	0.8	3
Total	**493**	**8.6**	**100**	**1,804,574**	**31**	**100**

Notes: W/sq.ft. and kWh/sq.ft.-yr are based on floor space of the whole building.
[1] Process equipment includes a Sussman electric steam boiler.

Figures 3-11 and 3-12 present end-use profiles of electric load and consumption for the CHDF building.

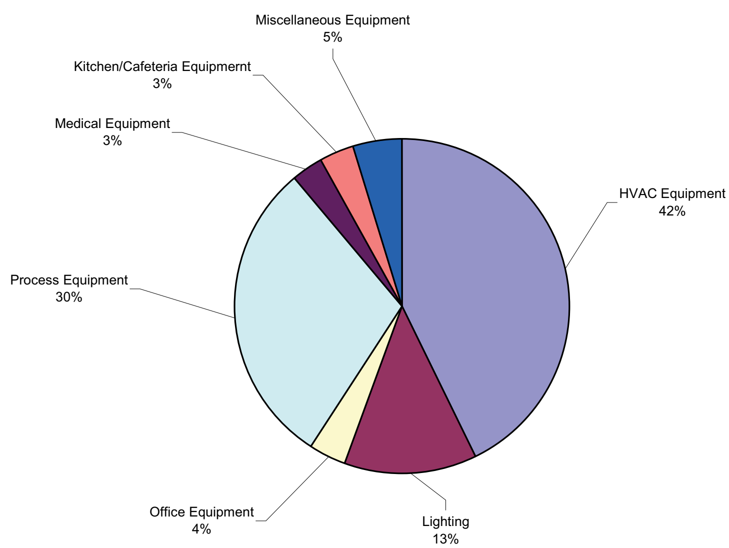

Figure 3-11 End-Use Profile of Electricity Load for the CHDF Building

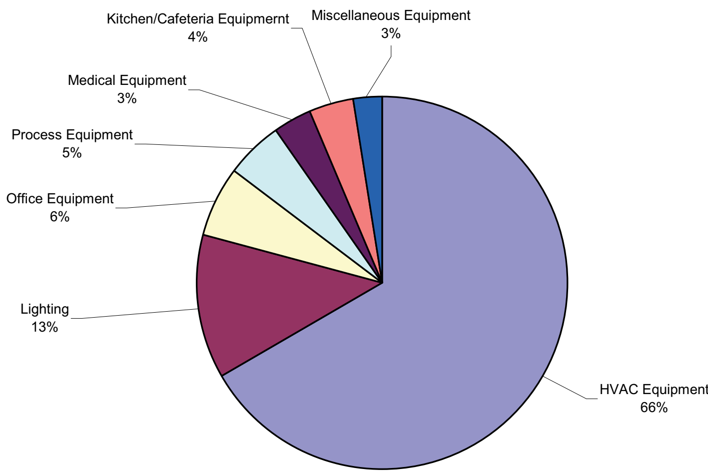

Figure 3-12 End-Use Profile of Electricity Consumption for the CHDF Building

3.6.3 Total Energy Analysis and Energy Benchmarking

The CHDF building energy benchmarking is based on total energy consumption intensity including electricity, natural gas, and fuel oil. Electricity contributes approximately 40% of total energy consumption and 64% of total utility cost. Natural gas contributes less than approximately 1% of total energy consumption and total cost. Fuel oil contributes approximately 60% of total energy consumption and 35% of total energy cost.

ES-PM was used to benchmark the CHDF building against similar hospitals. Analysis indicates that on a scale of 1 to 100, the CHDF building has a rating of 60 based on total annual energy use intensity ($EUI_{(total)}$ = 288 kBtu/sq.ft.-yr), which is 30% to 40% higher than for ENERGY STAR labeled acute hospitals located in the same climatological zones.

3.6.4 Field Survey Findings

Overall, the CHDF building survey revealed that its total energy intensity is relatively high. This can be attributed to certain system inefficiencies. The CHDF building uses a combination of pneumatic and DDC controls. The existing BAS system does not have the functional capabilities of the latest generation BAS. Comprehensive testing, adjusting, and balancing (TAB) of HVAC systems for CHDF has not been performed.

3.6.5 ECMs

Based on building survey results and the energy analysis performed for the CHDF building, several ECMs were developed. An estimate of implementation costs and expected savings for each recommended ECM was developed where possible. Table 3-20 lists the recommended ECMs in order of ease of implementation and simple payback calculations.

Table 3-20 Summary of ECMs for the CHDF Building

ECM	Cost of Implementation		Savings		SPP (yr)
	Capital Cost ($)	Labor Cost($)	kWh-yr	Cost ($)	
Advanced Interval Metering	-	$2,184[a]	36,090	$5,775	0.4
HVAC Equipment Scheduling	-	$546[b]	21,900	$3,504	0.2
Relamping	$21	$46	953	$153	0.4
Lighting Controls	$2,720	$1,945	15,030	$2,405	1.9
Higher Efficiency Equipment Purchase	NA	NA	22,400	$3,580	-
Awareness Program	$1,000[c]	$4,370[d]	18,050	$2,890	1.9
Total	**$3,741**	**$9,091**	**114,423**	**$18,307**	

Key:
SPP = Simple payback period.

Footnotes:
(a) Labor cost estimated at 1 hr/wk @ $42/hr (cost per labor-hour for electrician, 2006 RS Means)
(b) Labor cost estimated at 15 min/wk @ $42/hr
(c) Estimated cost for awareness program materials including posters, table top displays, signs, etc.
(d) Labor cost estimated at 2 hrs/wk @ $42/hr

3.7 CENTER FOR NURSING AND REHABILITATION

3.7.1 Facility Description

The Center for Nursing and Rehabilitation (CNR) is a 320-bed long-term health care facility located in Brooklyn, New York. The CNR is a member of CNR Health Care Network. The CNR building summary is presented in Table 3-21.

The primary cooling for the building non-resident areas is performed by 13 air-cooled condensing units (ACCUs) and split air-conditioning units ranging from 5 to 30 tons. The primary heating is performed by two natural gas-fired boilers. Resident room cooling is provided by packaged terminal air conditioners (PTACs). The combined installed capacity of air-handling units is 117 horsepower (hp). The combined installed capacity of the hydronic pumps is 10 hp. All air-handling systems are constant volume and all pumping systems are constant speed systems. Major heating, ventilating, and air conditioning (HVAC) equipment is from 15 to 25 years old.

Table 3-21 Summary of Energy Consumption/Cost/Intensities for the CNR Building

Parameter	Units	Parameter	Comment
General			
Year Built	-	1975	
Building Area	sq.ft.	141,151	
Number of Beds	-	320	
Number of Staff	person	445	

Table 3-21 Summary of Energy Consumption/Cost/Intensities for the CNR Building

Parameter	Units	Parameter	Comment
HVAC Equipment			
Primary Cooling	tons	443	13 ACCUs and 196 PTACs
	sq.ft./ton	319	
Primary Heating			Two Kewanee hot water natural gas-fired boilers 5,021 MBH each
Air Handling Units	hp	117	
	hp/1,000 sq.ft.	0.8	
Pumps	hp	10	
	hp/1,000 sq.ft.	0.07	
Energy Consumption/Cost/Intensities (based on 2006 data)			
Electricity			
Consumption	kWh/yr	3,664,017	
Demand Range	kW	500 to 950	
EUI (el)	kWh/sq.ft.-yr	26	
Cost	$/yr	$622,883	
Unit Cost	$/kWh	$0.17	
	$/sq.ft.-yr	$4.41	
Natural Gas			
Consumption	therms/yr	120,154	
EUI (n.g.)	kBtu/sq.ft.-yr	85	
Cost	$/yr	$129,181	
Unit Cost	$/therm	$1.08	
ECI (n.g.)	$/sq.ft.-yr	$0.92	
Total Energy			
Consumption	kBtu/yr	24,520,691	
EUI (total)	kBtu/sq.ft.-yr	174	
Total Cost	$/yr	$752,064	
ECI (total)	$/sq.ft.-yr	$5.3	

Key:
ECI = Energy cost intensity.
EUI = Energy use intensity.

3.7.2 Electricity End-Use Profile Development

Electricity end-use profiles indicate that the major contributor to electricity load and consumption for the CNR building is the HVAC systems (~64%), followed by lighting (~21%), and the remainder by other equipment groups that include process, kitchen, office, and miscellaneous equipment. Summary of electric load and consumption by end-use category are presented in Table 3-22.

Table 3-22 Summary of Electric Load and Consumption by End-Category, Center for Nursing and Rehabilitation, Brooklyn, New York

End-Use Category	Electric Load			Electric Consumption		
	kW	W/sq.ft.	%	kWh/yr	kWh/sq.ft.-yr	%
HVAC Equipment	591	4.2	68%	2,364,530	16.8	65%
Lighting	120	0.85	14%	787,740	5.6	21%
Office Equipment	12	0.1	1%	74,911	0.5	2%
Process Equipment	54	0.4	6%	102,375	0.7	3%
Computer Equipment	10	0.1	1%	87,600	0.6	2%
Kitchen Equipment	36	0.3	4%	138,731	1.0	4%
Miscellaneous Equipment	49	0.3	6%	121,010	0.9	3%
Total	**872**	**6.2**	**100%**	**3,676,896**	**26**	**100%**

Note: W/sq.ft. and kWh/sq.ft. are based on floor space of the whole building

Figures 3-13 and 3-14 present end-use profiles of electric load and consumption for the CNR building.

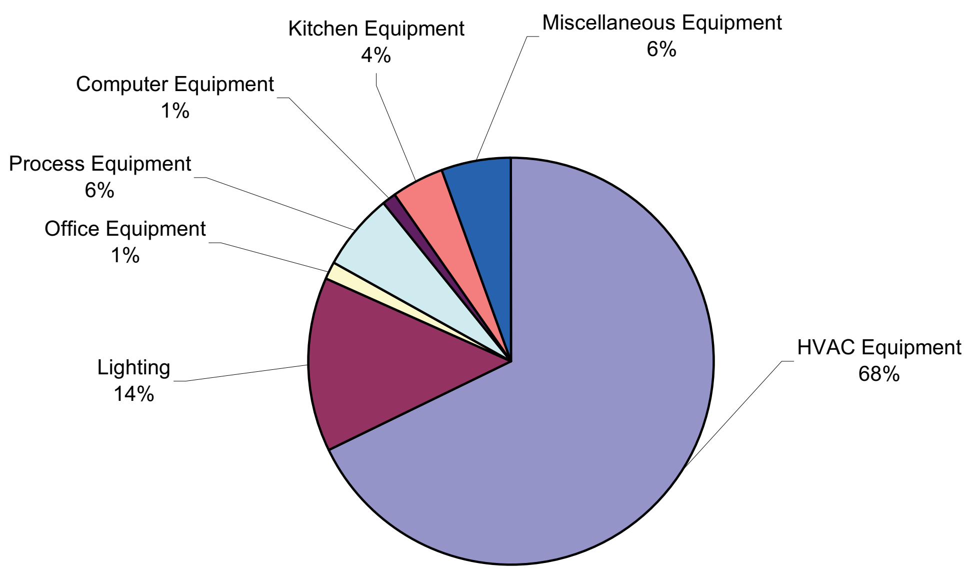

Figure 3-13 End-Use Profile of Electricity Load for the CNR Building

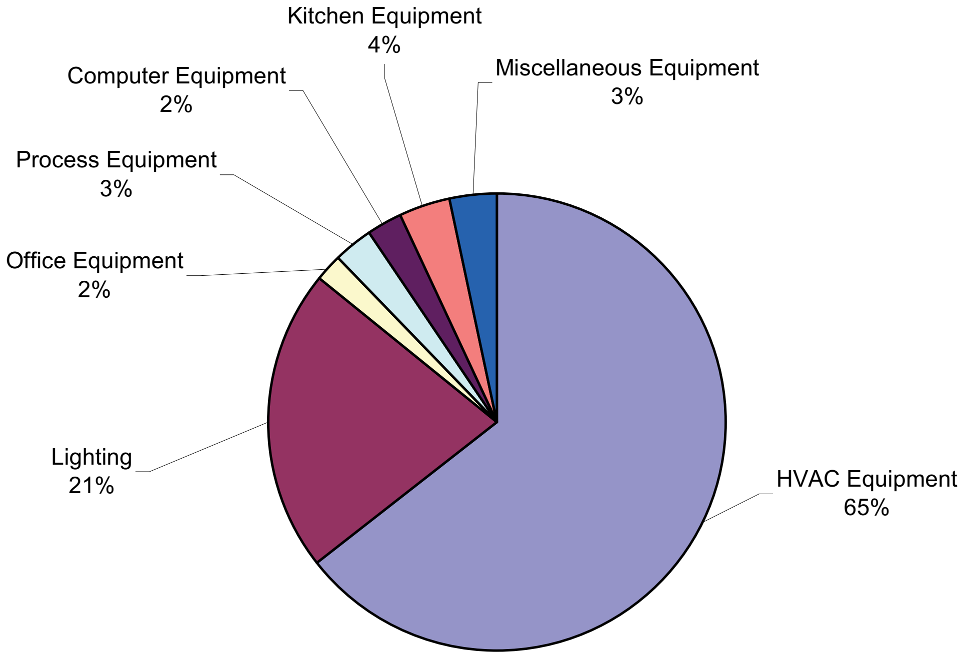

Figure 3-14 End-Use Profile of Electricity Consumption for the CNR Building

3.7.3 Total Energy Analysis and Energy Benchmarking

The CNR building energy benchmarking is based on total energy consumption intensity including electricity and natural gas. Electricity contributes approximately 51% of total energy consumption and 83% of total utility cost. Natural gas contributes approximately 49% of total energy consumption and 17% of total costs.

ES-PM was used to enter the CNR building utility data; however, ES-PM can benchmark acute and children's hospitals only and is not designed to benchmark long-term care facilities.

3.7.4 Field Survey Findings

Overall, the CNR building survey revealed that its total energy intensity is relatively low. This can be attributed to on-going energy efficiency facility efforts and good operation and maintenance (O&M) practices. The CNR building does not have a BAS at this time. It is recommended to consider installing a BAS in the future. Comprehensive testing, adjusting, and balancing (TAB) of HVAC systems for CNR has not been performed.

3.7.5 ECMs

Based on building survey results and the energy analysis performed for the CNR building, several ECMs were developed. An estimate of implementation costs and expected savings for each recommended ECM was developed where possible. Table 3-23 lists the recommended ECMs in order of ease of implementation and simple payback calculations.

Table 3-23 Summary of ECMs for CNR

ECM	Cost of Implementation		Savings		SPP (yr)
	Capital Cost ($)	Labor Cost($)	kWh-yr	Cost ($)	
Advanced Interval Metering	-	$2,184[(a)]	36,640	$6,230	0.4
HVAC Scheduling	-	$546[(b)]	11,677	$1,985	0.3
Relamping	$5,624	$3,256	14,575	$2,478	3.6
Lighting Controls	$1,120	$800	21,465	$3,650	0.5
Higher Efficiency Equipment Purchase	NA	NA	33,465	$5,670	-
Awareness Program	$500[(c)]	$2,184[(d)]	36,640	$6,230	0.4
Total	**$7,244**	**$8,970**	**154,460**	**$26,260**	

Key:
SPP = Simple payback period.

Footnotes:
(a) Labor cost estimated at 1 hr/wk @ $42/hr (cost per labor-hour for electrician, 2006 RS Means)
(b) Labor cost estimated at 15 min/wk @ $42/hr
(c) Estimated cost for awareness program materials including posters, table top displays, signs, etc.
(d) Labor cost estimated at 1 hr/wk @ $42/hr

3.8 WATERFRONT HEALTH CARE CENTER

3.8.1 Facility Description

Waterfront Health Care Center (WHCC) is a 160-bed long-term health care facility located in Buffalo, New York. The WHCC is a member of Kaleida Health. The WHCC building summary is presented in Table 3-24.

Table 3-24 Summary of Energy Consumption/Cost/Intensities for the WHCC Building

Parameter	Units	Parameter	Comment
General			
Year Built	-	1993	
Building Area	sq.ft.	80,000	
Number of Beds	-	160	
Number of Staff	person	275	
HVAC Equipment			
Primary Cooling	tons	55	Three DX cooling units serve new building only
	sq.ft./ton	563	
Primary Heating			Two Bryan (2,400 MBH each) natural gas-fired boilers
Air Handling Units	hp	68	Four rooftop units with heat recovery
	hp/1000 sq.ft.	0.9	
Pumps	hp	18	
	hp/1000 sq.ft.	0.2	

Table 3-24 Summary of Energy Consumption/Cost/Intensities for the WHCC Building

Parameter	Units	Parameter	Comment
Energy Consumption/Cost/Intensities (based on 2006 data)			
Electricity			
Consumption	kWh/yr	1,688,918	
Demand Range	kW	207 to 330	
EUI (el)	kWh/sq.ft.-yr	21	
Cost	$/yr	$194,404	
Unit Cost	$/kWh	$0.12	
ECI (el)	$/sq.ft.-yr	$2.43	
Natural Gas			
Consumption	Mcf/yr	11,478	
EUI (n.g.)	kBtu/sq.ft.-yr	143	
Cost	$/yr	$124,876	
Unit Cost	$/Mcf	$10.88	
ECI (n.g.)	$/sq.ft.-yr	$1.56	
Total Energy			
Consumption	kBtu/yr	17,242,278	
EUI (total)	kBtu/sq.ft.-yr	216	
Total Cost	$/yr	$319,280	
ECI (total)	$/sq.ft.-yr	$4.0	

Key:
ECI = Energy cost intensity.
EUI = Energy use intensity.

The primary cooling for the new building is performed by three McQuay DX cooling units. The old building is not air conditioned. The primary heating is performed by two natural gas-fired boilers. The old building is heated by electric resistance heaters. The combined installed capacity of air-handling units is 68 horsepower (hp). The combined installed capacity of the hydronic pumps is 18 hp. All air-handling systems are constant volume and all pumping systems are constant speed systems. Major heating, ventilating, and air conditioning (HVAC) equipment is from 15 to 25 years old.

3.8.2 Electricity End-Use Profile Development

Electricity end-use profiles indicate that the major contributor to electricity load and consumption for the WHCC building is the HVAC systems (~56%), followed by lighting (~20%), and the remainder by other equipment groups that include process, kitchen, office, and miscellaneous equipment. Summary of electric load and consumption by end-use category are presented in Table 3-25.

Table 3-25 Summary of Electric Load and Consumption by End-Category,Waterfront Health Care Center, Buffalo, New York

End-Use Category	Electric Load			Electric Consumption		
	kW	W/sq.ft.	%	kWh/yr	kWh/sq.ft.-yr	%
HVAC Equipment	169	2.1	46%	959,194	12.0	56%
Lighting	66	0.8	18%	342,358	4.3	20%
Office Equipment	12	0.1	3%	71,035	0.9	4%
Process Equipment	63	0.8	17%	161,343	2.0	9%
Kitchen Equipment	32	0.39	9%	116,948	1.5	7%
Miscellaneous Equipment	25	0.3	7%	55,321	0.7	3%
Total	**365**	**4.6**	**100%**	**1,706,199**	**21**	**100%**

Note: W/sq.ft. and kWh/sq.ft. are based on floor space of the whole building

Figures 3-15 and 3-16 present end-use profiles of electric load and consumption for the WHCC building.

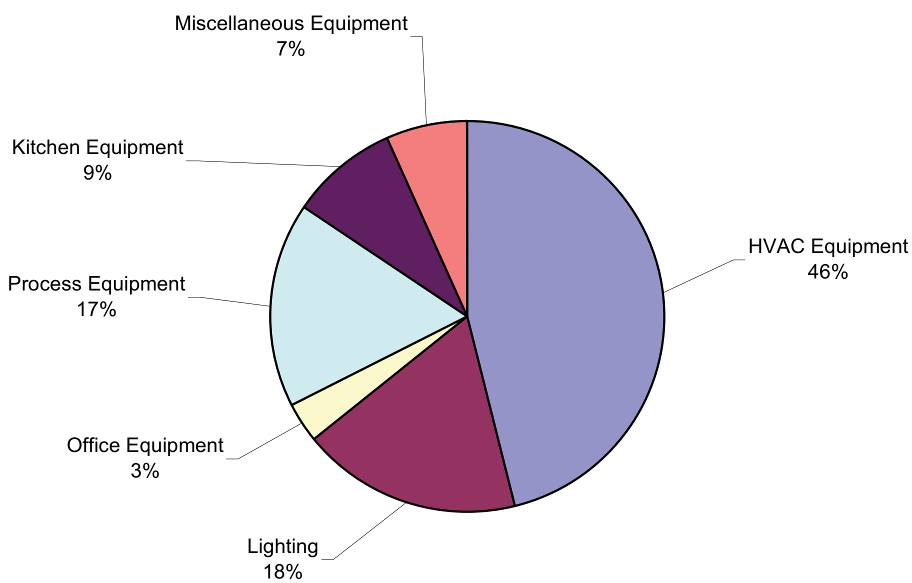

Figure 3-15 End-Use Profile of Electricity Load for the WHCC Building

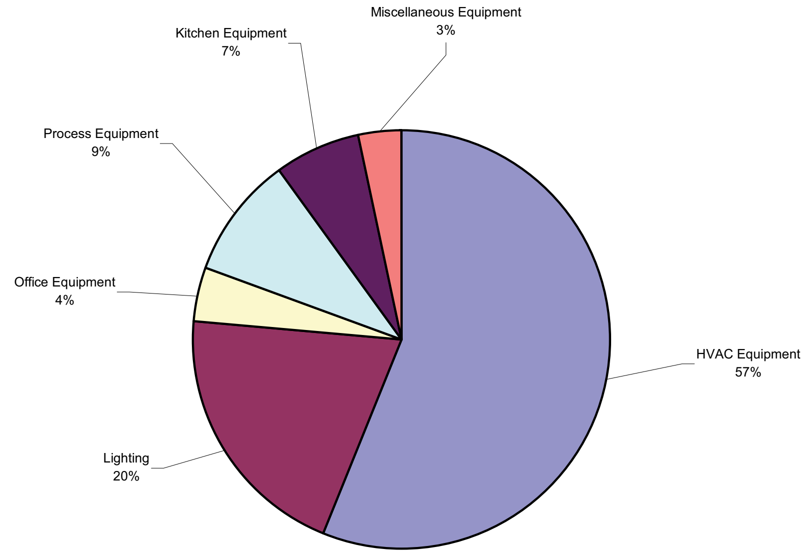

Figure 3-16 End-Use Profile of Electricity Consumption for the WHCC Building

3.8.3 Total Energy Analysis and Energy Benchmarking

The WHCC building energy benchmarking is based on total energy consumption intensity including electricity and natural gas. Electricity contributes approximately 33% of total energy consumption and 61% of total utility cost. Natural gas contributes approximately 67% of total energy consumption and 39% total cost.

ES-PM tool was used to enter the WHCC building utility data; however, ES-PM can benchmark acute and children's hospitals only and is not designed to benchmark long-term care facilities.

3.8.4 Field Survey Findings

Overall, the WHCC building survey revealed that it is well maintained by a full compliment of in-house maintenance staff. The WHCC uses an existing BAS, however, not to the full extent. Routine analysis of BAS output is critically important for reducing energy consumption by the facility's HVAC system. This effort should be streamlined and BAS trending and demand reduction capabilities should be fully utilized. Comprehensive testing, adjusting, and balancing (TAB) of HVAC systems for WHCC has not been performed.

3.8.5 ECMs

Based on building survey results and the energy analysis performed for the WHCC building, several ECMs were developed. An estimate of implementation costs and expected savings for each recommended ECM was developed where possible. Table 3-26 lists the recommended ECMs in order of ease of implementation and simple payback calculations.

Table 3-26 Summary of ECMs for WHCC

ECM	Cost of Implementation		Savings		SPP (yr)
	Capital Cost ($)	Labor Cost($)	kWh-yr	Cost ($)	
Advanced Interval Metering	-	$2,184[a]	16,890	$2,027	1.1
AHU Motor Replacement	$2,220	$1,660	52,064	$6,248	0.6
HVAC Scheduling	-	$546[b]	12,352	$1,482	0.4
Lighting Controls	$480	$343	7,600	$912	0.9
Higher Efficiency Equipment Purchase	NA	NA	24,330	$2,920	-
Awareness Program	$500[c]	$2,184[d]	16,890	$2,030	1.3
Total	**$3,200**	**$6,917**	**130,127**	**$15,619**	

Key:
SPP = Simple payback period.

Footnotes:
(a) Labor cost estimated at 1 hr/wk @ $42/hr (cost per labor-hour for electrician, 2006 RS Means)
(b) Labor cost estimated at 15 min/wk @ $42/hr
(c) Estimated cost for awareness program materials including posters, table top displays, signs, etc.
(d) Labor cost estimated at 1 hr/wk @ $42/hr

3.9 VILLAGE NURSING HOME

3.9.1 Facility Description

Village Nursing Home (VNH) is a 200-bed long-term health care facility located in New York, New York. The VNH is a member of Village Care of New York. The VNH building summary is presented in Table 3-27.

The primary cooling for the building is performed by five split air-conditioning units. The primary heating is performed by two fuel oil-fired boilers. The combined installed capacity of air-handling units is 38 horsepower (hp). The combined installed capacity of the hydronic pumps is 8 hp. All air-handling systems are constant volume and all pumping systems are constant speed systems. Major heating, ventilating, and air conditioning (HVAC) equipment is from 15 to 25 years old.

Table 3-27 Summary of Energy Consumption/Cost/Intensities for the VNH Building

Parameter	Units	Parameter	Comment
General			
Year Built	-	-	
Building Area	sq.ft.	56,800	
Number of Beds	-	200	
Number of Staff	person		
HVAC Equipment			
Primary Cooling	tons	113	Five split a/c units
	sq.ft./ton	319	
Primary Heating			Two A.L. Eastman and Sons (6,276 MBH each) dual-fuel boilers

Table 3-27 Summary of Energy Consumption/Cost/Intensities for the VNH Building

Parameter	Units	Parameter	Comment
Air Handling Units	hp	38	
	hp/1000 sq.ft.	0.7	
Pumps	hp	8	
	hp/1000 sq.ft.	0.1	
Energy Consumption/Cost/Intensities (based on 2006 data)			
Electricity			
Consumption	kWh/yr	1,110,560	
Demand Range	kW	146 to 292	
EUI (el)	kWh/sq.ft.-yr	20	
Cost	$/yr	$183,525	
Unit Cost	$/kWh	$0.16	
ECI (el)	$/sq.ft.-yr	$3.23	
Natural Gas			
Consumption	therms/yr	8,085	
EUI (n.g.)	kBtu/sq.ft.-yr	14	
Cost	$/yr	$10,985	
Unit Cost	$/therm	$1.36	
ECI (n.g.)	$/sq.ft.-yr	$0.19	
Fuel Oil No. 6			
Consumption	gals/yr	93,000	Estimated based on truck deliveries for 9 months.
EUI (f.o.)	kBtu/sq.ft.-yr	246	
Cost	$/yr	$81,142	
Unit Cost	$/gal	$0.87	
ECI (f.o.)	$/sq.ft.-yr	$1.43	
Total Energy			
Consumption	kBtu/yr	18,548,819	
EUI (total)	kBtu/sq.ft.-yr	327	
Total Cost	$/yr	$275,652	
ECI (total)	$/sq.ft.-yr	$4.9	

Key:
ECI = Energy cost intensity.
EUI = Energy use intensity.

3.9.2 Electricity End-Use Profile Development

Electricity end-use profiles indicate that the major contributor to electricity load and consumption for the VNH building is the HVAC systems (~40%), followed by lighting (~28%), and the remainder by other equipment groups that include process, kitchen, office, and miscellaneous equipment. Summary of electric load and consumption by end-use category are presented in Table 3-28.

Table 3-28 Summary of Electric Load and Consumption by End-Category, Village Nursing Home, New York, New York

End-Use Category	Electric Load			Electric Consumption		
	kW	W/sq.ft.	%	kWh/yr	kWh/sq.ft.-yr	%
HVAC Equipment	113	2.0	41%	399,550	7.0	37%
Lighting	48	0.8	18%	306,425	5.4	28%
Office Equipment	8.9	0.2	3%	52,990	0.9	5%
Process Equipment	32	0.6	12%	71,025	1.3	7%
Kitchen Equipment	31	0.54	11%	176,823	3.1	16%
Miscellaneous Equipment	42	0.7	15%	75,614	1.3	7%
Total	**275**	**4.8**	**100%**	**1,082,426**	**19**	**100%**

Note: W/sq.ft. and kWh/sq.ft. are based on floor space of the whole building

Figures 3-17 and 3-18 present end-use profiles of electric load and consumption for the VNH building.

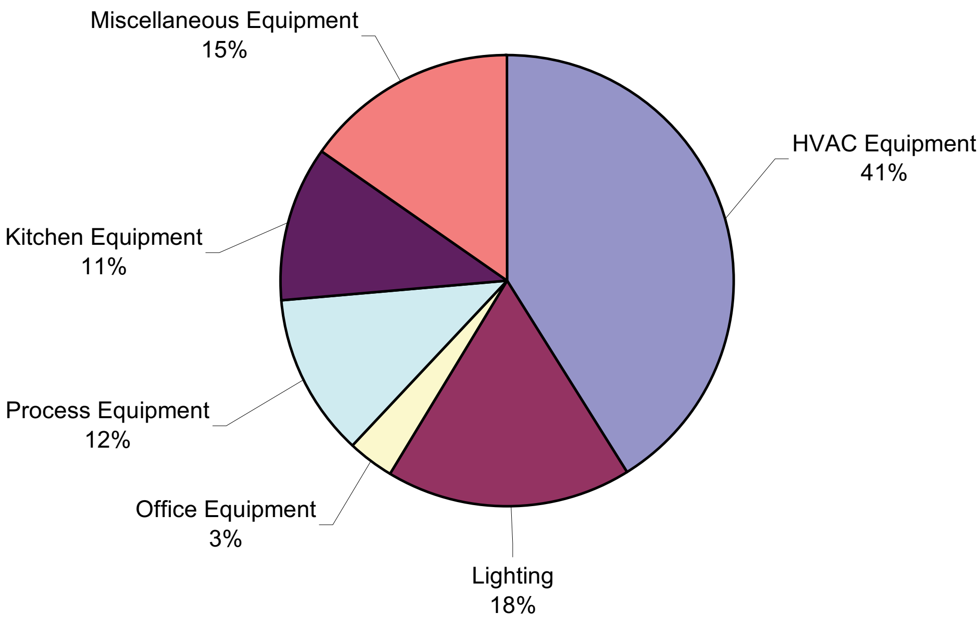

Figure 3-17 End-Use Profile of Electricity Load for the VNH Building

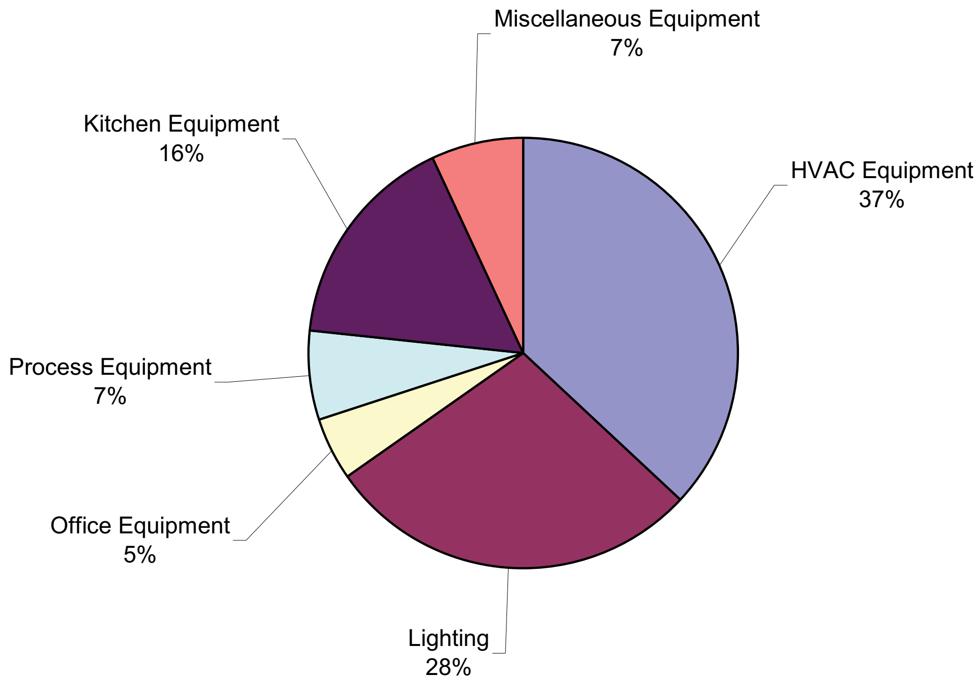

Figure 3-18 End-Use Profile of Electricity Consumption for the VNH Building

3.9.3 Total Energy Analysis and Energy Benchmarking

The VNH building energy benchmarking is based on total energy consumption intensity including electricity, natural gas, and fuel oil No. 6. Electricity contributes approximately 24% of total energy consumption and 67% of total utility cost. Natural gas contributes approximately 4% of total energy consumption and total cost. Fuel oil No. 6 contributes approximately 70% of total energy consumption and 29% of total costs.

ES-PM was used to enter the VNH building utility data; however, ES-PM can benchmark acute and children’s hospitals only and is not designed to benchmark long-term care facilities.

3.9.4 Field Survey Findings

Overall, the VNH building survey revealed that its total energy intensity is relatively high. This can be attributed to certain system inefficiencies. Comprehensive testing, adjusting, and balancing (TAB) of HVAC systems for VNH has not been performed.

3.9.5 ECMs

Based on building survey results and the energy analysis performed for the RHHC building, several ECMs were developed. An estimate of implementation costs and expected savings for each recommended ECM was developed where possible. Table 3-29 lists the recommended ECMs in order of ease of implementation and simple payback calculations.

Table 3-29 Summary of ECMs for RHHC

ECM	Cost of Implementation		Savings		SPP (yr)
	Capital Cost ($)	Labor Cost($)	kWh-yr	Cost ($)	
Advanced Interval Metering	-	$2,184[(a)]	29,020	$4,355	0.5
AHU Motor Replacement	$2,525	$1,570	15,420	$2,310	1.8
Lighting Controls	$480	$343	23,200	$3,480	0.2
Higher Efficiency Equipment Purchase	NA	NA	43,080	$6,460	-
Awareness Program	$500[(c)]	$2,184[(d)]	29,020	$4,350	0.6
Total	**$3,505**	**$6,281**	**139,760**	**$20,955**	

Key:
SPP = Simple payback period.

Footnotes:
(a) Labor cost estimated at 1 hr/wk @ $42/hr (cost per labor-hour for electrician, 2006 RS Means)
(b) Labor cost estimated at 15 min/wk @ $42/hr
(c) Estimated cost for awareness program materials including posters, table top displays, signs, etc.
(d) Labor cost estimated at 1 hr/wk @ $42/hr

3.10 RIVINGTON HOUSE HEALTH CARE FACILITY

3.10.1 Facility Description

The Rivington House Health Care Facility (RHHC) is a 219-bed long-term health care facility located in New York, New York. The RHHC is a member of Village Care of New York. The RHHC building summary is presented in Table 3-30.

Table 3-30 Summary of Energy Consumption/Cost/Intensities for the RHHC Building

Parameter	Units	Parameter	Comment
General			
Year Built	-	1995	
Building Area	sq.ft.	120,000	
Number of Beds	-	219	
Number of Staff	person		
HVAC Equipment			
Primary Cooling	tons	250	Thermax steam-fired absorption chiller (250 tons) and Multistack electric chiller (150 tons)
	sq.ft./ton	480	
Primary Heating	-	-	District steam
Air Handling Units	hp	145	
	hp/1000 sq.ft.	1.2	
Pumps	hp	98	
	hp/1000 sq.ft.	0.8	
Energy Consumption/Cost/Intensities (based on 2006 data)			
Electricity			
Consumption	kWh/yr	2,902,435	
Demand Range	kW	250 to 500	

Table 3-30 Summary of Energy Consumption/Cost/Intensities for the RHHC Building

Parameter	Units	Parameter	Comment
EUI (el)	kWh/sq.ft.-yr	24	
Cost	$/yr	$436,176	
Unit Cost	$/kWh	$0.15	
ECI(el)	$/sq.ft.-yr	$3.63	
Natural Gas			
Consumption	therms/yr	5,874	
EUI (n.g.)	kBtu/sq.ft.-yr	4.9	
Cost	$/yr	$8,131	
Unit Cost	$/therm	$1.38	
ECI (n.g.)	$/sq.ft.-yr	$0.07	
District Steam			
Consumption	Mlb/yr	9,428	
EUI (d.s.)	kBtu/sq.ft.-yr	94	District steam pressure assumed 125 psi.
Cost	$/yr	$237,495	
Unit Cost	$/Mlb	$25.19	
ECI (d.s.)	$/sq.ft.-yr	$1.98	
Total Energy			
Consumption	kBtu/yr	21,807,037	
EUI (total)	kBtu/sq.ft.-yr	182	
Total Cost	$/yr	$681,802	
ECI (total)	$/sq.ft.-yr	$5.7	

Key:
ECI = Energy cost intensity.
EUI = Energy use intensity.

The primary cooling for the RHHC building is performed by a 250-ton steam-fired absorption chiller and a 150-ton electric modular chiller. The primary heating is performed by district steam. Thus, RHHC obtains thermal energy from a distribution medium rather than generating it on-site. According to RHHC, the absorption chiller typically operates during on-peak hours and electric modular chiller during off-peak hours. Compared to electric chillers, absorption chillers have a low coefficient of performance (COP). Nonetheless, they can reduce operating costs and electric demand/consumption. The combined installed capacity of air handling units is 145 horsepower (hp). The combined installed capacity for the hydronic pumps is 98 hp. All air-handling systems are constant volume and all pumping systems are constant speed systems except two dual-temperature pumps. Major heating, ventilating, and air conditioning (HVAC) equipment is from 10 to 15 years old, the chillers are less than two years old.

3.10.2 Electricity End-Use Profile Development

Electricity end-use profiles indicate that the major contributor to electricity load and consumption for the RHHC building is the HVAC systems (~57%), followed by lighting (~23%), and the remainder by other equipment groups that include process, kitchen, office, and miscellaneous equipment. Summary of electric load and consumption by end-use category are presented in Table 3-31.

Table 3-31 Summary of Electric Load and Consumption by End-Category, Rivington House, New York, New York

End-Use Category	Electric Load			Electric Consumption		
	kW	W/sq.ft.	%	kWh/yr	kWh/sq.ft.-yr	%
HVAC Equipment	265	2.2	50%	1,574,501	13.1	57%
Lighting	78	0.7	15%	646,675	5.4	23%
Office Equipment	19	0.2	4%	114,513	1.0	4%
Process Equipment	57	0.5	11%	122,031	1.0	4%
Kitchen Equipment	32	0.3	6%	156,145	1.3	6%
Miscellaneous Equipment	74	0.6	14%	160,199	1.3	6%
Total	**526**	**4.4**	**100%**	**2,774,064**	**23**	**100%**

Note: W/sq.ft. and kWh/sq.ft. are based on floor space of the whole building

Figures 3-19 and 3-20 present end-use profiles of electric load and consumption for the RHHC building.

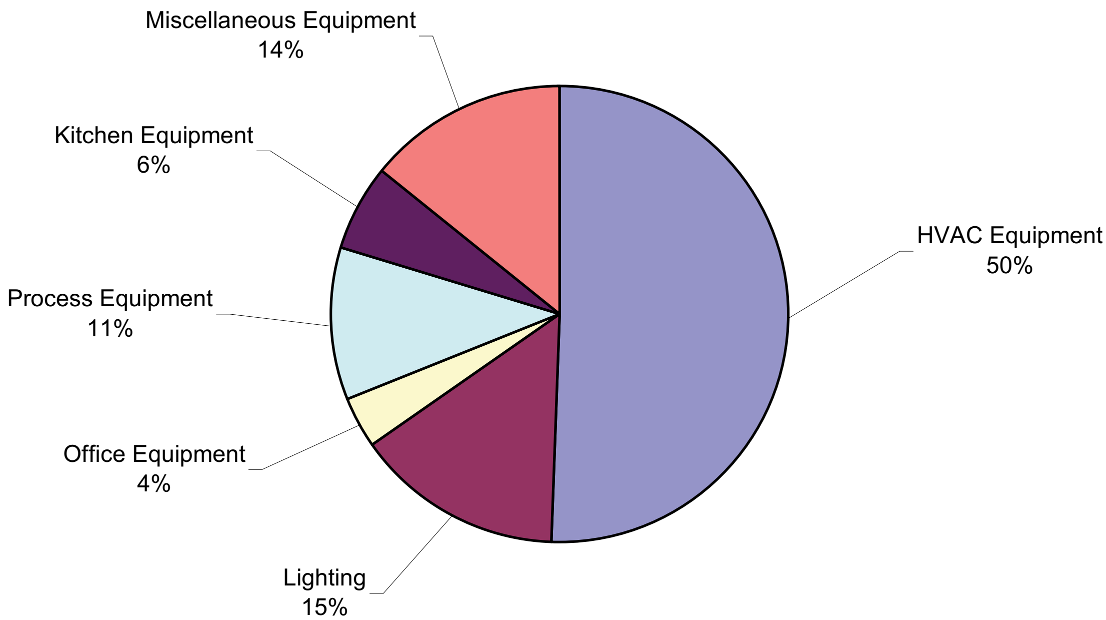

Figure 3-19 End-Use Profile of Electricity Load for the RHHC Building

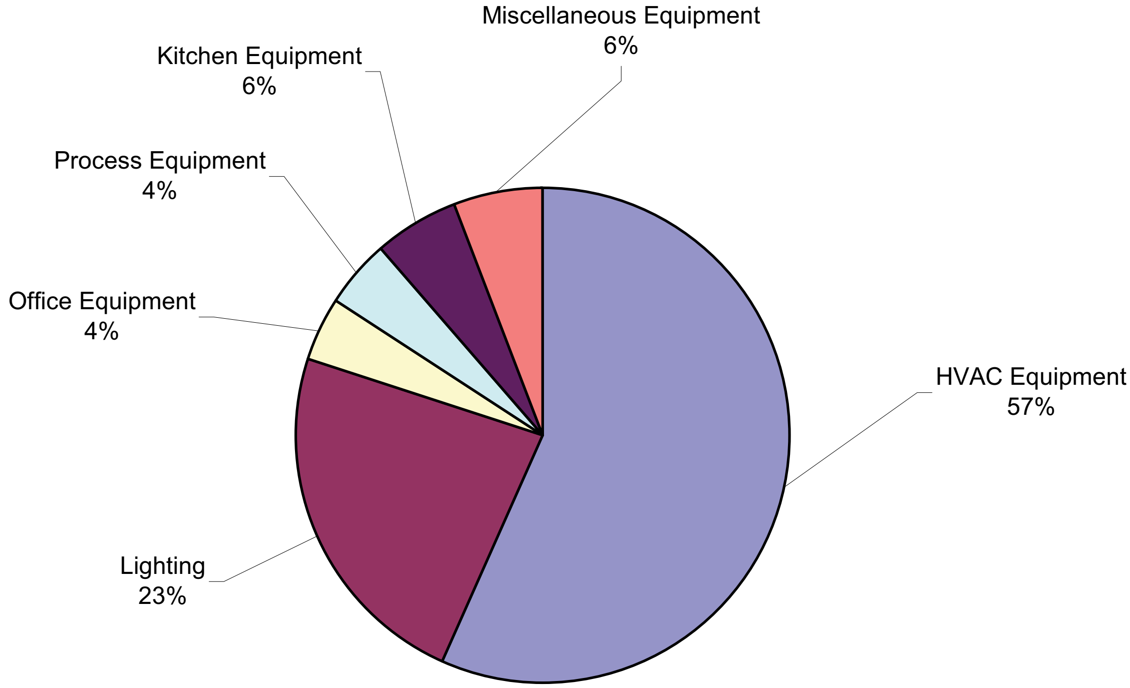

Figure 3-20 End-Use Profile of Electricity Consumption for the RHHC Building

3.10.3 Total Energy Analysis and Energy Benchmarking

The RHHC building energy benchmarking is based on total energy consumption intensity including electricity, natural gas, and district steam. Electricity contributes approximately 45% of total energy consumption and 64% of total utility cost. Natural gas contributes approximately 3% of total energy consumption and 1% total cost.District steam contributes approximately 52% of total energy consumption and 35% of total cost.

ES-PM tool was used to enter the RHHC building utility data; however, ES-PM can benchmark acute and children's hospitals only and is not designed to benchmark long-term care facilities.

3.10.4 Field Survey Findings

Overall, the RHHC building survey revealed that it is well maintained by a full compliment of in-house maintenance staff. The RHHC uses an existing BAS, however, not to the full extent. Routine analysis of BAS output is critically important for reducing energy consumption by the facility's HVAC system. This effort should be streamlined and BAS trending and demand reduction capabilities should be fully utilized. Comprehensive testing, adjusting, and balancing (TAB) of HVAC systems for RHHC has not been performed.

3.10.5 ECMs

Based on building survey results and the energy analysis performed for the VNH building, several ECMs were developed. An estimate of implementation costs and expected savings for each recommended ECM was developed where possible. Table 3-32 lists the recommended ECMs in order of ease of implementation and simple payback calculations.

Table 3-32 Summary of ECMs for VNH

ECM	Cost of Implementation		Savings		SPP (yr)
	Capital Cost ($)	Labor Cost($)	kWh-yr	Cost ($)	
Advanced Interval Metering	-	$2,184[a]	11,100	$1,777	1.2
HVAC Scheduling	-	$546[b]	14,454	$2,113	0.2
Relamping	$1,780	$1,140	8,665	$1,386	2.1
Lighting Controls	$480	$343	4,675	$748	1.1
Higher Efficiency Equipment Purchase	NA	NA	30,543	$4,887	-
Awareness Program	$500[c]	$2,184[d]	11,106	$1,777	1.5
Total	**$2,760**	**$6,397**	**80,543**	**$12,688**	

Key:
SPP = Simple payback period.

Footnotes:
(a) Labor cost estimated at 1 hr/wk @ $42/hr (cost per labor-hour for electrician, 2006 RS Means)
(b) Labor cost estimated at 15 min/wk @ $42/hr
(c) Estimated cost for awareness program materials including posters, table top displays, signs, etc.
(d) Labor cost estimated at 1 hr/wk @ $42/hr

SECTION 4
ENERGY CONSERVATION MEASURE (ECM) DEVELOPMENT

4.1 ECM DESCRIPTION

Following the building surveys, ECMs pertinent to electricity consumption were developed for each pilot facility. The following subsections describe the ECMs recommended for the pilot facilities studied under this project.

4.1.1 Retro-commissioning (RCx)

RCx involves a detailed assessment of a building's existing mechanical/electrical systems, a "tune-up" to bring them up to optimal performance, functional performance tests, and training of operations and maintenance (O&M) staff to make them capable of long-term monitoring and maintenance of the systems. Retrocommissioning can solve issues of high energy and maintenance costs, indoor environmental quality, and increase equipment life-span. It is highly recommended that RCx be undertaken at all the pilot facilities evaluated under this project. For all facilities involved, HVAC equipment was determined to be the major contributor to electricity load and consumption in the facility; therefore, any improvements in the performance of the systems would result in measurable energy savings. On average, major HVAC equipment was between 10-25 years old and never undergone performance testing. Some of this equipment will likely be replaced in the next several years; therefore, determining whether it is properly sized is critical. Conversely, if the equipment continues to operate for many years to come, optimizing performance is critical. Data collected during this study indicate that some equipment, such as some AHU supply and return fan motors, may not be operating at peak performance. RCx will help identify if this equipment should be replaced with smaller sized motors.

Published data indicates that RCx for hospitals can achieve at least a 5% energy reduction. The RCx effort should be coordinated with the TAB effort.

Published data indicates that RCx can cost between \$0.1/sq. ft. and \$0.5/sq.ft. One published study from the Center for Energy and Environment reported RCx costs for a large acute care hospital of approximately \$0.35/sq.ft. with savings of approximately \$0.30/sq. ft.-yr. It should be noted however that RCx costs are dependent on the number and complexity of building systems included in the study and the extent of the work performed. RCx can be undertaken as a separate project using an independent RCx agent or it can be part of a continuous effort included in the facility's routine service contract. The New York State Energy Research and Development Agency's (NYSERDA's) FlexTech/Technical Assistance program offers incentives for both RCx of existing buildings and commissioning of new buildings.

4.1.2 Advanced Interval Metering

Advanced meters are those that have the capability to measure and record interval data and communicate the data to a remote location in a format that can be easily integrated into an advanced metering system. The report "Guidance for Electric Metering in

Federal Buildings" (FEMP 2006) states that use of advanced metering can achieve at least 5% reduction in electricity consumption.

Several pilot facilities, including MFSH, BGH, and SJRH-AP, have interval electric meter installed. For these facilities, it is recommended that at least weekly tracking and analyses of electric energy data be performed. Downloading hourly demand data from the utility website and analysis of these data on a regular basis can provide valuable information regarding building energy consumption. In fact, it is possible to develop "normal" building consumption profiles for any time period (e.g. weekdays and weekends) and weather conditions and identify abnormalities from these profiles. Identifying when electric demand does not correspond to the "normal" demand (consumption) profile for the building, diagnosing the cause of the abnormality, and taking action to correct the inefficiencies was estimated to reduce annual electric consumption in the pilot facilities studied by 1% to 3%.

For those pilot facilities that do not currently have an interval electric meter installed, it is recommended that an interval meter be installed and weekly tracking and analyses of electric energy data be performed. NYSERDA offers assistance and incentives aimed at reducing peak load and enabling demand response through its Existing Facilities Program.

4.1.3 HVAC Equipment Upgrades and BAS Scheduling

The major contributor to electric demand in all pilot facilities studied is HVAC equipment, primarily chillers, major air handling units (AHUs), pumps, and room air conditioners (where applicable). It is critically important to ensure optimum operation of this major HVAC equipment. In all facilities studied, some AHU supply and return fan motors were determined to have low motor load factor (MLF) <0.7 and low power factor (PF) <0.8. It is recommended to evaluate their load during a RCx effort and consider replacing with motors that have a lower horsepower (hp) rating.

Old motors typically have efficiency in the range from 80 to 85%. According to the Federal Energy Management Program (FEMP), motor efficiencies typically for new energy efficient motors are in the range of 89 to 92%. Motor upgrades have a simple payback period (SPP) that does not exceed two years and is more favorable for motors with larger hp ratings. NYSERDA offers incentives for motor upgrades under the Premium-Efficiency Motors Program and the ECIPP.

In most facilities, scheduling can be applied to the AHUs that are not located in critical areas, such as kitchens, lobbies, and administrative areas, during unoccupied hours. Reducing daily operation of the AHUs by just one hour was estimated to reduce annual electricity consumption by as much as 1.3% with little or no payback period.

These ECMs can be implemented in a relatively short timeframe using in-house staff.

4.1.4 Lighting ECMs

Two types of lighting ECMs are recommended for the pilot facilities in this study: lighting controls and some relamping. These ECMs can be implemented in a relatively short timeframe using in-house staff.

An array of switching capabilities can be installed to eliminate lighting of an area or room during unoccupied periods, and when natural light provides sufficient illumination. All buildings included in this study have rooms that are used periodically, such as restrooms, storage rooms, break rooms, and offices. These types of usage areas can see significant energy use reductions through a combination of automated lighting controls that include occupancy sensors, time switches, and local override controls..
The building surveys revealed that more efficient lighting options could be used in some areas of each facility. Relamping ECMs address the energy savings that could be achieved from replacing low-energy efficiency lighting with high-efficiency lighting (i.e., incandescent with fluorescent).

Lighting retrofits can result in improved lighting quality and light level intensities, standardization on fewer lamps and ballasts, as well as reduced maintenance costs. Qualified lighting controls and lamps are incentivized through NYSERDA's Existing Facilities Program

4.1.5 Higher Efficiency End-Use Equipment

Purchasing energy efficient products reduces energy costs without compromising quality. Higher efficiency equipment, such as ENERGY STAR-labeled equipment, pertinent to most health care facilities, is summarized below (see Table 4-1). Typically, ENERGY STAR equipment provides at least a 10 to 20% reduction in electricity consumption and 5 to 10% reduction in electric load.

Successful energy management programs adopt a procurement policy for energy efficient equipment and appliances as a key element for their overall strategy. Instituting an effective policy can be as easy as asking procurement officers to specify ENERGY STAR qualified products, such as office equipment, in their contracts or purchase orders. NYSERDA provides incentives to cover the incremental cost under the Existing Facilities Program for a number of products that are above ENERGY STAR to provide even greater lifecycle cost savings.

Table 4-1 ENERGY STAR End-Use Equipment Pertinent to Health Care Facilities

Equipment Group
Commercial Appliances
Commercial Clothes Washers
Commercial Food Service Equipment
Commercial Solid Door Refrigerators and Freezers
Commercial Fryers
Commercial Hot Food Holding Cabinets
Commercial Steam Cookers
Vending Machines
Consumer Electronics
TVs
VCRs
Combination Units
DVD Players and Audio Equipment
Office Products
Computers
Monitors
Printers
Fax Machines
Scanners
Copiers
Multifunctional Devices (MFD)
Water Coolers
Residential Products
Refrigerators
Compact Refrigerators
Freezers

4.1.6 Energy Awareness Program

In addition to ECMs requiring capital costs, there are ECMs that can be achieved through daily energy awareness efforts by the hospital staff and do not require capital costs. Computers that are used intermittently in offices, training areas, etc. and should employ sleep-mode settings or be shut off when the machines are not in use.

Educating staff is a key element in any energy awareness program. The importance of employees' reporting equipment failures and turning off lights, air conditioning, or equipment not in use should be stressed on an on-going basis.

Based on a recent survey of energy use in the commercial sector, (LBNL 2004), it is reasonable to assume that approximately15% of office equipment and lighting in certain building areas (e.g., office space, administration) could be affected by staff awareness training. This translates into an approximately 1% annual consumption reduction.

4.2 SUMMARY OF ENERGY, COST, AND ENVIRONMENTAL BENEFITS

An estimate of implementation costs and expected savings for each recommended ECM was developed were possible and presented in the individual facility Energy Evaluation Reports. Generally, the recommended measures have a low cost of implementation and an SPP of less than three years. The cost of implementation and the expected savings from initiating an RCx project are highly variable and depend on the extent of the effort that is undertaken; therefore, this ECM was not included in the calculation of expected savings. A summary of the expected electricity consumption reductions and cost savings for the hospitals and long-term care facilities included as pilot facilities in this project is shown in Tables 4-2 and 4-3 respectively.

In addition to the expected energy and financial benefits realized from the implementation of the recommended ECMs, there are associated environmental benefits from energy reduction programs. A summary of the estimated reduction in air emissions from the implementation of the recommended ECMs for each pilot facility is also included on Tables 4-2 and 4-3.

Table 4-2 Summary of ECM Savings for Hospitals in the Pilot Program

Parameter	Units	MFSH	BGH	St. John's Andrus Pavilion	Dobbs Ferry	St. John's Park Care Pavilion	St. Vincent's	Total
Energy and Cost Savings Summary								
Baseline Electricity Consumption	kWh/yr	8,335,420	26,963,994	9,080,748	1,891,200	4,015,356	4,543,200	54,829,918
Electricity Consumption Reduction	kWh/yr	497,863	1,424,030	713,070	114,423	394,980	323,500	3,467,866
	%	6%	5%	8%	6%	10%	7%	6%
Cost Savings	$/yr	$54,765	$142,403	$114,090	$18,307	$63,200	$45,300	$438,065
Air Emissions Reduction Summary*								
CO2	tons/yr	417	1,198	597	96	330	270	2,908
SO2	lbs/yr	3,576	10,275	5,120	820	2,836	2,320	24,947
NOx	lbs/yr	1,175	3,380	1,680	270	930	760	8,195

* Pollutant emissions factors are available online at: www.cleanerandgreener.org/resources/emission_reductions.htm

Table 4-3 Summary Statistics of ECM Energy and Cost Savings for Long-Term Care Facilities in the Pilot Program

Parameter	Units	CNR	WHCC	Rivington House	Village Nursing Home	Total
Energy and Cost Savings Summary						
Baseline Electricity Consumption	kWh/yr	3,664,017	1,688,918	2,902,435	1,110,560	9,365,930
Electricity Consumption Reduction	kWh/yr	154,460	130,127	139,760	80,543	504,890
	%	4%	8%	5%	6%	5%
Cost Savings	$/yr	$26,260	$15,619	$20,955	$12,688	$75,522
Air Emissions Reduction Summary*						
CO2	tons/yr	130	120	125	73	448
SO2	lbs/yr	870	830	855	490	3,045
NOx	lbs/yr	300	280	290	170	1,040

* Pollutant emissions factors are available online at: www.cleanerandgreener.org/resources/emission_reductions.htm

SECTION 5
OUTREACH PROGRAM IMPLEMENTATION

5.1 EDUCATIONAL OUTREACH SEMINARS

Two half-day educational outreach seminars were held in New York City on February 13 and May 2, 2008. Each seminar was open to all Greater New York Hospital Association (GNYHA) and Continuing Care Leadership Coalition (CCLC) membership. The goal of each seminar was to provide information to health care facility personnel on applicable energy efficiency and conservation opportunities, describe NYSERDA programs and incentives available to health care facilities, and present case studies from the health care sector on facilities that have implemented energy efficiency, conservation, and alternative energy projects. The seminars were also simultaneously broadcast via webcast for those facilities unable to attend in person. The following metrics summarize participation in the seminars:

- February 13, 2008 Seminar: 29 registered participants; 20 signed in attendees; 2 attendees via webcast.
- May 2, 2008 Seminar: 25 registered participants for seminar and 8 for webcast; 35 signed in attendees; 3 attendees via webcast.

5.2 ENERGY MANAGEMENT GUIDEBOOK FOR HEALTH CARE FACILITIES

An Energy Management Guidebook for Health Care Facilities was prepared to help health care facilities in NYS assess their energy performance, identify and implement actions that will improve energy efficiency, and monitor and evaluate the results of their actions. The Guidebook is based on a model of continuous improvement where feedback on the actions taken to improve energy efficiency and conservation is provided in order to assess the effectiveness and initiate new measures as needed. Tools have been provided along with the Guidebook in the form of spreadsheets, checklists, and equipment inventory forms to help health care facilities initiate their own energy audit as part of a more comprehensive energy management program.

Hard copies of the Guidebook were provided to attendees at the May 2nd Seminar where the Guidebook was presented and discussed. Copies are also available for download at **http://www.nexeraconsulting.com/23/Default.aspx**.

SECTION 6
LESSONS LEARNED

Tracking the implementation and effects of the recommended ECMs was expected to provide much sought after metrics on cost and energy savings to share with the larger state-wide healthcare community encouraging even greater adoption of energy efficiency programs. However, the project had limited success in persuading the participating pilot facilities to implement any of the recommended ECMs outlined in Section 3 within the timeframe of the project. Follow-up phone calls, emails, and letters initiated by the Project Team had little impact on the likelihood of implementation.

The pilot study highlighted that numerous barriers exist within the healthcare industry to implementing energy efficiency measures. These barriers include financial limitations, competing priorities, and a lack of targeted information and resources. It is clear that overcoming these barriers requires significant commitment from both operations and management within each healthcare facility.

Specific issues identified by the pilot facilities that participated in this project that hindered the implementation of the recommended ECMs include:

- Financial constraints that deterred facilities from implementing even low-cost ECMs.

- Overcoming the initial capital expense of any ECMs even those demonstrating short payback periods, as the initial capital outlay was seen as important as the payback period for a facility in determining when or if they will implement any ECM.

- Facility assessments showed that, while low and no-cost ECM opportunities existed, most facilities would greatly benefit from higher cost programs (e.g. retro-commissioning).

- Competing priorities, such as large construction projects or daily emergencies, kept personnel from focusing on energy conservation.

- Facilities indicated a preference to include projects in future plans rather than implement in the short-term even if there was strong initial interest.

Successful buy-in of energy efficiency projects at hospitals requires consent from at least two key individuals at each facility: the Chief Financial Officer (CFO) and the Facilities/Energy Manager. However, with the ever increasing costs for energy and the constantly evolving sophistication of energy management technologies, energy management now involves the CFO, the Chief Operating Officer (COO), and Chief Information Officer (CIO), in addition to facilities managers, who must also provide buy-in. Involving facility executives from the beginning and following-up with executives regularly should be part of any future program.

Due to the financial constraints most healthcare facilities in the state are dealing with, it is clear that the availability and value of incentive programs, such as from NYSERDA, as well as the ease of applying for and receiving any rebates, is an important factor in determining when or if a facility will implement any ECM. Educating facilities about NYSERDA incentives at the program onset, and reiterating this information on a regular basis, is necessary to program success. Additionally, future programs might consider the addition of providing assistance with the actual initiation of projects, such as with vendor contacts, project planning, or initiating NYSERDA funding applications.

Implementing an effective outreach program was also determined to be critical to a successful sector-based program. Although no formal follow-up with outreach seminar participants was conducted, the Project Team was informed that at least one facility representative that attended one of the educational seminars contacted NYSERDA immediately following the seminar and initiated an application for project incentives. A long-term program to educate the healthcare industry on the benefits of energy efficiency and conservation, and the incentives, resources and assistance available to help with implementation is needed to drive this sector forward.

SECTION 7
REFERENCES

Center for Energy and Environment, 2003, Recommissioning of a Large Acute-Care Hospital.

Federal Energy Management Program (FEMP), 2006, Guidance for Electric Metering in Federal Buildings (DOE/EE-0312)

Lawrence Berkeley National Laboratory, 2004, After-hours Power Status of Office Equipment and Energy Use of Miscellaneous Plug-load Equipment (LBNL-S3729-Revised).

APPENDIX A

HEALTH CARE FACILITY INFORMATION FORM

Health Care Facility Information Form

Building Information	Description	Comment
1. Hospital Name		
2. Hospital Address		
3. Hospital Type (acute, non-acute, etc.)		
4. Year built		
5. Number of Buildings		
6. Number of Floors		
7. Floor Space Area (sq. ft.)		
8. Number of Patient Beds • Total occupied beds • Total licensed beds		
9. Major Renovations within last 3 years (HVAC lighting, etc.)		
10. Building Energy Management System (yes/no)		
11. Number of electric meters		
12. Number of natural gas meters		
13. Electricity data: Please list most recent 12-months cost and consumption (monthly or total)		
14. Natural gas data: Please list most recent 12-months cost and consumption (monthly or total)		
15. Previous energy conservation measures (please describe)		
16. Name of Utility Provider		

For information on other
NYSERDA reports, contact:

New York State Energy Research
and Development Authority
17 Columbia Circle
Albany, New York 12203-6399

toll free: 1 (866) NYSERDA
local: (518) 862-1090
fax: (518) 862-1091

info@nyserda.org
www.nyserda.org

Sector-Based Approach to Energy Efficiency within Hospitals and Health Care facilities in New York State

Final Report 08-14

State of New York
David A Paterson, Governor

New York State Energy Research and Development Authority
Vincent A. DeIorio, Esq., Chairman

SECTOR-BASED APPROACH TO ENERGY EFFICIENCY WITHIN HOSPITALS AND HEALTH CARE FACILITIES IN NEW YORK STATE

NYSERDA Final Report 08-14