FINAL TECHNICAL REPORT

Department of Energy Award: DE-FG36-04GO14212

Recipient: H**ACKENSACK UNIVERSITY MEDICAL CENTER**

Project Title: Photovoltaic and Energy Efficiency Systems Installation

Project Director/Principal Investigator:

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Award Date:	September 30, 2004
Rev:	January 6, 2006
Rev:	January 8, 2008
Rev:	September 2009
Grant Period:	October 1, 2004- September 30, 2010

Executive Summary

Hackensack University Medical Center's major initiative to create a cleaner healthier and safer environment for patients, employees and the community served by the medical center is built on its commitment to protect the environment and conserve precious energy resources. Since 2004 the Medical Center launched a long term campaign to temper the negative environmental impact of proposed and existing new construction at the medical center and to improve campus wide overall energy efficiency. The plan was to begin by implementing a number of innovative and eco-friendly enhancements to the Gabrellian Women's and Children's Pavilion, in construction at the time, which would lead to Certification by the US Green Building Councils Leadership & Environmental Design (LEED) program. In addition the medical center would evaluate the feasibility of implementing a photovoltaic system in the new construction (in development and planned) to provide clean pollution free electricity. The steps taken to achieve this included conducting a feasibility study complete with architectural and engineering assessments to determine the potential for implementation of a photovoltaic system on the campus and also to conduct an energy survey that would focus on determining specific opportunities and upgrades that would lead to a healthier energy efficient interior environment at the medical center.

The studies conducted by the medical center to determine the viability of installing a photovoltaic system identified two key issues that factored into leaderships decision not to implement the solar powered system. These factors were related to the advanced phase of construction of the women's and children's pavilion and the financial considerations to redesign and implement in the ambulatory cancer center.

The medical center, in spite of their inability to proceed with the solar aspect of the project upheld their commitment to create a healthier environment for the patients and the community. To achieve a healthier energy efficient interior environment the medical center made substantive upgrades and improvements to the HVAC, plumbing electrical and other operating systems. Measures that were implemented range from use of lighting and plumbing fixture sensors , to reduce electrical and water usage, to use of refrigerants containing hydrochlorofluorocarbons (HCFCs) which cause significantly less depletion of the ozone layer than the refrigerants more commonly used. Additional appropriate energy efficiency component upgrades include the installation of Chiller plants with variable frequency drives (VFDs) and harmonic filters, high efficiency motors, solar window glazing, and lighting/motion sensors.

Accomplishments

The revised goals and objectives for the final funding period:

The goal for the plan modification and extended time period will be consistent with the medical center's ongoing effort to incorporate innovative and eco-friendly enhancements that promote conservation of energy resources. All of our efforts will be aimed to achieve LEED certification.

The project seeks:
1) To demonstrate how a medical center can effectively preserve energy resources and create a positive environmental impact.

2) To demonstrate how medical centers can reduce costs associated with electricity use.

HUMC identified and prioritized planned energy efficiency projects that included projects for which we are requesting funding and, though they do not include solar energy work, they contributed to the campus' overall energy efficiency and positive impact on the environment.

Four major projects supported by the grant include:
An extensive energy analysis of the entire campus was conducted to identify risk areas and opportunities to improve energy efficiency.

HUMC retrofit campus wide, lighting in 8 garages and vending machines as well as optimizing Lighting and Temperature Control to Reduce Energy Usage.

A state of the art real-time web-based continuous chiller plant analyzer was implemented to ensure optimal usage conditions.

An intelligent demand response control system was implemented. It works to curtail energy peak load demand and respond by initiating measures to control the medical centers electrical usage.

Summary of Project Activities:

Hackensack University Medical Center's major initiative to create a cleaner healthier and safer environment for patients, employees and the community served by the medical center began over the past 10 years. Hackensack University Medical Center has invested more than $500 million in its physical plant including inpatient, ambulatory and research facilities. It was a vision of expansion going from 900,000 square feet to nearly 3 million square feet, in what would become the largest hospital expansion and renovation project ever approved by the Department of Health in the State of New Jersey. Hackensack University Medical Center continues today with new buildings and services continually upgraded to meet the needs of the community we serve.

The goal, started prior to the onset of the grant, was to achieve US Green Building Council's Leadership & Environmental Design (LEED) certification in the new *Gabrellian Women's and Children's Pavilion*. The certification, which is premised upon the incorporation of a number of innovative and eco-friendly enhancements in this 300,000 square foot building, that was under construction, was the first mark of the hospitals commitment to a healthier environment. Recognizing the our original project proposal to develop a "green building" did not include a solar power segment, Glen Strahs , Department of Energy, conducted a site visit. As a result of that visit, he recommended that HUMC consult with energy engineers for assistance in developing a suitable solar project that also considered our advanced construction schedule.

At the outset the medical center was concerned about the viability of a solar power project on the Hackensack University Medical Center campus, in particular, the *Sarkis Gabrellian Women's and Children's Pavilion*. Lack of space, (particularly roof space), extremely high land value and even higher acquisition costs, the advanced construction schedule, (the building is due to open in December, 2005) and other factors presented considerable obstacles for a solar project at that time. These factors were prime consideration in the decision not to go forward with a solar component in this building as it would have been fiscally irresponsible given the extent of the effort and the considerable resources needed to add a solar component.

In the fourth quarter of 2005, the medical center had engaged in an extensive consultation with members from the USGBC. The evaluation was aimed to determine the suitability of the proposed site for the ambulatory cancer center.

A no cost extension for eighteen months was requested on 12/15/2005 as directed by Glenn Strahs to allow the hospital to evaluate the use of solar technology in the proposed Ambulatory Cancer Center that was scheduled to break ground in the spring of 2007. This extension was granted in January 2006. There was one energy survey completed over the next 10 months however any additional planning for the Cancer Center was placed on hold while select local permits and variances were acquired.

In February 2006, the Hackensack University Medical Center design team met with Brendan Owen, Director of LEED Design and Construction and Max Zahniser, LEED

NC Certification Manager at the offices of the U.S. Green Building Council (USGBC) in Washington, D.C. to review the LEED Certification of Point Potential matrix
Believed to be among, if not, the first significant hospital project in the nation to apply for and receive LEED certification, the Women's and Children's Pavilion featured products such as non-fiberglass building insulation and toxin-free paints and adhesives which together with other finishes fabrics and furnishings make for a healthier building and in general, promote a safer environment. This is extremely important in any hospital inpatient setting and especially so in this new building where children with cancers and others with deficient immune systems are treated everyday, in fairly significant numbers.

Cancer Center Development

In the fourth quarter of 2006 the medical center was given site approval by the city of Hackensack to go forward with the construction of the Ambulatory Cancer Center to be located on Atlantic St. between 1st Avenue and Prospect St. The medical center received state level approval for the project in December 2007. The engineers initiated their evaluation of environment and planned to conduct an extensive energy survey later in 2008. Subsequently, the ground breaking for construction occurred April 16, 2008 and the evaluation of energy and potential to implement solar, while scheduled, did not occur until early spring 2009.

In the second quarter of 2008 approximately 60-70% of the site excavation is completed. All of the requisite approvals to start the project had been obtained and BR&A was hired to perform the commissioning for LEED certification and solar evaluations.
In the third quarter of 2008, some unforeseen field conditions identified necessitated modifications to the foundations of the buildings. Additional concrete to reach a competent rock bearing was added to the southeast corner of the site as well as additional caissons and grade beams added to the east foundation wall. The concrete footing work was initiated and the structural steel work was scheduled to begin in November 2008. Work was delayed during the quarter due to the removal of oil tanks from the property several that had been leaking necessitating a comprehensive soil mitigation effort that included environmental testing and remediation of soil contamination.
In the fourth quarter of 2008, work continued on clean up of the ground from the leaking oil tanks that were found on the property. The structural steel work experienced a brief delay and began in late December. The delay was related to the soil mitigation effort.

In spite of the delays incurred during the design and planning for the Ambulatory Cancer Center in September 2009 the medical center initiated the construction of the new cancer center facility. During the design and planning phase, two independent energy surveys aimed to evaluation the feasibility of installing a photo-voltaic system at the medical center were completed prior to breaking ground for the construction. Based on the findings of the surveys and other considerations the facilities planning committee decided not to pursue the plan to install a photo-voltaic system..
It is HUMC's intention that, in spite of our inability to proceed with the original solar project, we will proceed with select initiatives that will also demonstrate the medical centers strong commitment to protect the environment and conserve precious energy resources

In September 2009, the medical center submitted a revised Statement of Objectives to the Department of Energy, Golden Office, to extend the grant and redirect the purpose to accommodate the lack of photovoltaic systems implementation.
To achieve a healthier energy efficient interior environment the medical center made substantive upgrades and improvements to the HVAC, plumbing electrical and other operating systems. Measures implemented ranged from use of lighting and plumbing fixture sensors ,in order to reduce electrical and water usage, to use of refrigerants containing hydrochlorofluorocarbons (HCFCs) which cause significantly less depletion of the ozone layer than the refrigerants more commonly used. Additional appropriate energy efficiency component upgrades include the installation of Chiller plants with variable frequency drives (VFDs) and harmonic filters, high efficiency motors, solar window glazing, and lighting/motion sensors.

Specific efforts that the grant supported included:
Retrofit Lighting in Parking Garages
Eight garages on the main campus required energy efficient lighting. These garages have existing 150W metal halide lamps and fixtures. While these fixtures were considered state of the art a number of years ago more efficient lamp and fixture combinations have since been developed. The existing fixtures were replaced with T 8 fluorescent lamps and electronic ballasts all enclosed in a vapor tight fixture. The new fixtures have been relocated in optimal positions to minimize wasted light in the ceiling cavities. 1,265 fixtures were replaced.

Optimize Vending Machine Operations
Lighting and temperature control were the two areas of opportunity for reducing energy consumption in the facility's vending machines. The vending machines internal lighting is continuously on, consuming electricity around the clock. The cold beverage machines refrigeration systems are designed to keep beverages at the same cool temperature regardless of the frequency of machine use. The lamps and ballasts inside the vending machines have been disconnected to avoid electricity usage and a vending miser smart controller technology was installed on a portion of the cold beverage machines. The Vending Miser technology employs an occupancy sensor technology and fuzzy logic to learn occupancy and patterns of usage of the machine then cycles the refrigeration unit off to save energy but calls it back in time to accommodate the learned occupancy periods. 25 vending machines throughout the facility were selected for this technology.

Optimize Chiller Plant Efficiency
The goal for the chiller plants was to reduce the amount of steam and electric consumed during operation by implementing a chiller plant analyzer oversight management tool. The initiative involved the installation of precise Flow Meters and Current Transformers to measure all input and output parameters of the HUMC Main Campus Chillers. The activity at these points are monitored through a web-based system and alerts the Stationary Engineers at the medical center when the chillers are operating outside the peak specifications. By monitoring chilled water supply and discharge temperatures, kilowatt readings, GPM-flow readings the system the hospital can ensure that the chillers

are functioning optimally and a real time savings can be achieved by identifying inefficiencies very early.

Expert coordination and continuous Monitoring by UP&M's team of consultant engineers is provided to calibrate HUMC's Chiller Plant to make certain that the Chiller Plant Maintains a satisfactory level of operation. They also advise the staff on future enhancements to enhance the Chiller Plant into more energy savings, which ensures the most efficient operation without any wasted energy consumption.

HUMC installed Emacx, an Intelligent Demand Response Control System that works with the Medical Center's Building Automation System to curtail energy Peak Load demand and respond by slowing down as many equipment motors throughout the facility a fraction to control the Medical Center's electrical usage. The overall goal for this initiative was aimed to conserve energy, use less electricity and gas, while maintaining a comfortable climate within the facility.
The Emacx System was integrated with 2 of our Building Automation Systems (Siemens / Honeywell) and Monitoring our power usage from the 26 Killovolt service from PSEG.14 Variable Frequency Drives (VFD) were installed on Air Handlers that were installed without VFD. Real time monitoring and display of the HUMC's energy usage, serves as a tool to validate the readings/charges from PSEG and our 3rd party Energy Provider-Pepco.

Plant Operations negotiated a rate from Pepco of 13 cents a Kilowatt hour up to a certain usage and utility demand, as the demand increases and our usage increases the rate increases, The Emacx system will predict this increase and curtail our usage by decreasing our demand in small increments from a combination of loads to keep our usage below this demand parameter from these Building Automation Systems.

Plant Operations can also utilize the Emacx system to continuously operate the HVAC Systems at the most efficient levels, and recommission the overall performance of all the energy usage systems.

Product Development and Technology Transfer Activities

This does not apply to this project.