2008 SACUBO BEST PRACTICES ENTRY: BUILDING ENERGY CONSERVATION PROGRAM

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Abstract

The University of Georgia (UGA) has implemented a building energy conservation program which entails the auditing of buildings to identify items that can be implemented at a reasonable cost using internal funding and personnel. The rapid energy cost spikes during the aftermath of Hurricanes Rita and Katrina in 2005 helped bring awareness of the need for energy conservation. The program began strictly as an energy cost-saving mechanism in response to large, unanticipated (and unbudgeted for) energy cost increases. However, as the program evolved and continued, the collateral benefits for the environment in terms of reduced carbon dioxide emissions and other areas also were recognized as positive outcomes from this program.

Personnel from the Engineering Outreach group and the Physical Plant Division began working in the 2004-05 timeframe to develop a plan for how an energy audit program would be structured and the best way to gain administration acceptance and support for it. The UGA energy audit program now is being used as a model for developing similar programs at universities and colleges across the University System of Georgia. The UGA engineering and facility personnel will be called upon to provide guidance and leadership to the sister schools within the system, under the direction of the Board of Regents staff.

Introduction of the Organization

The University of Georgia (UGA), established in 1785 as the nation's first state-chartered university, is the flagship institution among the 35 colleges and universities in the University System of Georgia. With nearly 34,000 students, approximately 9,000 faculty and staff, and an annual budget of $1.4 billion, UGA is the largest and most comprehensive educational institution in Georgia and a driving force in the state's economic growth.

The University of Georgia's academic reputation is on the rise, and admission is increasingly competitive. More than 17,000 applicants applied for the fall 2007 class of approximately 5,000 freshmen. For the past nine years, the University of Georgia has been ranked among the nation's top 22 public universities by *U.S. News & World Report,* and the institution is consistently recognized as one of the best values in American higher education.

More than 1,600 employees serve in the University's Office of Finance and Administration, striving to provide the essential support required by the University of Georgia to achieve its ambitious academic, research and service mission. Seven divisions are housed under the auspices of Finance and Administration, managing the University's fiscal, human and physical resources. The Physical Plant (PPD) is one of those divisions, and this submission addresses a collaborative effort between the PPD and an academic unit on campus, the Faculty of Engineering.

Statement/(Restatement) of the Problem/Initiative

In 2005, two catastrophic hurricanes crashed into the Gulf Coast region. In the aftermath of the devastating storms, the cost of building supplies skyrocketed, and so did the cost of fuels. As people stood in long lines to pay nearly $4.00 for a gallon of gasoline, awareness of the need for greater conservation of natural resources took hold.

The surges in energy costs were large and unanticipated (and therefore, unbudgeted for) by many institutions. UGA's energy conservation program began strictly as a cost-saving measure in response to the steep hikes in fuel prices. However, as the program evolved, the collateral benefits for the environment in terms of reduced carbon dioxide emissions and other areas also were recognized as positive outcomes from the program.

Personnel from the Engineering Outreach group and the Physical Plant Division began working in the 2004-05 timeframe to develop a plan for how an energy audit program would be structured and the best way to gain administration acceptance and support for it. The UGA energy audit program now is being used as a model for developing similar programs at universities and colleges across the University System of Georgia. The UGA engineering and facility personnel will be called upon to provide guidance and leadership to the sister schools within the system, under the direction of the Board of Regents staff.

Design

Varying levels of involvement can be undertaken when conducting a building energy audit. As defined by the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE), a Level 1 audit is a quick review of the building and systems to identify readily apparent (to the reviewer) items that should be addressed to save energy.[1] The next level in complexity (Level 2) involves a more detailed review of how the building systems are performing and the level of efficiency of the equipment compared to accepted standards. From this review, the set of energy conservation measures (ECM) is produced. The third level of a building energy audit is one which not only identifies ECMs, but also does the detailed engineering to implement the changes. The engineering and implementation plan also would include sufficient monitoring to verify that energy cost savings are realized. This audit (Level 3) is "investment grade," and it is the path that an energy services company would take if they were doing an energy performance contract for the University. The audits being conducted on the UGA campus generally can be classified as a Level 2 audit. The program is being expanded to include measurement and verification of the energy savings that result from ECM implementation, as well as identifying water conservation measures.

The audit process follows generally accepted industry standard practices for building energy auditing, and the Engineering Outreach engineer conducting the audits has done similar programs in prior consulting positions. The following tasks compose the building audit process performed:

[1] ASHRAE, 2004. *Procedures for Commercial Building Energy Audits*, Amer. Soc. of Heating, Refrigeration and Air Conditioning Engineers, Atlanta, GA

- **Site review** – Walk through the facility to understand the equipment in place and how it is operated.
- **Monitor key performance measures** – Install data loggers on key energy-consuming equipment and throughout the facility to measure directly how the systems are performing.
- **Simulation model of building energy usage** – Develop a computer simulation energy model of the building using an industry-accepted standard package.
- **Prepare a list of potential Energy Conservation Measures (ECMs) –** Create a list of measures that potentially would be feasible for this building based on the site reviews and experience with similar facilities.
- **Conduct detailed engineering studies for specific ECMs** – Some of the ECMs require detailed technical or statistical information for proper analysis. For example, light level studies were conducted within the gyms and natatorium areas to help determine the degree to which lighting may be cut back without unduly interfering with the normal usage of the spaces.
- **Detailed analysis of each ECM –** Perform a detailed technical and financial analysis of each ECM to determine the final list of recommendations. Technical evaluations include energy savings as well as the related environmental benefits from reducing energy usage. Financial analysis involves the energy cost savings expected, the cost to implement the measure, the simple payback period for this ECM and a 10-year Net Present Value analysis of the capital investment.

- **Prepare the final list of recommended ECMs and prepare the implementation plan** – Pare down the list of ECMs for implementation, based on the financial and environmental benefits, ease of implementation and visibility to the general UGA community. Also include any other notes or concerns for items to investigate based on the performance monitoring and site reviews.
- **Measurement and verification** – Implement a plan that will verify energy savings and continue monitoring over time. Document energy savings and environmental benefits from all energy conservation measures resulting from the building energy audit program. *(Note: this phase of the audit will be done in conjunction with actual implementation of the ECMs.)*

Implementation

The Engineering Outreach and PPD team decided in the spring of 2006 to implement an energy audit of one building to use as a demonstration case for how such a program might be implemented across the campus. The building selected, ironically enough, was the Ecology Building. This building is representative of the design and construction standards just before energy issues came to the national forefront in the 1970s. The building itself was designed and built in the early 1970s. It consists of nearly 80,000 ft² of conditioned floor space on a single level**.** The Ecology Building audit identified a total of 14 individual ECMs that are being investigated further for implementation. The audit process for this building was similar to the buildings that came later; that is, only ECMs that would not involve a large capital expense were evaluated in detail. For example, this building would likely benefit from a total rehabilitation (or

replacement) of the HVAC system. However, the School of Ecology is considering an expansion or replacement of this building in the five to seven-year timeframe and thus, an expensive HVAC replacement is not justifiable at this time.

Total implementation cost (audit and implementation) of the ECMs from the Ecology audit was estimated at $48,560. Estimated energy cost savings are around $25,230 per year, which gives a payback period of 1.9 years for the project as a whole. The 10-year total Net Present Value of making these changes is $159,467. In addition, a total reduction of 385 tons per year of carbon dioxide emissions will be achieved by implementing this plan. The $48,560 implementation cost includes $12,000 of UGA Engineering Outreach labor for the audit and subsequent monitoring and verification of savings, and an additional $1,900 for the purchase of monitoring equipment for this audit.

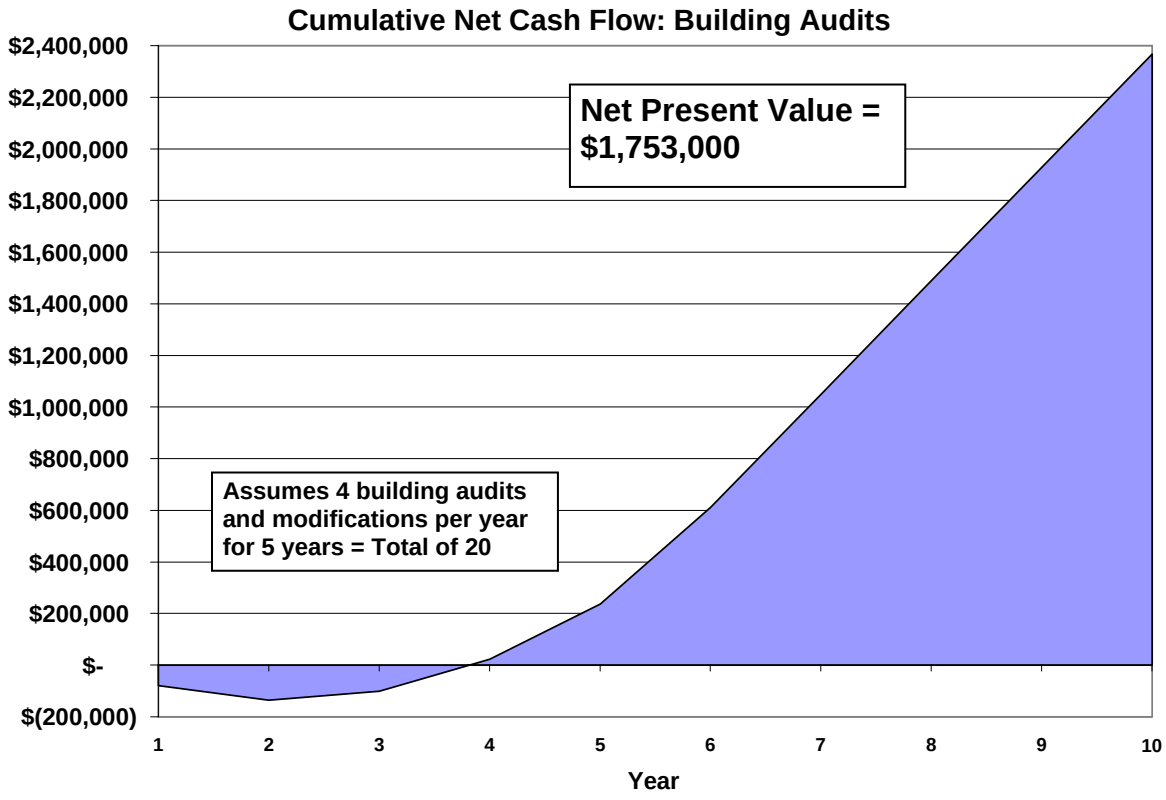
The results of the Ecology Building audit were used as the basis for a recommendation to the UGA administration for continued internal funding of the audit program. This was presented to the administration in a report that came out of the UGA Energy Conservation Executive Committee charged to identify and develop a procedure for addressing campus energy usage and costs. Key participants from UGA's Engineering Outreach program and the Physical Plant were members of this committee. The group recommended a balanced program that included an affordable up-front expense which gradually will have larger and larger benefits.

One of the options considered for the implementation of this program was the use of outside energy performance contracts. The Energy Conservation Executive Committee identified a combination of internal energy audits and energy performance contracts from outside entities as the best balance between speed and efficiency in implementing energy

performance measures. However, attorneys did not think that entering into long-term energy performance contracts was permissible under current state law. Therefore, the recommendation for initial implementation was at first purely an internal energy audit and implementation program.

When the legal issues are resolved with using energy performance contracts, they will be considered as a parallel program that will be closely monitored by the university. Figure 1 shows the projected cash flow assuming that a limited internal energy auditing process that balances funding restrictions with the overall need to become more efficient will be implemented. This plan assumes a limited implementation of auditing and ECM implementation, with an accounting of energy savings that 'pay for' the continuance of future auditing programs. *(Note: it will take several years for this program to generate a positive cash flow.)*

Figure 1



In September 2006, the UGA administration accepted and began to fund the energy conservation program recommendations of the Energy Conservation Executive Committee. The University funded a half-time position within the Engineering Outreach group to conduct energy audits on campus. In addition, funding was provided for implementation of the recommendations from the audits.

While the energy auditing program was being discussed within the University administration, the Engineering Outreach group did an audit on the University's dairy barn operations in eastern Clarke County, Georgia, approximately 10 miles east of the Athens campus. Due to its location, this facility was billed separately for the electrical power used, and thus, dairy barn managers were motivated to investigate potential energy savings. This audit used similar procedures as with the other buildings, but customized them to reflect the specific nature of a dairy operation. Others from within the University's Extension Service are using this audit as a model for developing and implementing a program at dairy operations throughout the state.

After receiving formal approval and funding for an energy audit program within the UGA Athens campus, the program began in earnest. During the fall of 2006, two buildings with a total floor space of approximately 460,000 ft^2 were audited. One of the buildings was the 90,000 ft^2 Driftmier Engineering Center main building, and the second building was the Ramsey Student Center for Physical Activities. The Ramsey Center was designed and built during the mid-1990s. It serves as the main recreational center for students, faculty and staff, and houses classroom, departmental administrative and faculty offices and research facilities. This building totals approximately 370,000 ft^2 over three

levels, and it contains approximately 13.5 million cubic feet of space (most, but not all of which is conditioned).

The Driftmier audit review was conducted by students in the HVAC II engineering course (ENGR 4660) under the direction of Dr. Tom Lawrence in Engineering Outreach. The entire semester topic of this course was the energy audit, and it was conducted using the same methods and procedures as the other audits. Partial support for additional monitoring equipment to conduct this class study was provided under a grant to Dr. Lawrence from the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE).

Beginning early in 2007, two parallel efforts were conducted. The first of these was an energy conservation contest conducted between two student housing dorms. The contest compared their electrical energy and water consumption conservation efforts. The buildings are essentially identical in design and operation, with minor variations. UGA's Engineering Outreach program provided the equipment and labor needed to measure and evaluate energy savings that resulted. This included the analysis needed to compare measured energy and water usage with that predicted based on data collected in the weeks leading up to the contest. While not an energy audit *per se*, this contest helped graphically illustrate the benefits in terms of achieving actual energy usage reductions when a well run awareness campaign is conducted. Energy savings are achieved both by using technology, mostly behind the scenes, and through human decisions done on a daily basis. This campaign fit well with the overall energy conservation program goals at UGA and helped to increase awareness of the issue with the student body.

Parallel to this effort, an energy audit was conducted on the Main Library. The Main Library was constructed in two phases. The first building was built around 1950 and contains nearly 77,000 ft² in four stories above ground and two below the main floor. A larger annex building was added in the early 1970s, and it contains over 201,000 ft² of floor area in seven levels above ground and two below the main floor. This building serves as the main library repository for the UGA Athens campus, although other satellite library facilities exist.

Currently, energy auditing is being done on the Riverbend Research complex. This consists of two buildings constructed approximately 20 years ago, but built in three separate project phases. The buildings house a large number of laboratory facilities, along with offices and conference rooms.

The total cost of implementing all energy conservation measures identified to date would approach $500,000, with an estimated annual energy cost avoidance of around $235,000. The total carbon dioxide emissions avoided by implementing all these measures would total approximately 3,400 tons per year.

Once the audits are complete, the work does not stop; instead, it really has just begun. Typically, the results are reviewed with the main building stakeholders for their comments and to make them aware of items that are being considered. The UGA Physical Plant Division then works to implement the items, by prioritizing them with other ongoing energy conservation activities. In many cases, PPD and Engineering Outreach personnel actively discuss the conservation measures and the design changes needed; occasionally, they will reassess the situation as new information is obtained. As

this process continues, additional ECM ideas can develop, even on the buildings already audited.

Benefits

The UGA energy auditing and conservation measure implementation program only started in earnest in the middle of 2006. It is just now beginning to take shape and proceed with fruitful results. Total cost of all measures initially identified by this process is estimated at $506,000. These measures were identified either formally from audits or informally as the result of discussions and reviews. Annual energy cost savings for all measures are estimated at $362,000.

Not all the recommended ECMs will be considered for eventual implementation, due to various circumstances or based on the result of more detailed study conducted by PPD and Engineering Outreach personnel. In addition, funding for implementation of the measures also is being used for other energy conservation items within the central energy system that are outside the building energy audit program (e.g., steam plant and chilled water loops). However, this process indicates that for the program as a whole, upfront expenses likely could be recovered by cost avoidance within 1.5 to 2 years. As a case in point – utilizing current funding sources and based on input from building constituents, the PPD is implementing measures to save approximately $90,000 annually, which fully recovers the initial audit costs of $47,400. Even though these initial measures represent only 25 percent of the potential savings of the program, the upfront evaluation costs of the audit program are recouped within the first year of implementation.

Most importantly, the savings will continue to accrue for many years to come. In addition, and some might consider just as importantly, there are significant environmental benefits that will result from the energy conserved from this program of energy auditing and implementation of recommended ECMs.

The University of Georgia's approach also is being used as a model for other colleges and universities within the state system. UGA personnel are supporting the state Board of Regents staff by visiting other schools when requested to provide recommendations on how those schools might proceed with their own energy auditing and conservation programs. As a result of this process, the state Board of Regents has created a revolving energy savings account to fund energy-saving projects at all system schools. With this fund in place, and from savings compounding from the initial measures, full implementation of the energy audit program at UGA is anticipated over the next two to three years.

Retrospect

Due to the recent extreme drought conditions in the state of Georgia, awareness also is rising about water utilization and conservation. UGA's energy auditing program easily can be expanded to include potential water conservation measures, since the engineers spend a good deal of time visiting the sites and reviewing operation of the main equipment systems. The engineers have begun to consider water conservation along with energy in the current audits being conducted on the Riverbend Research complex buildings.