**Application Cover Sheet**
**2011 Illinois Governor's Sustainability Awards**
**Presented by the University of Illinois Sustainable Technology Center**
http://www.istc.illinois.edu/info/govs_awards.cfm

Company/Organization Name**:** Retrocommissioning

Address: 1501. S Oak St.

City: Champaign State: IL Zip: 61820

Number of Employees at Location: 17 NAIC Code (if applicable): N/A

Name of Parent Company (if a subsidiary): University of Illinois

**Representative Contact Information**

Governor's Award Contact Name: Karl Helmink / Damon McFall

Contact Telephone: 271-244-6426 Fax: 217-333-4294 E-mail: khelmink@illinois.edu

**Choose Your Award Category**

Governor's Sustainability Award (My organization has not previously won an award.)

**Organization Type:** (Choose only one.) Final decision on the category rests with ISTC.

Educational Institution

If you chose "Other", please specify: Click here to enter text.

**Organization's Sustainability Report link (if desired; but this is not necessary for the application):**

**www.fs.illinois.edu/retro**

**Save this form under your organization's name/cover sheet and submit electronically along with your application and supporting documents to: GovsAwards@istc.illinois.edu**

## Applications must be received electronically by May 27, 2011.

**Upon submission of your application and all related documents, an email confirmation will be provided. If you do not receive an email confirmation, please contact: GovsAwards@istc.illinois.edu.**

**Abstract**

The Retro-commissioning (RCx) team at the University of Illinois at Urbana-Champaign was established in 2007 and has been working to reduce energy consumption in campus buildings by repairing and optimizing their air and hydronic systems and restoring buildings to their required operating standards.

To date, the RCx team has spent approximately $6,000,000 visiting 27 of the campus' buildings and has garnered an average energy savings per building of 26%. This has lead to a cumulative savings of nearly 850,000 MBTU or $9,730,000 in total utility costs using the campus fully-loaded utility rates at the university since RCx's inception. With a multidisciplinary team of engineers, controls specialists, and tradesmen, the team is able to see a project through from design to implementation. Typical projects within buildings include: creating occupancy schedules, replacing or repairing worn small capital equipment, upgrading, and installing new sensors and controls. To ensure the sustainability of results, all buildings are monitored after the work is completed by the RCx team. The RCx teams actively mentor other organizations as well as students interested in the RCx field. RCx work has greatly improved the indoor air quality of buildings which increases comfort of students and staff in buildings. The efforts of the RCx team have made a major contribution to the campus' Energy Management Initiative which has resulted in the total campus energy being reduced by 54,500 BTU/sqft, or 17.3%, over a period of only three years in existing buildings. The RCx team has been honored by the Building Operating Management's FMXcellence Recognition Program for excellence in facilities management.

**Retrocommissioning at the University of Illinois Urbana-Champaign**

The Retrocommissioning (RCx) team at the University of Illinois Urbana-Champaign was formed in 2007 after being chosen from 15 proposed energy reduction projects to receive $1 million from the Academic Facilities Maintenance Fund Assessment (AFMFA). The AFMFA continued to provide $1 million in FY09, and after observing the great success of the team, increased the funding provided per year to $1.5 million in both FY10 and FY11. The additional funding expanded the effort to a second RCx team that works in parallel with the first. Currently, the team is comprised of 17 members including engineers, union tradesmen, controls specialists, and student engineers that are solely dedicated to RCx projects. In addition to the RCx team, facility managers and maintenance workers at the buildings where RCx projects take place are involved in the RCx process and attend meetings with the team throughout the entire process.

**Retrocommissioning Process**

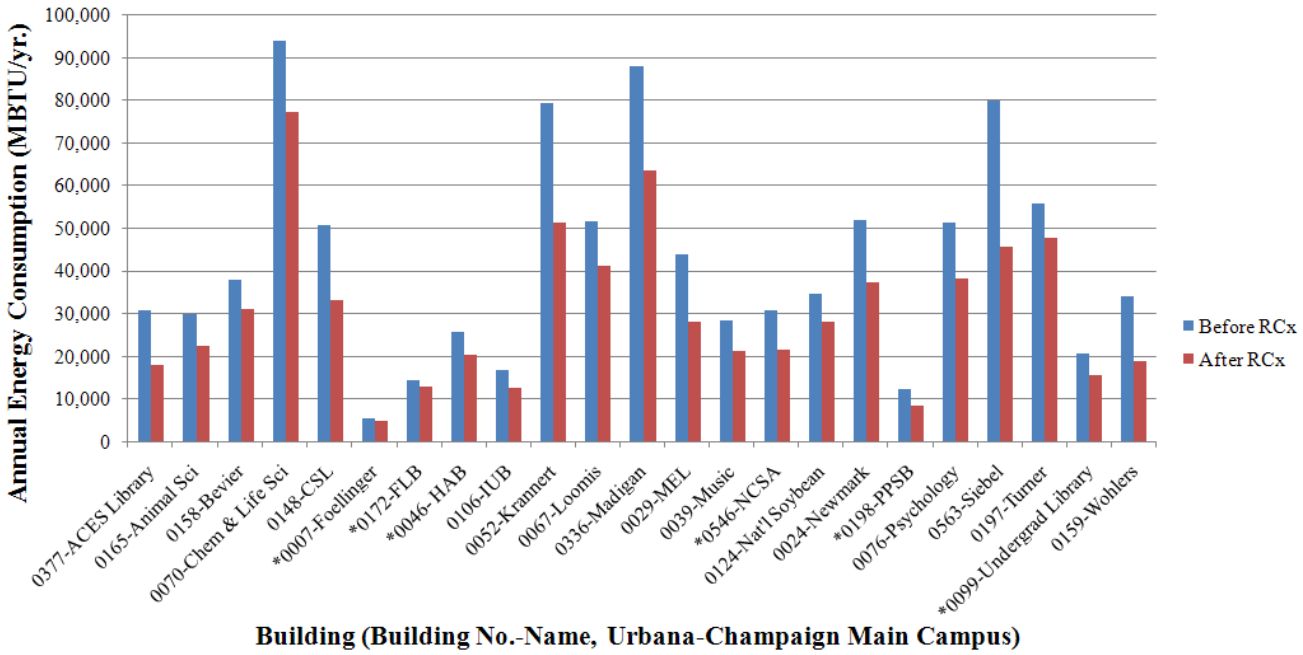
The mission of the RCx team is to reduce energy consumption and the related greenhouse gas emissions of campus buildings by repairing and optimizing their air and hydronic systems while maintaining or improving the comfort level of the building's occupants. Buildings to undergo the RCx process are selected based on criteria such as: 1) level of energy consumption, 2) condition of existing temperature control equipment, and 3) department participation.

Once a building has been selected, the team recommends upgrades or repairs that will impact the building's energy consumption. A primary energy conservation measure employed is the use of occupancy schedule to reduce or eliminate the use of air conditioning and heating when a building is not occupied. Such schedules also allow for reduction in exhausted air and outdoor air intake. In large, single zone, occupant driven spaces, $CO_2$ sensors are installed to allow outside air only when the level of $CO_2$ within a zone exceeds a threshold requiring fresh air. This allows conditioned return air to be recirculated through the building when it is unoccupied reducing the amount of energy intensive conditioning of air required. With sustainability in mind, RCx recalibrates and repairs existing equipment and rebalances HVAC systems ensure that all systems are functioning properly and are optimized. In order to do this, common work includes identifying and repair leaking control valves, cleaning coils, repairing dampers, and installing new DDC controls. Larger capital projects are recommended at times which require assistance from the Engineering Design, Maintenance or Construction departments. All documentation created and knowledge gained is transferred to building

systems manuals which are given to facility managers, then union shops, and controls specialists who continue to monitor buildings and provide support in order to ensure the energy reduction implementations are sustained.

**Garnering Real Results**

Prior to January 2011, the RCx teams had completed work in 23 campus buildings and had been able to reduce energy consumption by **26% on average per building**. The following graph shows the energy use before and after the RCx process was undergone in various campus buildings.




*** For buildings RCx has completed within less than a year to date, data reflects the consumption for the months to date after completion and the corresponding months from one year prior to RCx visit.**

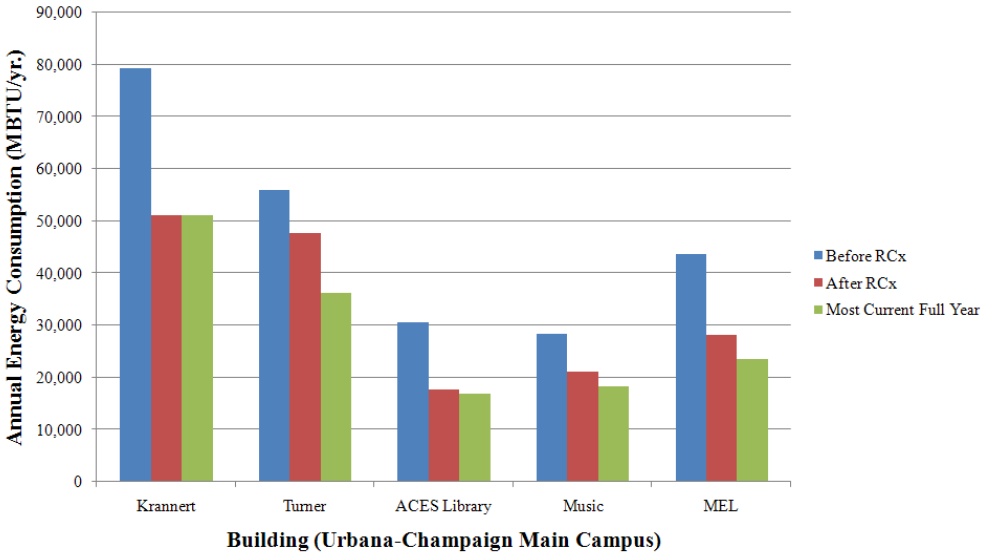
As can be noted by the graph, the RCx team has had many success stories, one such is Siebel Center for Computer Science. In Siebel, the programming of variable air volume (VAV) systems was found to be erroneous leading to room controls that essentially fought each other by heating and then correcting by cooling immediately afterward resulting in significant energy wasted. RCx reduced consumption by 31,141 MBTU, or 42.7%, after just one year by implementing such changes as reprogramming the VAVs, using existing occupancy sensors in office to control the VAVs that served

them, recalibration of all VAVs to allow for new minimum air flow requirements, installing a $CO_2$ sensor in a large auditorium to mediate the required outdoor air quantity for the room, and cleaning of a clogged outdoor air louver. In total this project cost RCx $450,000, and in the first year, the annual savings were $586,000 which gave the project payback of less than 0.77 years.

Wohlers Hall, a building housing lecture halls and offices has experienced similarly impressive results. Before RCx, occupants complained of lack of thermal comfort in the building. In response to this, variable frequency drives were added to the heating water pumps to regulate the water flow efficiently, the old control system was replaced with a new web-based system that allows for remote monitoring of the building systems and control of exhaust fans, a heating water reheat valve replacement project was completed and aggressive occupancy schedules were implemented. In the first year after RCx, a total of 15,389 MBTU in energy usage was avoided, a reduction of 45% from the baseline year before the RCx project was completed.

In total, the RCx team has completed work on approximately 3,450,000 gross square feet of building area, or over **21%** of total main campus building area, and has been able to avoid the consumption of nearly **850,000 MBTU** in total to date; this is enough to power nearly 30,600 homes in Chicago [1]. In addition, this reduction in energy use corresponds to a **reduction in $CO_2$ emissions of 64,800 short tons** to date. This reduction in energy consumption has also led to the avoidance of nearly **$9,730,000 in utility costs** in just under four years of RCx team operation at a cost of $5,250,000 prior to January 1st, 2011. For each square foot, a $1.52 was invested, $2.82 was gained, or a profit of $1.29 per square foot; this is a return on investment of 85.3%.

Furthermore, these results have been sustained. The following graph shows five buildings the RCx team accomplished early on and a comparison of their energy consumption for their baseline year before the RCx visit, for the year after RCx visit and for the most recent full year period since the visit.




**Sharing the Benefits**

Due to the incredible success the RCx team has experienced by implementing changes that have relevance in numerous applications, the team is eager to share its ideas and methods with the community within and outside of campus. Members of the RCx team have mentored and been invited to present to several organizations such as the Building Commissioning Association (BCxA), PECI in Chicago, and the Illinois Smart Energy Design Assistance Center (SEDAC) and at events such as the Illinois Sustainable University Symposium. Several colleagues around the country have inquired about the outstanding program. In addition, the RCx team maintains a website that serves as outreach to anyone interested in RCx activities. The website outlines results of completed projects, lists current projects and contains detailed information on the purpose and process of RCx.

The website can be found at: http://www.fs.illinois.edu/retro/

The RCx department also provides a mentoring program that allows students to work alongside the teams, gaining hands-on experience with HVAC and control systems. Students are given the freedom to study as many aspects of the retrocommissioning process as they would like and to develop valuable skills such as reading building drawings, sustainable engineering practices, and HVAC system fundamentals. The purpose of the mentoring program is to foster students' interest in energy

conservation measures and to prepare them for a future career in a world where the interest in sustainability and energy efficiency is rapidly going mainstream.

The benefits of retrocommissioning at the University of Illinois are many-fold. Undoubtedly, the university benefits by the reduction in energy consumption and, as a result, lower utility costs, and the well-being of the environment benefits due to the reduction in greenhouse gas emissions; however, there are other underlying benefits that should not go unnoticed.

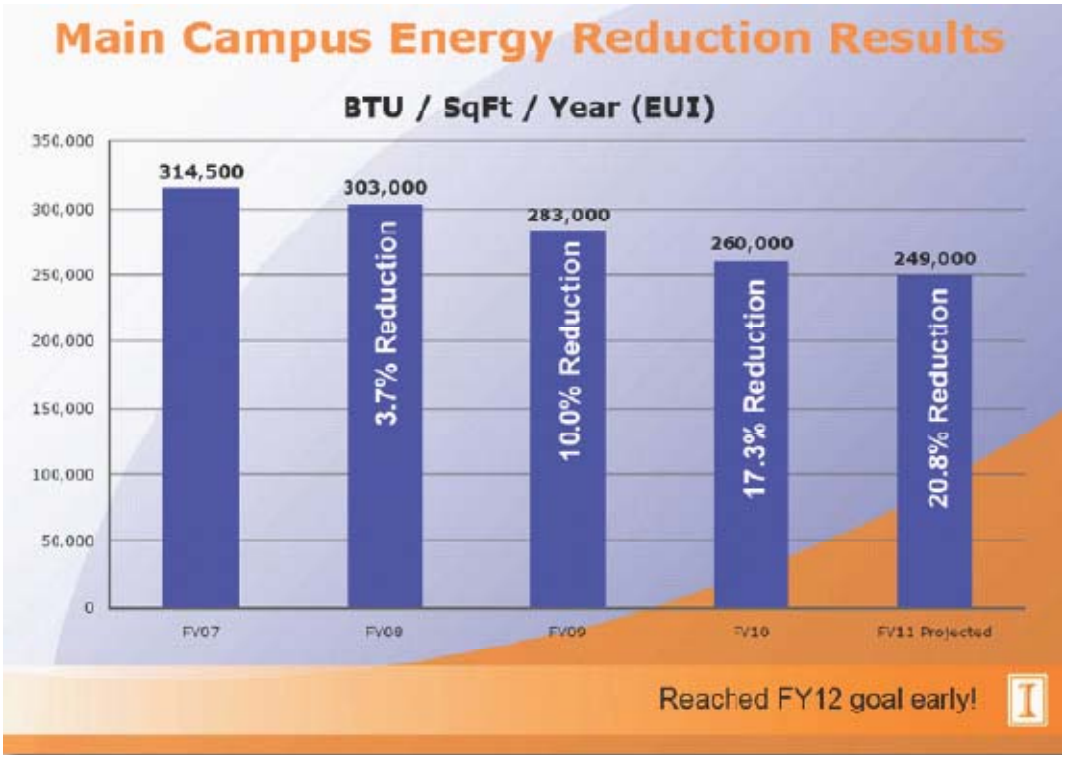
By restoring the heating, ventilation and air conditioning systems to their proper functionality and installing sensors to monitor $CO_2$ concentrations in classrooms, the RCx work has contributed to improved indoor air quality (IAQ) in campus buildings. The improved IAQ creates an environment that is more conducive to working and learning of students, faculty, and staff at the university. Such an environment is crucial in a university setting where learning is the top priority.

Finally, the team members themselves benefit in that they are able to become much more aware of energy conservation methods. Because of the nature of the projects, team members are also able to create lines of communication between the RCx department and facilities managers at all of the buildings the RCx team has visited, thus effectively extending the reach and breadth of the team. For their efforts the RCx team was honored in March 2010 by the Building Operating Management's FMXcellence Recognition Program for excellence in facilities management.

**Saving the Planet, One Building at a Time**

To date, since its inception in 2007, the Retro-commissioning team has been able to save the University of Illinois a total of 850,000 MBTU which corresponds in nearly $9,730,000 in avoided utility costs. RCx is only one facet of the larger global energy reduction picture at the university. In 2008, the University of Illinois at Urbana-Champaign established its Energy Management Initiative, a collaborative effort to reduce the university's energy consumption and to increase awareness of sustainability issues through enhanced utility metering, lighting retro-fits, building energy conservation measures, and the creation of liaisons between student committees and the Office of Sustainability. The RCx team has been supported by and has worked heavily with this effort since it began and has seen tremendous results. As noted in the following figure, from its inception in FY07 to FY10, the Initiative has resulted in a savings

of 54,500 BTU/Sq.Ft., or about 17.3% of the total campus energy usage in only three years, well ahead of the five-year period goal to achieve 17%. If the current trend continues, the university is on track to reduce its energy consumption by 20.8% by the end of FY11 which is outstanding progress and a major step in the right direction for the university's commitment to sustainability.



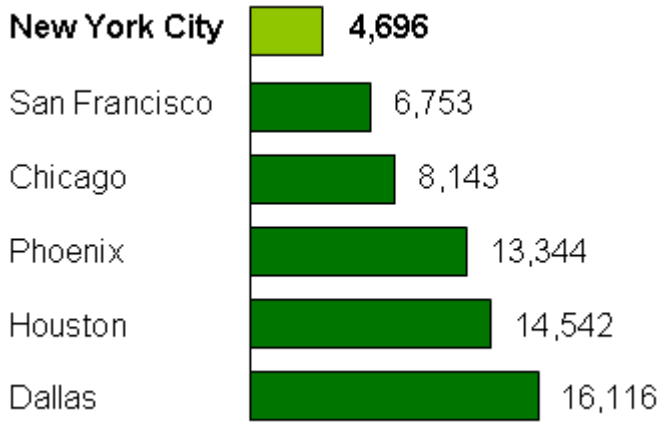

Known for shaping future leaders, the University of Illinois at Urbana-Champaign has embraced the importance of sustainability to the future generations of students that will engage in learning at its campus. The retrocommissioning team is working hand in hand with the university to ensure that its goals of sustainability are met, one building at a time.

**Compliance Statement:**

The Facilities & Services Safety and Compliance Department confirmed that the University of Illinois at Urbana-Champaign is not facing compliance action or subject to an environmental enforcement action or notice of violation from the U.S. EPA or Illinois EPA.

## Supplemental Pages

**Average Annual Household Energy Consumption by City**




1. Average Annual Residential Electricity Usage by City, 2000-2005. Source: Mayor's Office of Long Term Planning and Sustainability, City of New York.

## RCx Economic Summary to Date, Apr 2011

| Building | Time Period of RCx Visit | RCx Follow Up Complete | Annual Cost Avoidance Time Period | Building Area (GSF) | % Energy Avoided | Actual Energy Avoided (MMBTU) | Projected Avoided Utility Cost per Year * | Current Avoided Utility Costs * (Green indicates 1st full year) | Cumulative Avoided Utility Cost since RCx | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Energy (MMBTU) | Cost Avoidance * |
| National Soybean Research Center | Aug 07-Sep 07 | Nov 07 | Sep 07-Aug 08 | 98,854 | 18.8% | 6,486 | $65,000 | $106,773 | 21,717 | $354,756 |
| Krannert Center for Performing Arts | Oct 07-Dec 07 | Mar 08 | Nov 07-Oct 08 | 298,293 | 35.4% | 28,106 | $375,000 | $523,194 | 98,135 | $1,843,345 |
| Newmark Civil Engineering Building | Jan 08-Feb 08 | Jun 08 | Feb 08-Jan 09 | 183,931 | 28.6% | 14,871 | $150,000 | $227,986 | 32,264 | $497,189 |
| Turner Hall | Mar 08-Apr 08 | Jan 09 | Apr 08-Mar 09 | 180,002 | 11.3% | 6,110 | $200,000 | $86,409 | 31,667 | $473,073 |
| ACES Library Info. & Alumni Center | May 08-Jun 08 | Jul 08 | Jun 08-May 09 | 82,742 | 42.0% | 12,877 | $75,000 | $207,655 | 34,795 | $561,163 |
| **FY08Totals** | | | | **843,822** | | **68,451** | **$865,000** | **$1,152,017** | | |
| Music Building | Jul 08-Aug 08 | Sep 08 | Aug 08-Jul 09 | 105,343 | 26.0% | 7,406 | $95,000 | $116,743 | 20,611 | $314,715 |
| Mechanical Engineering Laboratory | Sep 08-Oct 08 | Apr 09 | Oct 08-Sep 09 | 151,859 | 35.7% | 15,637 | $150,000 | $253,944 | 43,964 | $707,740 |
| Animal Sciences Laboratory | Nov 08-Jan 09 | May 09 | Dec 08-Nov 09 | 149,211 | 25.3% | 7,560 | $100,000 | $128,500 | 17,780 | $294,604 |
| Chemical & Life Sciences Laboratory | Feb 09-May 09 | May 09 | Mar 09-Feb 10 | 231,315 | 17.9% | 16,840 | $350,000 | $323,779 | 33,032 | $531,933 |
| Madigan Laboratory Edward R | Feb 09-May 09 | Jul 09 | Mar 09-Feb 10 | 171,007 | 27.9% | 24,579 | $300,000 | $425,492 | 48,438 | $826,325 |
| Wohlers Hall | May 09-Aug 09 | Aug 09 | May 09-Apr 10 | 99,550 | 45.2% | 15,388 | $175,000 | $247,308 | 29,365 | $464,739 |
| Loomis Laboratory of Physics | Jun 09-Jul 09 | Oct 09 | Jun 09-May 10 | 175,513 | 20.2% | 10,424 | $175,000 | $173,423 | 18,805 | $300,617 |
| **FY09Totals** | | | | **1,083,798** | | **97,834** | **$1,345,000** | **$1,669,189** | | |
| Psychology Laboratory | Sep 09-Nov 09 | Jul 10 | Sep 09-Aug 10 | 152,725 | 25.7% | 13,223 | $200,000 | $238,075 | 41,117 | $740,211 |
| Siebel Center for Computer Science | Aug 09-Dec 09 | May 10 | Sep 09-Aug 10 | 266,825 | 42.7% | 34,141 | $300,000 | $586,561 | 55,893 | $943,069 |
| Bevier Hall | Dec 09-Feb 10 | May 10 | Dec 09-Nov 10 | 156,770 | 17.7% | 6,685 | $140,000 | $112,342 | 7,645 | $118,760 |
| Coordinated Science Laboratory | Jan 10-Apr 10 | May 10 | Feb 10-Jan 11 | 124,007 | 34.9% | 17,735 | $150,000 | $284,803 | 20,472 | $329,856 |
| Illini Union Bookstore | Apr 10-Jun 10 | Oct 10 | Apr 10-Mar 11 | 96,407 | 25.5% | 4,243 | $110,000 | $65,402 | 4,243 | $65,402 |
| Nat Center for Supercomp Appl | May 10-Jun 10 | Sep 10 | May 10-Mar 11 | 141,708 | 30.6% | 9,454 | $150,000 | $126,913 | 9,454 | $126,913 |
| Undergraduate Library | Mar 10-Mar 10 | Aug 10 | Jun 10-Mar 11 | 95,905 | 23.6% | 4,828 | $110,000 | $89,550 | 4,828 | $89,550 |
| **FY10Totals** | | | | **1,034,347** | | **90,309** | **$1,160,000** | **$1,503,647** | | |
| Foellinger Auditorium | Oct 10-Nov 10 | Nov 10 | Jul 10-Mar 11 | 51,765 | 10.8% | 570 | $25,000 | $5,037 | 570 | $5,037 |
| Henry Administration Building | Jul 10-Oct 10 | Oct 10 | Jul 10-Mar 11 | 160,497 | 17.0% | 4,163 | $115,000 | $50,804 | 4,163 | $50,804 |
| Foreign Languages Building | Jul 10-Sep 10 | Oct 10 | Sep 10-Mar 11 | 110,942 | 11.1% | 1,591 | $55,000 | $19,842 | 1,591 | $19,842 |
| Physical Plant Service Building | Nov 10-Dec 10 | ? | Sep 10-Mar 11 | 162,881 | 31.5% | 3,863 | $100,000 | $67,330 | 3,863 | $67,330 |
| **FY11Totals** | | | | **486,085** | | **10,187** | **$295,000** | **$143,013** | | |
| **Grand Totals** | | | | **3,448,052** | | **266,781** | **$3,665,000** | **$4,467,865** | **584,412** | **$9,726,971** |
| | | | | | **26.3%** | | | *** Fully Loaded Utility Rates** | | |
| RCx efforts typically result in a payback of 2 years or less. | | | | | | | | Chilled Water Cost: 1 MMBTU = | | $12.89 |
| Energy savings are calculated by comparing the annual cost savings time period after the RCx visit with previous year period month for month. | | | | | | | | Electricity Cost: 1 kWh = | | $0.079 |
| Cumulative savings are calculated by comparing additional months after a year with the same base year (2007, FY08/09) for the first year savings. | | | | | | | | Steam Cost: 1 klb = | | $19.83 |
| | | | | | | | | | | |
| These values are calculated from the metered data and could also reflect lighting retrofits and other energy savings projects at a specific site or general campus infrastructure. | | | | | | | | | | |