

**FACILITIES MANAGEMENT**  
**Energy Conservation Projects Summary**  
**Updated 05/22/2016**

**Utility Operations – Completed in FY16**

*Buchtel Parking Garage LED Lighting Upgrades* - Project scope includes the upgrade of (139) existing florescent lighting fixtures and (2) incandescent EXIT signs to LED.

This project is expected to qualify for a \$2,212.40 rebate from Xcel's Custom Lighting Efficiency program, which would bring the net Energy Reserve Fund capital requirement to \$10,049.40, and result in a payback of 1.75 years based on an annual incremental electrical savings of \$5,717 at the current electric utility rate of \$0.113.

The project would also reduce the electrical shop labor needed to perform a relamp of the existing florescent fixtures, both now and in future years, due to the additional lamp life of the LEDs. The LED lamp warranty is 5 years and the estimated LED lamp life is 50,000 hours or 5.7 years of 24/7 use.

*UTS and Sturm Data Center [Lighting] LED Lighting Upgrades* – The project scope consists of the upgrade of (63) existing florescent lighting fixtures to LED fixtures controlled via area occupancy sensors.

This project is expected to qualify for a \$1,590.00 rebate from Xcel's Custom Lighting Efficiency program, which would bring the net Energy Reserve Fund capital requirement to \$13,273, and result in a payback of 4.47 years based on an annual incremental electrical savings of \$2,972 using an estimated 50% occupancy rate. The range of estimated payback for projects identified to date is from 1 to 5 years, so this project would be at the upper end of the range.

This project would also reduce the cooling load requirements for Liebert systems serving the data systems, due to lower operating lighting wattages associated with the upgraded LED fixtures. The net effect would be a slightly lower cooling energy requirement necessary to support the data centers. The estimated energy savings do not include the cooling savings.

The project would also reduce the electrical shop labor needed to do a relamp both now and in future years, due to the additional lamp life of the LEDs and the reduced burn time resulting from the occupancy sensors. The LED lamp warranty is 5 years and the estimated LED lamp life is 50,000 hours or 5.7 years of 24/7 use.

*Centennial Halls Common Area Lighting & Occupancy Sensor Upgrades - \$74,739*

This project includes the installation of occupancy sensors for control of the non-emergency common hallway lighting fixtures, along with the replacement of (740) existing resident floor hallway fixtures and the relamp of (80) stairwell lighting fixtures with occupancy sensors added to half of the stairwell lighting fixtures. An expected Xcel rebate of \$9,711, would bring the overall net energy reserve cost to \$65,028. The estimated annual utility savings are expected to be 189,414 kWh or \$16,290, resulting in a payback of 3.99 years, based on a current rate of \$0.086/kWh.

The range of estimated payback for projects identified to date is from 1 to 5 years, so this project would be on the upper end of the range.

The project would also result in maintenance labor savings of approximately \$6,770 over the 15 year expected life of the fixtures as a result of a greater average lamp life associated with the replacement lamps. The maintenance savings are not included in the above payback analysis.

### **Utility Operations- In Progress**

*Cherrington Parking Garage LED Upgrades* – Project scope includes the upgrade of (108) existing ceramic metal halide fixtures with new 2-lamp vapor tight LED fixtures. An expected Xcel Custom Lighting Efficiency program rebate of \$2,160 would result in a total project capital requirement to \$27,588, of which \$8,534 would be charged to the Parking Reserve Fund bringing the net Energy Reserve Fund requirement to \$21,214, and result in a payback of 5 years based on an annual incremental electrical savings of \$3,810, using our current metered rate of \$0.076 per kWh. The range of estimated payback for projects identified to date is from 1 to 5 years, so the project would be at the upper end of the range.

This project would also replace the existing stairwell lighting fixtures, for which we have experienced a high failure rate, while improving the overall lighting quality and upgrading the parking garage to the standard applied to other recent garage lighting upgrades.

The project would reduce the electrical shop labor needed to perform a relamp of the existing ceramic metal halide fixtures, both now and in future years, due to the additional lamp life of the LEDs. The LED lamp warranty is 5 years and the estimated LED lamp life is 50,000 hours or 5.7 years of 24/7 use.

*Nelson Hall LED Upgrades* - Project scope includes the upgrade of the existing CFL lighting fixtures located in common area hallways to LED and the stairwell fluorescent fixtures to LED with occupancy sensors.

This project is expected to qualify for a \$4,832 rebate from Xcel's Custom Lighting Efficiency program, which would bring the net Energy Reserve Fund capital requirement to \$42,624, and result in a payback of 4.83 years based on an annual incremental electrical savings of \$8,822 at the FY15 Nelson Hall electric utility rate of \$0.088.

This project would also reduce the cooling demand during summer months, due to lower operating lighting wattages associated with the upgraded LED fixtures. The net effect would be a slightly lower electrical demand due to a reduced cooling energy requirement, but this benefit would be partially offset due to a slightly higher natural gas requirement as a result of the reduced wattages. The estimated energy savings do not include the cooling savings.

The project would also reduce the electrical shop labor needed to perform a relamp both now and in future years, due to the additional lamp life of the LEDs and the reduced burn time resulting from the occupancy sensors. The LED lamp warranty is 5 years and the estimated LED lamp life is 40,000 hours or 5.48 years of 24/7 use as compared to a life of 10,000 hours or 1.36 years for the existing CFL, while improving overall lighting levels and lighting quality in the hallways.

*RSECS School of Engineering [Mechanical] Konvekta Heat Recovery System* - Funding has been approved for the upgrade to a new higher efficiency heat recovery system which will save cooling, heating and ventilation energy. The ventilation savings are the result of the pressure drop across a single coil used for both heating and cooling purposes as compared to three coils included in the base design. The project is expected to qualify for a rebate of \$24,000, as determined by Group14 Engineering, Inc., the company who performed Xcel's Energy Design Assist program modeling. The anticipated annual cost savings associated with the Konvekta system would be \$81,159 of annual electric and gas savings, in comparison to a conventional heat recovery system. These savings were calculated using an electric rate of \$0.075/kWh and a gas rate of \$0.571/therm. The annual utility savings associated with an initial investment of \$385,179 in Energy Reserve funding, would result in a payback of 4.45 years. The range of estimated payback for projects identified to date is from 1 to 5 years, so this project would be near the top of the range.

*Lucid Energy Dashboard [Controls]* - This initiative includes the development of customized software and integration services to allow for the visualization of our residence hall building's electric and gas consumption in real-time by campus students, faculty and staff, along with sustainability initiatives application software and conservation competition application software. We are proceeding with the installation of real-time electric utility metering required to incorporate additional facilities into the dashboard. Once the added metering has been completed the facilities included in the dashboard will be as follows:

- Johnson McFarlane
- Centennial Towers
- Centennial Halls
- Nagel
- Nelson
- Anderson Academic Commons
- Olin Hall
- Seeley Mudd
- Daniels
- Physics
- Ricketson Law
- Newman Performing Arts

*Central Plant [Controls] Enernoc Demand Response* – During 3 demand response events during the summer of FY10, we were able to meet or exceed our commitment to reduce our electrical demand by 280kW. The facilities which are included in this program are Ritchie Center and the Central Plant. The Central Plant reductions are achieved in part through temperature setback in the facilities served by the Central Plant. In FY16 we incorporated the Daniels, Performing Arts and Law meters into the Demand Response program, effectively adding 180 kW of demand response capacity and bringing our total demand response capability to 500 kW. Our participation in the Demand Response generated \$5,509.87 of revenue January 2015 thru September 2015.

*Dorm Energy Competition* – Nagel, Nelson, J-Mac, Halls and Towers all competed in an Energy and Water Conservation Competition during the Fall Quarter of FY10, promoting a variety of conservation measures including turning off lights and appliances when not in use, taking shorter showers, using natural lighting when available and washing clothes in cold water. Each dorms electrical, gas and water consumption were compared the same period in 2008. The winner of the competition Nelson Hall saw their electrical consumption drop by 28% and gas consumption drop by 8%. All dorms experienced lower consumption in all categories during the competition. During the Fall Quarter of FY11, the average weather adjusted drop in electrical consumption was 3% while overall gas consumption was 21% lower than the previous year. The FY13 winner of the competition was J-Mac with a drop in utilities of 2% Electric, 14% Gas and 17% water.

*Iconics Visualization Software [Controls]* – Implementation of a new graphical user interface for the existing automation systems is in progress. Phases I and II, the integration of Metasys and Tracer Summit, are complete. The integration of the Tridium systems, Phase III, is in progress with an estimated completion of FY13. This software tool will provide the following features/benefits:

- Establish a platform for consistent scheduling, alarm notification and archival of trend data across existing HVAC automation systems

- Allow for the upgrade of existing Johnson Control Metasys automation system without the need for replacement of existing hardware or reprogramming of new network control hardware
- Integration to lighting systems for the purposes of automated scheduling
- Provide a solution for the visualization of real-time energy consumption data
- Create a common user interface while allowing for integration of a variety of building automation systems including lighting systems on future new construction or retrofit projects

*Contract Gas Purchase* - Our current gas purchase strategy was originally based on an evaluation of a 3 year contract ending December of 2010. A new contract with Asgard initially reduced the price per Dth from \$7.55 to \$5.09 for the months of Jan, Feb and March of 2011, resulting in a net savings of approximately \$163,000.

The Asgard quoted volumes represent 66% of our expected gas consumption for the months of Jan, Feb and March 2011.

Moving forward several options exist for a longer term gas purchase strategy. The three basic options include the following:

1. **Fixed price** contract based on our total estimated consumption (lowest short term risk)
2. Ongoing purchases at **market rates** (lowest long term risk)
3. **Combination strategy** - a portion of our estimated consumption would be purchased via a fixed price contract with the remaining requirement met through market rate transactions

The combination strategy would limit the potential risk of unexpected increases in gas prices due to weather swings or supply disruptions, while allowing for some benefit in the event prices fall below the negotiated levels. This strategy would also reduce the probability of a need to liquidate excess gas purchases at market rates which are below the fixed pricing level.

### **Utility Operations - Under Consideration/Evaluation**

*Sturm Central Plant [Controls] Demand limiting* – This project would create an electric load shed strategy within buildings served by the Central Chilled water plant. During periods of high chilled water demand, these demand limiting routines would be triggered to lower the peak electrical demand at the Central Plant thereby reducing the monthly peak demand level and reduce the utility cost. The effect of any reduction in peak demand will also help to lower our winter costs, due to the current demand ratchet Xcel has in place.

*Boettcher West [Mechanical] Thermal Coating* – This initiative would include the application of a thermal coating to the exterior walls to reduce heat transfer during both the heating and cooling seasons.

*Shwayder [Lighting] Gallery Track Lighting Upgrade* – This project would upgrade the existing halogen track lighting to LED.

*General Campus Stairwell [Lighting] Lighting Upgrade*– This project would add occupancy sensors to additional stairwell lighting fixtures, to reduce energy consumption when the stairwells are not in use. The average occupancy of a typical stairwell is approx. 9%. As of January, 2013, we are in the process of finalizing pricing to upgrade the stairwell lighting in Centennial Halls, Centennial Towers, Ritchie Center, Nelson and Daniels.

*General Campus LED [Lighting] Lighting Upgrade*– This project includes the upgrade of 376 existing incandescent fixtures and 91 metal halide fixtures to LED in multiple buildings across campus.

*GENERAL Retro-commissioning Study [Survey]*– We are continuing to evaluate expanding our retro-commissioning efforts to Driscoll North & South as well as other facilities not previously submitted. Our focus of this initiative would be to verify and optimize controls system performance via functional testing. Xcel's rebate program will fund up to 75% of the costs of this initiative, not to exceed \$25,000.00, if approved.

*General Outdoor Lighting [Lighting] Controls Upgrade* – This project would replace existing timeclocks with network controls and allow for scheduling of outdoor lighting systems via our Iconics Graphical User Interface. This upgrade would result in labor cost savings due to the elimination of the need to reset existing clocks on a regular basis as well as lower electrical consumption via the use of an Astronomical software. The Astronomical software reduces the required hours of operation by automatically adjusting for the daily changes in the timing of sunrise and sunset.

*General Campus [Lighting] Upgrade of Walkway Lighting* - Facilities is developing project to upgrade to higher efficiency lamps and ballasts in walkway lighting fixtures.

*General Campus [Lighting] Upgrade of Uncovered Parking Lot & Walkway Lighting* - Facilities is developing a project to upgrade existing HPS and Metal Halide lamps located in walkway and uncovered parking areas to LED. This project would target both energy consumption as well as a reduction in maintenance requirements.

*Ritchie Center [Controls] Demand Based Ventilation* – This project would include the installation of VFDs on AHUs 8,9,10,11&12, this would be the preliminary step prior to adding CO2 sensing and controls necessary for variable flow control based on occupancy requirements. We are planning to evaluate the opportunity for Xcel rebate funding, as part of the upcoming retro-commissioning study.

*Newman Center [Mechanical] Evaporative Pre-coolers for Air Cooled Chillers* – We are evaluating options to add evaporative pre-cooling to the existing air cooled chillers which would reduce peak compressor kW by 30% and improve the EER(energy efficiency rating) from 8 to 12.

#### **Utility Operations – Completed Prior to FY16**

##### *Nelson Parking Garage Lighting Upgrade - \$29,023*

The scope of this project included the replacement of (98) existing 150W High Pressure Sodium fixtures with (90) new 108W 4 lamp fluorescent fixtures and (8) 90W Ceramic Metal Halide lamps. An expected Xcel rebate of \$2,344, would bring the net project cost to \$26,679. The estimated annual utility savings are 133,150 kWh or \$10,652 based on a current rate of \$0.08/kWh, resulting in a payback of 2.5 years,

##### *Daniel's Parking Garage Lighting Upgrade - \$21,108*

The scope of this project is to replace the existing (71) existing 150W High Pressure Sodium fixtures with (60) new 108W 4 lamp fluorescent fixtures and (11) 90W Ceramic Metal Halide lamps. An expected Xcel rebate of \$1,846, would bring the net project cost to \$19,262.

The estimated annual utility savings are 89,702 kWh or \$7,176 based on a current rate of \$0.08/kWh, resulting in a payback of 2.68 years

*Ritchie Magness Arena LED Lighting Retrofit* - This initiative includes \$45,000.00 of energy reserve funding to support the upgrade of (64) existing 1000 watt metal halide lighting fixtures to dimmable LED lighting fixtures.

The project is expected to qualify for a \$18,400.00 rebate from Xcel's Custom Lighting Efficiency program, which would bring the net Energy Reserve Fund capital requirement to \$26,600.00, and result in a payback of 2.5 years based on an annual incremental electrical savings of \$10,609.00. The range of estimated payback for projects identified to date is from 1 to 5 years, so this project would be at the lower end of the range.

This project would also reduce the cooling load requirements for Magness area, due to lower operating lighting wattages associated with the upgraded LED fixtures. The net effect would be a slightly lower cooling energy requirement necessary to support the Magness ice sheet, primarily during the summer months. This project was completed August of 2014.

*Seeley Mudd General Building Lighting Upgrade* - This project includes the upgrade of existing 4 Lamp T8 and T12 fixtures to High Efficiency T8 fixtures throughout the building and new stairwell fixtures with integrated occupancy sensors.

This project is expected to qualify for an Xcel rebate of \$6,809.00, which will bring the overall net energy reserve cost to \$41,562.00. The estimated annual utility savings are expected to be 139,493 kWh or \$10,462.00 based on a current rate of \$0.075/kWh, resulting in a payback of 3.97 years. The range of estimated payback for projects identified to date is from 1 to 5 years, so this project would be in the upper portion of the range.

This project also reduces the cooling load requirements for the building, due to lower operating lighting wattages associated with the more efficient fixtures. The net effect would be a slightly lower cooling energy requirement necessary to support cooling needs, primarily during the summer months.

An added benefit of this upgrade would be avoided electrical labor and material costs necessary for the replacement of the existing lamps and ballasts in the near future. In addition this project will help to standardize the types of lamps and ballasts installed at Seeley Mudd, thereby reducing the inventory requirements of our electrical shop.

*Ritchie Center [Controls] Retro-commissioning Upgrades* – Funding has been approved for implementation of selected conservation measures identified and evaluated in the study phase.

The selected upgrades include the following initiatives:

- Demand controlled ventilation based on CO2
- Zoning of areas served by AHU-1
- Conversion of VAV controls from pneumatic to DDC
- Re-programming of AHU sequences and occupancy modes
- Chiller Plant optimization
- Heating Plant optimization

The expected payback for all measures included in the funding request is 1.85 years.

*Ben Cherrington Parking Garage [Lighting] Ceramic Metal Halide Lighting Upgrade* - \$30,762.94

The scope of this project is to replace the existing Metal Halide lamps and ballasts with new Ceramic Metal Halide lamps and ballasts. An expected Xcel rebate of \$5,400, would bring the net project cost to \$22,309. The estimated annual utility savings are 86,093 kWh or \$6,284 based on a current rate of \$0.073/kWh, resulting in a payback of 4 years, The range of

estimated payback for projects identified to date is from 1 to 5 years, so this project would be on the upper end of the range.

The existing metal halide lamps and ballasts are nearing the end of their useful life, therefore an added benefit of this upgrade would be avoided electrical labor and material costs necessary for the replacement of the existing lamps and ballasts in the near future.

*Olin Hall [Mechanical] Heating Water Pump Upgrade* –This upgrade would match the pumps to the installed heating system requirements, reducing the necessary horsepower and set the stage for the conversion of existing 3-way valve assemblies to 2-way, minimizing the pumping related energy requirement during periods of partial load. The scope of this includes the upgrade of an existing constant volume heating water pump to an Armstrong IVS Sensorless pumping package with variable speed drive, along with the conversion of air handling unit heating coils from 3-way to 2-way. This project is expected to qualify for an Xcel rebate of \$1200.00, which would result in a net cost to \$7,338.00. The projected annual utility saving are 16,625 kWh or \$1,712 based on a current rate of \$0.0103/kWh, resulting in a payback of 4.29 years.

*Seeley Mudd [Mechanical] Konvekta Heat Recovery System* - This project supports the upgrade to a new higher efficiency heat recovery system which will save cooling, heating and ventilation energy. The ventilation savings are the result of the pressure drop across a single coil used for both heating and cooling purposes as compared to two coils currently installed. The project is expected to qualify for a \$20,000 rebate from Xcel's Custom Efficiency program and generate \$54,879 of annual electric and gas savings, in comparison to a conventional heat recovery system. These savings were calculated using an electric rate of \$0.073/kwh and a gas rate of \$0.551/therm. The annual utility savings associated with an initial investment of \$274,350.00 in Energy Reserve funding, would result in a payback of 4.63 years.

*Seeley Mudd Chiller Upgrade [Mechanical] Centrifugal Magnetic Bearing Option* – This upgrade allowed for the substitution of a higher efficiency Centrifugal Magnetic Bearing Chiller for a Rotary Screw Chiller which was the original basis of design. This project qualified for a \$6,070.49 rebate from Xcel's Cooling Efficiency program, which will brought the net Energy Reserve Fund capital requirement to \$47,600.00, and resulted in a payback of 4.82 years based on an annual incremental electrical savings of \$9,877.00. The average expected service life of Centrifugal Chillers as published by ASHRAE is 23 years or nearly 5 times the expected payback timeframe.

*General Campus LED Lighting Upgrade* - The scope of this project is to replace the (96) existing Ritchie Center Display Case T8 lamps and ballasts with LED lamps and drivers and upgrade total of (27) existing walk-in freezer and cooler T8 and T12 lighting with LEDs and (13) occupancy sensors. An expected Xcel rebate of \$1,281.00 which would bring the net project cost to \$8,403.00.

The estimated annual utility savings are 39,980 kWh or \$3,278.00 based on a current rate of \$0.082/kWh, resulting in a payback of 2.56 years, The range of estimated payback for projects identified to date is from 1 to 5 years, so this project would be in the middle of the range.

*SMART GRID [Controls]*– \$50,086 of capital from the Utility Reserve Funds was approved for a detailed analysis by School of Engineering and Computer Science to evaluate the potential benefits of deploying smart grid technology and create software necessary to identify and model the targeted loads. This system would include the integration of new and/or existing electric meters into our building automation systems and the development of software to limit our peak electrical consumption thereby avoiding demand (kW) cost. The initial estimate, based on a preliminary evaluation by the School of Engineering, was for an annual electric utility savings of

\$29,482 or 0.75% of the total electric bills if deployed in the 4 buildings (Daniels, Newman, Sturm Central Plant and Ritchie) which represent 1/3 of our campus consumption. School of Engineering and Computer Science presented their final analysis on Sept. 21<sup>st</sup>, 2012, which included evidence supporting a shift of afternoon classes into the morning hours to lower peak loads during summer months and reduce the need for mechanical cooling.

*Ritchie Center [Mechanical] Ice Chiller Upgrade* –The project scope includes an upgrade to higher efficiency chillers similar to the design for Pepsi Center which increases efficiency from 1.93 kW/Ton to 0.949 kW/Ton and at the same time creating additional redundancy and an increases capacity by 42% from 225 to 320 Tons.

This project is expected to qualify for a \$15,800.00 rebate from Xcel's Motor and Drive Efficiency program, which will bring the net Energy Reserve Fund capital requirement to \$72,455.00, and result in a payback of 5 years based on an annual incremental electrical savings of \$14,491.00. This project was completed September, 2012.

*Highlands Ranch Golf Course [Lighting] T12 Lighting Upgrades* – This project is expected to qualify for an Xcel rebate of \$4,183.00, which will bring the overall net energy reserve cost to \$8,092.00. The estimated annual utility savings are expected to be 25,219 kWh or \$2,219.00 based on a current rate of \$0.088/kWh, resulting in a payback of 3.65 years. This project was completed September, 2012.

*Nelson Hall [Survey] Retro-commissioning Study* – This initiative focused on the verification and optimization of HVAC and controls systems performance via functional testing, along with identification of energy conservation opportunities. The results of this study included 27 potential energy conservation measures with a total potential annual utility savings of \$25,350. The payback estimates for the projects identified ranged from less than 1 year to over 20 years. The Study qualified for funding under the Xcel Recommissioning program. The net cost of this study after rebate is \$13,750.00. The final report presentation was completed January, 2013.

*Sturm Hall [Survey] Energy Engineering Study* – The scope of this Engineering Study included functional testing of our existing control systems as well as an analysis of the conversion of specific air handling units from constant volume to variable volume. The results of this study included 9 potential energy conservation measures with a total potential annual utility savings of \$36,157. The payback estimates for the projects identified ranged from 3 years to over 20 years. The Study qualified for funding under the Xcel Energy Engineering program. The net cost of this study after rebate is \$6,597.00. The final report presentation was completed January, 2013.

*Tennis Parking Garage [Lighting] LED Lighting Upgrades* – The scope of this project included the upgrade of existing T8 lamps and ballasts with LED lamps and drivers. An Xcel rebate of \$1,101.00 resulted in a net project cost to \$11,525.00. The estimated annual utility savings are 24,115 kWh or \$3,038.00 based on a current rate of \$0.126/kWh, resulting in a payback of 3.8 years.

*Kitchen Walk-in Freezers & Coolers [Mechanical] Motor Efficiency Upgrades* – The scope of this project is to replace the existing fan motors with high efficiency ECM motors in the walk-in freezers and coolers at Ritchie, Nelson, Driscoll North, Nagel, Centennial Halls, Seeley Mudd, Law and HRTM to improve operational efficiency while also lowering the amount of heat



generated by the motors thereby reducing the refrigeration compressor loading. An Xcel rebate of \$4,970.00 resulted in a net project cost of \$11,523.00. The estimated annual utility savings are 124,276 kWh or \$11,061.00 based on a current rate of \$0.089/kWh, resulting in an anticipated payback of 1.0 years.

*Campus [Lighting] Stairwell Lighting Upgrades* - The scope of this includes the replacement of existing two lamp 32W T8 stairwell lighting fixtures with the FSC 6000 Series fixture. The replacement fixture reduces energy consumption when the stairwells are not in use through the utilization of an integrated occupancy sensor. The average occupancy of a typical stairwell is approx. 9%. The buildings included in the initial evaluation were Centennial Halls, Centennial Towers, Ritchie Center, Daniels and Nelson Hall.

The upgrade of (84) Centennial Halls and Towers stairwell lighting fixtures was completed in June of 2013. The total cost of the upgrade was \$16,380.00. An expected Xcel rebate of \$3,000 would bring the net cost to \$13,380. The annual utility saving based on a calculated annual reduction of 49,411 kWh per year would be \$3,854, resulting in a payback of 3.47 years.

*Olin Hall [Mechanical] Evaporative Pre-coolers for Air Cooled Chiller* – The scope of this includes the installation of an evaporative pre-cooler assembly on the Olin air cooled chiller to lower the condenser inlet temperature. This upgrade is estimated to lower our peak demand by approx. 25kW which would qualify for a \$10,000 rebate from Xcel bringing the net cost to \$19,373. The annual utility saving using 1900 equivalent full load hours would be \$5753, resulting in a payback of 3.37 years.

*Johnson McFarlane [Survey] Energy Star Certification* – On September 14, 2011, the Johnson McFarlane Residence Hall became the first building on campus to achieve the U.S. Environmental Protection Agency's ENERGY STAR Award. This certification signifies the building performs in the top 25 percent of similar facilities nationwide for energy efficiency and meets strict energy efficiency performance levels set by the EPA. Commercial buildings that earn EPA's ENERGY STAR certification use an average of 35 percent less energy than typical buildings and also release 35 percent less carbon dioxide into the atmosphere.

*Centennial Towers Chilled Water System Pump Controls* – This project will automate the control of (2) 5HP and (2) 3HP chilled water pumps and (2) 7.5HP condenser water pumps based on outside air temperature, saving pump energy primarily during nighttime hours when the building does not require mechanical cooling. Estimated payback is 2.94 years. This project was completed November, 2011.

*Mary Reed [Controls] Controls Upgrade* – This initiative integrated existing standalone digital controls in Mary Reed serving Dupont, Renaissance and The Chancellor's Office to our automation network, allowing for remote monitoring, occupancy scheduling and alarming of the building HVAC systems. The project was completed October, 2011.

*General Campus T12 [Lighting] Lighting Upgrade Phase II* – This project includes the upgrade of existing T12 fixtures and the addition of restroom occupancy sensors in Seeley Mudd, Driscoll Center, Facilities and Boettcher Auditorium. This project also includes the installation of LED lights in the stairwell of the Cherrington Garage. The estimated payback of the project is 2.32 years. The project was completed July, 2011.

*University College T12 [Lighting] Lighting Upgrade* – The upgrade of existing T12 fixtures was completed November, 2011. The estimated payback of the project is 1.59 years.

*Academic Office Annex T12 [Lighting] Lighting Upgrade* – The upgrade of existing T12 fixtures was completed November, 2011.

*Physics [Mechanical] AHU-1VFD Addition* – The addition of a VFD on the supply fan associated with AHU-1, would allow for airflow setback during unoccupied hours. The estimated payback of the project is 2.2 years. The project was completed October, 2011.

*Ritchie Center [Lighting] Pool Lighting Upgrade* – This project replaced the existing 1000 Watt Metal Halide Fixtures with higher efficiency fluorescent T5HO fixtures and allow for the implementation of a non-event lighting level for additional savings. The new fixtures have been modeled to improve the event lighting levels. The measured reduction in annual post-retrofit electrical consumption is 186,600 kWh, or over 50% of pre-retrofit consumption levels. The construction phase of this project was complete in September, 2011. An Xcel rebate of \$20,630.00 (\$12,790.00 of which was applied to the Utility Reserve) and a electric utility rate of \$0.082/kWh resulted in a payback of 2.24 years on a Utility Reserve investment of \$54,924.00.

*Centennial Halls & Towers [Mechanical] Boiler Replacement* – The capital upgrade to higher efficiency boilers was initiated in April, 2011. This project is expected to increase our boiler efficiency from 60% to 85%. In FY2010, Halls and Towers combined total natural gas consumption was 259,101 Therms or 12.9% of our campus total. The project also includes the upgrade of the existing hot water pumping systems to variable speed. The modeled annual electric and gas cost savings for this initiative is \$22,014. Centennial Halls upgrade was completed October, 2011 and Centennial Towers was completed December, 2011.

*UtiliTech [Survey] Utility Bill Analysis* – This initiative includes the review of our past Electric and Gas bills to determine if overcharges, potential cost savings or usage/metering errors exist. The report findings were presented October, 2011, and included an evaluation of the conversion of Ritchie, Daniels, Newman and Nelson from SG to PG service, along with correction of the sales tax rate associated with two meters and a recommendation to convert the SAE meter from SG to rate C.

*Frontier Hall [Controls] Controls Upgrade* – This project included the extension of our existing Johnson Controls Metasys system to include control of the primary heating and cooling systems in addition to the make-up air handling unit, allowing for remote monitoring, occupancy scheduling and alarming of the building HVAC systems. This project was completed February, 2012.

*Metallurgy [Controls] Controls Upgrade* – This project included the extension of automation to the primary building heating and cooling systems, allowing for remote monitoring, occupancy scheduling and alarming of the building HVAC systems. This project was completed February, 2012.

*Ricketson Law [Controls] Demand Limiting* – This initiative included software development and testing of a strategy which sheds electric load during periods of high demand to reduce our monthly peak demand levels and lower utility costs. This project was completed March, 2012.

*Vending Misers [Controls]* – This project included the installation of vending miser devices with infrared occupancy sensors. These devices will deactivate the vending machine lights and

prevent unnecessary compressor cycling during unoccupied periods. Energy savings are based on reduced runtime of the vending machine compressors and display lighting. The USG Sustainability Committee contributed half of the estimated costs of the project to promote sustainability initiatives on campus, which will brought the overall net cost to \$8,000.00. Based on the previously conducted Shwayder Energy Audit, the estimated annual utility savings are expected to be 66,250 kWh or \$2,650.00 based on a \$0.04/kWh non peak rate, resulting in a payback of 3.02 years. This project was completed March, 2012.

*UTS & Sturm Hall [Survey] Data Center Analysis & Controls* – The project kick-off meeting was held September 21<sup>st</sup>, 2009. This analysis identified potential energy conservation measures and their estimated payback, in addition to providing a real-time monitoring system for ongoing analysis of energy efficiency and diagnosis of potential server distribution or overheating issues. Installation of the real-time monitoring systems was completed on December 4<sup>th</sup>, 2009. A meeting to present the preliminary findings and recommendations is scheduled for June 4<sup>th</sup>, 2010. Receipt of final Xcel rebate occurred February, 2012.

*Ritchie Center [Survey] Retro-commissioning Study* – This initiative included an energy analysis component, focusing on HVAC and controls systems, along with a retro-commissioning element which will verify and optimize controls system performance via functional testing. The Study qualified for funding under the Xcel Standard Offer program. The Standard offer program allows for additional rebate dollars resulting from the implementation of energy conservation measures during the course of the study. The net cost of this study after rebate was \$32,500.00. The study findings were presented to Xcel, June 2011. Receipt of final Xcel rebate occurred March, 2012.

*Shwayder Art [Survey] Retro-commissioning Study* – This survey included the identification of conservation opportunities related to HVAC and controls systems. The study findings were presented to Xcel, June 2011. Receipt of final Xcel rebate occurred March, 2012.

*Olin Hall [Mechanical] Mechanical & Controls Upgrades* – Funding has been established to accomplish the following conservation measures:

- Fume Hood Presence Sensors [\$31,600/1.66 years]
- Bench Exhaust Timers [\$2500/0.13years]
- AHU-2&3 VFD's [\$15,100/1.52years]
- AHU-2&3 Supply Air Reset [\$700/0.15years]
- Load shedding/demand response [\$22,000/1.8years]
- Install separate cooling unit for data closet to allow for unoccupied control of AHU-1

We have received approval of these conservation measures under the Xcel self-direct rebate program. The initial measurement and verification has been completed and implementation is in progress. Xcel rebate is pending final measurement and verification results.

*Centennial Towers [Lighting] Residence Hallway Motion Sensor Lighting Upgrade* – This project included the installation of infrared occupancy sensors for control of the non-emergency common hallway lighting fixtures. Housing contributed \$7000.00 in funding to support the project, and the motion sensors qualified for an Xcel rebate of \$6,800, bringing the overall net energy reserve cost to \$7,919.00. The estimated annual utility savings are expected to be 66,084 kWh or \$4,890.00 based on a current rate of \$0.074/kWh, resulting in a payback of 3.05 years.

*University Hall [Mechanical] Variable Speed Chilled Water Pumping* – Installation of a chilled water pump VFD was completed June 2011, allowing for more efficient part load operation. A rebate of \$600.00 was received from Xcel.

*Johnson McFarlane [Mechanical] HVAC Upgrades* – The (6) make-up air units which provide ventilation to the restrooms and hallways were converted from electric to hot water heat. In addition the heating plant pumps were provided with VFD's and high efficiency motors allowing for more efficient full and part load operation. We received rebate checks totaling \$5700.00 on 10/20/2010 for high efficiency VFD's and motors installed as part of the heating system upgrade project.

*Olin, Driscoll Center & Sturm [Mechanical] Heating and Cooling Coil Cleaning* – The ventilation unit coils were cleaned in July, 2010. The result of this conservation measure is an increase the thermal efficiency of the coils and lower the pressure drop thereby improving airflow efficiency.

*Ammi Hyde [Mechanical] Boiler Replacement* – The upgrade to a higher efficiency boiler was completed October, 2010.

*Ammi Hyde [Controls] Controls Upgrade* – Installation of new digital controls allowing for remote monitoring and control of building HVAC systems, including optimization of occupancy scheduling was completed August 2010. VAV box changes to minimize bypass airflow and reduce fan energy needed to effectively ventilate and cool the building during periods of part load were completed December, 2010.

*Seeley Mudd [Survey] HVAC Upgrades* – Implementation of the measures identified as part of the Energy Analysis is in progress. The conservation measures include the following items:

- Heating Water Pump VFD's
- Chilled Water Pump VFD's
- High Efficiency Heat Recovery Pump Motors
- Upgrade of the Domestic Hot Water Heater
- Upgrade of Existing Heating Water Boiler Burner

The estimated payback is 3.26 years.

This project was completed December, 2010.

*Seeley Mudd [Mechanical] X-ray Back-up Cooling System* – This upgrade provides additional assurance of the availability of cooling to the X-ray, while reducing the amount of time the chilled water systems are required to operate during low ambient conditions. The project was completed January, 2011.

*Sturm Central Plant [Survey] Energy Analysis* – On April 20, 2010 Xcel approved a \$32,520.00 engineering analysis to study the following energy conservation measures:

- Utilization of existing flat plate in sidecar configuration
- Optimization of chiller staging routines
- Optimization of plant and building variable chilled water flow
- Reduction of peak demand requirements

The net cost of this analysis after receipt of the Xcel rebate will be \$8,130.00. The final report was completed in October, 2010.

*Shwayder Art [Controls] VAV Box Controls Upgrade* – The installation of (26) new VAV box digital controls has allowed for the optimization of AHU-2's pressurization controls. The upgrade was completed July, 2011.

*Centennial Halls [Survey] Onsite Energy Assessment* – In partnership with Housing, we initiated an onsite assessment to identify energy related opportunities. A final meeting to review the finding was held August 5, 2012. The measures identified in the assessment are as follows:

- Lighting Controls
- Common Area H&V Control Upgrades
- Evaporator Fan Controls and Motor Retrofit
- Lighting Retrofit
- Make-up Air Heat Recovery

*Centennial Towers [Survey] Onsite Energy Assessment* – In partnership with Housing, we initiated an onsite assessment to identify energy related opportunities. A final meeting to review the finding was held August 5, 2012. The measures identified in the assessment are as follows:

- Lighting Controls
- Cooling Tower VFD
- Lighting Retrofit
- Chiller Retrofit

*Shwayder Art, Seeley Mudd, University Hall, Daniels, Physics & Evans Parking [Mechanical] Heating and Cooling Coil Cleaning* – The ventilation unit coils were cleaned in October, 2010. The result of this conservation measure is an increase the thermal efficiency of the coils and lower the pressure drop thereby improving airflow efficiency.

*Daniels [Survey] Re-commissioning Study* – A retro-commissioning study aimed at optimizing the performance of the existing mechanical systems and reducing energy consumption was completed August 19, 2010. The net cost of this study, after receipt of the rebate is \$1,215.00.

*Newman [Controls] Systecon Upgrade* – This capital project included the upgrade of the original Systecon control package and the recommissioning of the chilled and heating water systems. Since the completion of the project in November, 2010, we have experienced a reduction in consumption of 185,311 kWh through April, 2011 and a cost savings at our current kWh unit cost of \$18,531.

*Facilities [Controls] Controls Upgrade* – This project would include the install digital controls to allow remote monitoring and control of building HVAC systems, including optimization of occupancy scheduling. The project was completed March, 2011.

*Sturm Hall 348C [Mechanical] Variable Speed Hot Water Pumping* – Funding has been approved to install heating water pump VFDs, allowing for more efficient part load operation. This upgrade qualifies for an Xcel rebate of \$1,500.00. This project was completed February, 2011.

*General Campus T12 [Lighting] Lighting Upgrade Phase I* – This project was completed February of 2011 and included the upgrade existing T12 fixtures and add restroom occupancy sensors in selected buildings, including Ammi Hyde, Metallurgy, Mass Comm, Boettcher West, Wesley Hall, Centennial Halls and Centennial Towers. The estimated payback of the project is 2.41 years.

*Ritchie Center [Survey] Geothermal Study* – A preliminary feasibility study was completed April of 2011, to evaluate the potential cost and savings of a geothermal well system located under the existing soccer fields to the west of the Ritchie Center. The result of the study was an annual gas

and electric savings of \$150,000 on an initial investment of \$2.7 million, or a payback of 18 years.

*Physics [Controls] AHU-1 Retro-commissioning* – The replacement of existing heating valves and reprogramming of the sequence of operation to optimize energy efficiency was completed June, 2010.

*Boettcher West [Mechanical] Boiler Upgrade* – Installation of new high efficiency hot water boilers was completed October, 2010.

*Boettcher Auditorium [Mechanical] Mechanical Upgrades* – An upgrade of the HVAC systems was completed during the Summer of 2010. This project included the addition of digital control systems and new ventilation units on the 1<sup>st</sup> and 2<sup>nd</sup> floors.

*EnergyCAP Utility Tracking Database Implementation* – This software initiative provides the following functionality:

- Electronic data entry of our Xcel utility invoices
- Weather normalization of our utility data
- Improved analysis of the realized savings associated with implemented energy conservation measures
- Greenhouse gas tracking and reporting
- ENERGY STAR benchmarking interface
- Enhanced data analysis and filtering tools to identify billing errors
- Export to Banner capabilities

The new database was online as of July 1, 2010.

*Setback of Cooling Set-points across campus* – An initiative started in June of 2009 has resulted in temperature setback of 4 degrees F in all academic buildings on campus which do not have unique requirement precluding setback. The goal of this initiative during the months June thru August was to reduce our carbon footprint and save utility dollars in the process. The total reduction throughout our Education facilities during the summer months of June, July, August and September in comparison to the previous year was 1,210,067 kWh or 12% and over 1000 Tons of carbon emissions. These savings include other energy conservation measures as well as the fact we experienced milder weather this year in comparison to the previous year.

*Ritchie Center [Survey] Onsite Energy Analysis* – An onsite assessment to identify energy related opportunities was completed on February 22, 2010. The measures included in the assessment are as follows:

- AHU VAV Conversion
- Low-E Ceiling Joy Burns Arena
- Lighting Retrofit – Magness and Natatorium
- Add Condensing Boiler
- Replace Ice Rink Chillers

*University Hall [Survey] Onsite Energy Analysis* – An onsite assessment to identify energy related opportunities was completed on February 11, 2010. The measures included in the assessment are as follows:

- Restroom Occupancy Sensors
- Common Area Lighting Retrofit
- AHU VAV Conversion
- Variable Volume Pumping

*Centennial Halls [Controls] Retro-commissioning of Make-up Air Handling Unit serving Kitchen Area* – Upgrade of the existing pneumatic controls and reprogramming of the sequence of operation to optimize energy efficiency via interlock with Kitchen Hood controls was completed during the summer of 2010.

*Sturm Hall [Lighting] Common Area Lighting Retrofit and Restroom Occupancy Sensor Upgrade* – This project was completed in September of 2009 and included occupancy sensors in all restrooms and utilization of time clocks to allow scheduling of the hallway lighting “off” during the unoccupied hours of 11PM to 6AM. The final measurement and verification was forwarded to Xcel on January 19, 2010. The measured annual savings were 182,810 kWh, resulting in a final rebate of \$18,281.00 and a simple payback of slightly over 2 years, using the second quarter 2010 blended kWh rate of \$0.085, and after all project costs are accounted for.

*Ricks Center [Controls] Rooftop AHU Upgrade* – This project included lockout of the compressor during low ambient outside air conditions and upgrade of the RTU economizer controls. The upgraded controls will also allow for more effective scheduling and monitoring of the areas served. The estimated payback is 4 years.

*Newman Center [Survey] Energy Analysis* – This Analysis identified several energy conservation measures including night setback, upgrade to higher efficiency chilled and heating water systems and waterside economizer. The payback ranged from less than one year to 16 years. Since implementation of the night setback measure, the FY10 electrical consumption for the months June, July, August and September is 267,000 kWh or 23% lower than the same period in FY09. An Xcel rebate contributed \$18K of the \$24K cost associated with the analysis.

*Ben Cherrington [Mechanical] Motor & VFD Rebate* – An Xcel rebate of \$6,330.00, for VFD’s installed during summer of FY09 under the HVAC upgrade project, has been received.

*Boettcher West [Mechanical] VFD Rebate* – An Xcel rebate of \$5,450.00, for VFD’s installed during summer of FY09 under the HVAC upgrade project, has been received.

*Shwayder Art [Mechanical] AHU-2 Motor & VFD Upgrade* – Installation of supply and return fan VFD’s and motors is complete. An Xcel rebate of \$4,600.00 has been received.

*Ritchie Center [Lighting] Concourse Restroom Occupancy Sensors* – Installation of occupancy sensors for control of the restroom lighting is complete. The projected savings are 17,001 kWh with a project payback of 4 years. An Xcel rebate of \$1,590.00 has been received.

*Seeley Mudd [Survey] Energy Analysis* – An energy analysis of the Seeley Mudd facility has been completed. This analysis identified several measures which may make sense, based on the University payback criteria as follows:

- Heating Water Pump Motors and VFD’s [\$15,000/4.01 years]
- Chilled Water Pump Motors and VFD’s [\$17,300/2.49 years]
- Heat Recovery Pump Motors [\$17,300/1.65 years]

A final review meeting was held with our Xcel representative on January 29, 2010, completing all rebate requirements prior to issuance of an Xcel rebate in the amount of \$10,500.00. The net cost of this analysis after receipt of the rebate was \$3,500.00.

*Ritchie Center [Mechanical] Hot Water Pump VFD Upgrade* – Installation of a 20HP VFD is complete. An Xcel rebate of \$1,600.00 has been received.

*Melink Kitchen Hood Upgrades [Controls]* - We received approval to proceed under the Xcel Self-direct program in August, 2009. Installation of systems in All Kitchens including Ritchie, Driscoll North, Nelson Hall, Centennial Halls and Towers was been completed May 2010. The final measurement and verification showed an annual reduction of 129,321 kWh and we received an Xcel rebate of \$13,917. The calculated project payback is 3.7 years.

*Real-time Monitoring [Controls]* – Ben Zenner and Charles Riesenberg who received PINS award grant money developed a webpage which displays real-time electrical consumption data from Nagel, Nelson, Halls, Towers and J-Mac. The webpage is available at the following URL: <http://ctl.du.edu/energy/>

*Penrose Library [Lighting] Control Panel Upgrade* - This project will allow for occupancy scheduling of the lighting systems in the library. The building is typically unoccupied for 6 hours each day. The cost of this retrofit is approx. \$25,000.00 and the projected savings would be 260,538 kWh. The funding has been released and material has been ordered. Installation will be started upon delivery of materials and completion of the initial measurement and verification required under the Xcel rebate program. Installation of the lighting controls was completed August 2010. We are currently in the process of integrating this system to our Iconics graphical user interface which will allow for remote display and scheduling of the lighting zones.