

# COLORADO COLLEGE

## 2015 ENERGY REPORT



Mark J. Ferguson, P.E.  
Campus Operations & Plant Manager



# Table of Contents

---

Executive Summary.....	2
Utilities Overview.....	3
Avoided Cost.....	4
Our Carbon Footprint.....	5
Benchmarking.....	6
Benchmarking Educational Facilities.....	9
Benchmarking Residential Facilities.....	10
Benchmarking Support Facilities.....	11
Utility Rates.....	12
Renewable Energy Purchases.....	13
2015 Facilities Sustainability Projects.....	14
2016 Facilities Sustainability Projects.....	22

# Executive Summary

---

The Facilities Services Department at Colorado College (CC) is committed to taking action to meet the College's carbon goals. Utilities management at Colorado College is an area of increased physical plant emphasis. In FY 15, CC experienced an 8.4% decrease in energy consumption campus wide due to near average weather and a continued emphasis on energy efficiency. Cumulative avoided costs for utilities are estimated to be nearly \$3.4M since the 2008 baseline. Some notable accomplishments for 2015 are:

- Increased Renewable Energy Purchases - This year CC increased its purchases of renewable energy. In total this academic year, CC purchased 4.6% of our total energy from renewable sources or 16.2% of our electricity.
- Recognitions – Colorado College was selected as the WasteReuse Colorado Customer of the Year. This year Colorado College also achieved a gold ratings from ASHEE for STARS (sustainability tracking, assessment, and ratings system). Colorado College was recognized as an EPA Green Power Partner for renewable energy purchases made during the 2014 academic year.

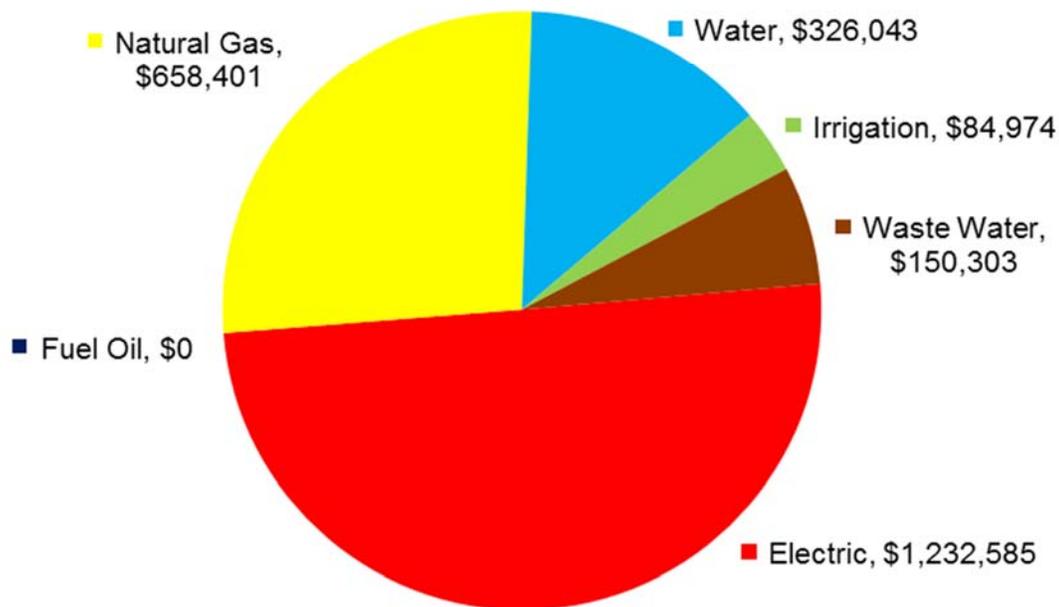


- 2015 Sustainability Projects – This year CC completed a large quantity of projects with the purpose of supporting campus energy efficiency goals. Completed projects include the conversion to LED lighting in many facilities on campus, commissioning of the Spencer Center, and automation of the central heating plant operations. More detail on this year's completed projects begins on page 14 of this report.
- 2016 Sustainability Projects – We have an exciting list of projects on the horizon for fiscal year 16. These projects include the completion of solar installed by students at our Baca Campus. More detail on these projects begins on page 22 of this report.

# Utilities Overview

---

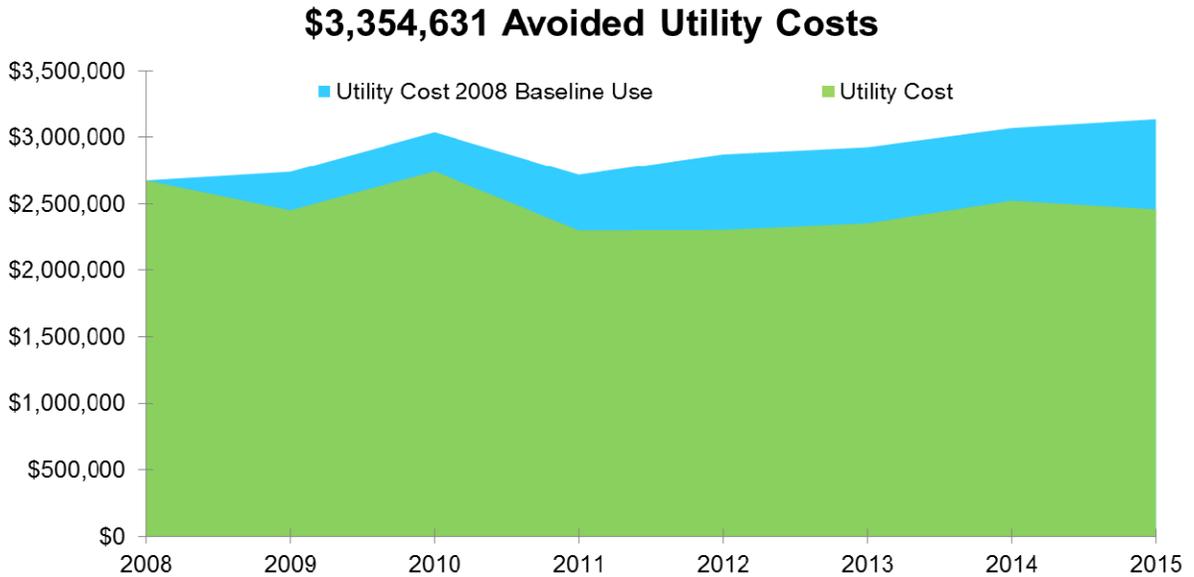
## CC 2015 Utility Cost Summary Total Cost \$2,458,708



- **For the 2015 academic year, Colorado College’s main campus energy related characteristics were:**
  - Approximately 2,064,590 square feet (SF) of space
  - Approximately 95 acres of land
  - 152 Buildings
- **For the 2015 academic year, Colorado College’s main campus energy performance statistics were:**
  - Energy use averaged **79.0 kBtu per square foot (SF)**
    - 8.4% decrease over previous year
    - 16.2 % of electricity from renewable sources
  - Energy costs averaged **\$0.92 per SF**
    - 6.4% decrease over previous year
    - \$3.4M in avoided costs since 2008
  - MTCO<sub>2</sub> emissions from energy use averaged **0.0085 MTCO<sub>2</sub>e per SF**
    - 8.6% decrease over previous year
    - 28.8% decrease from 2008

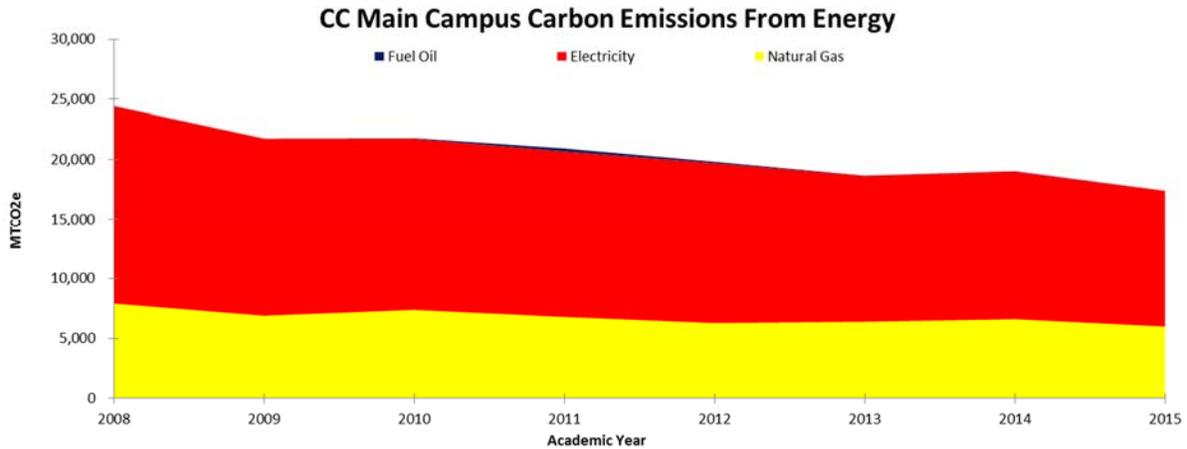
# Avoided Cost

The cumulative campus utility cost avoidance compared to the campus baseline of 2008 is estimated at nearly \$3.4M. The avoided cost for the 2015 academic year is estimated at \$676K. These numbers reflect combined utility savings, which include avoided electricity, natural gas, water, and waste water costs. Below is a graphical representation of overall avoided utility costs (area in blue).

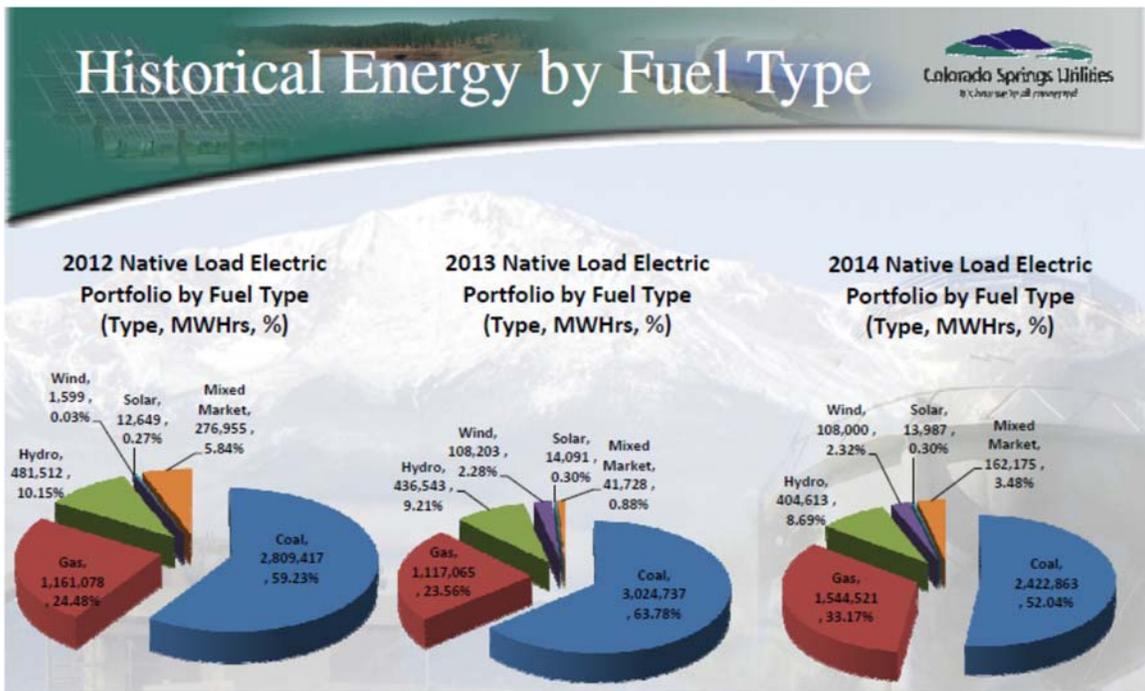


# Our Carbon Footprint

Colorado College’s commitment to become carbon neutral stems from the College’s signing of the Presidents’ Climate Commitment in early 2009. The College’s carbon footprint, in 2008, from energy use is estimated at 24,437 metric tons of CO<sub>2</sub> (MTCO<sub>2</sub>). Since 2008, Colorado College has made steady progress toward its carbon neutrality goal. For 2015, the College’s carbon emissions from energy use are estimated at 17,392 MTCO<sub>2</sub> for a reduction of 28.8% compared to the 2008 baseline. These measurements assume a consistent Colorado Springs Utilities (CSU) fuel mix and include emissions as listed below:

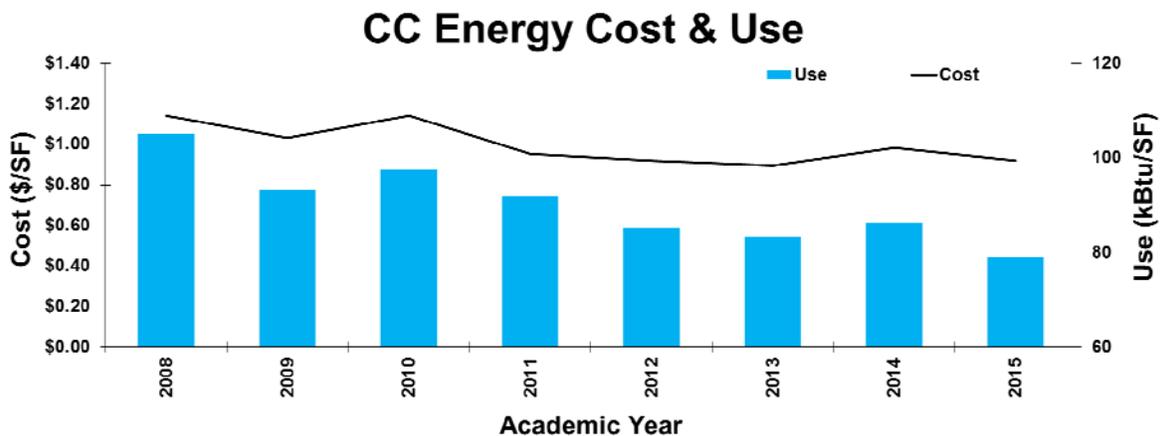


If we were to take into account CSU’s fuel mix, the reduction would be much greater. Since 2008 CSU has improved its use of renewable energy. Last year’s fire at the Drake Power Plant resulted in a much cleaner CSU fuel mix. You can note the last 3 year’s fuel mix below:



# Benchmarking

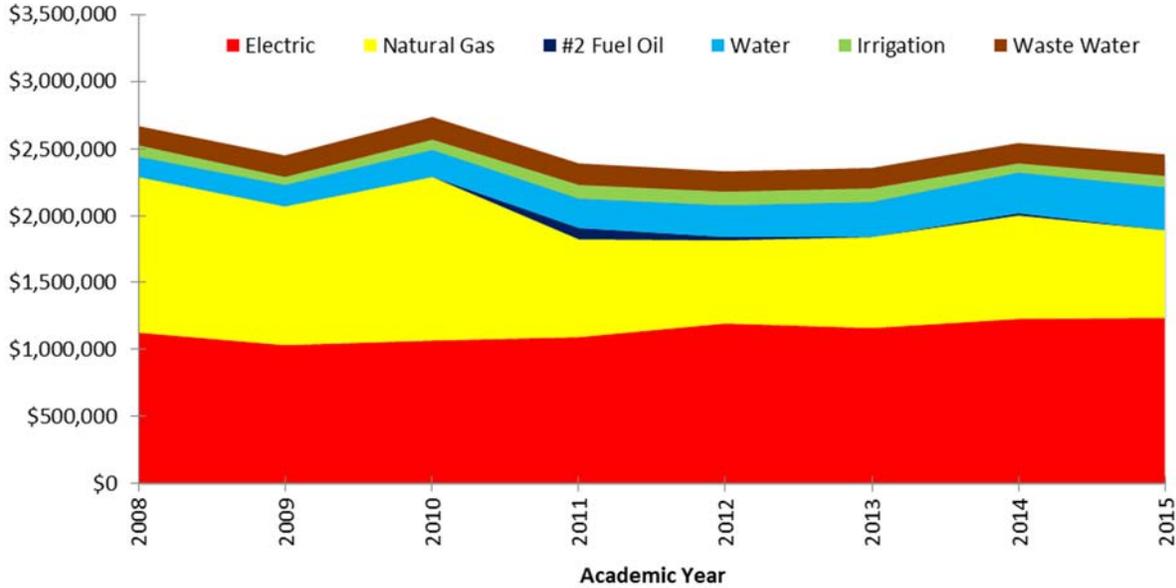
Colorado College has been tracking overall campus energy and cost intensity since 2008. For reference, the Association of Physical Plant Administrators (APPA), who represents the largest international association of educational institutions and their facilities departments, list the 2014 average energy intensity at 130 kBtu/SF/Yr. APPA lists the average utilities cost per square foot at \$2.46 / SF. The chart below shows CC is well below both figures with an average energy intensity of 79 kBtu/SF/Yr and energy cost of \$0.92/SF. The chart confirms CC's sustained decline in both energy cost and use.



One factor that is unclear is what effect CC's block plan has on our overall energy use intensity. The block is thought to require more educational space because all spaces are used simultaneously. For comparison, the following annual kBtu/SF/Yr numbers were calculated using the most recent ASHEE STARS data available:

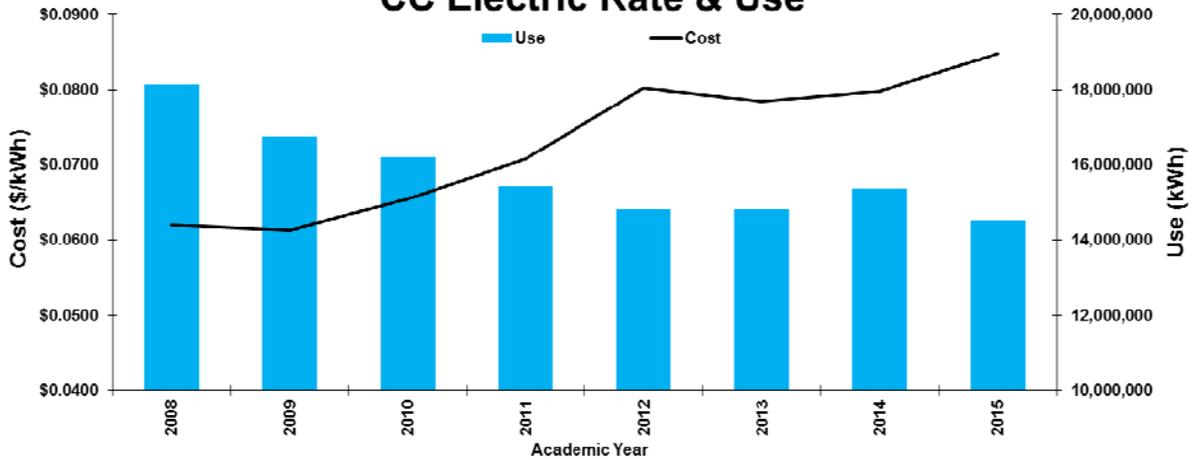
- Colby College 144 kBtu / SF 12/2014 data
- Colgate University 161 kBtu / SF 07/2013 data
- Middlebury College 137 kBtu / SF 05/2014 data
- Pomona College 83 kBtu / SF 04/2014 data
- University of Denver 104 kBtu / SF 07/2011 data
- University of Colorado Boulder 144 kBtu / SF 09/2014 data
- Williams College 148 kBtu / SF 08/2011 data

### CC Utility Costs by Service

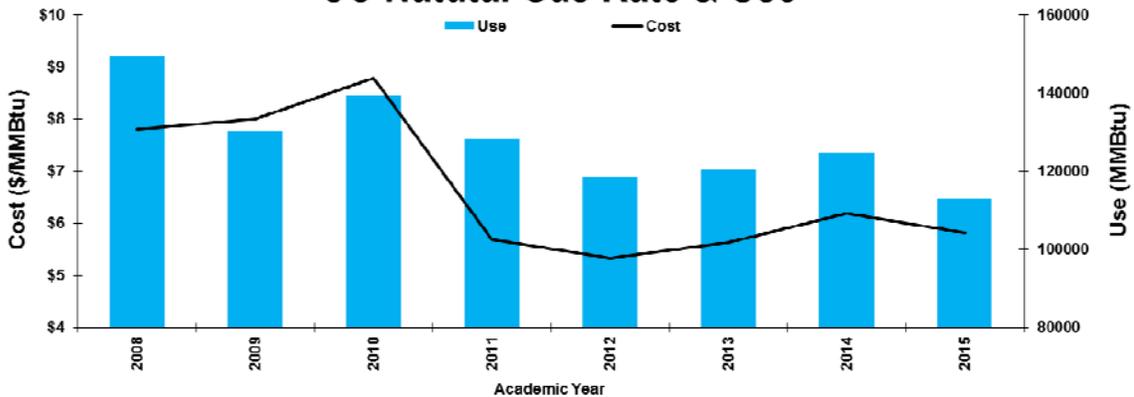


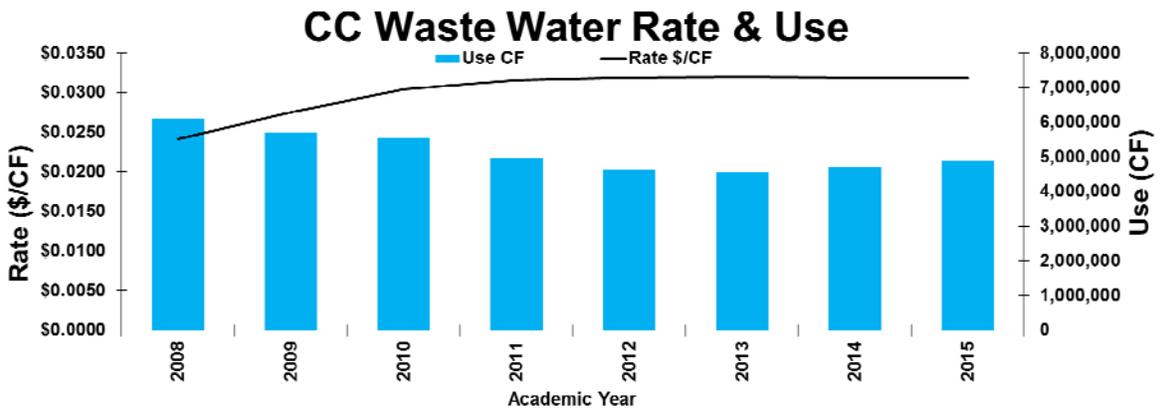
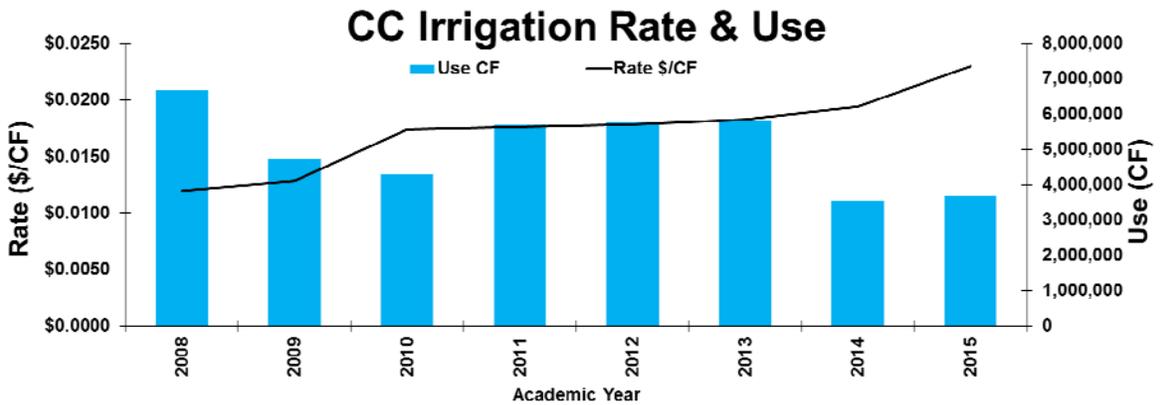
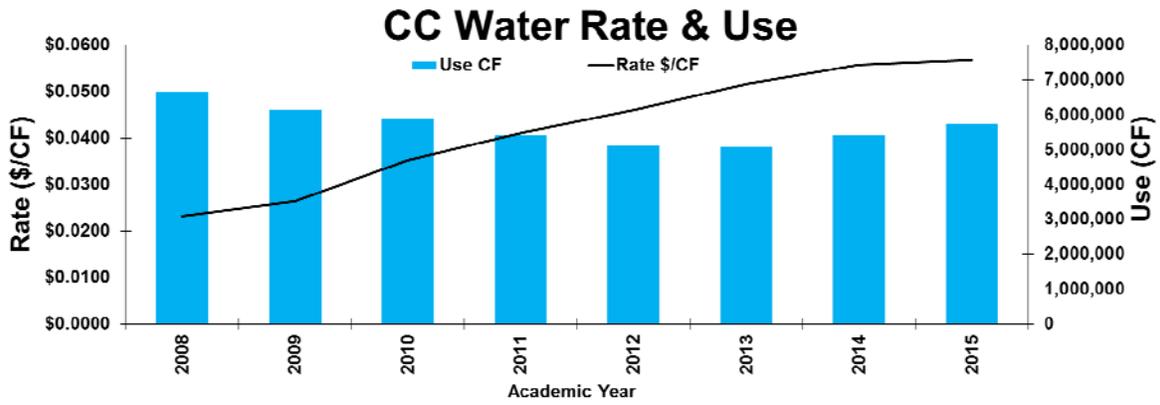
The chart above breaks down expenses by utility commodity. The most notable information is the increase in electricity and water costs despite reduced use. The charts below give more detail on these relationships.

### CC Electric Rate & Use



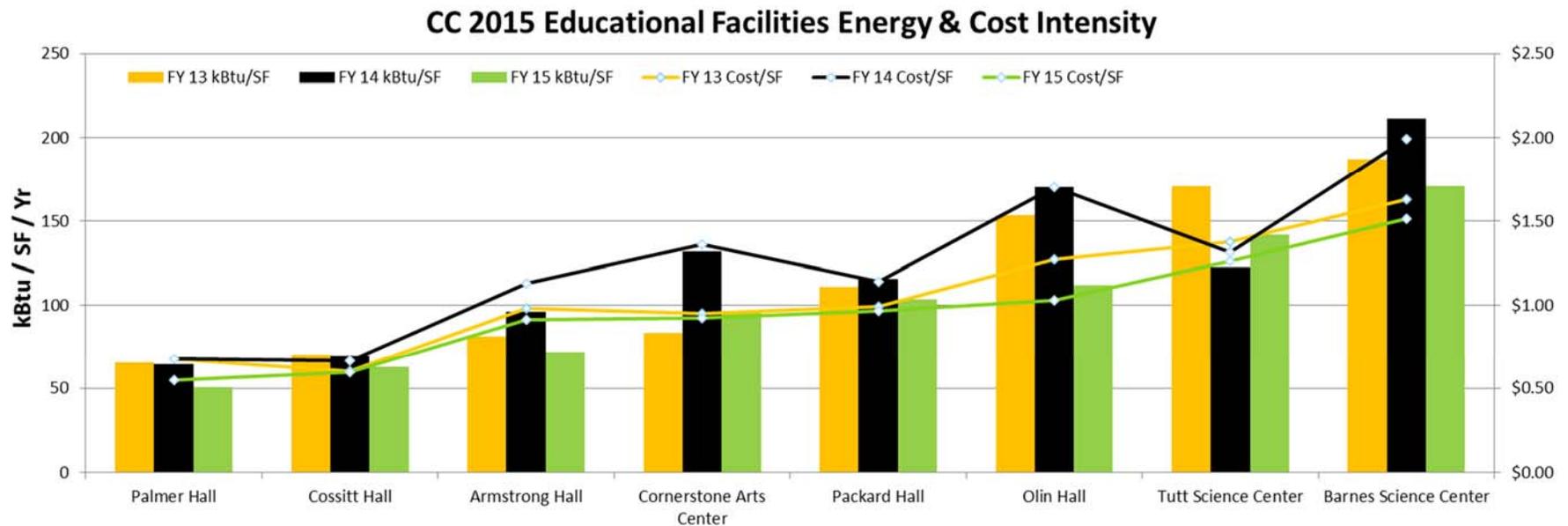
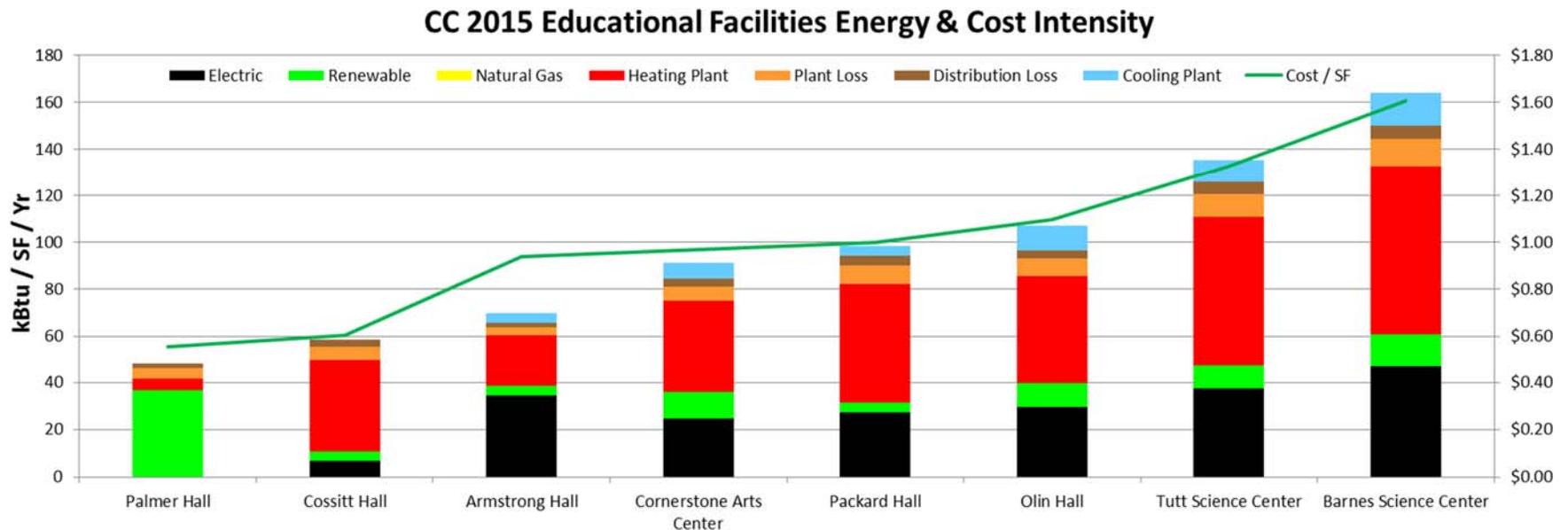
### CC Natural Gas Rate & Use





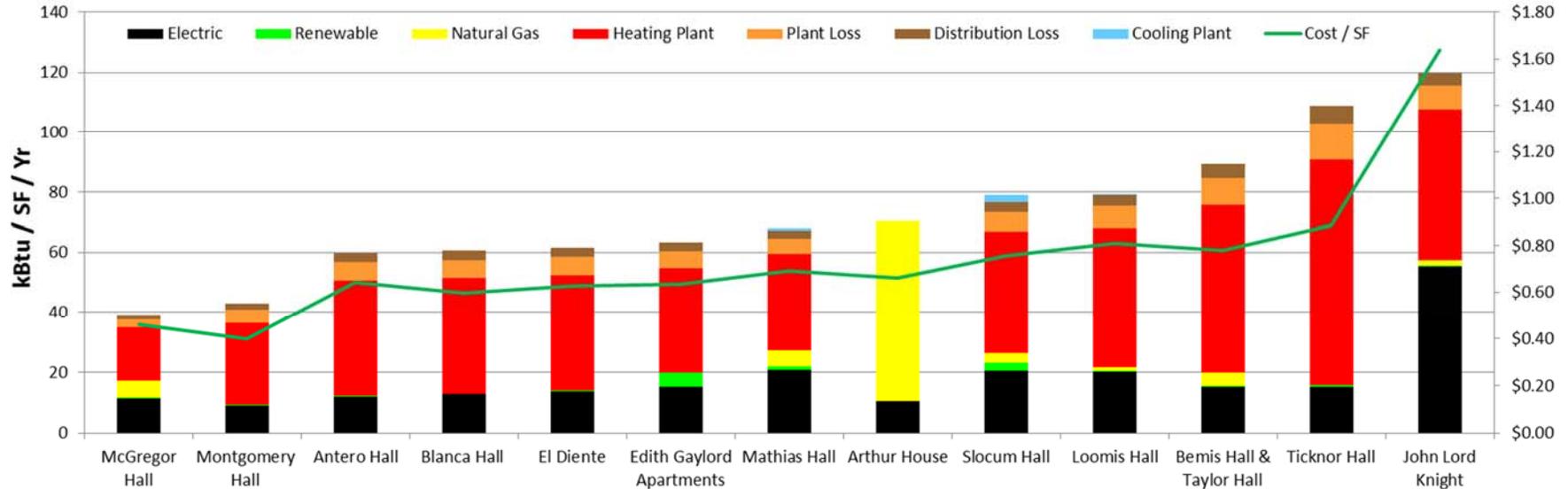
This is the third year for energy benchmarking at the building level. Four years ago, thermal metering was installed. Thermal metering has enabled CC to measure the amount of heating and cooling energy flowing from the central plant to respective buildings. The following charts are the result of building level thermal and electrical metering.

# Benchmarking Educational Facilities

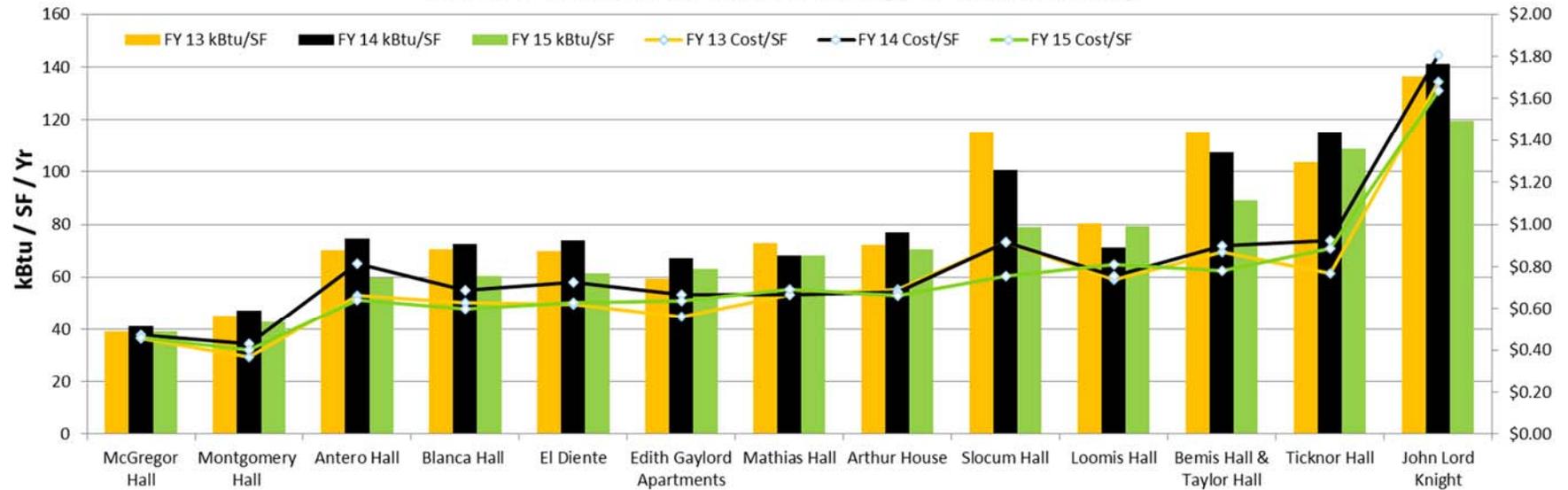


# Benchmarking Residential Facilities

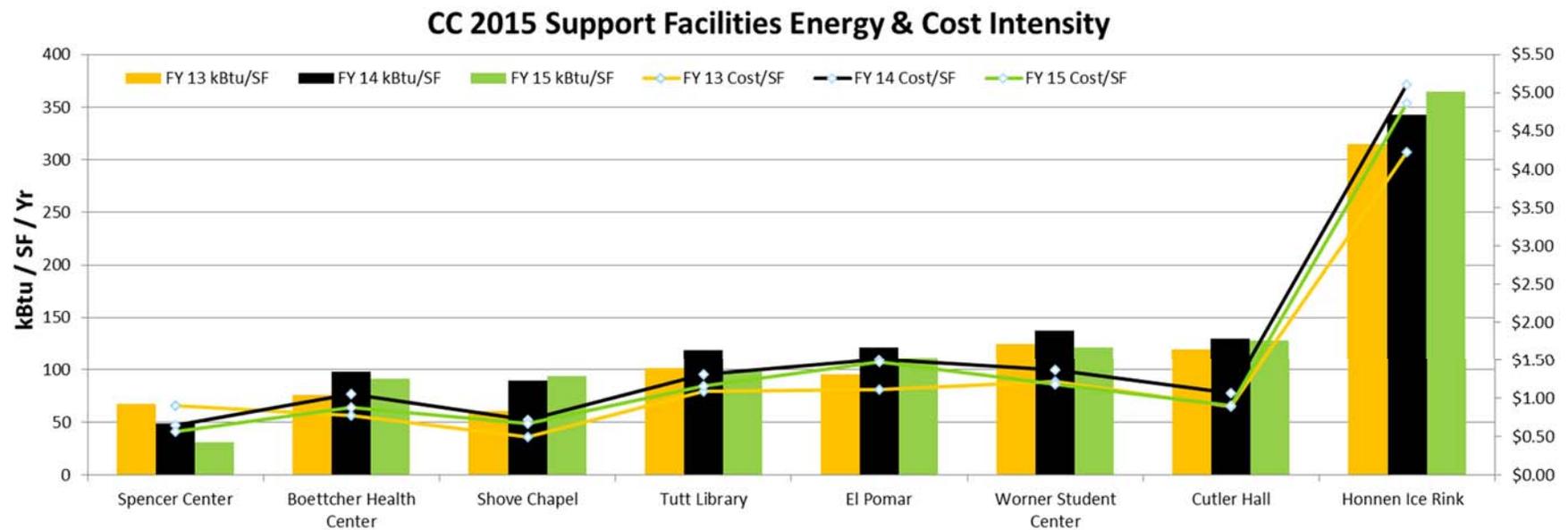
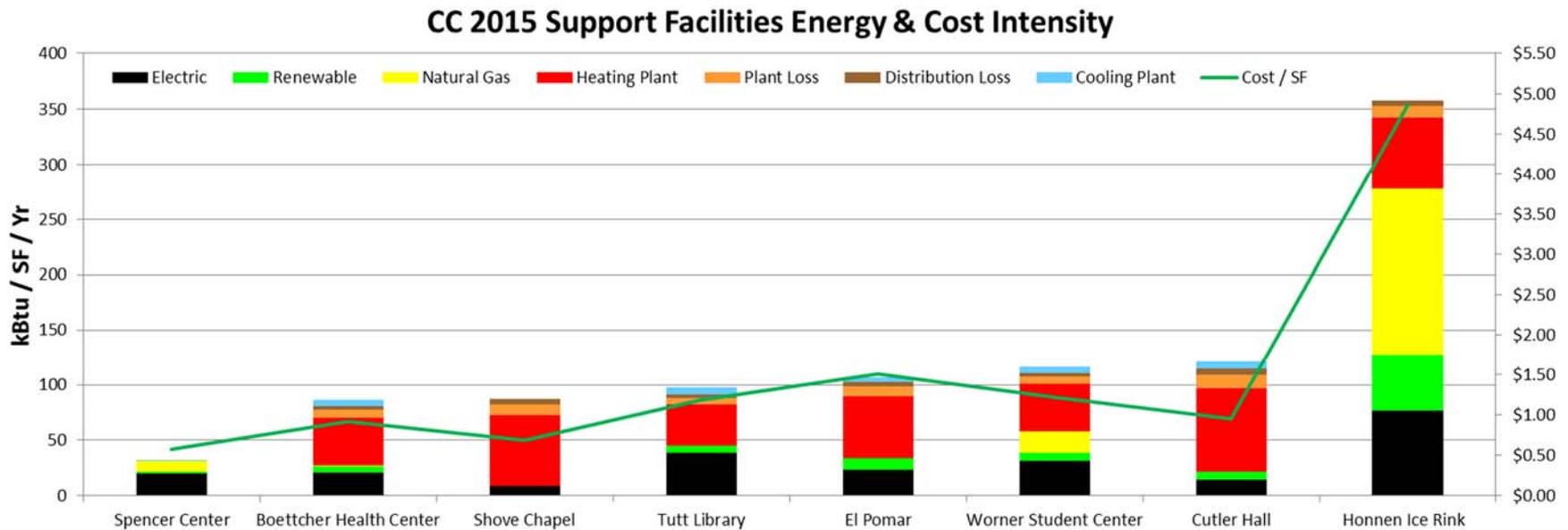
### CC 2015 Residence Facilities Energy & Cost Intensity



### CC 2015 Residence Facilities Energy & Cost Intensity



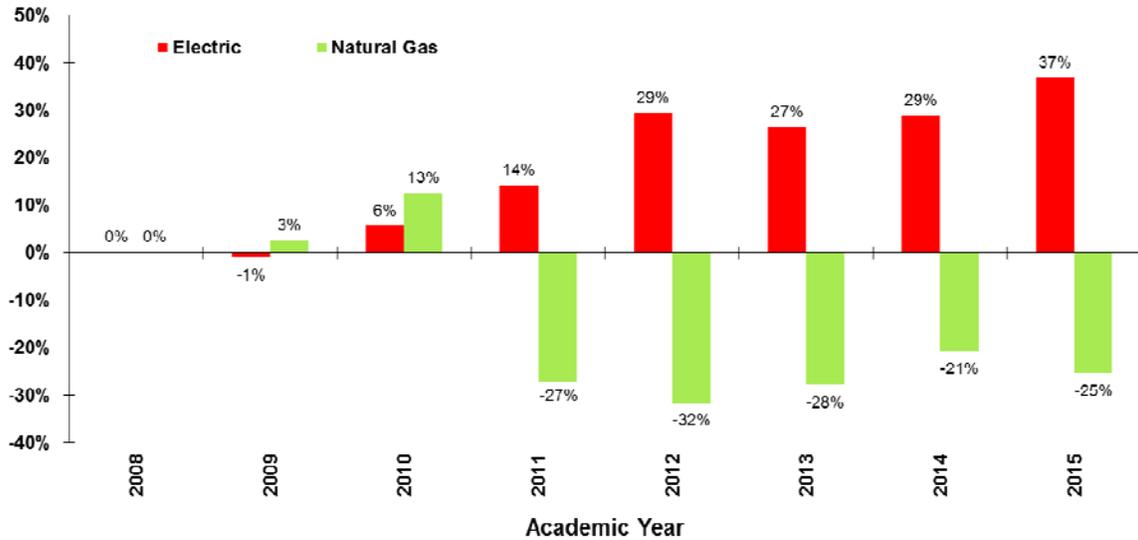
# Benchmarking Support Facilities



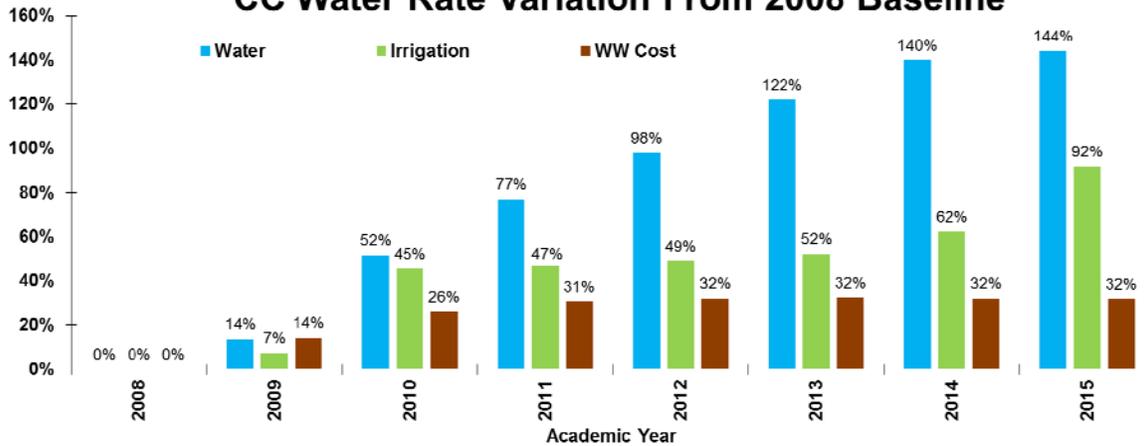
# Utility Rates

CC has made significant improvements in reducing utility consumption since 2008. Despite these improvements, total costs are relatively unchanged due to annual increases in utility rates. The charts below show the variation in commodity rates per unit experienced by CC since 2008. Electricity and water rate increases have seen larger than expected upward pressure. Natural gas costs have declined due to market conditions.

**CC Energy Rate Variation From 2008 Baseline**



**CC Water Rate Variation From 2008 Baseline**

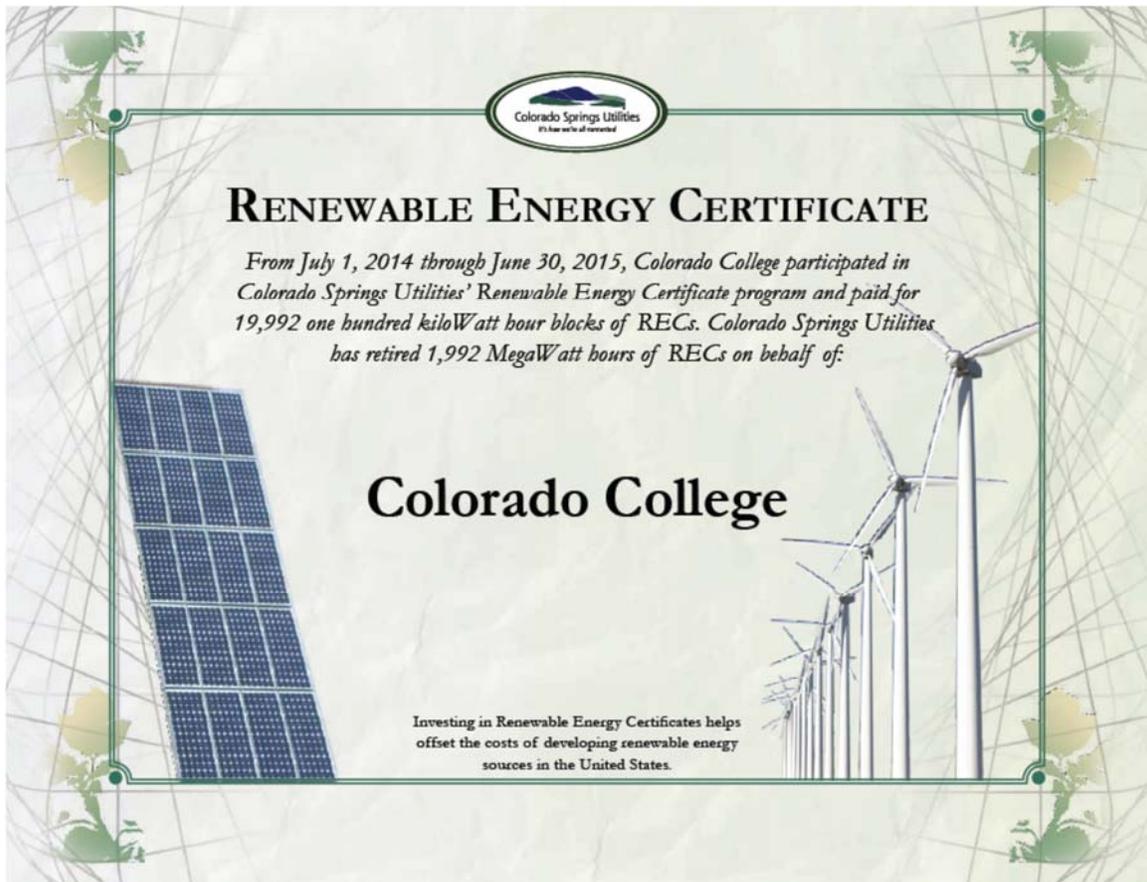


## Renewable Energy Purchases

This year, Colorado College earned recognition as an EPA Green Energy Partner based on the level of renewable energy purchases made during the 2014 academic year. During the 2015 academic year Colorado College increased its participation in community solar gardens signing 2 - 20 year contracts to purchase the production from 416 kW of community solar garden capacity and retain all of the associated environmental attributes.

For the 2015 academic year, we purchased 4.6% of our total energy from renewable sources or 16.2% of our electricity. The bulk of our renewables was provided by wind purchased from Colorado Springs Utilities (CSU). The College entered into a two year wind contract beginning September of 2012 for 1000 MWh's of wind per year. In April 2013, we doubled our purchase to 2000 MWh's / year. The contract ended on December 31<sup>st</sup>, 2014.

All wind power was applied to the College's Central Plant which serves most large buildings on campus with high temperature heating water and chilled water. Below is the renewable energy certificate provided by CSU for the 2015 wind purchase.



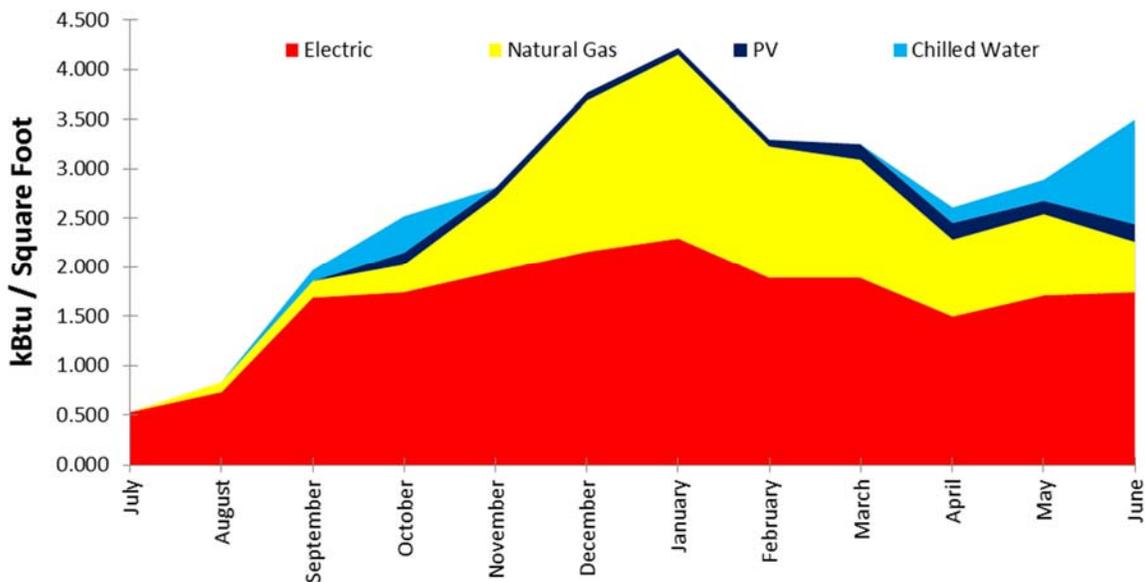
# 2015 Facilities Sustainability Projects

## Spencer Center Commissioning Update

Project Status: **Complete August 2015**

Project Description: This project was the follow-up to last year’s renovation of the Spencer Center. As part of this project we worked with contractors and building occupants to validate building systems were operating and performing as designed. The HVAC system was tested and adjusted through both the heating and cooling seasons. Items affecting the building energy consumption were discovered and corrected. Such items included a cross connection in the buildings condensing water loop and a factory defect in the occupancy sensors which control both the space lighting and HVAC. The project also measured energy consumption for comparison to the 20 kBtu/Sf target. Last year Spencer Center used 31 kBtu/Sf. The chart below details monthly energy use by source for Spencer. Approximately 10 kBtu/Sf of the buildings energy use was from natural gas which is used only in La’au’s Taco Shop.

**Spencer Center FY 15 Energy Use by Source**



## Campus Controls Upgrades Phase 1

Project Status: **Construction**

Project Description: This project is a 3 phase project to replace obsolete controls on campus with the latest platform of AX direct digital controls. The updated controls allow the College to apply more sophisticated logic and manage energy consumption more closely. In addition to updating controls, the project allows more space for archiving data and alarms. This data is essential for benchmarking continuous operational improvements. In each of the science buildings notifications are being created to automatically notify faculty via text or email when lab conditions such as power outages or temperature fluctuations beyond a specified threshold occur.

## Firm Natural Gas Transportation

Project Status: **Complete October 14**

Project Description: The firm natural gas transportation project is a change in the way we buy natural gas at our central plant. Previously we were on an interruptible rate meaning Colorado Springs Utilities could interrupt the delivery of natural gas to us at any time. When this happens, we switch to our back-up fuel #2 fuel oil. This project moves us from interruptible service to firm service meaning our service cannot be interrupted. As part of this project the College has contracted to purchase natural gas from ontinum Energy. Since the project was completed in October of 2014, the central plant has only burned fuel oil for operator training and emergency power testing. We have added a fuel additive to preserve our stored fuel oil.

Project Highlights:

- Improve central plant reliability
- Ability to lock pricing

## Real-Time Energy Dashboards

Project Status: **Construction**

Project Description: This project is to create dashboards internal to our building automation system. These dashboards will provide building technicians real-time feedback on building operations. Getting this information in real-time will help technicians understand and manage building energy use. A dashboard created for electrical use at Armstrong Hall can be referenced below.

Project Highlights:

- Project cost = \$2500



## Monthly Building Automation Review

Project Status: **Ongoing**

Project Description: The monthly building automation review project is a periodic review with stakeholders to review building performance through the building automation system and make adjustments as needed. This periodic review is used to commission new projects, trouble shoot controls issues, and retro-commission buildings that are not performing as well as expected.

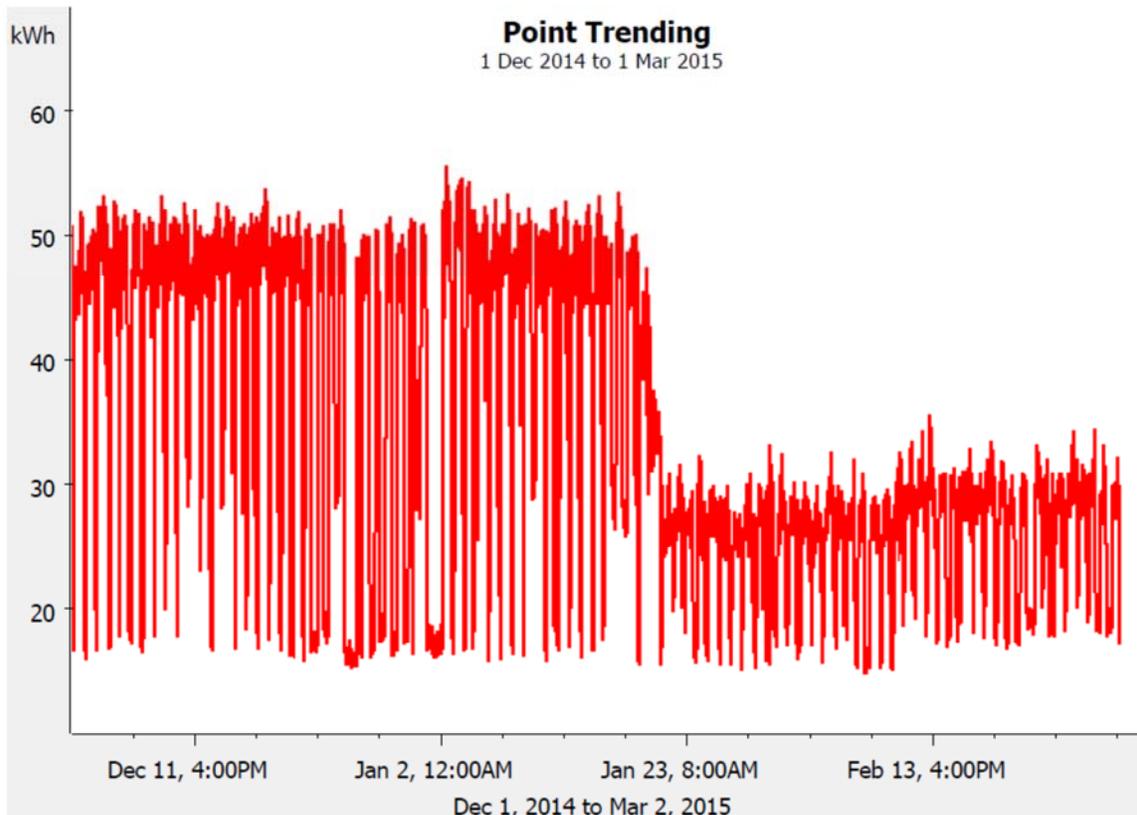
### Honnen LED Lighting

Project Status: **Complete January 2015**

Project Highlights:

- Energy reduction = 75%
- Simple payback = 9 Months
- Estimated carbon savings = 100 MTCO<sub>2</sub> / Yr

Project Description: The Honnen LED lighting project replaced 1000W metal halide lighting in Honnen Ice Arena with 231W LED fixtures. This project was completed near the end of January 2015. After rebates the final project cost was \$13k. We saved \$6,808 in the first five months of operation. Below is real-time energy metering which shows the reduction in electrical consumption at Honnen Ice Arena.



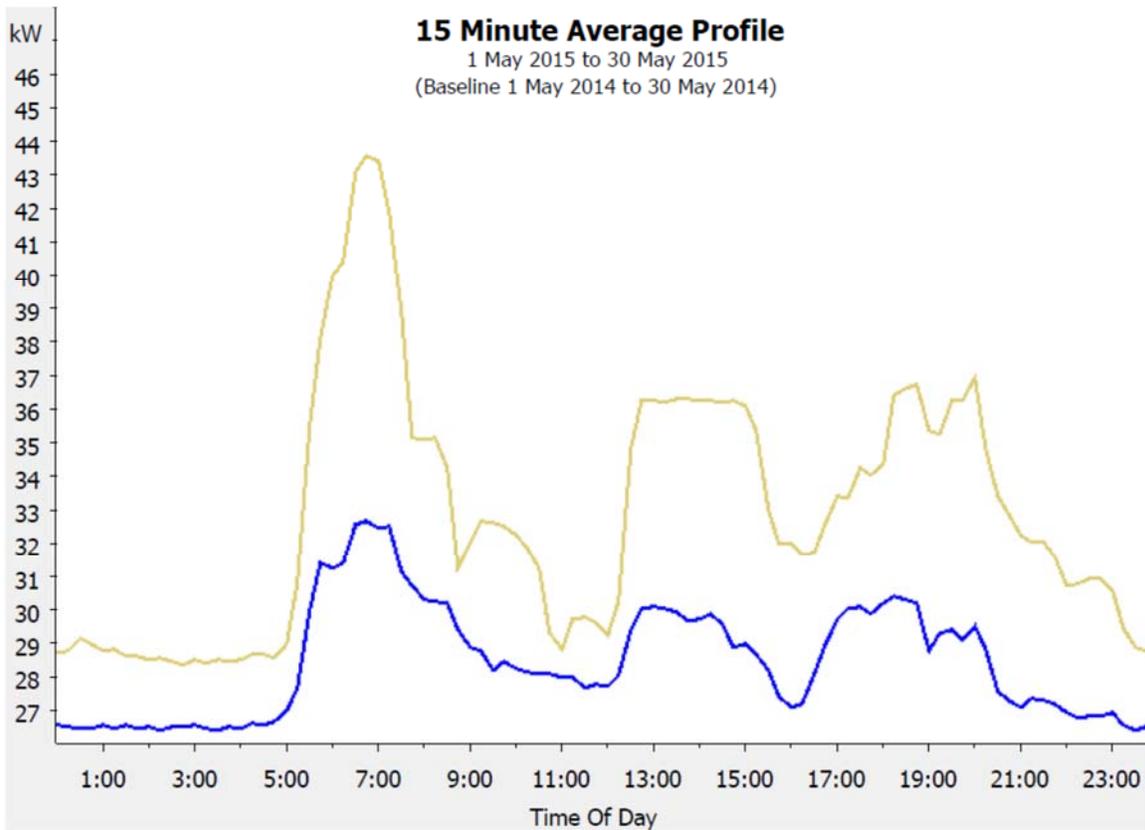
## Schlessman LED Lighting

Project Status: **Complete May 2015**

Project Description: Replace metal halide lighting in the Schlessman Pool with more efficient LED lighting. Below are some project highlights and a snapshot from our real-time energy metering showing the reduction in electrical demand on the average daily profile resulting from improvements made this year including LED lighting. The yellow line indicates electrical demand during the same period one year prior.

Project Highlights:

- Energy reduction = 75%
- Estimated Simple Payback = 1 Year
- Estimated carbon savings = 40 MTCO<sub>2</sub> / Yr



## Worner Steam Generator

Project Status: **Complete June 2015**

Project Description: The Worner steam generator project added a steam generator to the Worner Center to support cooking operations and allow the temperature of the high temperature hot water loop to be lowered during the summer. The campus high temperature hot water loop temperature during the summer is driven by the need for steam to support cooking operations at Worner Center. By removing this constraint, the centralized system will be able to run at a lower temperature. This will save energy by decreasing system losses in the campus distribution system.

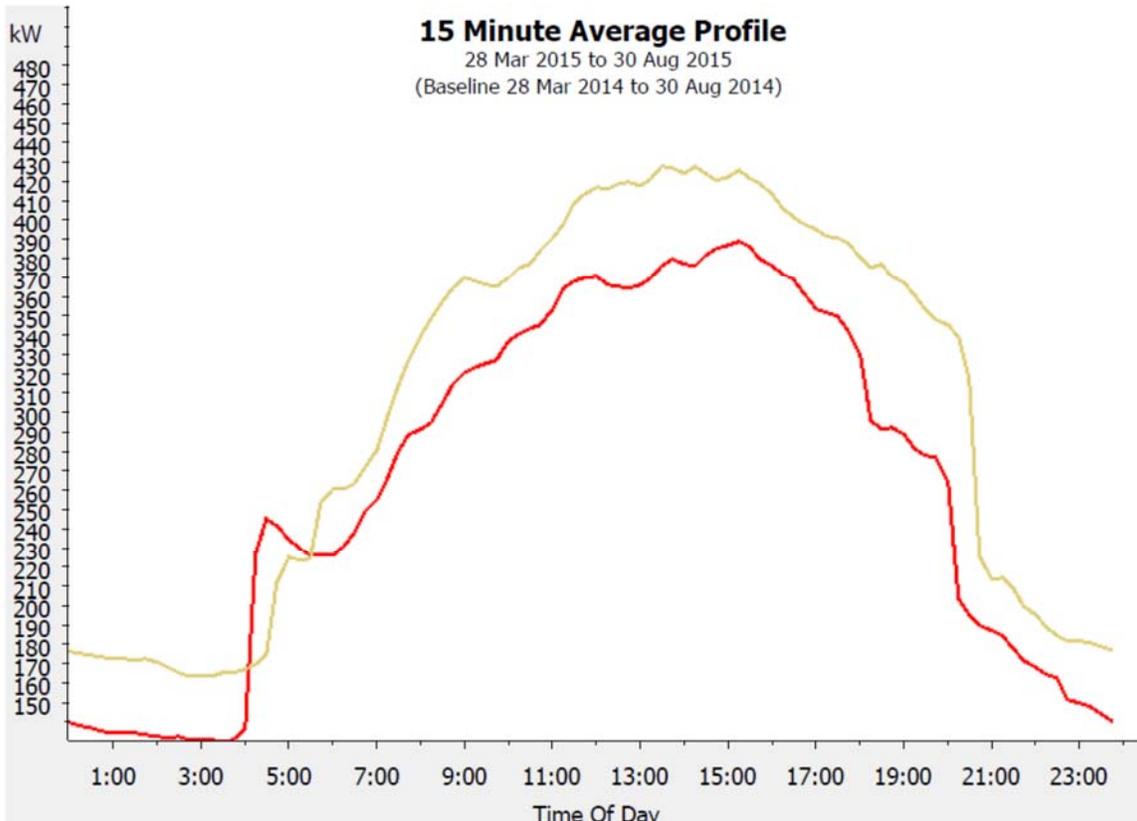
Project Highlights:

- Improves campus high temperature hot water system efficiency during the summer

## Central Plant Demand Limiting

Project Status: **Complete**

Project Description: This project included training and adjustments to the controls on the chilled water plant to limit plant demand and save cost. These improvements will save approximately \$30k per year in demand penalties charged by Colorado Springs Utilities while delivering the same level of service to campus. Last year the peak demand on our central plant reached 1029 kW. So far this year our highest peak demand has been 750 kW. The graphic below shows part of our revised strategy in practice. You will note from the red line that the plant starts earlier and is limited for the first few hours of operation. Getting an earlier start helps us use less power throughout the day.



## El Pomar Efficiency Upgrades

Project Status: **In-Progress**

Project Description: The El Pomar energy efficiency upgrades project includes lighting and controls retrofits to improve building energy efficiency. El Pomar is one of the most expensive facilities on campus for electricity averaging over \$0.13/kWh making it a great opportunity for efficiency upgrades. So far we have completed LED lighting retrofits in the auxiliary gym, squash, and racket ball courts. These retrofits reduced lighting energy consumption by more than 70% in these areas. The next step is to add occupancy sensors that will control both lighting and HVAC.

## Central Plant Controls Upgrade Phase 1

Project Status: **Complete**

Project Description: Phase 1 of the central plant controls upgrade project completed the automation of the central plant heating operation. This included automation of the campus high temperature hot water expansion tank controls, variable frequency drives for high temperature hot water system pumps, and improved flow control of the campus high temperature hot water loop. The controls work includes adding system logic to allow for the modulation of the high temperature hot water system expansion tank and distribution system pumps and valves. These controls will enable the central plant to adjust system temperature more frequently to help optimize central heating plant efficiency. The project also added alarms for safety allowing the plant to be left unmanned. This summer central plant operators used this new unmanned operation time to perform maintenance activities on the distribution system.

Project Highlights:

- Improves central plant efficiency
- Improves distribution system reliability

## Schlessman Pool Water Conservation

Project Status: **In-Progress**

Project Description: The Schlessman pool water conservation project is intended to reduce water consumption at the pool. Our benchmarking efforts have revealed that the pool consumed more than 760,000 cubic feet (CF) of water last year. The calculation below estimates the daily consumption from evaporation which translates to ~57,000 CF for the year. We have performed extensive testing and are making repairs to the pool piping to correct the problem.

<b>Indoor Pool Measurements</b>
Air Temperature = 79° F Relative Humidity = 24% CO <sub>2</sub> = 263 ppm Water Temperature = 82° F
<b>CC Uncovered Indoor Pool Evaporation Calculation</b> Simplified Calculation Using ASHRAE 2007 Applications Handbook
$wp = 0.1 A * (pw - pa) * Fa = 0.1 * 4700 * (1.1 - 0.24) * 1.0 = 404.2 \text{ lbs/hr}$ <p style="text-align: center;"><b>CC Pool Evaporation = 48.44 gallons / hour</b></p> A = 4700 square feet pw = 1.1 in hg (@ 82° F water temp) pa = 0.24 in hg (@ 79° F air temperature at 24% RH, 39 dew point) Fa = 1.0 public, schools

## Barnes Repair 5<sup>th</sup> Floor Heating Piping

Project Status: **Complete**

Project Description: Barnes repair 5<sup>th</sup> floor heating piping is the second phase of piping repairs in Barnes Science Center. The project includes work to weld leaky Victaulic fittings and replace pneumatic controls on the 5<sup>th</sup> floor. The project saves energy because the old piping must be maintained at higher operating temperatures through the summer to prevent leaking. Welding the piping will allow heating system temperatures to be setback in the summer.

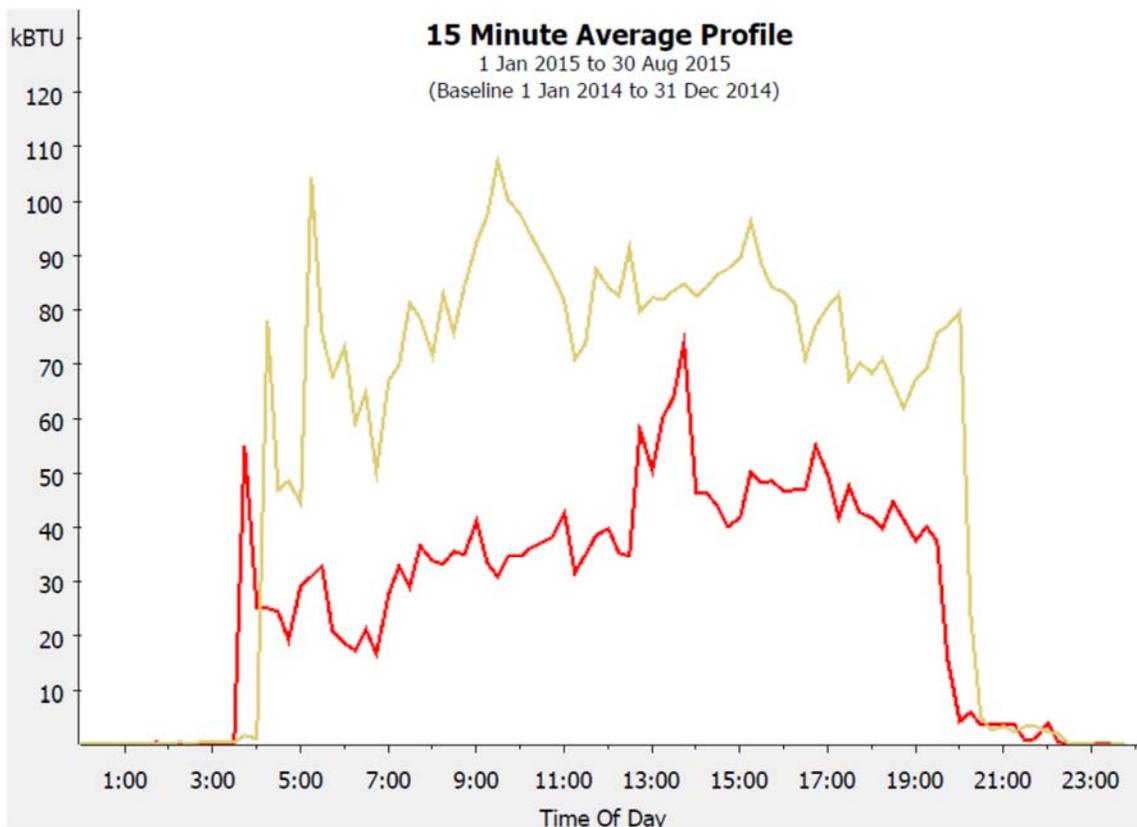
Project Highlights:

- Summer energy savings
- Improved system reliability
- Improved occupant comfort

## Olin Freeze Protection

Project Status: **In-Progress**

Project Description: The Olin freeze protection project was created out of necessity to correct frequent winter time issues resulting in flood damage to Olin Hall. The goal of the project is to positively pressurize the building to prevent bringing cold air into exterior pipe chases. The project also include perimeter leak detection and automation that will close the buildings domestic water supply valve and send an alarm to the heating plant when a leak is detected or specified flow thresholds are exceeded. Initial results show a dramatic reduction in energy consumption. The red line on the chart below shows the buildings average daily chilled water demand is less than half of what it was one year prior.



## Cossitt LED Lighting

Project Status: **Complete March 2015**

Project Description: The Cossitt LED lighting project replaced metal halide lighting in Cossitt with more efficient LED lighting. Below are some project before and after photos.

Project Highlights:

- Energy reduction = 75%
- Estimated Simple Payback = 1 Year

Before



After



# 2016 Facilities Sustainability Projects

---

## Tutt Library Design Review

Project Status: **In-Progress**

Project Description: The Tutt Library design review project is a continuous effort to ensure the owners project requirements are accurately captured in the building's design documents. The new Tutt Library is to be a building whose design teaches critical lessons about how to create and sustain healthy, productive, and flexible student, staff, and faculty spaces. The purpose of this project is to make sure that the design meets the Colorado College's innovative high performance standards. High performance at Colorado College means achieving the optimal balance between maximizing building performance and occupant comfort while minimizing operational life cycle cost, energy consumption and carbon emissions. Achieving high performance design requires collaboration and integrated solutions from each discipline of the design team and owner collaboration throughout the design process.

Project Highlights: The Tutt Library Project high performance design goal is to achieve the following levels of sustainable building performance in the new library.

- Net Building Energy Use = 0 kBtu/SF/Yr or less
- Net Carbon Emission = 0 MTCO<sub>2</sub>e/Yr or less
- Annual Energy Cost = \$0.50/SF/Yr or less
- Total Building Envelope Performance (U) = .05 or less
- Indoor Air Quality = 700 PPM CO<sub>2</sub> or less during occupied times
- Occupant Comfort = ±2°F or less from set point
- Artificial Lighting = .3W/SF or less
- Building Power Factor = not less than 0.95 lagging at the utility meter
- A building that educates occupants about its sustainable features and how to properly use them.
- A building that supports campus recycling practices.

## Central Plant Water Conservation & Heat Recovery

Project Status: **Planning**

Project Description: The central plant water conservations & heat recovery project will work to optimize water use and heat recovery at the central plant. Currently we utilize domestic water to cool the bearings on our central high temperature hot water pumps. This project would automate the flow of water to these pumps and look at recovering heat from this water. The recovered heat could be sent to either the low temperature heating loop or the chilled water loop during the heating season. The project will also look at recovering heat from the ice rink cooling tower.

Project Highlights:

- Improves central plant efficiency
- Reduces water use and cost

## Baca PV Solar

Project Status: **In-Progress**

Project Description: The Baca PV solar project is nearly complete. This project will provide more power than is consumed at the Baca Campus. The project is a hands on opportunity for students to learn about renewable energy. The picture below is of students who participated in the second day of installation as part of early new student orientation.

Project Highlights:

- Student installed
- 2 – 15.5 kW PV arrays



## Campus Controls Upgrades Phase 2

Project Status: **Planning**

Project Description: This project is phase 2 of a 3 phase project to replace obsolete controls on campus with the latest platform of AX direct digital controls. The updated controls allow the College to apply more sophisticated logic and manage energy consumption more closely. In addition to updating controls, the project allows more space for archiving data and alarms. This data is essential for benchmarking continuous operational improvements.

## Campus LED Lighting Upgrades

Project Status: **On-going**

Project Description: The campus LED lighting upgrade project is an ongoing project to replace lighting on campus with more efficient LED lighting. This project assists leverages utility rebates to assist with the restoration and replacement of campus lighting.

Project Highlights:

- Takes advantage of utility rebates
- Improves lighting levels
- Reduces energy consumption

## Honnen Firm Natural Gas Transportation

Project Status: **Construction**

Project Description: The Honnen firm natural gas transportation project is a change in the way we buy natural gas at our Honnen Ice Arena. Currently we are on an interruptible rate meaning Colorado Springs Utilities can stop natural gas delivery to us at any time. When this happens, Honnen Ice Arena is without heat. This project moves us from interruptible service to firm service meaning our service cannot be interrupted. For this project the College will utilize its existing contract to purchase natural gas from ontinum Energy.

Project Highlights:

- Firm natural gas supply
- Utilizes existing capacity

## El Pomar Electrical Service Upgrades

Project Status: **Planning**

Project Description: The El Pomar electrical service upgrades project will either split the buildings electrical service or combine it with the central plant to reduce cost. Due to demand at El Pomar the building experiences rates as high as \$018/kWh which is more than double the campus average of \$0.085/kWh. The buildings use profile is unique because its peak demand occurs between 4 pm and 10 pm during the winter which is an on-peak period. During this time student are utilizing the fitness center and the field lights at on. During this same period, the central chiller plant is idle and could supply the additional capacity required. Another technique would be to add meters and move the facility from the ETL rate to the E2C rate which does not charge for demand. Either method would yield approximately a 3 to 5 year payback.

Project Highlights:

- Reduces energy costs

## Central Plant Controls Upgrade Phase 2

Project Status: **Planning**

Project Description: The central plant controls upgrade phase 2 project will improve the automation of the central plant heating operation. The controls work includes adding controls and system logic to enable remote starting and automate temperature modulation of the high temperature hot water generators and distribution system pumps. These controls optimize central heating plant reliability and efficiency. The project will expand alarms for safety allowing the plant to be controlled remotely and left unmanned for extended periods beyond just the summer. The extended periods of time will allow central plant operators time to perform maintenance activities on the distribution system and respond to after-hours emergencies on campus.

Project Highlights:

- Improves central plant efficiency
- Improves system reliability
- Improves after hours response to campus emergencies

## Barnes Repair 1<sup>st</sup> & 3<sup>rd</sup> Floor Heating Piping

Project Status: **Planning**

Project Description: Barnes repair 1<sup>st</sup> & 3<sup>rd</sup> floor piping is the third phase of piping repairs in Barnes Science Center. The project includes work to weld leaky Victaulic fittings and replace pneumatic controls on the 1<sup>st</sup> & 3<sup>rd</sup> floor. The project saves energy because the old piping must be maintained at higher operating temperatures through the summer to prevent leaking. Welding the piping will allow heating system temperatures to be setback in the summer.

Project Highlights:

- Summer energy savings
- Improved system reliability
- Improved occupant comfort

## Cutler HVAC System Replacement

Project Status: **Design**

Project Description: This project will replace the existing heating, ventilation and air conditioning (HVAC) systems at Cutler Hall. Currently Cutler utilizes steam for heating provided from Bemis Hall. The systems do not have good zone control, so as a result occupants are often too hot or too cold. The new system will utilize a new variable refrigerant flow heat pump system to maximize occupant comfort and efficiency while maintaining the historic characteristics of the building. The system will also help support renovation to repurpose the second floor of the facility.

Project Highlights:

- Improved system reliability & efficiency
- Improved occupant comfort

## Cornerstone Retro-Commissioning

Project Status: **In-progress**

Project Description: The Cornerstone retro-commissioning project will reduce the overall energy intensity at Cornerstone Arts Center. The project is to evaluate the operation of building systems and return them to the intended design parameters. From there additional savings opportunities will be identified and pursued to maximize the buildings energy performance. Currently the building utilizes large quantities of outside air. As part of this project we will attempt to minimize the amount of conditioned air that leaves the building when indoor air quality is at acceptable levels. In many cases commissioning work also improves occupant comfort.