COLORADO COLLEGE

2018 ENERGY REPORT

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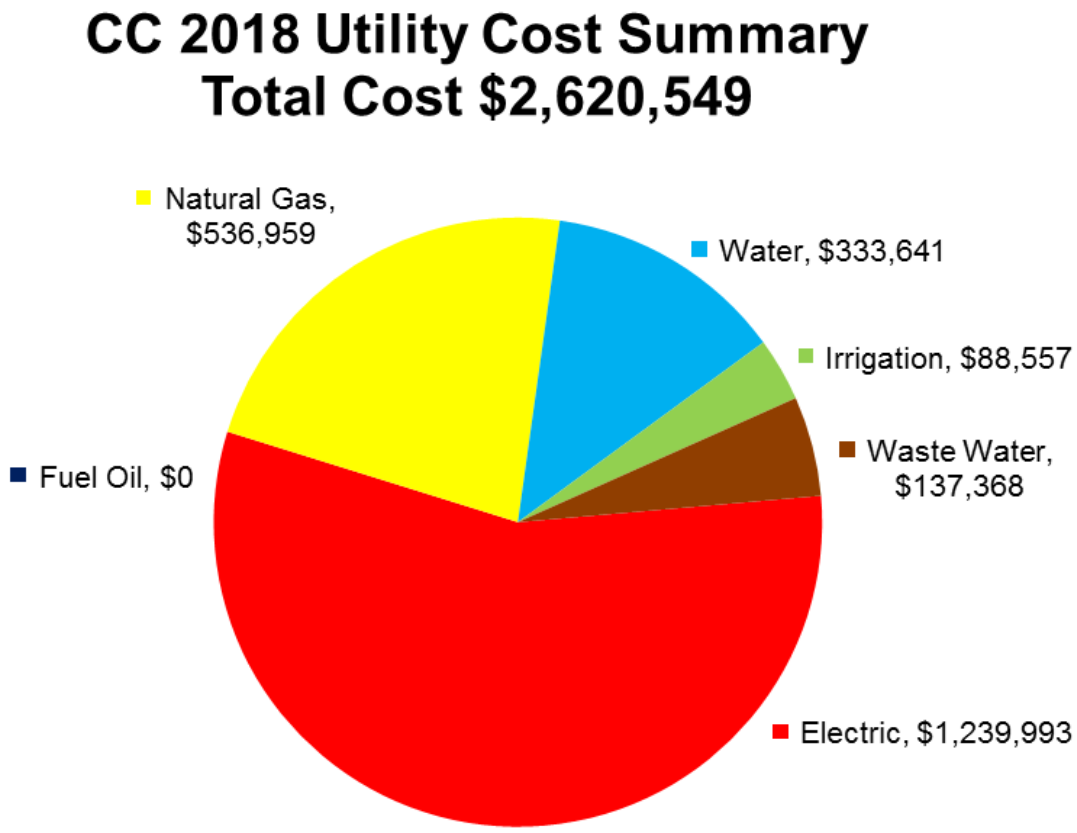
Executive Summary

The Facilities Services Department at Colorado College (CC) is committed to taking action to meet the College's carbon goals. The stewardship of resources and utilities management is one of the primary strategic initiatives of the Technical Services Department. In FY 18, CC experienced a 16.1% increase in energy consumption due to the addition of the Fine Arts Center to the campus building portfolio. Since 2008 campus energy intensity per square foot has decreased 28.0% even after the addition of the Fine Arts Center. Cumulative avoided costs for utilities are estimated to be over $5.7M since the 2008 baseline year.

Notable events for 2018 are:

- Energy – Campus energy intensity per square foot increased 7.6% over the 2017 academic year with the addition of the Fine Arts Center. Energy costs increased 19.0% partially due to an 8.5% rate increase for electricity.
- Water – Campus potable and non-potable water consumption was decreased by 4.4% for the 2018 academic year. Rates increased by 7.5% for potable water and 14.8% for non-potable water over the 2017 academic year.
- Renewable Energy Production - This year 7.1% of the electricity used on campus was produced from on & offsite solar. 3.4% of the electricity consumed was produced from on-campus solar arrays.
- Carbon – The campus has reduced annual carbon emissions from energy consumption by 33.4% over the 2008 baseline. Tutt Library achieved net-zero carbon performance for the 2018 fiscal year with the help of environmental benefits from community solar garden production banked during the 12 month construction period.
- Utilities Infrastructure – This year we made progress on improving the reliability and resiliency of our aging high temperature hot water (HTHW) distribution system infrastructure. We replaced HTHW piping to Packard Hall and Montgomery Hall. We added new HTHW service to Barnes Science Center which was previously served by Olin Hall. High temperature hot water valves were replaced servicing the southern campus loop, Armstrong Hall, Montgomery Hall.
- 2018 Sustainability Projects – Completed projects include Tutt Library, East Campus Housing, and Cutler Hall. The Central Plant Water Conservation and Heat Recovery Project was completed reducing water consumption at the Williams Central Plant by approximately 3.5M gallons for 2018. Work continued on the conversion to LED lighting in many facilities on campus. Significant work was completed to initiate campus energy efficiency planning and incorporation the Fine Arts Center into campus maintenance operations.
- 2019 Sustainability Projects – For the upcoming year we are focused on beginning work on updating the Campus Utilities Master Plan to support the updated Campus Master Plan. Work has begun to identify and integrate the path to net–zero for the Robson Arena design. We anticipate another phase of upgrades to improve the reliability and resiliency of our campus high temperature hot water system.

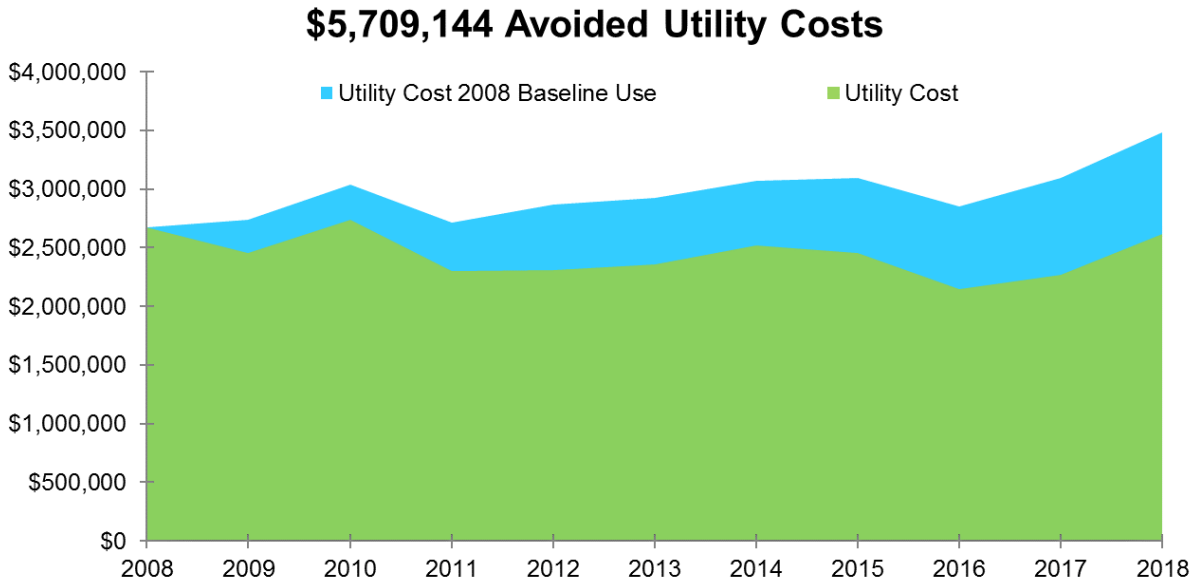
Utilities Overview



- **For the 2018 academic year, Colorado College's main campus energy related characteristics were:**
  - Approximately 2,266,002 square feet (SF) of space
  - Approximately 95 acres of land
  - 162 Buildings
- **For the 2018 academic year, Colorado College's main campus energy performance statistics were:**
  - Energy use averaged **75.8 kBtu per square foot** (SF)
    - 16.1% increase over previous year
    - 7.1% of electricity from renewable sources
  - Energy costs averaged **$0.91 per SF**
    - 10.8% increase over previous year
    - $5.7M in avoided costs since 2008
  - $MTCO_2$ emissions from energy use averaged **0.0072 $MTCO_2e$ per SF**
    - 14.3% decrease over previous year
    - 33.4% decrease since 2008

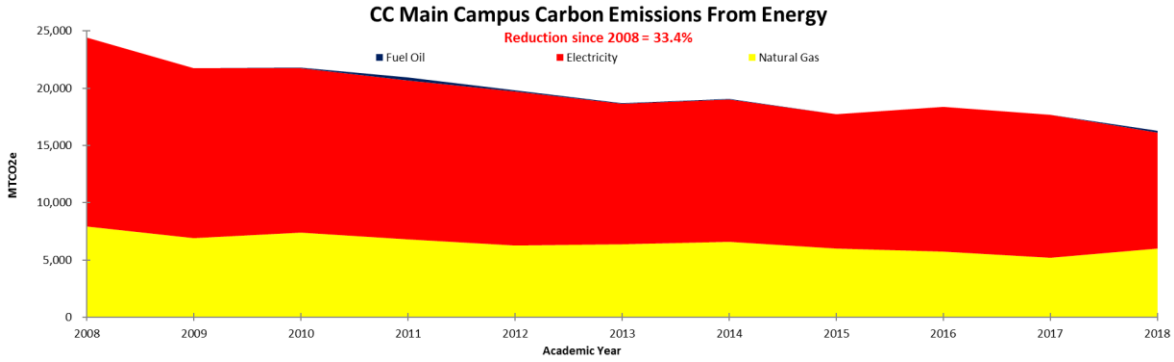
Avoided Cost

The cumulative campus utility cost avoidance compared to the campus baseline of 2008 is estimated at $5.7M. The avoided cost for the 2018 academic year is estimated at $864K. 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).



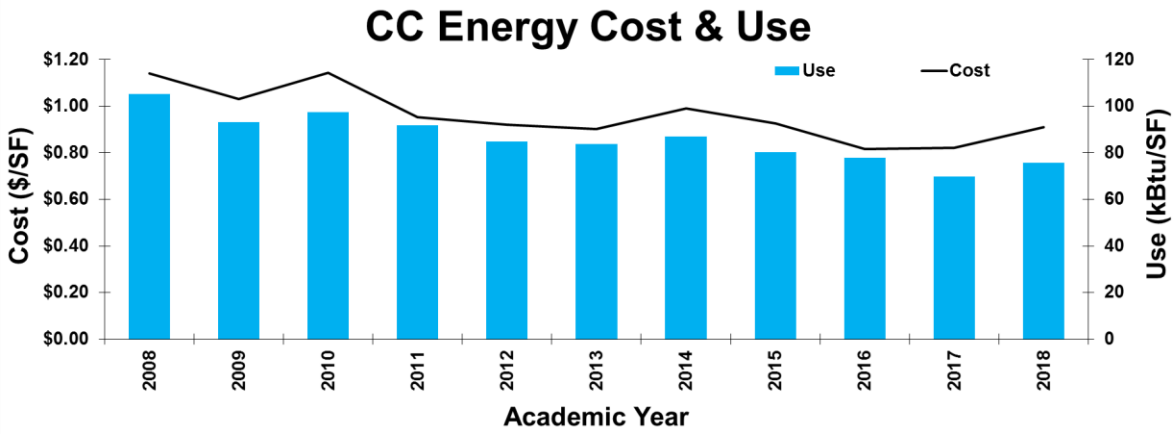
Carbon Footprint

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_2 ($MTCO_2$). Since 2008, Colorado College has made steady progress toward its carbon neutrality goal. For 2018, the College's carbon emissions from energy use are estimated at 16,274 $MTCO_2$ for a reduction of 33.4% compared to the 2008 baseline. This year carbon emissions decreased due to renewable energy credits and carbon offsets acquired to compensate for the additional carbon footprint of the Fine Arts Center. These measurements assume a consistent Colorado Springs Utilities (CSU) fuel mix and include emissions as charted below:



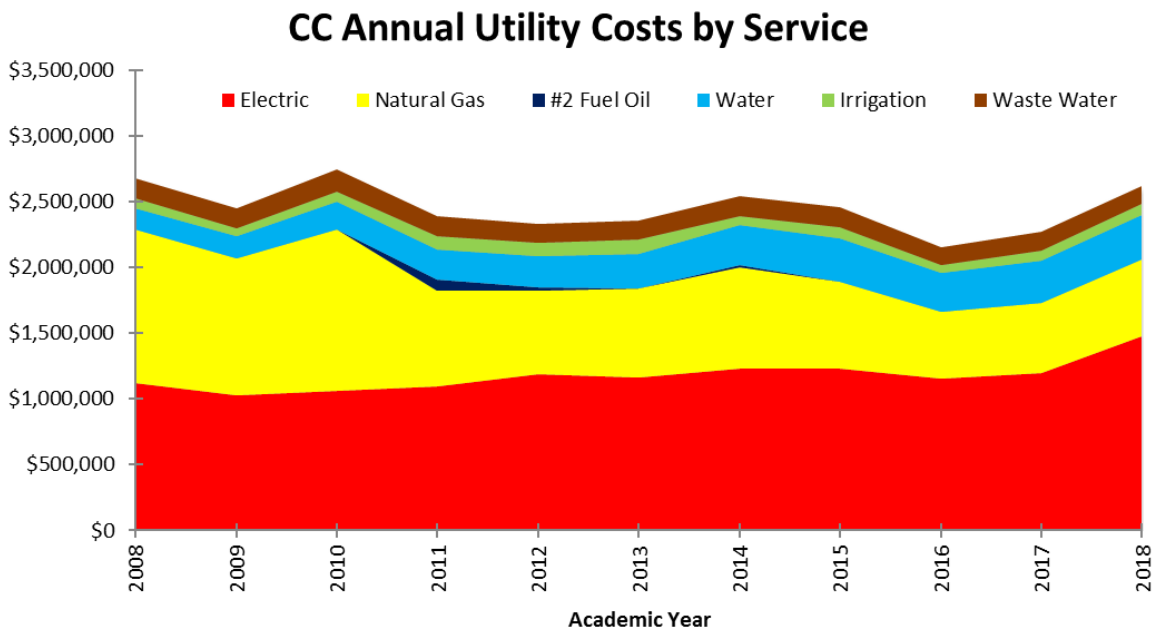
Benchmarking Colorado College

Colorado College has closely monitored and documented 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 2017 average energy intensity for higher education facilities at 114 kBtu/SF/Yr. APPA lists the average utilities cost per square foot at $2.06 / SF. The chart illustrates that CC's performance far exceeds both figures with an average energy intensity of 76 kBtu/SF/Yr and energy cost of $0.91/SF. The chart confirms CC's sustained decline in both energy cost and consumption (use).

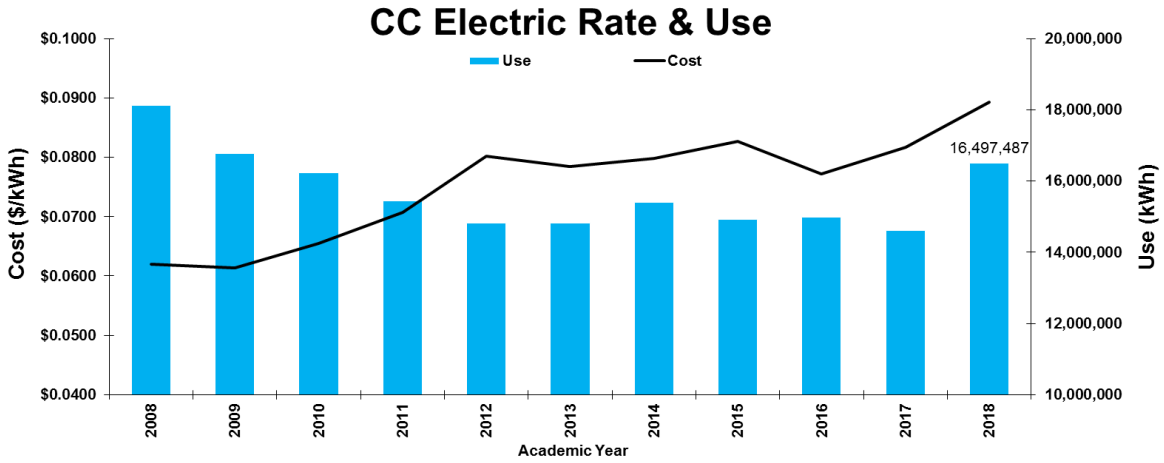


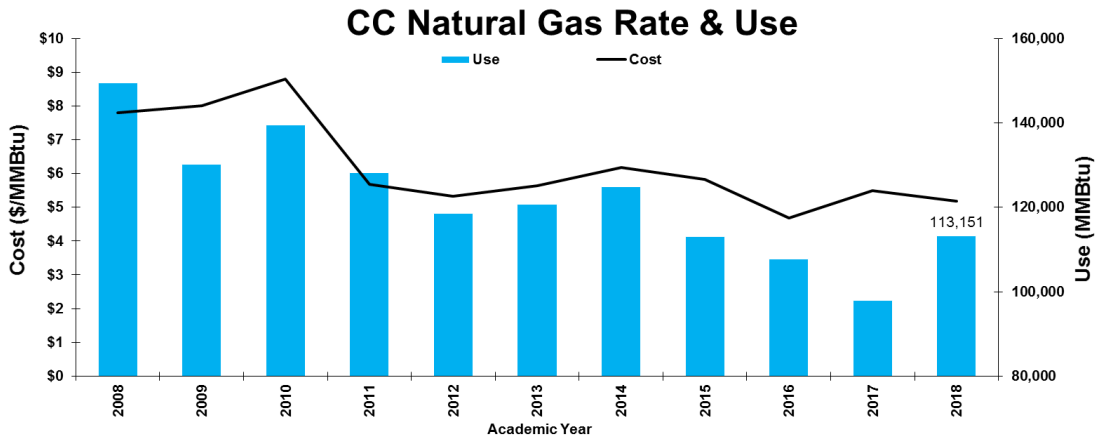
One factor that is unclear is what effect CC's block plan has on our overall energy use intensity. The block is thought to require more educational space because all spaces are used simultaneously. For comparison, the following annual kBtu/SF/Yr numbers were calculated using the most recent AASHE STARS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

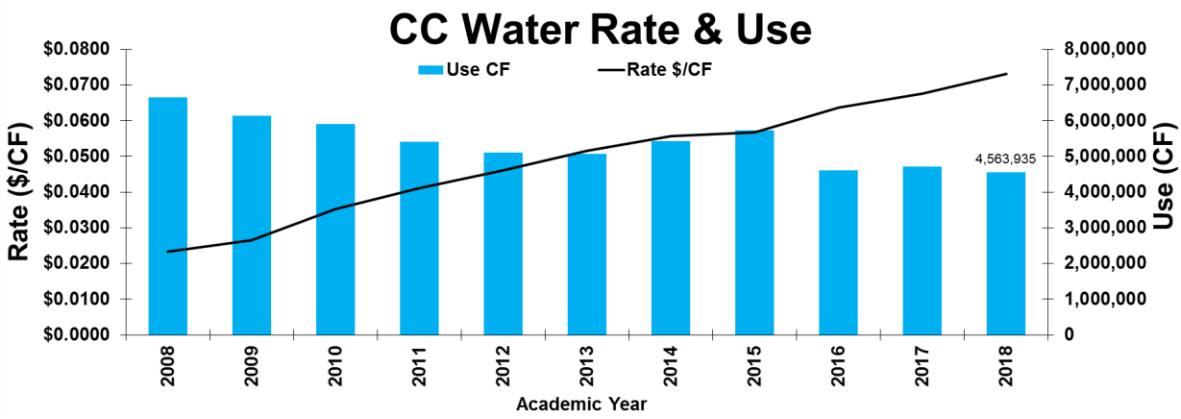
• Colby College	144 kBtu / SF	12/2014 data
• Colgate University	129 kBtu / SF	06/2016 data
• Middlebury College	177 kBtu / SF	06/2016 data
• Pomona College	114 kBtu / SF	06/2014 data
• University of Denver	104 kBtu / SF	06/2014 data
• University of Colorado Boulder	90 kBtu / SF	06/2016 data
• Williams College	148 kBtu / SF	06/2014 data

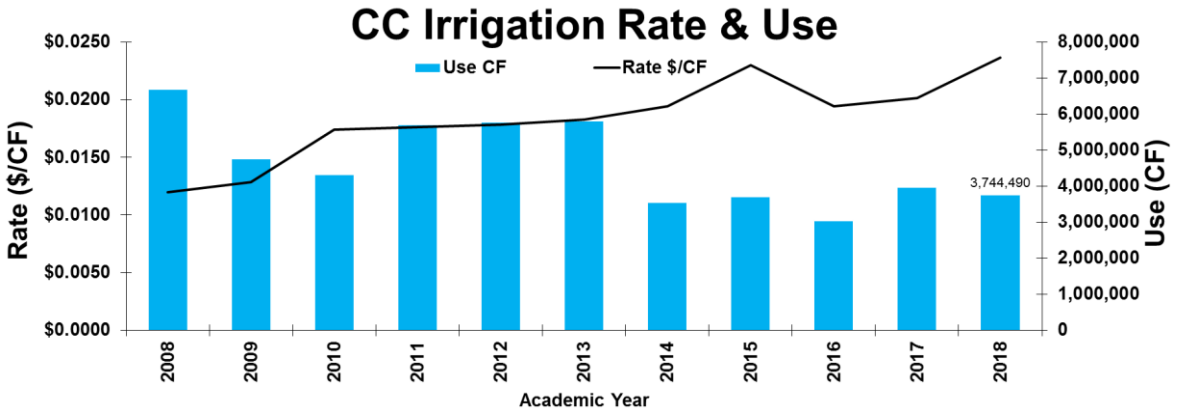


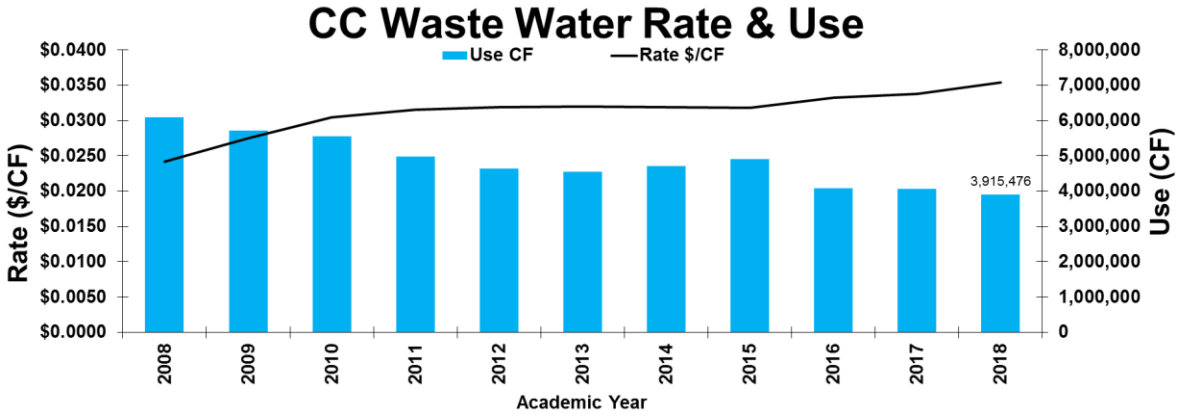
The chart above breaks down expenses by utility commodity. The most notable information is the continued increases in water and electricity rates. You will note large increases this year in energy consumption due to the addition of the Fine Arts Center at Colorado College. The charts below give more detail on these relationships.





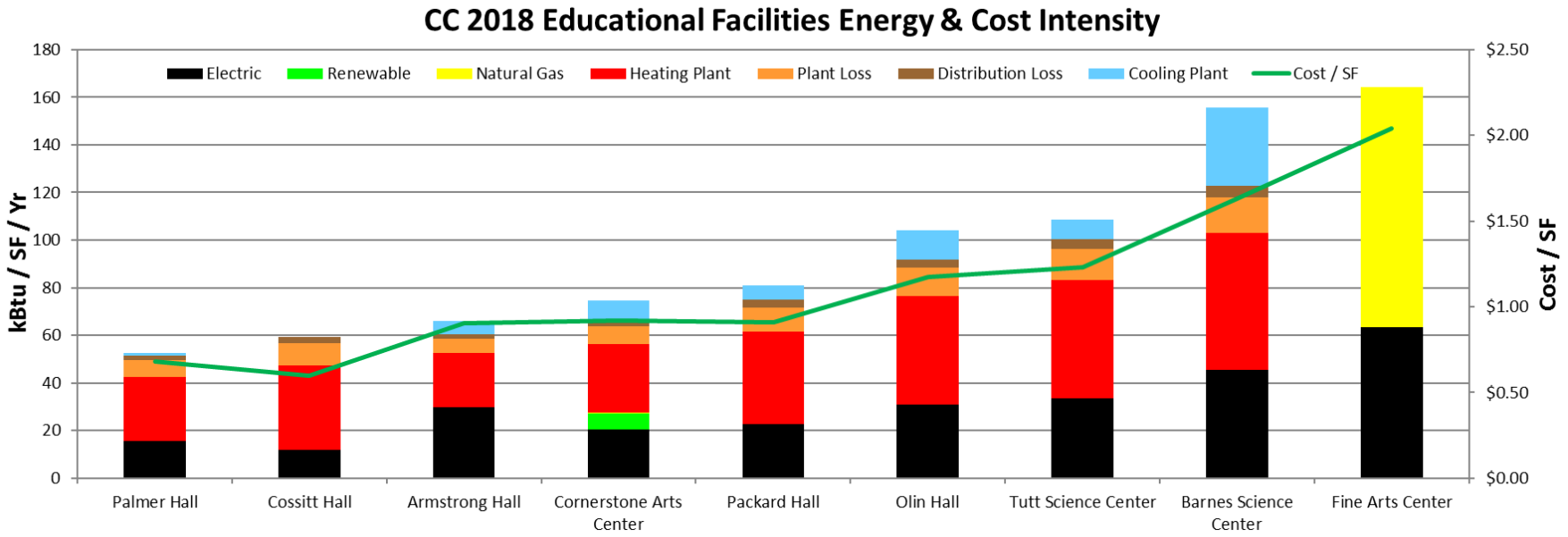


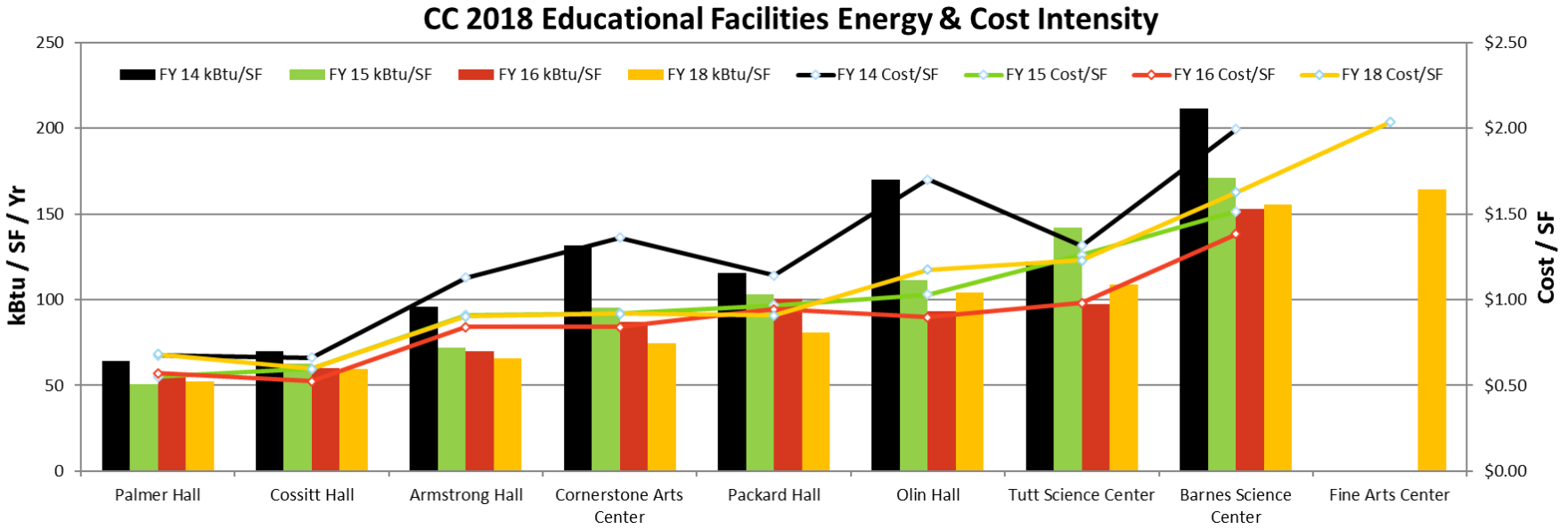




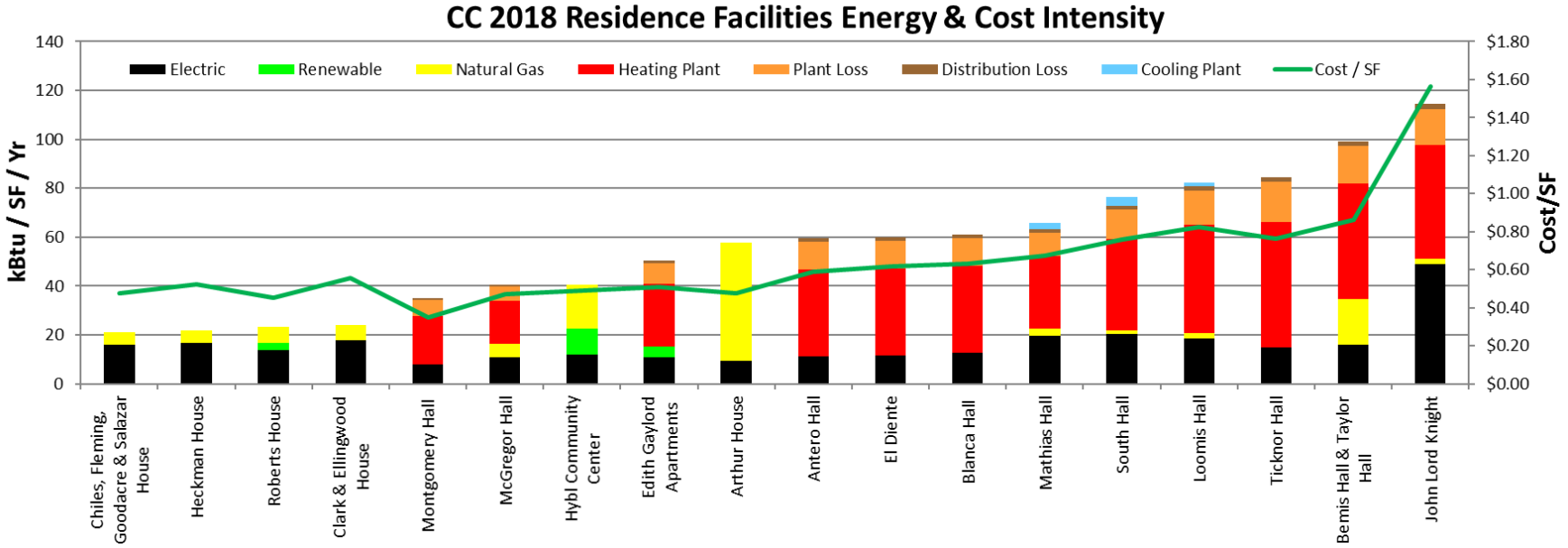
This is the sixth year for energy benchmarking at the building level. In 2011, thermal metering was installed. Thermal metering has enabled CC to measure the amount of heating and cooling energy flowing from the central plant to respective buildings. The following charts are the result of building level thermal and electrical metering.

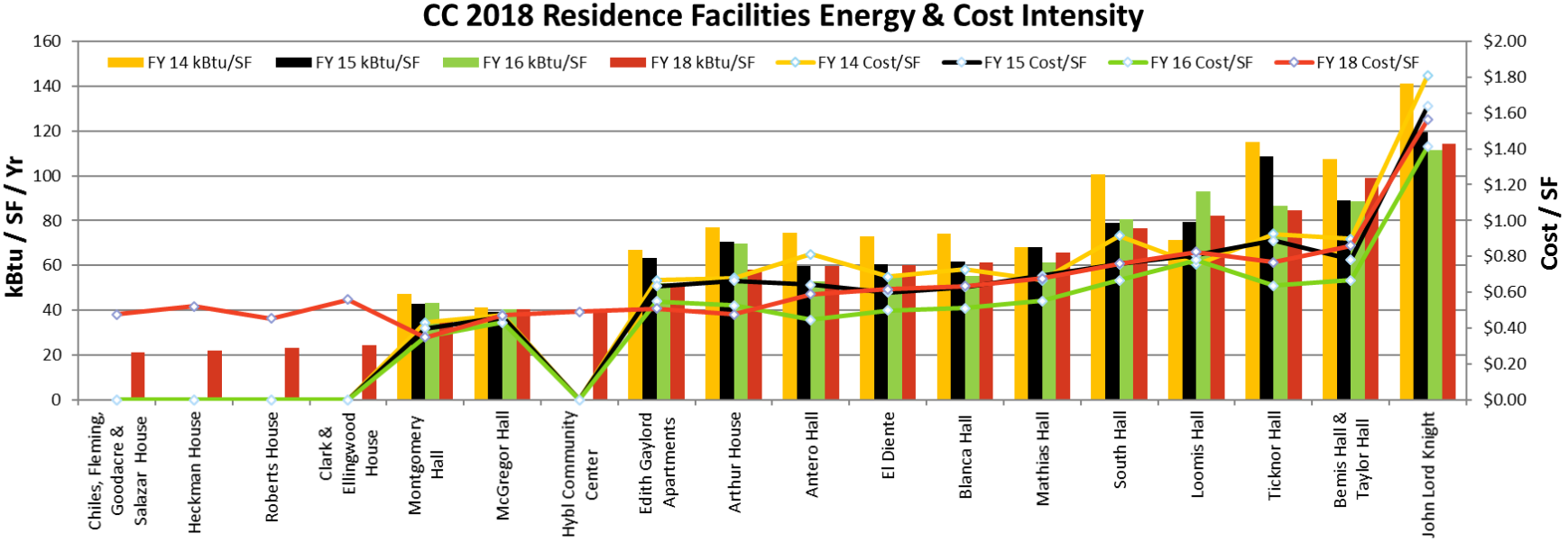
Benchmarking Educational Facilities



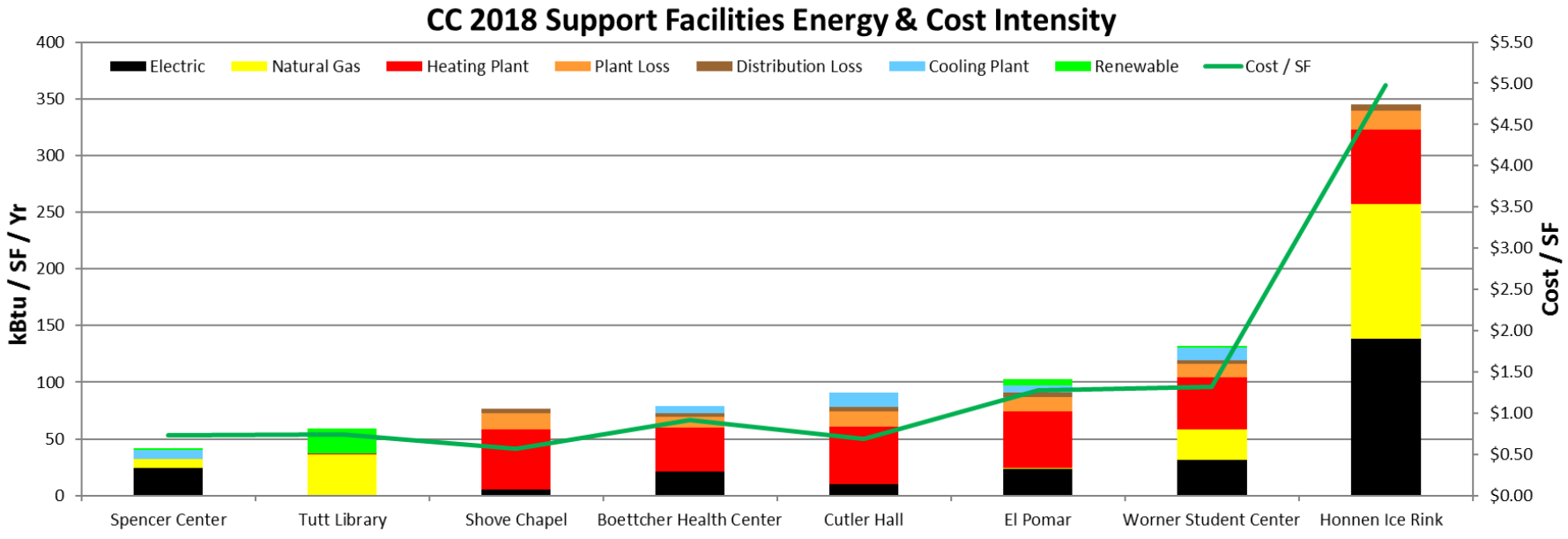


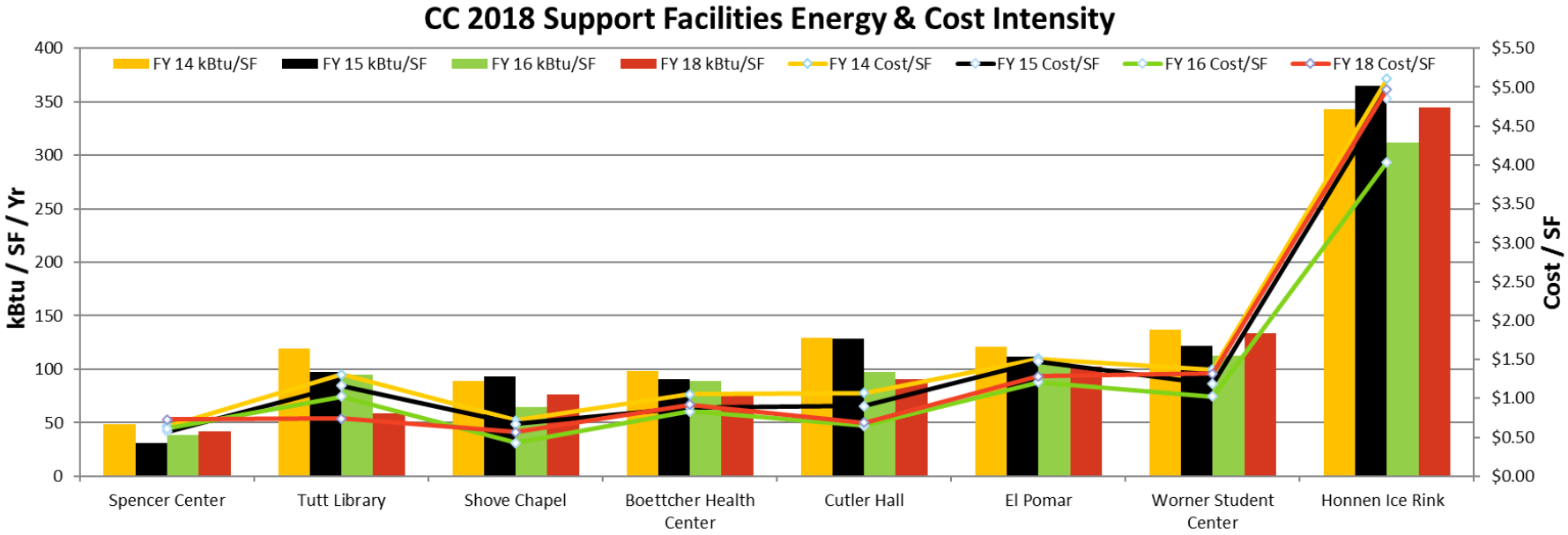
Benchmarking Residential Facilities

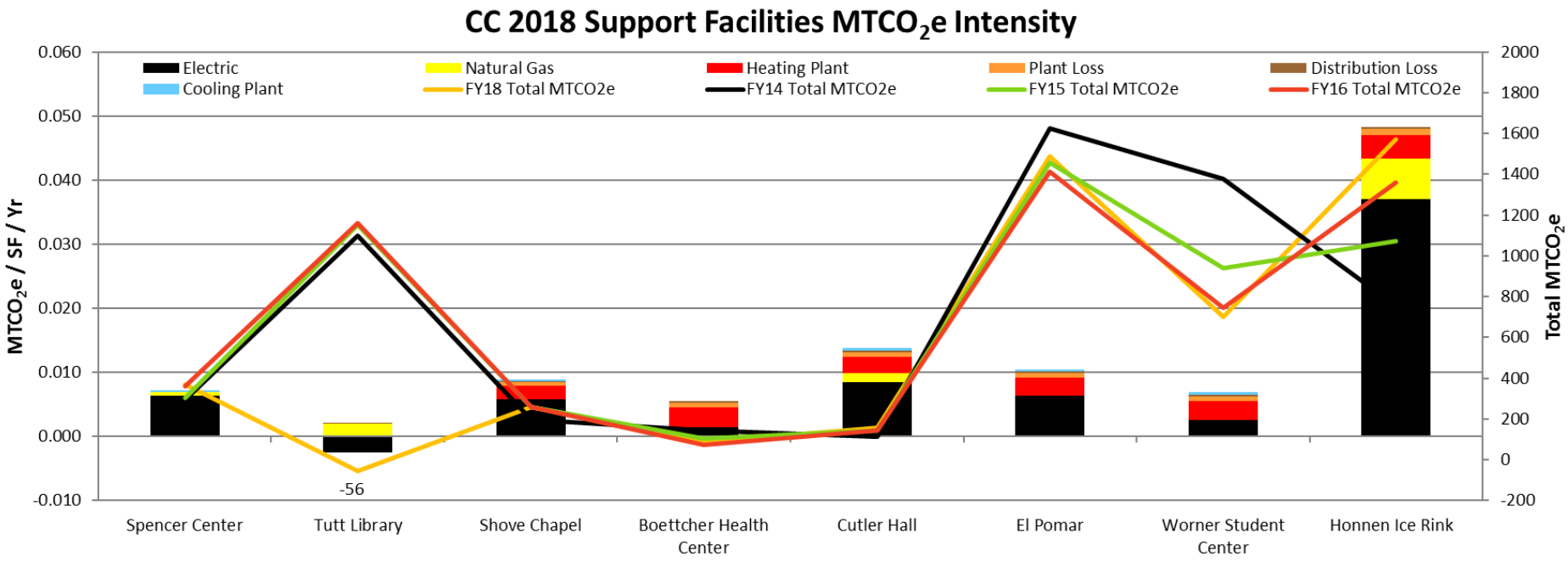




Benchmarking Support Facilities

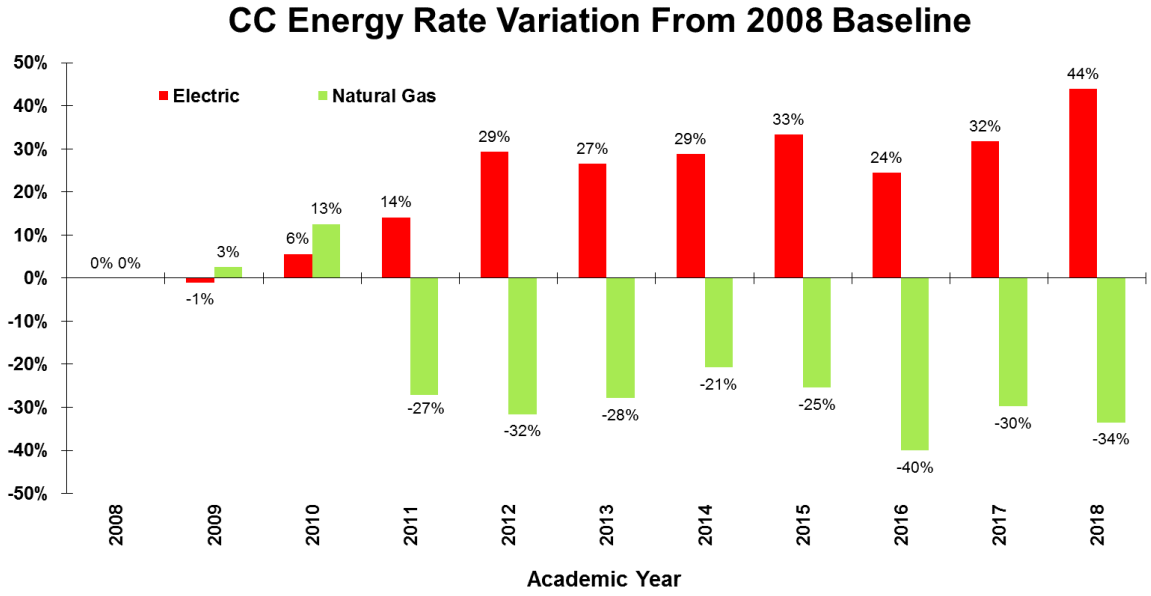


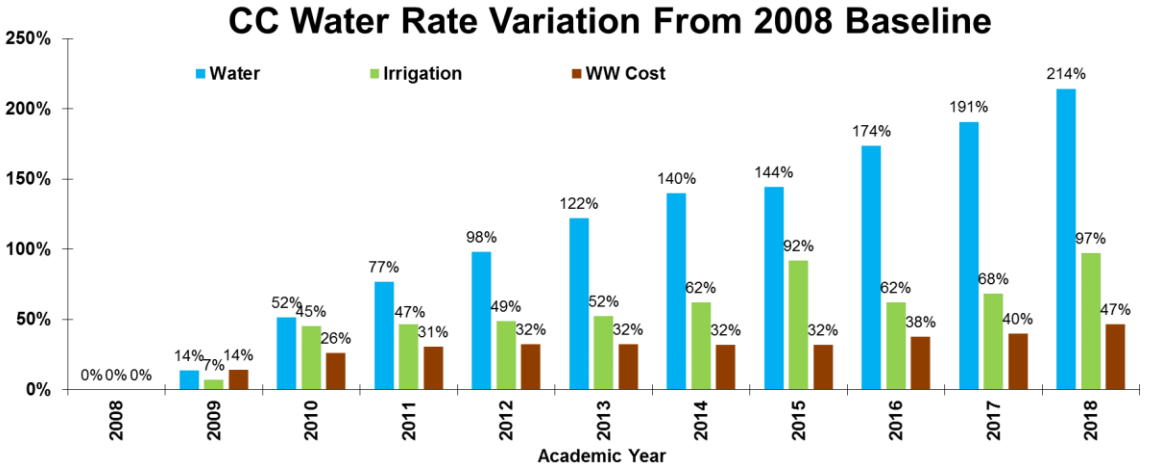



CC 2018 Support Facilities MTCO2e Intensity
Electric
Natural Gas
Heating Plant
Plant Loss
Distribution Loss
Cooling Plant
FY18 Total MTCO2e
FY14 Total MTCO2e
FY15 Total MTCO2e
FY16 Total MTCO2e
MTCO2e / SF / Yr
Total MTCO2e
0.060
0.050
0.040
0.030
0.020
0.010
0.000
-0.010
2000
1800
1600
1400
1200
1000
800
600
400
200
0
-200
-56
Spencer Center
Tutt Library
Shove Chapel
Boettcher Health Center
Cutler Hall
El Pomar
Worner Student Center
Honnen Ice Rink

Utility Rates

CC has made significant improvements in reducing utility consumption since 2008. Because of these improvements, total costs are relatively unchanged even with increases in most 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.





For the 2018 academic year the campus experienced an 8.5% increase in electrical rates over the previous year. Water rates increased by 7.5% for potable water and 14.8% for non-potable water over the 2017 academic year. On January 1, 2019 we are expecting Colorado Springs Utilities to change rates as follows:

- Potable Water 12% increase
- Non-Potable Water 11.7% increase

2018 Energy & Sustainability Projects

Cutler HVAC System Replacement

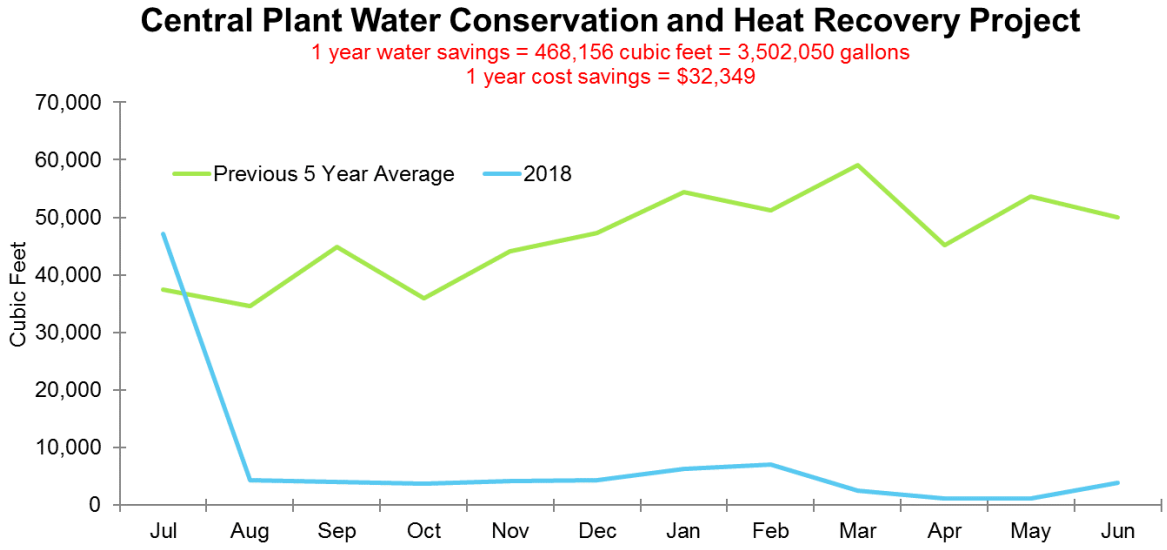
Project Status: Complete August 2018
Project Description: This project replaced the existing steam heating and ventilation system and added air conditioning at Cutler Hall. The system did not have good zone control, so as a result occupants were often too hot or too cold. The new system utilizes a new variable refrigerant flow heat pump system to maximize occupant comfort and efficiency while maintaining the historic characteristics of the building.
Project Highlights:

- Improved system reliability & efficiency
- Improved occupant comfort

Central Plant Water Conservation & Heat Recovery

Project Status: Complete August 2017
Project Description: The central plant water conservations & heat recovery project optimized water use and heat recovery at the central plant. Since 1960 when the Williams Central Plant was constructed we utilized domestic water to cool the bearings on our central HTHW pumps. This project added a closed heat recovery loop from our low temperature hot water loop and automated the flow of water to these pumps. The recovered heat is sent to El Pomar Sports Center and Schlessman Natatorium. See the chart below for initial results.
Project Highlights:

- Improves central plant efficiency
- Reduces water use and cost



Barnes Science Center
High Temperature Hot Water Improvements

Project Status: Complete July 2018

Project Description: This project added a new HTHW service to Barnes Science Center beneath the new Academic Walk. Previously Barnes Science Center was served with heating, hot water, and steam from Olin Hall. This project decouples Barnes from Olin hall in preparation for a new science facility as projected in the Campus Master Plan. In addition Barnes Science Center now provides snow melt to the Academic Walk along the north side of the building.

Project Highlights:

- Improved system reliability and resiliency

Heckman PV Solar

Project Status: Complete August 2018
Project Description: This project installed a 13.3 kW PV array on Heckman House. Heckman House has performed at an energy intensity of 22 kBtu/SF/year through its first year of operation. It utilizes a high efficiency ground source geothermal heating and cooling system. Adding PV will help the house lower its energy intensity near 15 kBtu/SF/year.

Montgomery Hall
High Temperature Hot Water Service Replacement

Project Status: Complete August 2018
Project Description: This project replaced failing HTHW piping and associated valves to Montgomery Hall. New piping is triple wall construction with a life expectancy of 50 years.
Project Highlights:

- Improved system reliability and resiliency

Fine Arts Center Energy Audit and Commissioning Phase 1

Project Status: Complete
Project Description: The Fine Arts Center energy audit and commissioning project phase 1 completed preliminary planning and identification of projects for reducing the overall energy intensity, associated carbon emissions, and cost at the Colorado Springs Fine Arts Center at Colorado College. This initial phase looked at both utility supply and demand opportunities. The project evaluated the operation of building systems and added real-time metering of utilities services into campus building automation. Commissioning work completed repairs to the buildings humidification system, replacement the building condensate return tank and associated apparatus, and small additions of building automation to improve occupant comfort.

Packard Hall
High Temperature Hot Water Service Replacement Phase 1 of 2

Project Status: Complete September 2018
Project Description: This project replaced failing HTHW piping servicing Packard Hall routed between Worner Center and Honnen Ice Rink. A new larger gas service was installed to Worner Center. An additional phase is needed to cross Cache La Poudre Street. New piping is triple wall construction with a life expectancy of 50 years.
Project Highlights:

- Improved system reliability and resiliency

2019 Energy & Sustainability Projects

Utilities Master Plan Update

Project Status: Planning
Project Description: The Utility Master Plan Project will update our 1998 utilities master and align it with our revised 2015 campus master plan. The plan will be completed in phases to complete condition assessments, identify future projects, and locate utilities in geographical information system format.

Tutt Library Commissioning

Project Status: Ongoing
Project Description: The Tutt Library Commissioning Project will continue work on tuning building systems at Tutt Library to reduce energy consumption to modeled levels. The upcoming work includes revising controls strategies for the buildings micro turbines to improve staging and reduce gas consumption.

Packard Hall
High Temperature Hot Water Service Replacement Phase 2 of 2

Project Status: Planning
Project Description: The Packard Hall High Temperature Hot Water Service Replacement Phase 2 of 2 Project will complete replacement of HTHW service to Packard Hall across Cache La Poudre St.

Schlessman Pool Heat Exchanger Replacement

Project Status: Planning
Project Description: The Schlessman Pool Heat Exchanger Replacement Project will replace a failing HTHW heat exchanger and associated valves servicing Schlessman Pool with a new heat exchanger and titanium tube bundle. The replacement will reduce water and chemical treatment associated with the pool and central plant.

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, troubleshoot controls issues, and retro-commission buildings that are not operating at their peak efficiency.

Robson Arena Design

Project Status: Complete

Project Description: The Robson Arena Design Project will work on incorporating high performance design criteria provided by the college to the design team into the final design resulting in a net-zero design for the Robson Arena and associated future natatorium.

Project High Performance Design Criteria:

Building Envelope - Design to the following minimums:

- Wall U-factor = 0.05
- Glazing total percentage = 15%
- Roof U-Factor = 0.02
- Window assembly U-factor = 0.25
- Glazing SHGC = 0.25 E, W, S & 0.35 N
- Low emissivity (Low-E) ceiling

Electrical – Design the following minimums:

- Artificial Lighting = .3 W/SF
- Dimmable LED fixtures to minimize radiant heat with occupancy sensors throughout. Include daylight sensors near glazing.
- PV Solar – 250kW
- CHP – Design combined heat and power (CHP) system for fuel switching to achieve parallel load following operation with heat rejecting to building heating system and campus HTHW loop. Emergency power operation.

HVAC – Design to the following minimums:

- Design a system that maximizes occupant comfort. Ensure the most efficient use of site utilities.
- CO2-Demand control ventilation designed to maintain < 700 PPM during peak occupant loads.
- Design a rink heating a dehumidification air distribution system to minimize convective loads across the ice surface.

Ice Plant – Design to the following minimums:

- Design a resilient ice plant to ensure system reliability.
- Utilize environmentally friendly refrigerant.
- Heat recovery - Utilize campus HTHW and CW distribution systems achieve maximum ice plant efficiency and ensure resiliency of campus summertime operations.
    - The facility should be sized to export ~5 MBH (5,000,000 Btu/hr) @ 265°F minimum and 400°F maximum May through October.
    - Campus CW operates 6am through 10pm May through October.

Ice Sheet

- Design an all-purpose floor with reheat to support full year operation.
- Design robust insulation below the ice surface to minimize conductive loads.
- Design complete drainage system around the footing and under the rink floor.
- Design a water treatment system to minimize low flood water temperature

Worner Center Kitchen Improvements

Project Status: Ongoing
Project Description: The Worner Center Kitchen Improvements Project will repair multiple energy issues at Worner Center. The scope includes replacing HTHW valves service the kitchen, replacing the dishwasher, insulating refrigerant piping, and adding the freezer to the emergency generator.

Campus LED Lighting Upgrades

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

- Takes advantage of utility rebates
- Improves lighting levels

Fine Arts Center LED Lighting Upgrades

Project Status: Construction
Project Description: The Fine Arts Center LED lighting upgrade project is an ongoing project to replace lighting at the Fine Arts Center with more efficient LED lighting. This project leverages utility rebates to assist with the restoration and replacement of campus lighting.
Project Highlights:

- Takes advantage of utility rebates
- Improves lighting levels