



2016 – 2017

Campus Annual Energy Use Report

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Year at a Glance

Utility Costs:

	<u>FY 2014-2015</u>	<u>FY 2015-2016</u>	<u>FY 2016-2017</u>
Total Utility Costs	\$1,986,375	\$1,747,496	\$1,798,437
Electricity Costs	\$1,106,862	\$1,106,076	\$1,122,669
Fuel Costs	\$641,253	\$383,770	\$411,953
Water & Sewer Costs	\$238,260	\$257,650	\$263,815

Weather Normalized Energy Consumption:

	<u>FY 2014-2015</u>	<u>FY 2015-2016</u>	<u>FY 2016-2017</u>
Total Energy KBTUs	143,581,770	141,965,762	141,105,662
Fuel KBTUs	100,459,995	100,624,460	101,217,429
Electricity KBTUs	43,121,775	41,341,302	39,888,233

Water Consumption:

	<u>FY 2014-2015</u>	<u>FY 2015-2016</u>	<u>FY 2016-2017</u>
Total Water CCF	40,277	40,046	39,947

Performance vs. 3% Annual Energy Reduction Goal:

	<u>FY 2014-2015</u>	<u>FY 2015-2016</u>	<u>FY 2016-2017</u>
Energy Utilization Index (KBTUs/GSF/Year)	101.2 Base Year	100.0 (1.1% Cum. Reduction)	99.2 (1.9% Cum. Reduction)

2016-2017 Energy Conservation Projects & Initiatives:

Lighting Upgrade Projects: The original lighting fixtures in the areas and buildings listed below were retrofitted to LED lighting technology:

- Campus Outdoor Lighting - Walkway & parking lot lights
- 1550 Summit Avenue rental property –Building-wide retrofit
- Leonard Center – Hallways, locker rooms, pool area, fitness center, and racquetball courts
- Kagin Commons - Ballroom lighting & dimming controls
- Campus Center stairwells – Test installation of bi-level light fixtures with integrated occupancy sensors

Electrical/Mechanical Projects: Upgrades were made to electrical and mechanical systems:

- Stadium – Replacement of electric resistance heating equipment with high-efficiency boilers
- Leonard Center - Upgrade to the Pool air handling unit to reduce energy consumption when unoccupied
- Markim Hall – installation of 13 KW of solar photo-voltaic panels
- Campus Center – Installation of variable frequency drives for the kitchen hood exhaust fans
- Chiller plant – Recommissioning of the chiller plant’s controls and operation

Sub-metering and Energy Reporting Initiatives:

- Submeters – Continued installation of additional submeters for monitoring electricity and steam condensate
- kWh360 – Implementation of cloud-based utility bill tracking software application
- GRITS – Implementation of cloud-based energy conservation project tracking software application

Executive Summary

This report summarizes the energy and water consumed on Macalester College's campus during FY 2016 – 2017. The College utilizes electricity, natural gas, and #2 fuel oil as its primary sources of energy, with each energy source providing different amounts of energy per unit but at significantly different costs. For example, the electricity consumed in FY 2016-2017 comprised only 31% of the total energy consumed across the campus but accounted for 62% of the College's total expenditures for energy.

Because the energy used in Macalester College's central heating and cooling plant is highly affected by seasonal weather variations the fuel used in the boiler plant and the electricity used in the chiller plant are presented in a weather normalized basis to provide a standardized method of measuring year-to-year progress toward the College's energy reduction goals.

Several components of the campus' energy use have not been weather normalized for this report. The amount of electricity used for lighting, distributed mechanical equipment, and building plug loads has not been weather-normalized in this report because it varies more with changes in the number of people on campus over the academic year than with seasonal weather variation. In addition, the quantity of natural gas used for heating the houses on campus has not been weather normalized because it accounts for a relatively small percentage of the campus' overall fuel consumption.

Starting with FY 2015-2016, Macalester College has set a goal of 3% per year reduction in its total energy consumption for the following five-year period. FY 2014-2015 was selected as the baseline period for measuring progress toward the consumption targets. In order to achieve these goals, Macalester has increased its ongoing energy conservation efforts via participation in Xcel Energy's Commercial Energy Efficiency Program, implementation of lighting efficiency and control projects, and the deployment of other new technologies. An energy manager position was also created within the Facilities Services department to assist with the implementation of energy conservation projects and to track the College's progress toward achieving the campus' energy reduction targets.

Progress towards achieving the energy reduction targets is monitored by tracking all of the energy sources used on campus each year and calculating the College's energy utilization index (EUI) value. The EUI value is presented in KBTUs/GSF/Year and is a commonly used value for energy use evaluations because it accommodates the use of weather normalization and also compensates for changes in the area of the campus over time.

Since the 2014-2015 base year the College has reduced its EUI value from 101.2 KBTU/GSF/Year to 99.3 KBTU/GSF/Year, which represents about 50% progress toward the 6% cumulative reduction target for two years. Although electrical consumption in FY 2016-2017 was 7.5% less than in the base year the weather-normalized amount of fuel consumed during the year was 1% higher. Since fuel usage comprises about 2/3 of the total energy consumed on campus the increase in fuel usage offset nearly all of the reduction made in electrical consumption.

Macalester College's total expenditures for electricity and fuel in FY 2016-2017 were \$1,534,000, which was approximately 3% higher than the previous fiscal year's total energy costs. The cost for FY 2016-2017 was 10% less than the amount spent in the FY 2014-2015, largely due to the lack of a natural gas curtailment request from Xcel Energy in that year.

In addition to the expense for fuel & electricity, in FY 2016-2017 Macalester consumed 39,947 CCF of water, at a cost of approximately \$264,000. (1 CCF = 100 Cubic Feet = 748 Gallons.) The amount of water consumed on campus has varied very little over the last three years.

Fuel Consumption & Cost

Campus Fuel Consumption

Approximately 89,000,000 KBTUs of natural gas were consumed on campus during FY 2016-2017, with 84% of the fuel energy used by the central heating plant and the balance used in the various buildings and houses on campus for space heating, water heating, and cooking applications. The Art building's kilns and forges are also a significant consumer of natural gas on campus. No fuel oil was used by the central heating plant during FY 2016-2017.

The actual amount of fuel consumed in any given year can be adjusted via weather normalization calculations to allow comparison with the fuel consumption in other years. After weather normalization, the amount of fuel energy consumed on campus in FY 2016-2017 was 101,200,000 KBTUs, which was 7% higher than the cumulative fuel use goal for the year.

Campus Fuel Cost

The total cost for the natural gas consumed on Macalester College's campus in FY 2016-2017 was \$412,000, which was 7% higher than the \$384,000 spent on natural gas in FY 2015-2016. Although the amount of fuel consumed was only slightly higher than the prior year the cost increase was disproportionately larger due to a 6% increase in the rate charged by Xcel Energy for natural gas.

As noted previously, Macalester College did not use any #2 fuel oil in its central heating plant during the 2016-2017 fiscal year. Macalester benefits from a lower price for natural gas year-round due to an agreement with Xcel Energy that, at their request, the College will use fuel oil in the boiler plant instead of natural gas during periods of extremely cold weather.

Electricity Consumption & Cost

Campus Electrical Consumption and Demand

Macalester College's actual electrical consumption in FY 2016-2017 was approximately 11,766,000 KWH. 87 % of Macalester's total electric energy was used for the electrical loads that are served by the campus main electric meter, such as building lighting, distributed mechanical equipment, and plug loads. The College's chiller plant used about 9% of the campus' total electric energy, and the remaining 4% was used in the various campus buildings and houses that have individual electric meters.

After adjusting the amount of electricity consumed by the chiller plant for seasonal weather variations, the campus' total electricity consumption during the year was 11,691,000 KWH. The normalized total for FY 2016-2017 was 7.5% less than the 2014-2015 baseline period, out-performing the 6% energy reduction goal for the year.

In addition to the amount of electricity consumed on campus (measured in kilowatt-hours or KWH), the College is also charged for the rate at which it uses electricity (demand, which is measured in kilowatts or KW). Macalester was billed for 28,534 KW in FY 2016-2017, which was slightly less than the amount used in the 2014-2015 base year.

Campus Electrical Cost

Despite the significant reductions that been achieved in the amount of electricity consumed on campus, the \$1,123,000 spent on electricity in FY 2016-2017 was nearly identical to the amount spent in the previous two years due to electrical rate increases from Xcel Energy. Demand charges during FY 2016-17 comprised 28% (\$314,000) of the campus' total electrical costs.

Electrical consumption and demand charges for Macalester College's chiller plant in FY 2016-2017 were \$170,000. Although the chiller plant's electrical consumption in FY 2016-2017 amounted to approximately 9% of the electricity consumed on campus it accounted for more than 20% of the campus' total electrical demand charges and 11% of the campus' total energy costs.

Water Consumption & Cost

During FY 2016-2017 Macalester College consumed 40, 000 CCF of water, or approximately 30,100,000 gallons (1 CCF = 100 Cubic Feet = 748 gallons). This quantity of water would fill 30 swimming pools that are each 267 feet long by 50 feet wide to a depth of 10 feet. The total amount of water consumed during the year was nearly identical to the amount consumed during the previous two years, although there was variation on a monthly basis.

Macalester College's total water & sewer charges in FY 2016-2017 were approximately \$264,000, which represents 15% of the College's total expenditures for electricity, fuel, and water/sewer charges. The rate at which the College is charged for water & sewer costs has increased by 7% since the 2014-2015 base year.

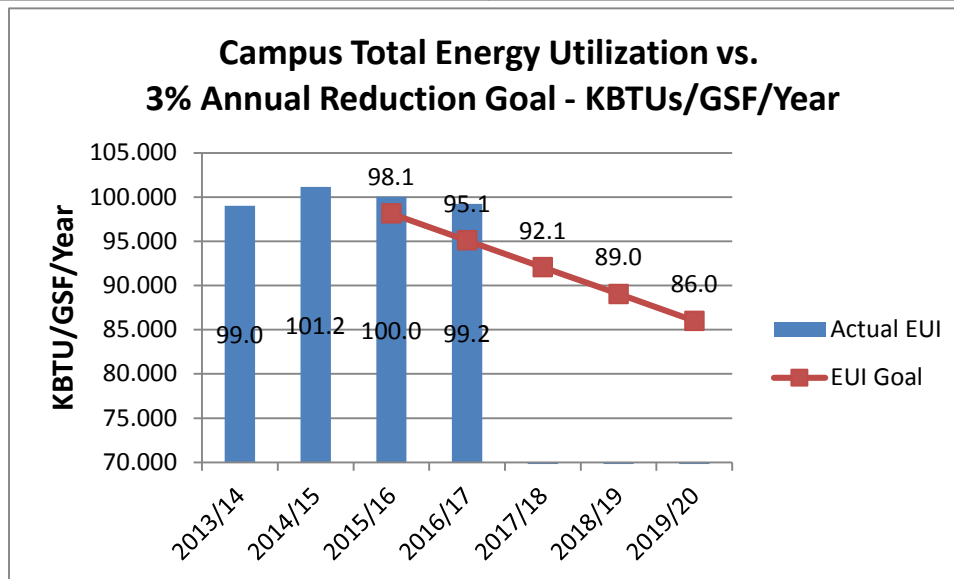
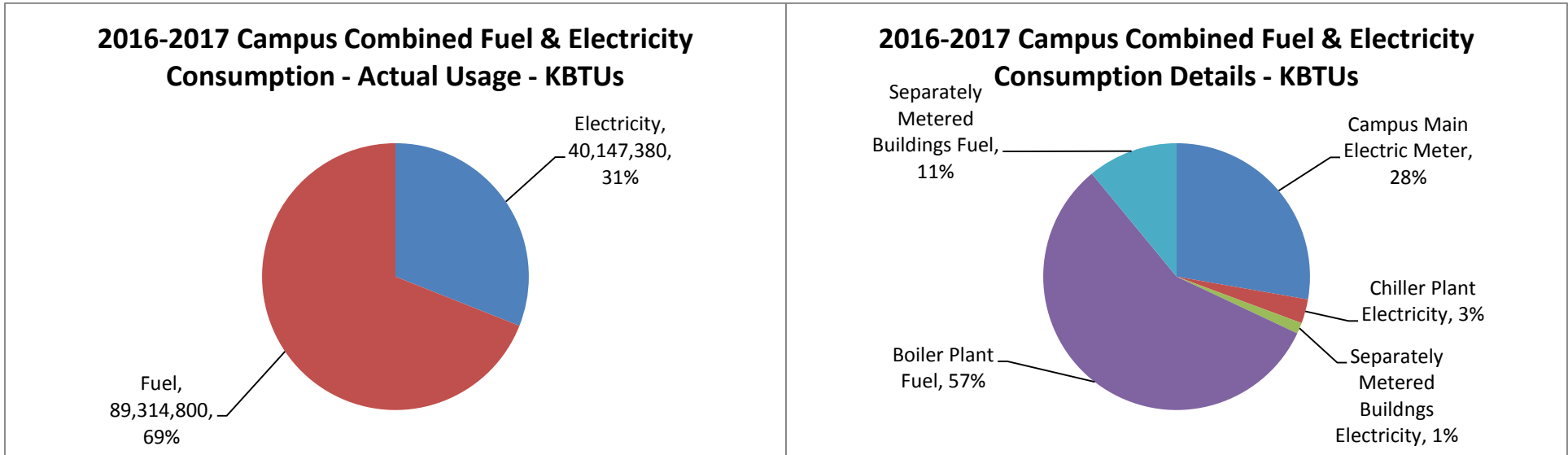
Energy Conservation Projects & Reporting Initiatives

The energy conservation projects and reporting initiatives listed below were completed in FY 2016-2017:

- Lighting Retrofits:
 - Campus walkway lighting – conversion of low pressure sodium light fixtures to LED
 - Parking lot lighting – conversion of low pressure sodium light fixtures to LED
 - 1550 Summit Avenue building – replacement all of the building's incandescent, fluorescent, metal halide, and low pressure lighting with LED lamps
 - Campus Center stairwell lighting – test replacement of the existing fluorescent stairwell fixtures with LED fixtures that have integrated occupancy sensors
 - Leonard Center – replacement of the fluorescent & metal halide lighting in the hallways, pool area, fitness center, and racquetball courts with LED; also installation of vacancy controls for lighting in the facility's racquetball courts
 - Kagin Commons – retrofit of the existing halogen & incandescent fixtures with custom LED emitters
 - Chapel – replacement of incandescent spotlights with LED
- Electric/Mechanical:
 - Stadium – replacement of the electric resistance heating equipment with high-efficiency boilers and hot water perimeter radiation
- HVAC Equipment Recommissioning & Controls:
 - Campus Center – installation of variable speed drives and controls to implement demand controlled ventilation for the kitchen hoods and their associated makeup air units
 - Chiller plant & chilled water system distribution – recommissioning of the chiller plant's controls and operation based on an analysis completed by Trane Company and partially funded by Xcel Energy
 - Olin-Rice, Campus Center, and Leonard Center – set point and schedule changes as recommended by the Michaels Energy recommissioning study
- Sub-metering & Reporting:
 - Subscription to GRITS (Green Revolving Investment Tracking System) for tracking of energy conservation projects
 - Continued installation of web-enabled Mamac sub-meters for monitoring electrical consumption and steam condensate in all major campus buildings
 - Trial subscription to Singh360 web-based utility expense and energy use reporting software

Charts & Graphs

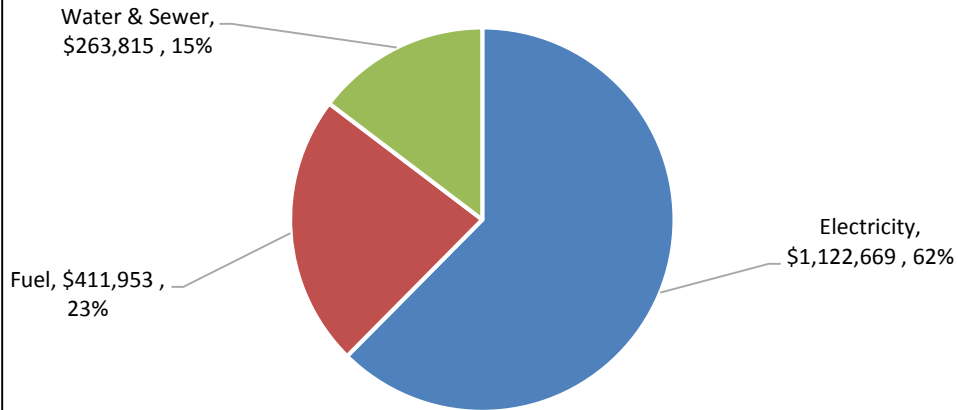
Campus Total Energy Consumption



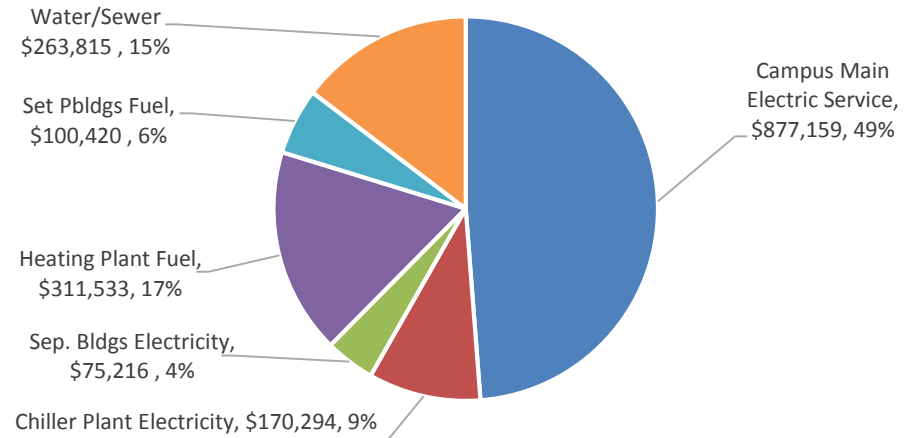
2016 -2017 Macalester College Campus Energy Use Report

Campus Total Utility Costs

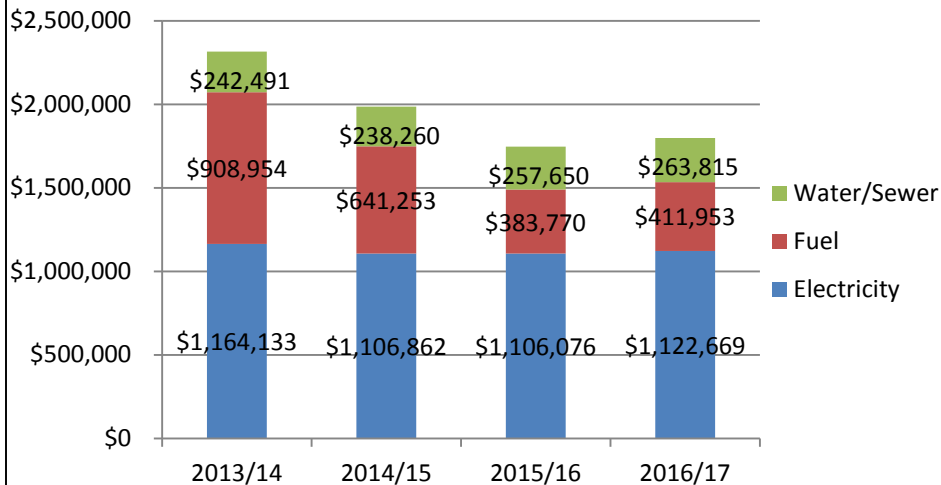
2016-2017 Campus Utility Cost Summary



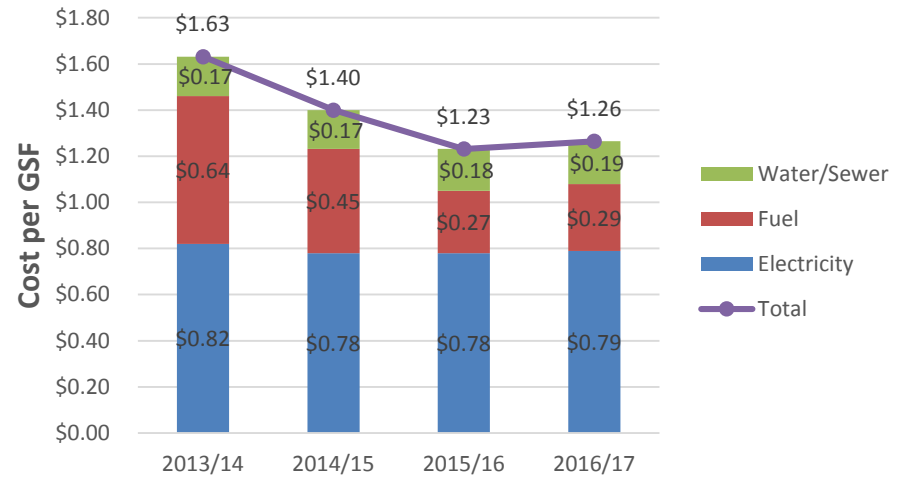
2016-2017 Campus Utility Cost Details



Campus Combined Annual Total Utility Cost

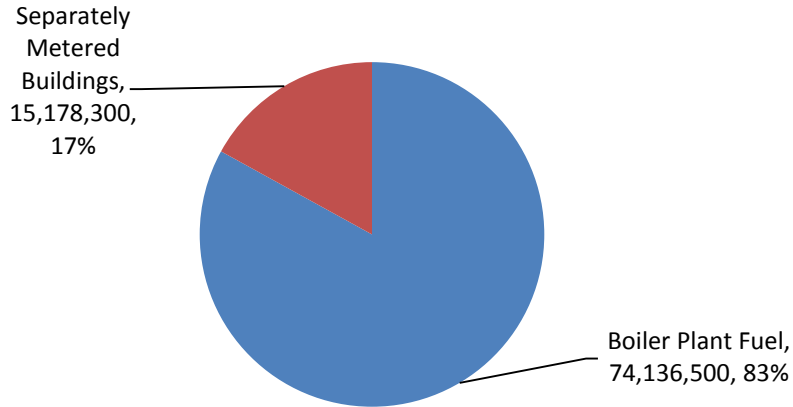


Campus Combined Utility Costs per GSF

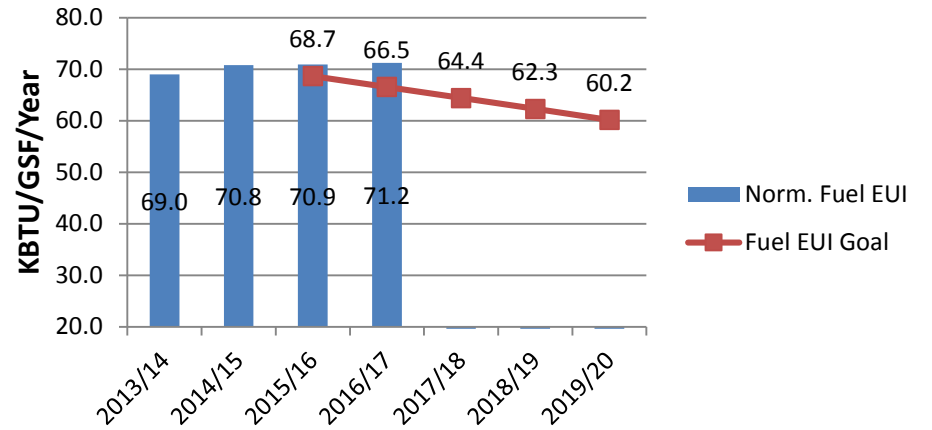


Campus Fuel Consumption

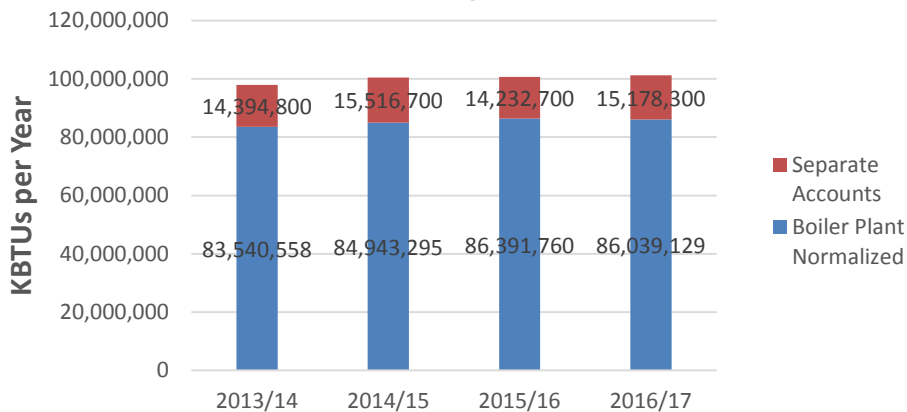
2016-2017 Campus Fuel Consumption - Actual Usage - KBTUs



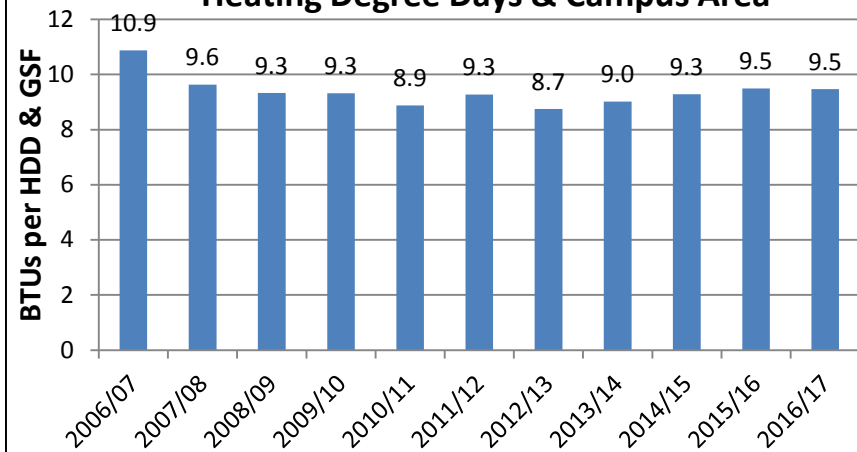
Campus Total Fuel Consumption vs. 3% Annual Reduction Goal - KBTUs/GSF/Year



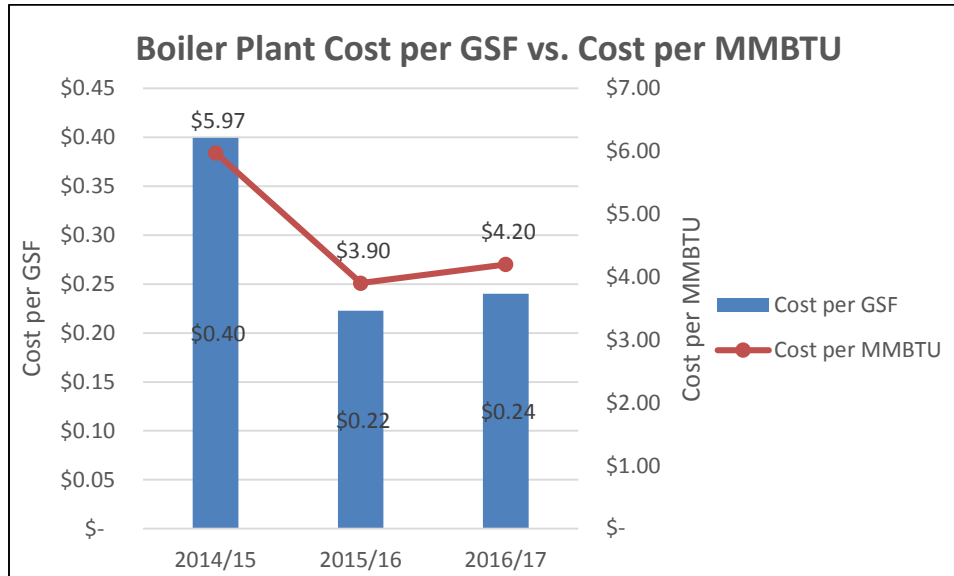
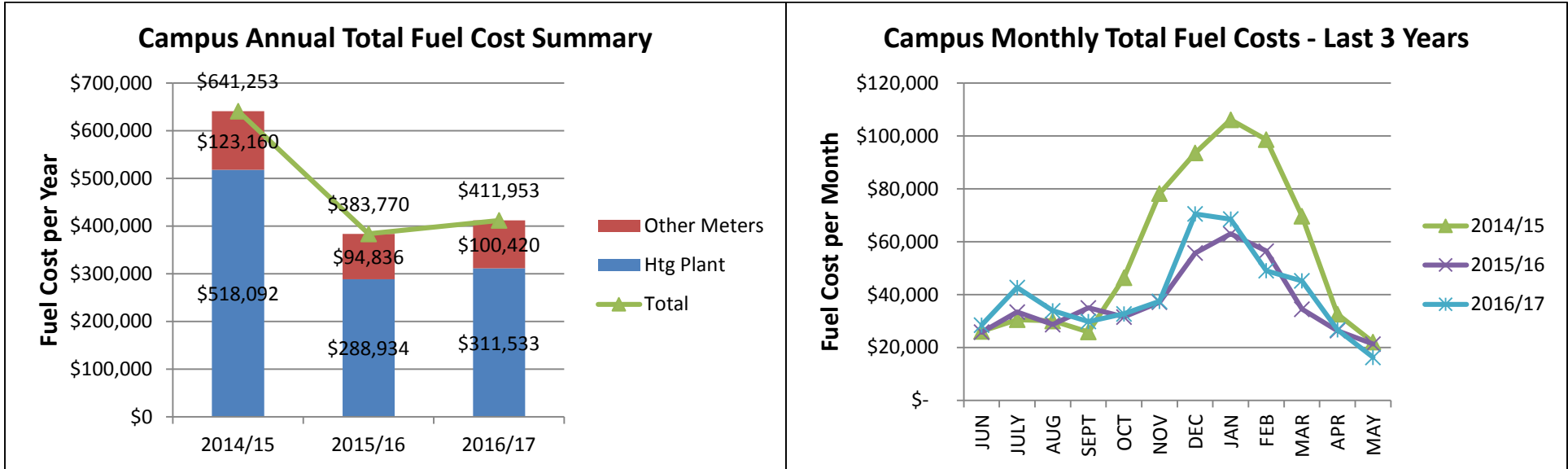
Campus Total Fuel Consumption - Boiler Plant Normalized & Separate Accounts - KBTUs/Year



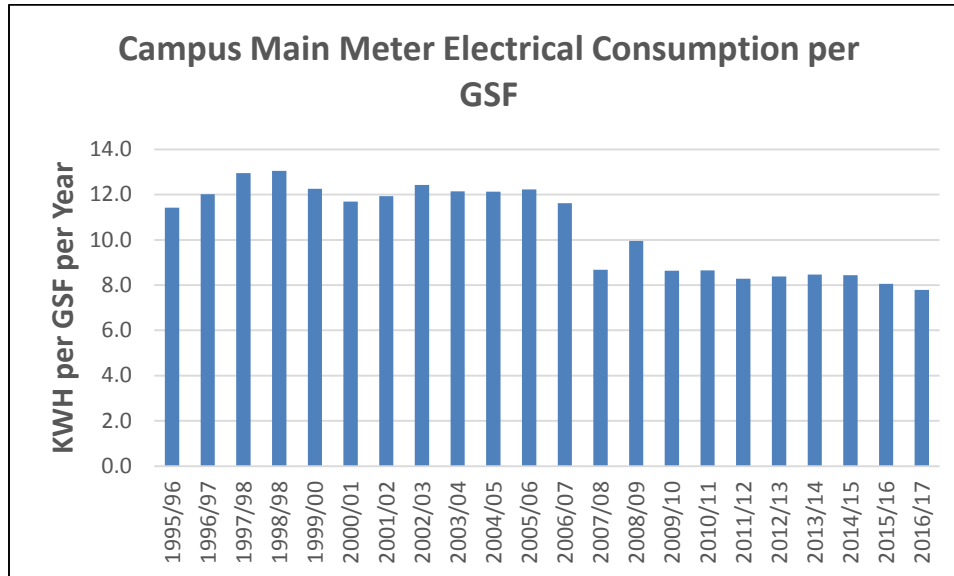
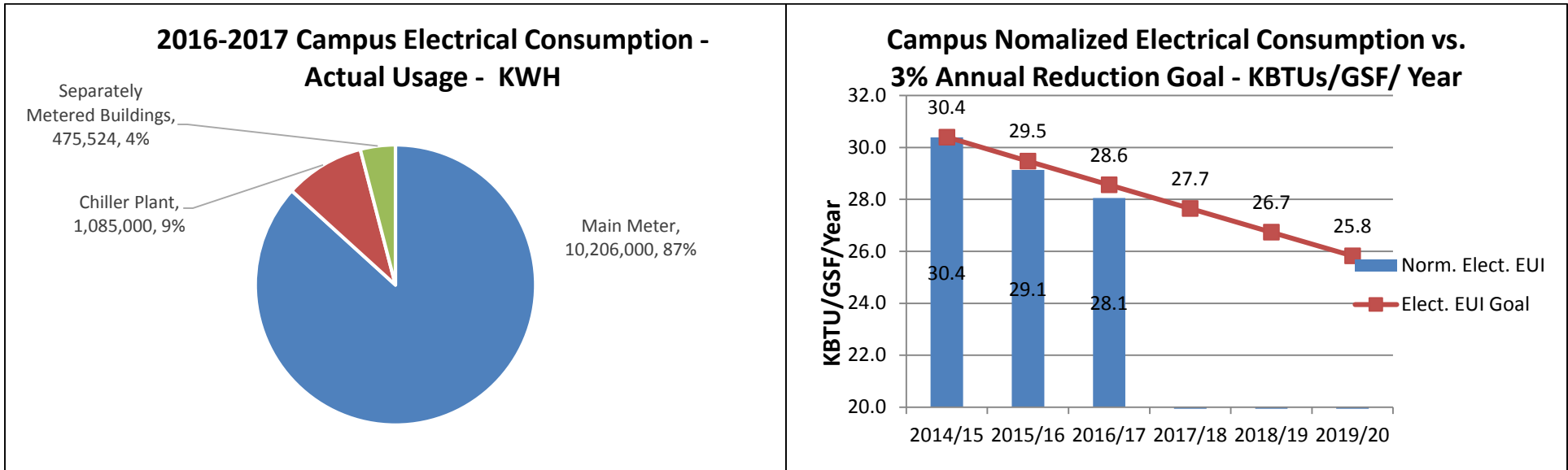
Boiler Plant Annual Fuel Consumption per Heating Degree Days & Campus Area



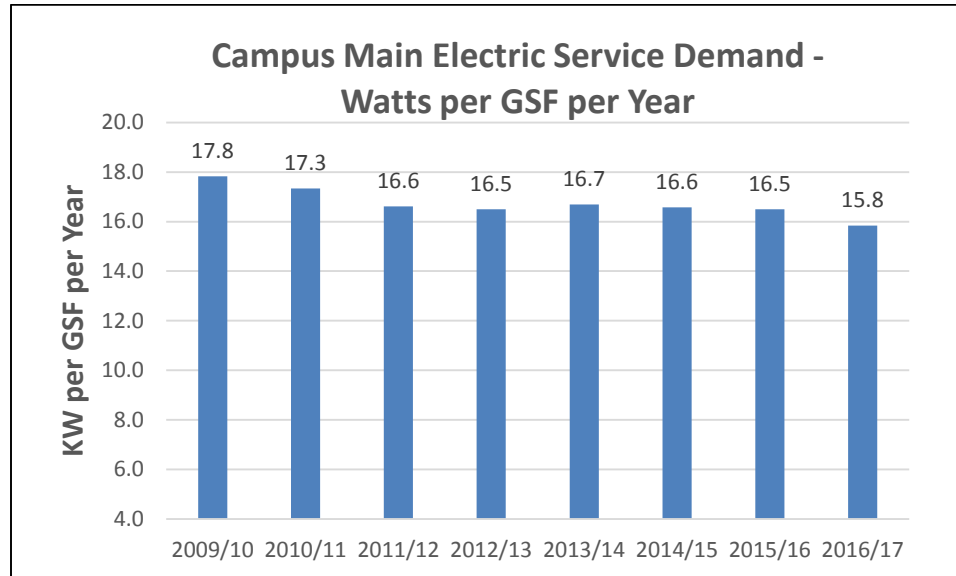
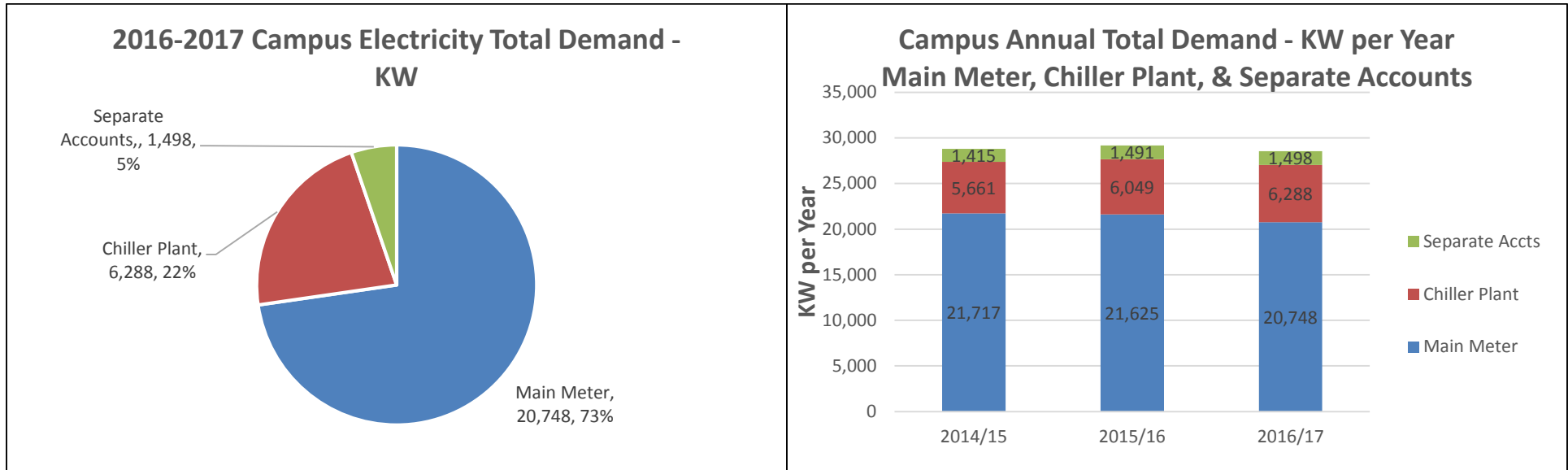
Campus Fuel Cost



Campus Electrical Consumption

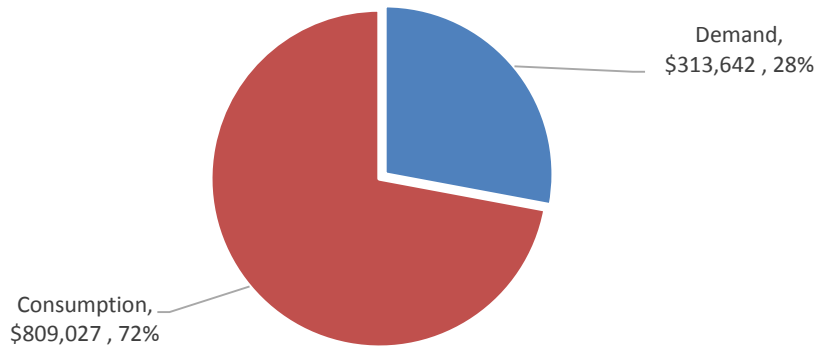


Campus Electrical Demand

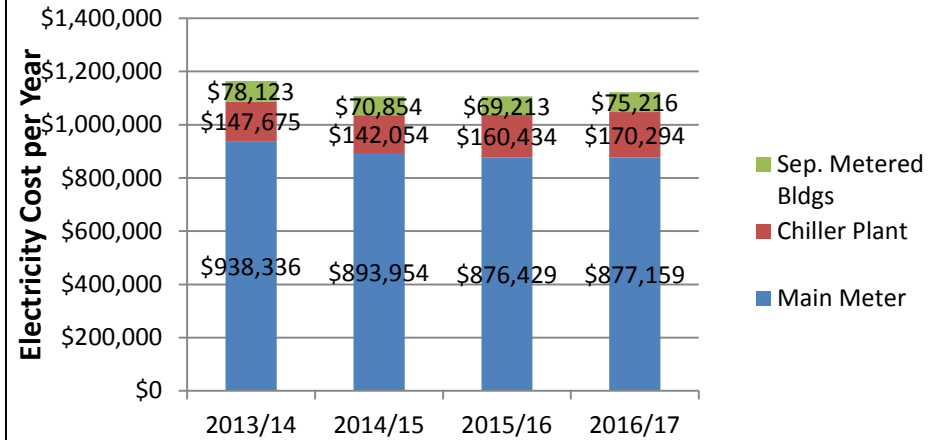


Campus Electrical Cost

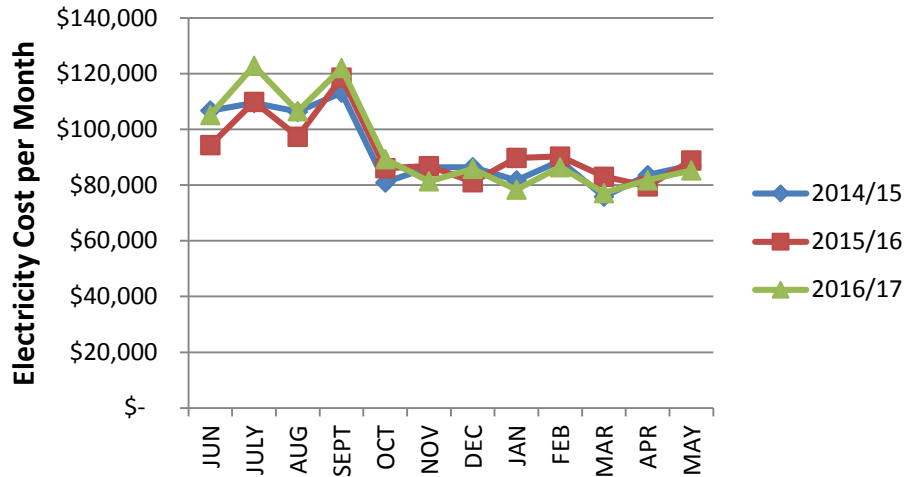
2016-2017 Electrical Consumption & Demand Costs



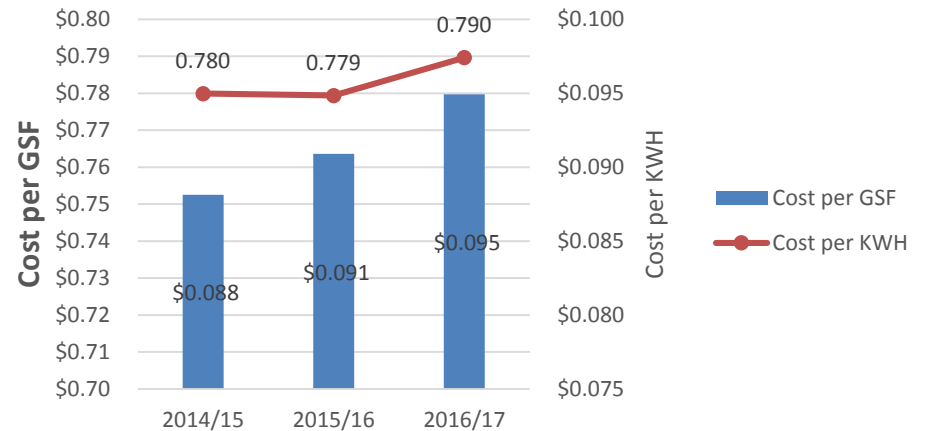
Campus Annual Electric Cost Summary



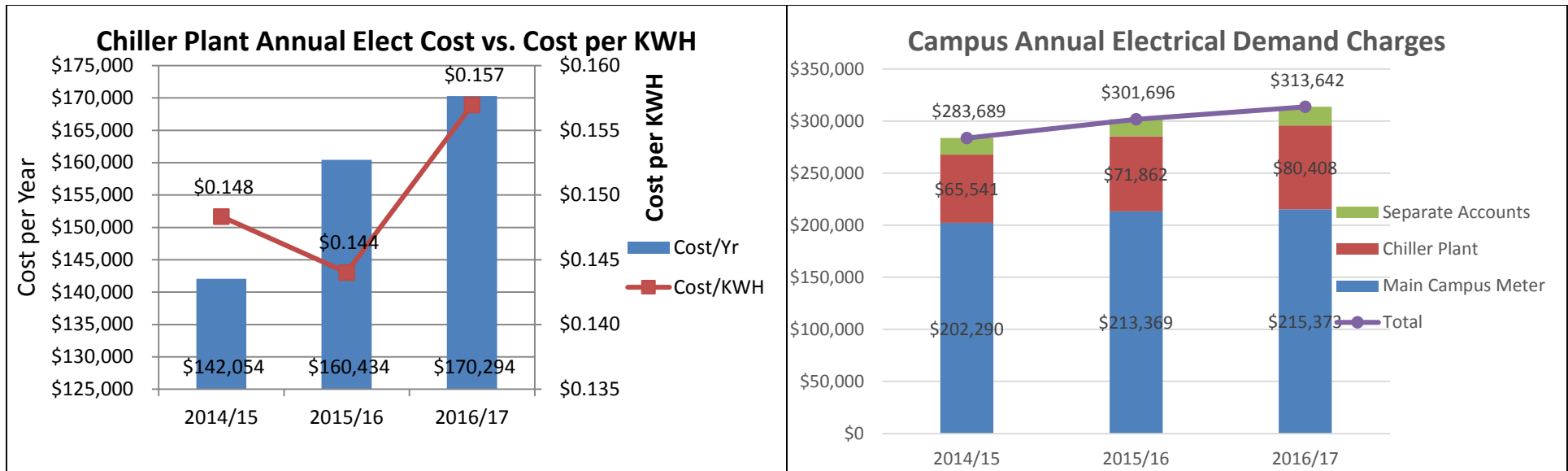
Campus Monthly Electricity Costs - Last 3 Years



Campus Electricity - Cost per GSF vs. Cost per KWH

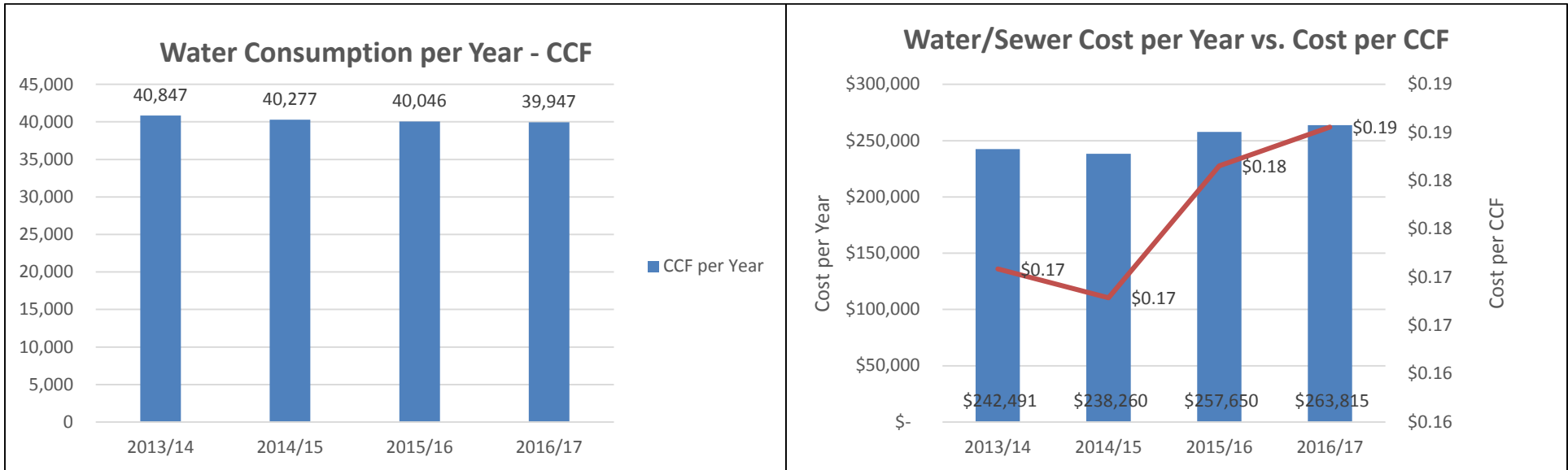


2016 -2017 Macalester College Campus Energy Use Report

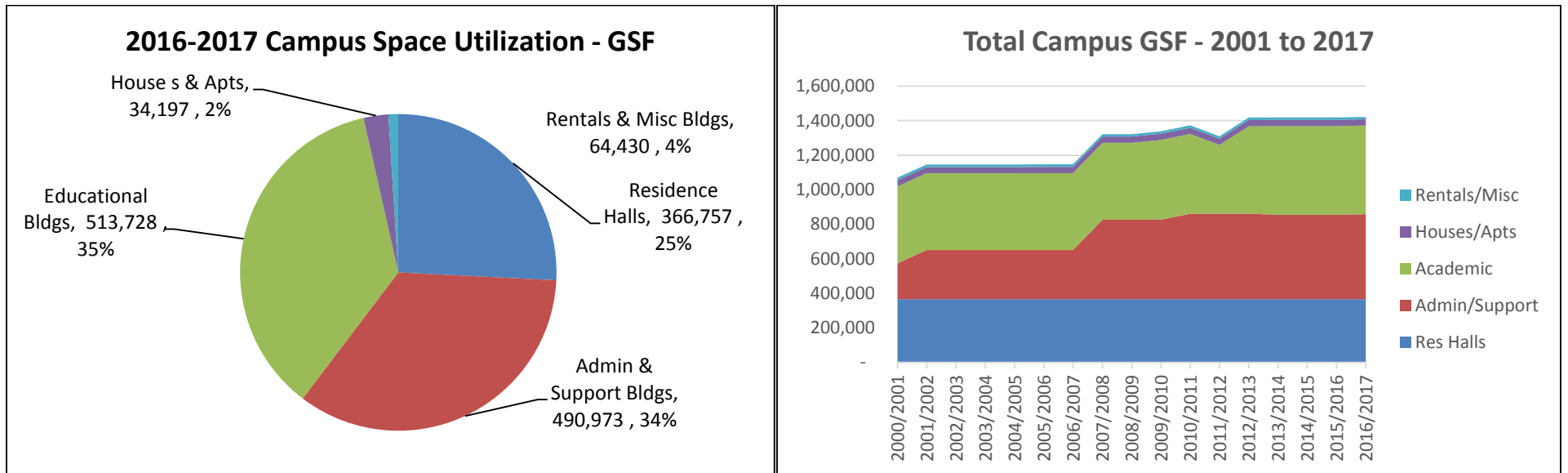


2016 -2017 Macalester College Campus Energy Use Report

Water Consumption & Costs

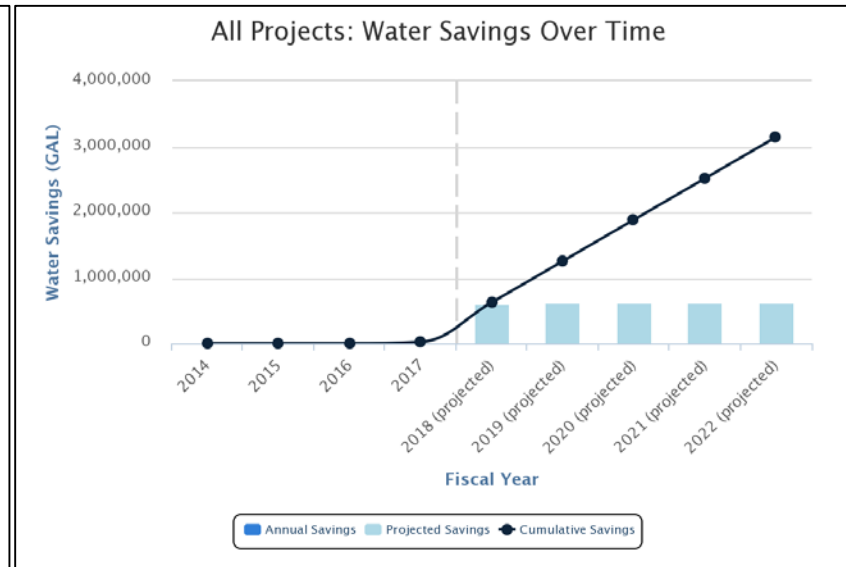
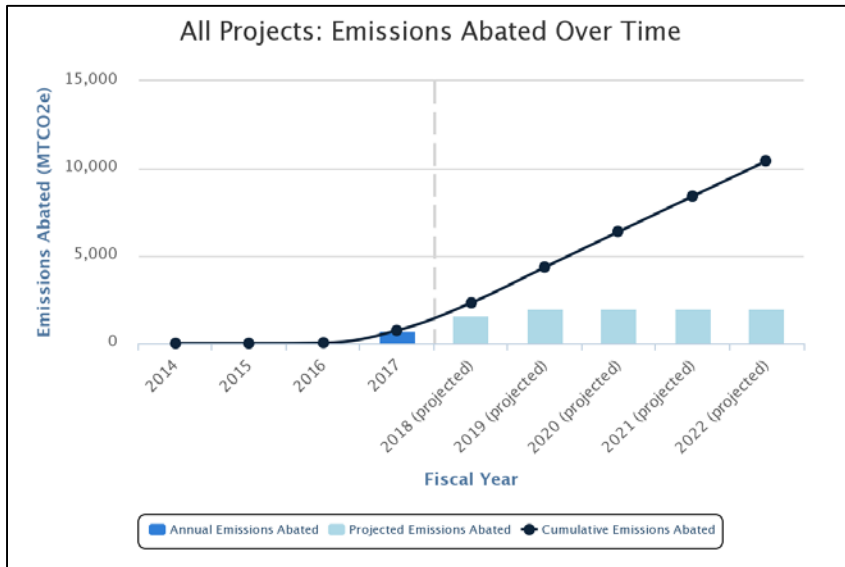
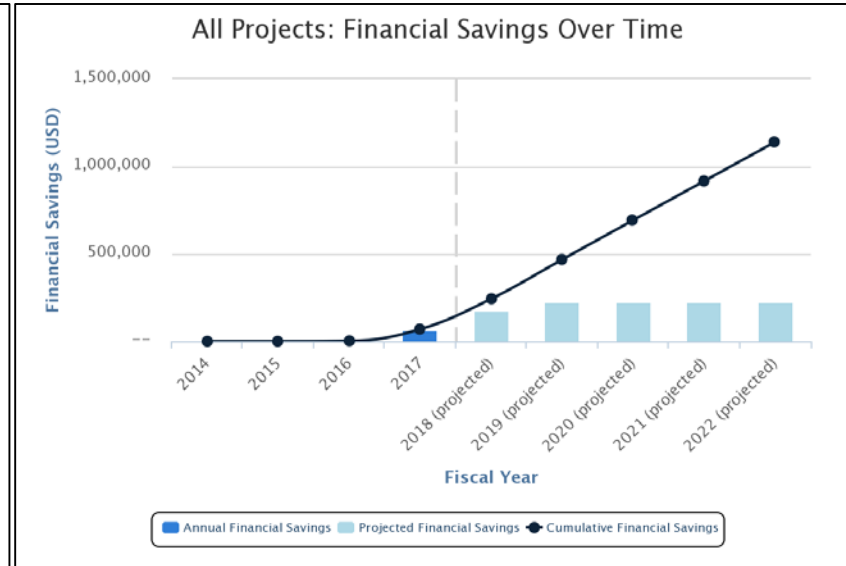
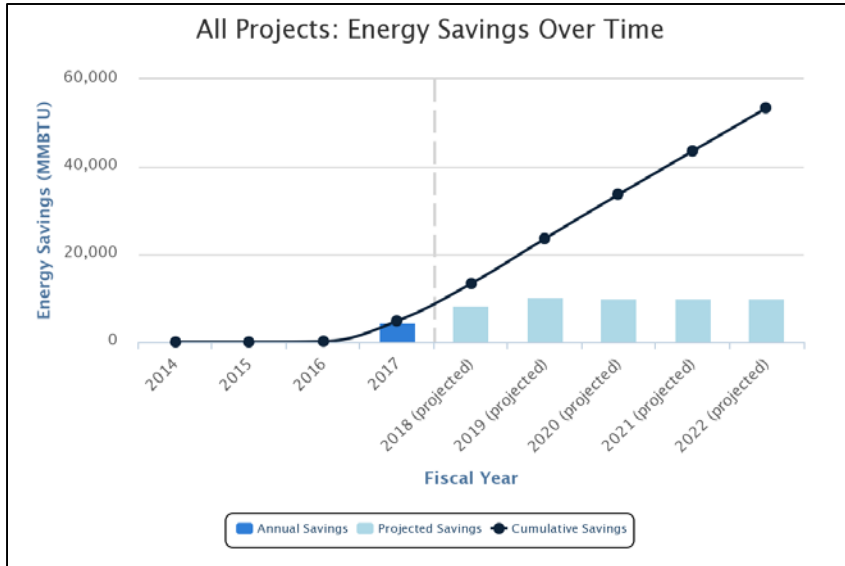


Campus Square Footage Information



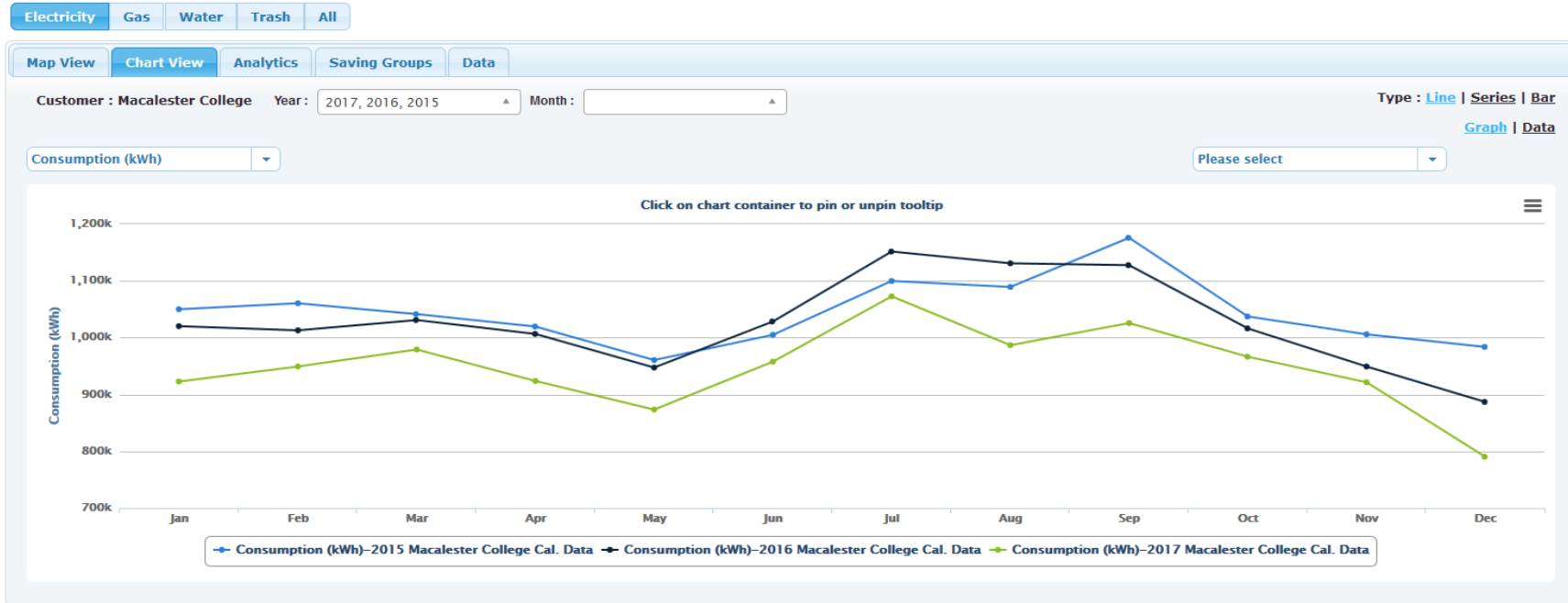
2016 -2017 Macalester College Campus Energy Use Report

2016-2017 GRITS Energy Project Data



2016 -2017 Macalester College Campus Energy Use Report

kWh360 Main Campus Electric Service Utility Bill Data



Electricity Gas Water Trash All

Map View Chart View Analytics Saving Groups Data

Customer : Macalester College Versus: Saving/Loss Graph | Statistics

Weather Normalized (Base Year : 2015)

Export to

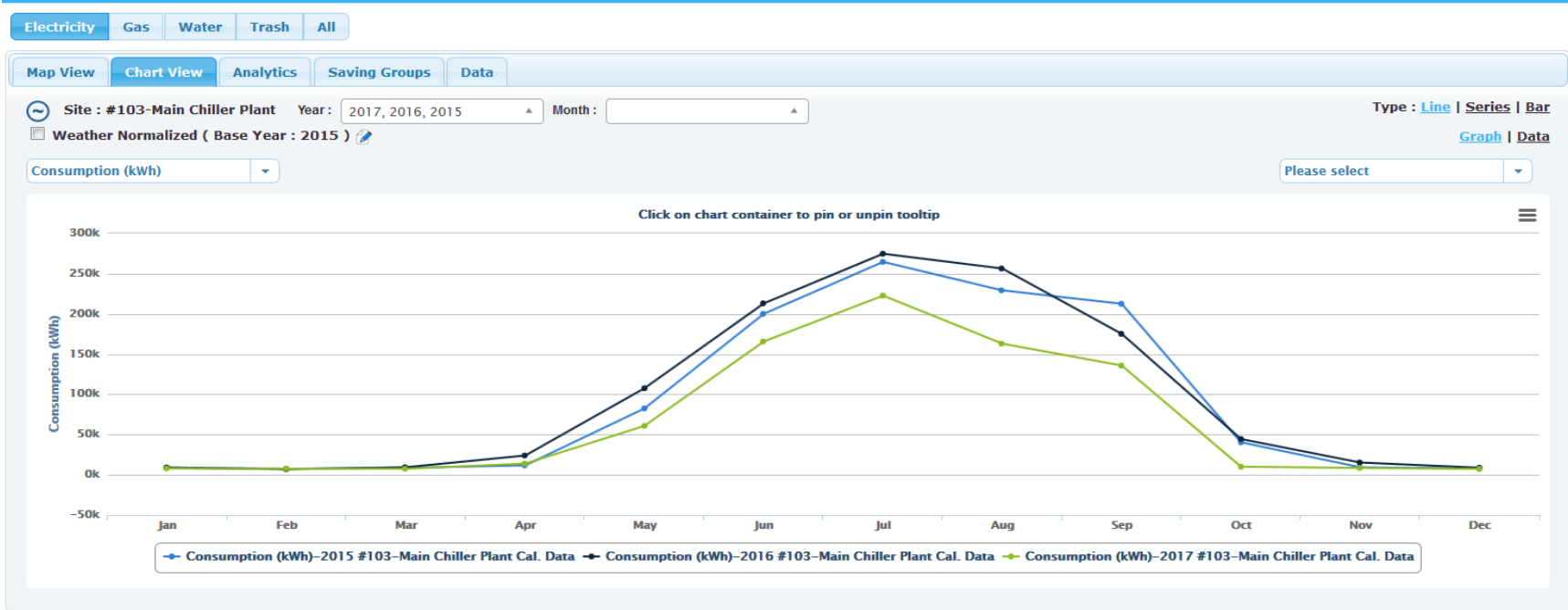
Year	Total Consumption (kWh)	Average kW (kW)	Total amount (\$)	Average Rate (\$/kWh)	Projected kWh (kWh)	Total Consumption Increase/Decrease (kWh)	Projected Amount (\$)	Total Cost Increase/Decrease (\$)
2017	11,370,525	1,314	\$1,105,400	0.168	12,388,387	-1,017,862	\$1,219,169	-\$113,768
2016	12,310,229	1,402	\$1,164,908	0.178	12,529,846	-219,617	\$1,179,197	-\$14,287
2015	12,530,192	1,431	\$1,110,508	0.160	12,530,194	-2	\$1,110,510	\$0

Total Consumption Saving (kWh) : -1,237,481 Total Saving : -\$128,055

*Note: Negative savings value = decrease in amount spent for utility; positive value = increase in expenditure

2016 -2017 Macalester College Campus Energy Use Report

kWh360 Chiller Plant Electric Service Utility Bill Data



Electricity Gas Water Trash All

Map View Chart View Analytics Saving Groups Data

Site : #103-Main Chiller Plant Versus : Saving/Loss Base Year : 2015 (defined)

Weather Normalized (Base Year : 2015)

Graph | Statistics Export to

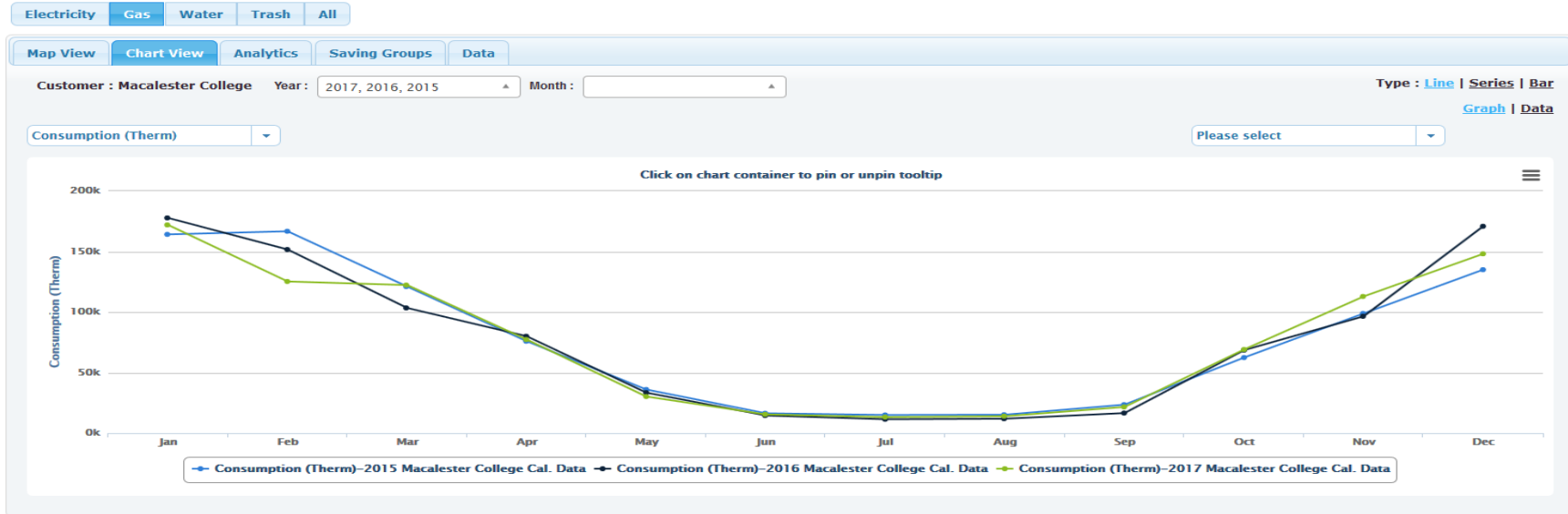
Year	Normalized Total Consumption (kWh)	Total Consumption (kWh)	Average kW (kW)	Total amount (\$)	Average Rate (\$/kWh)	Projected kWh (kWh)	Total Consumption Increase/Decrease (kWh)	Projected Amount (\$)	Total Cost Increase/Decrease (\$)
2017	812,350	917,380	106	\$157,290	0.171	1,083,436	-166,056	\$185,686	-\$28,396
2016	1,145,656	1,140,088	130	\$177,410	0.156	1,083,634	56,454	\$168,603	\$8,807
2015	1,083,634	1,083,634	124	\$155,150	0.143	1,083,634	0	\$155,150	\$0

Total Consumption Saving (kWh) : -109,602 Total Saving : -\$19,589

*Note: Negative savings value = decrease in amount spent for utility; positive value = increase in expenditure

2016 -2017 Macalester College Campus Energy Use Report

kWh360 Natural Gas Utility Bill Data



Electricity **Gas** Water Trash All

Map View **Chart View** **Analytics** Saving Groups Data

Customer : Macalester College Versus :

Weather Normalized (Base Year : 2015)

[Graph](#) | [Statistics](#)

Export to

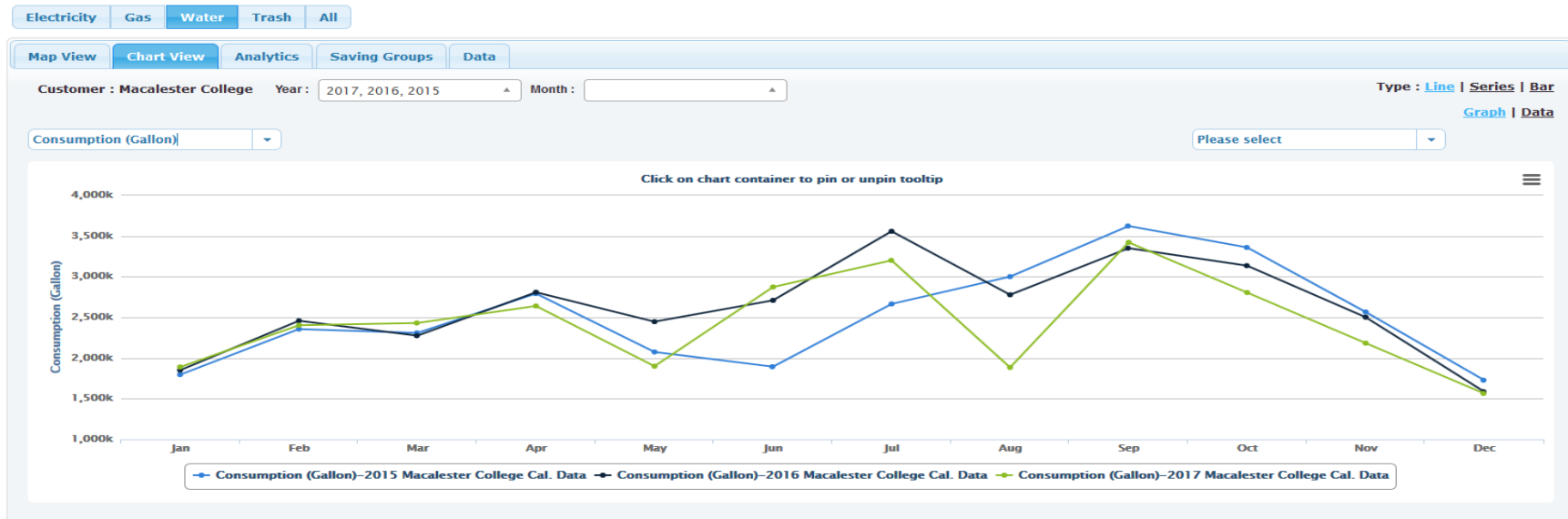
Year	Normalized Total Consumption (Therm)	Total Consumption (Therm)	Total amount (\$)	Average Rate (\$/Therm)	Projected Consumption (Therm)	Total Consumption Increase/Decrease (Therm)	Projected Amount (\$)	Total Cost Increase/Decrease (\$)
2017	921,444	1,091,264	\$470,531	0.760	1,029,739	61,525	\$444,755	\$25,782
2016	937,089	1,166,179	\$432,199	0.719	1,144,293	21,886	\$420,392	\$11,809
2015	930,737	1,144,565	\$490,868	0.799	1,144,564	1	\$490,868	\$0

Total Consumption Saving (Therm) : 83,412 Total Saving : \$37,591

*Note: Negative savings value = decrease in amount spent for utility; positive value = increase in expenditure

2016 -2017 Macalester College Campus Energy Use Report

kWh360 Water/Sewer Utility Data



Electricity Gas **Water** Trash All

Map View Chart View **Analytics** Saving Groups Data

Customer : Macalester College Versus :

[Graph](#) | [Statistics](#)
 Export to

Year	Total Consumption (Gallon)	Total amount (\$)	Average Rate (\$/Gallon)	Projected Consumption (Gallon)	Total Consumption Increase/Decrease (Gallon)	Projected Amount (\$)	Total Cost Increase/Decrease (\$)
2018	54,169	\$604	0.011	47,822	6,347	539	65
2017	29,198,823	\$270,482	0.013	29,051,445	147,378	269,367	-8,454
2016	27,615,280	\$233,955	0.011	25,807,986	1,807,294	220,228	13,728
2015	25,528,236	\$207,422	0.010	25,528,236	0	207,422	0

Total Consumption Saving (Gallon) : 1,961,019 Total Saving : \$5,339

*Note: Negative savings value = decrease in amount spent for utility; positive value = increase in expenditure

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