Updated Strategic Energy Plan

With Usage for FY 2017-2018

Submitted September 7th, 2018

Office of Sustainability & Energy Management

Facilities Management

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Special thanks to the HVAC, Plumbing, and Electric Shop without which none of the energy and cost savings measures could have been implemented without.

Western Carolina UNIVERSITY

Executive Summary

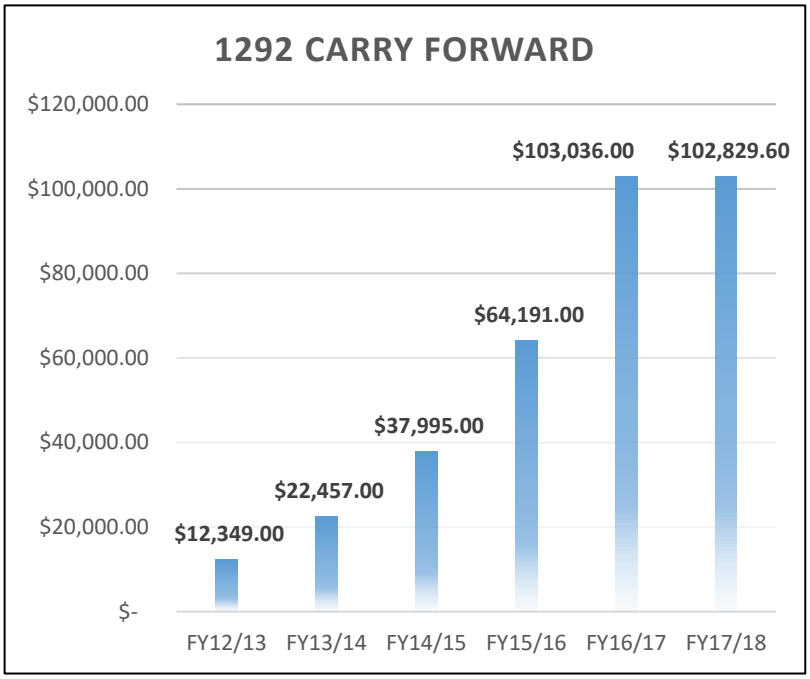
Approach

WCU's approach to Energy Management continues to focus on demand-side management by implementing no-cost to low-cost proven conservation and energy efficiency measures first. This is accomplished via the building automation system (BAS) which is software that operates two-thirds of the campus heating, ventilation, and air conditioning (HVAC) which can represent 40-50% of a building's total energy usage (*EIA, 2017*).

"You can't manage what you don't measure." While this is an old business adage, it is also central to energy management at WCU. With the upgrade to ultra-sonic steam condensate meters at near completion, WCU can now benchmark building energy performance on a larger scale than ever before. This has brought to light that five buildings account for almost 25% of all utility costs on campus (see pg. 4). **Since FY12/13, meter upgrades along with House Bill (HB) 1292 energy savings have resulted in a total avoided cost of almost $650,000.**

Summary of Fiscal Year 17/18:

- HB 1292 Carry Forward which documents energy saving projects has grown from $12,349 in FY12/13 to $102,830 in FY17/18 **($330,509 to date)**
- Recovered steam revenue in FY17/18 was $135,422 (**$318,566** over the past three years since upgrading to ultra-sonic).
- Re-tuning and scheduling efforts at the Health and Human Science Building have reduced energy usage by 21% and reduced chiller starts by 77%.



- Commissioning of Brown Dining Hall BAS and HVAC systems helped identify and address issues within the one year warranty period. Building meets and exceeds ENERGY STAR qualifications by almost 20%.
- STEM – Lab ventilation risk assessment, advanced building control strategies, and fault detection and diagnostics (FDD) underway in order to lower operational costs and meet aggressive ENERGY STAR target.
- Total Utilities for **FY17/18 - $4,075,046** (Electric - $2,699,481, NG - $878,778, Water - $417,087)

This document summarizes the past fiscal year's usage along with an update on past goals and future focus which is determined based on feedback from current projects and increasing meter data.

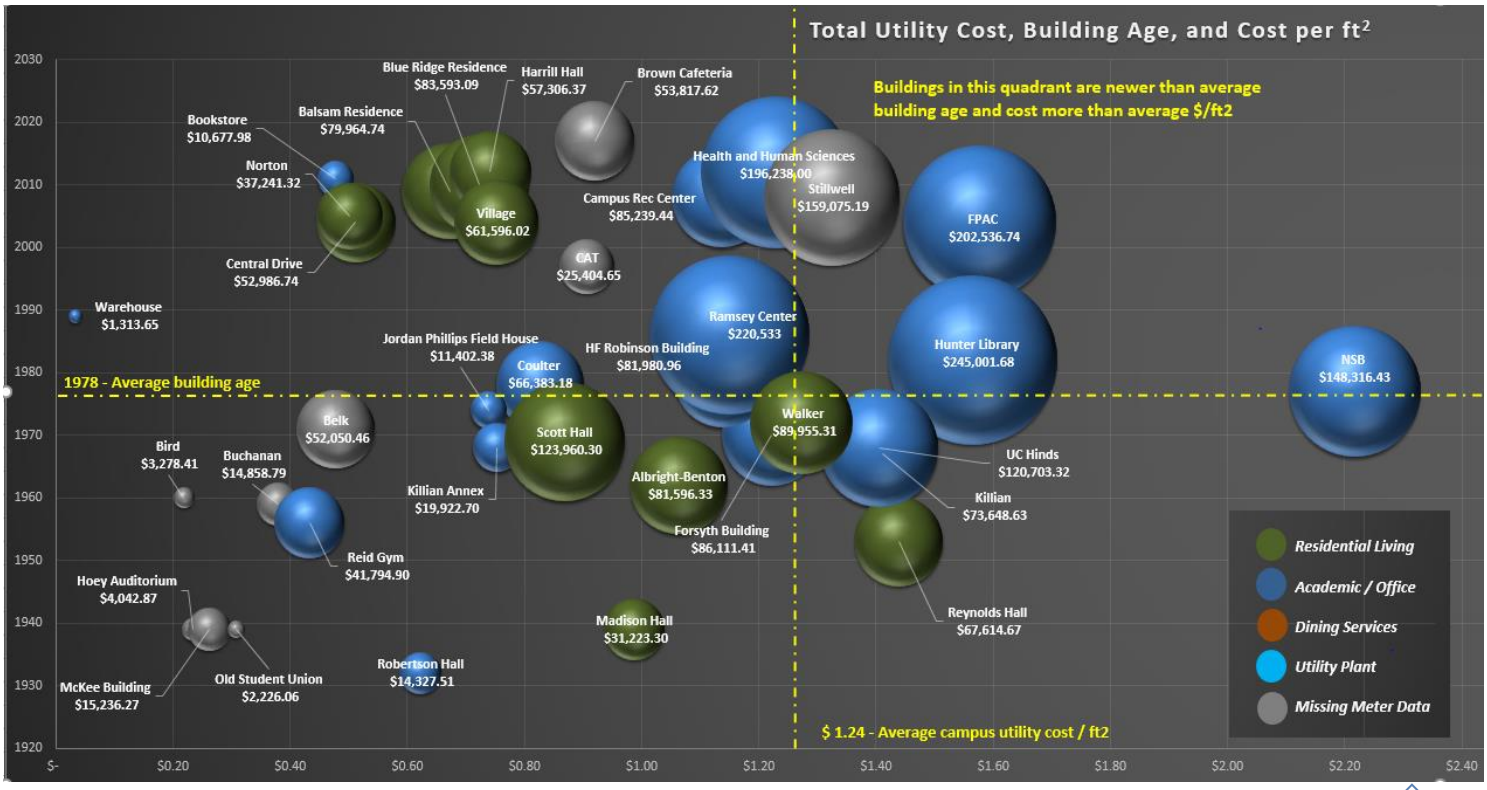
FY17/18 Usage

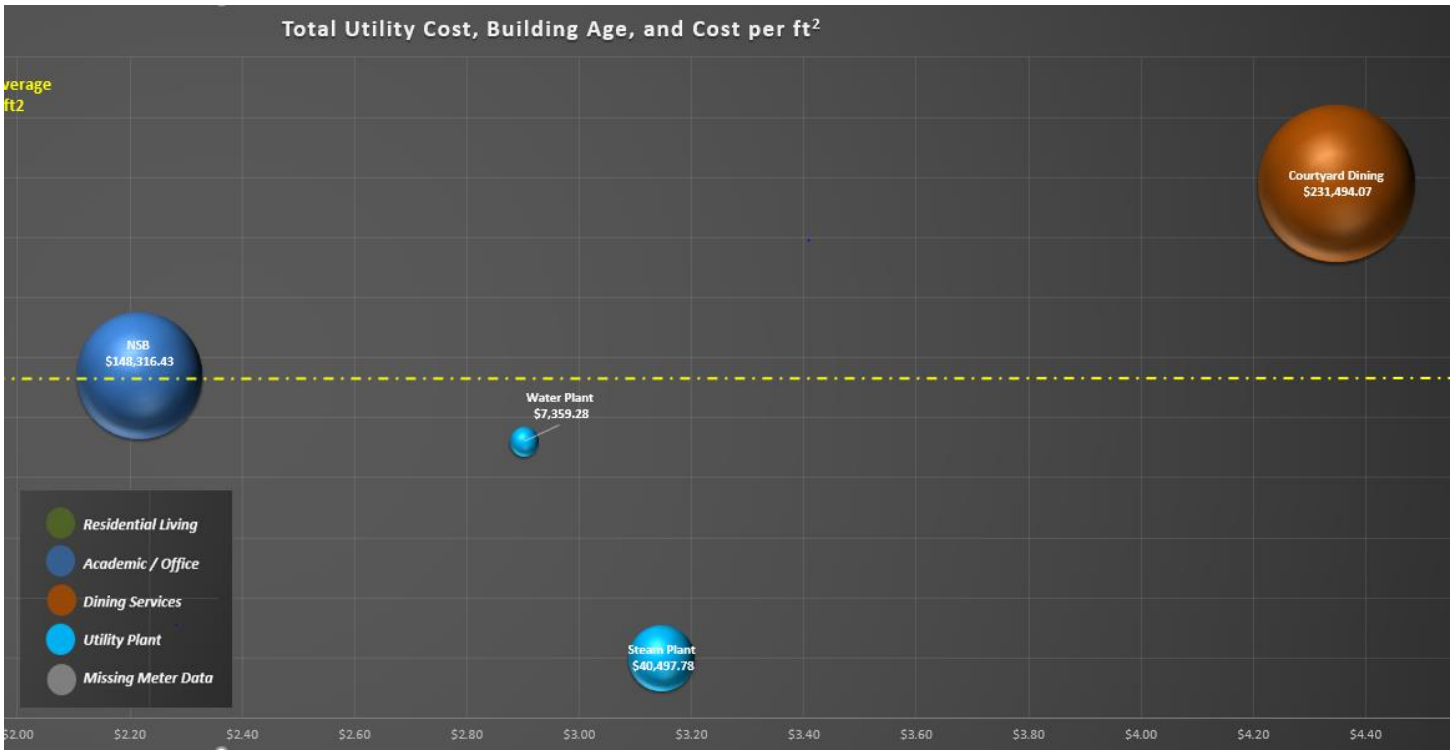
WCU currently stands at a 42% reduction in energy usage intensity (EUI) compared to the baseline year of 2002-2003. While this is less than the previous year's reduction of 44%, there was also an increase in heating demand (a more granular analysis is needed to determine the impact of weather on energy usage). Current level exceeds the State Energy Office's Utility Savings Initiative of 40% by 2025.

Overall, the utility cost per square foot (electric, natural gas, and water) remained the same as last year at $1.24/ft^2 (while natural gas usage increased, electric usage decreased). Compared to other universities in the UNC system, WCU is the eight lowest out of seventeen in terms of energy usage per square foot (kBTUs / ft^2). While done in the nature of friendly competition, comparison to other universities is often discouraged as a campus heavy with lab and engineering buildings will typically use more energy than a liberal arts campus. There is also the varying climate zones across North Carolina that make it difficult to compare Boone to Wilmington. Another significant factor to usage is the age of the buildings, their mechanical equipment, and the building envelope that contains them.

With additional sub-metering and more data available, we have a more complete picture of total energy usage and can examine the relationship between building age and energy usage.

When the average age of the 40 largest buildings on campus (1978) is graphed against the energy cost per square foot, we are able to see a building like the Fine and Performing Arts Center (FPAC) is newer than 1978, yet costs much more than the campus average of $1.24/ft^2 to operate.





Buildings above the average age and to the right of the campus average merit further investigation. Dining services, lab buildings, and utility plants not surprisingly cost more per square foot to operate and should be compared to buildings of similar end use. However, note on the continuation of this graph how much further away Courtyard Dining is to the rest of campus. It's energy usage intensity (EUI) of 293 kBTUs / ft^2 is indeed higher than the national median value of 224 kBTUs / ft^2 (ENERGY STAR, 2014) and represents an opportunity to improve operational costs.

This analysis also brought to light that the five most expensive buildings represent almost 25% of campus utilities. Focus on improving the operations and / or equipment in those top five buildings would be the most effective use of time and resources. As previously mentioned, re-tuning of the existing equipment and improved scheduling has already decreased usage at HHS by 21% since its first year of operation. Variable frequency drives (VFDs) are currently being added to the air handlers at the

Building	Sum of Cost per ft2	Built	Sum of Building cost	% of Campus Utilities
Hunter Library	$ 1.56	1982	$ 245,001.68	5.4%
Courtyard Dining	$ 4.35	2009	$ 231,494.07	5.1%
Ramsey Center	$ 1.15	1986	$ 220,533.00	4.9%
FPAC	$ 1.58	2004	$ 202,536.74	4.5%
Health and Human Sciences	$ 1.23	2012	$ 196,238.00	4.3%
Stillwell	$ 1.32	2008	$ 159,075.19	3.5%
NSB	$ 2.22	1977	$ 148,316.43	3.3%
Scott Hall	$ 0.87	1969	$ 123,960.30	2.7%
UC Hinds	$ 1.41	1968	$ 120,703.32	2.7%
Walker	$ 1.27	1972	$ 89,955.31	2.0%
Forsyth Building	$ 1.22	1970	$ 86,111.41	1.9%
Campus Rec Center	$ 1.14	2008	$ 85,239.44	1.9%
Blue Ridge Residence	$ 0.72	2010	$ 83,593.09	1.8%
HF Robinson Building	$ 1.14	1979	$ 81,980.96	1.8%
Albright-Benton	$ 1.06	1962	$ 81,596.33	1.8%

Top 5 buildings represent 24% of campus utilities $1,095,803

Top 15 buildings represent 48% of campus utilities $2,156,335

Ramsey Center. While Hunter Library needs extensive mechanical upgrades, opportunities exist to improve the current operations at FPAC and Courtyard Dining. Additional programming software and training is to be purchased this fiscal year in order to initiate a re-tuning project at FPAC. A review of the current operating conditions of the HVAC equipment at Courtyard Dining is being considered especially in light of the data gathered above.

With the addition of a controls technician this coming fiscal year, much of this work can eventually be performed in-house with additional training and some outside consultation. The next section provides an update on FY2017/2018 and goals for the coming FY2018/2019.

Update for past FY2017/2018

- On-going steam meter upgrade recovered **$123,194** in previously uncaptured steam usage in FY17/18 **($306,339** since installation in FY15/16); 29 of 32 buildings on steam currently upgraded.

- Captured **$102,830** in energy related savings for 1292 Carry Forward in FY17/18 **($330,508** since FY13/14). Building automation system modifications to schedule and programming at Belk and Forsyth created additional savings to offset the loss of approximately $15,000 of steam condensate to new leaks in system.

- On-going re-tuning at HHS (optimization of building automation system to provide more free / available air-side cooling at the air handlers in-lieu of mechanical cooling from chiller) has saved not only energy, but has reduced number of starts on chiller by 77%.

- Events2HVAC scheduling software launched at Hinds University Center. This software takes the reservation schedule from 25Live and pushes schedule out to individual building automation controllers. Instead of running HVAC equipment from 7am – 11pm, 14 spaces can now run on 25Live schedule (i.e. 2pm-4pm from 25Live instead of 7am-11pm from the building automation schedule). In addition to energy savings, this reduces staff time required for scheduling events.

- Upgraded 90's era building automation system at Reynolds and Robertson Residence Halls. This will increase reliability and in-house ability to troubleshoot problems on critical heating and cooling systems.

- Commissioning of Brown Dining Hall BAS and HVAC systems helped identify and address issues within the one year warranty period (i.e. one zone enabling entire chiller / boiler, incorrect setpoint on boilers resulting in low efficiency, incorrect placement of hot water sensor on loop). Building meets and exceeds ENERGY STAR qualification by almost 20%.

- Along with HVAC staff, attended week-long Direct Digital Controls (DDC) Training through the University of Wisconsin in order to improve our understanding of building automation systems (two-thirds of existing campus HVAC) and to help prioritize our needs.

- Presented *Re-tuning at Health and Human Science Building, an Optimization of existing HVAC and Building Automation Systems* at NCAPPA.

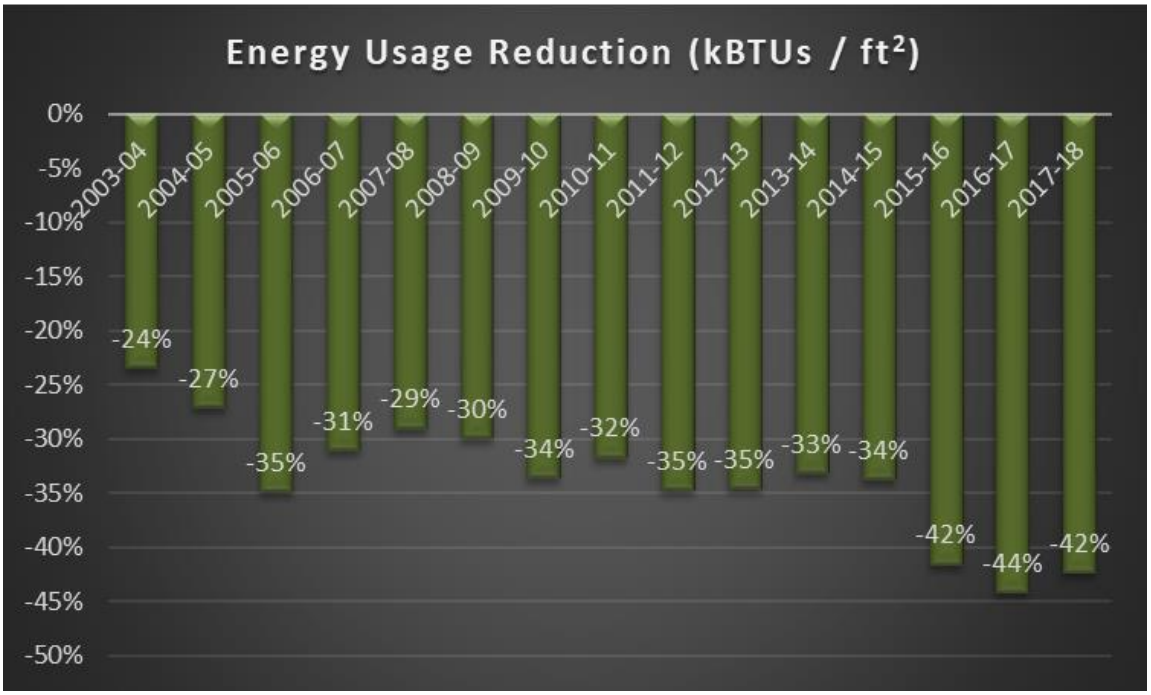
- Outreach - met with ABTech Sustainability Committee to share best energy practices at WCU.

- Presented on energy management and building automation systems to multiple construction management and environmental science classes on campus.

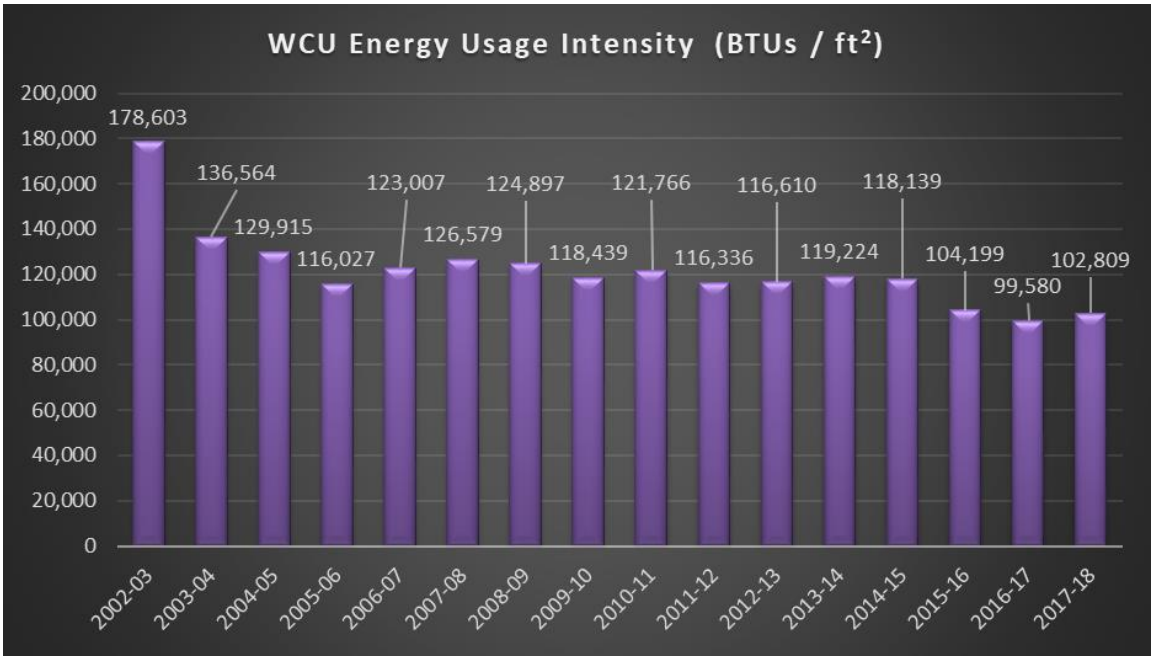
Goals for FY2018/2019

- Continue to work with engineering team on building control strategies for STEM.
- Install VFDs (variable frequency drives) on 25 air handlers at Ramsey as part of tiered controls upgrade project.
- Replace electric meter at Ramsey in order to track energy savings for controls upgrade.
- Roll-out Events2HVAC at the Health and Human Science Building (approximately 30 spaces currently reserved through 25Live).
- Obtain a copy and training on Schneider's Workplace Technician in order to increase in-house ability to resolve BAS issues and initiate re-tuning projects (i.e. FPAC).
- Prioritize buildings in need of BAS upgrades that no longer have building level controllers available or lack manual over-ride ability.
- Start new controls technician position on alarm management optimization of critical equipment (i.e. chillers, boilers, and air-handlers).
- Install 4 BTU meters for Hunter Library chiller plant. Currently no way of measuring chilled water usage at Hunter, Stillwell, Hoey, or McKee.
- Install ultrasonic meter at Balsam cooling towers, currently un-metered. Estimated $5,000 - $6,000 in potential annual avoided sewer charges based on other cooling tower data.
- Integrate electric vehicle charging station meters with building automation system for data collection and make data available to students and classes.
- Address humidity issues at FPAC Museum (additional engineering underway)

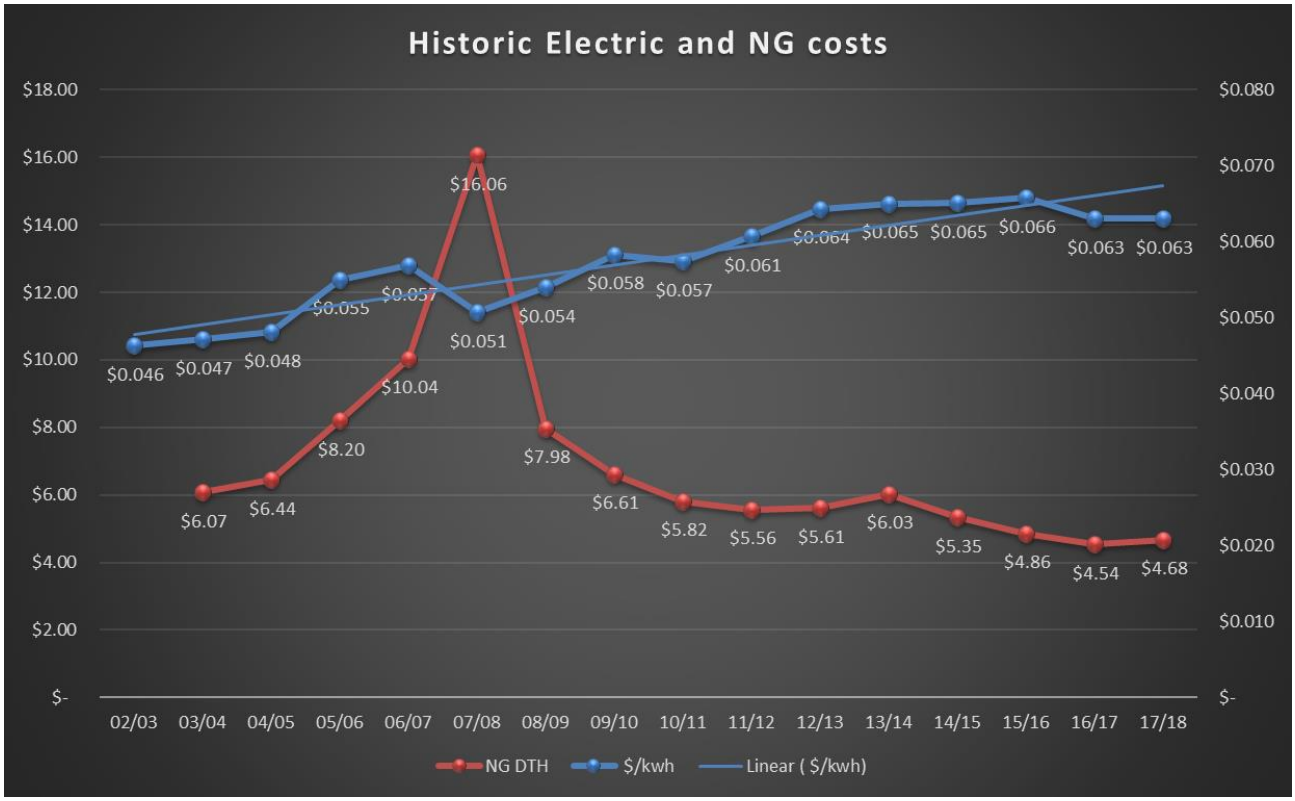
Addendum



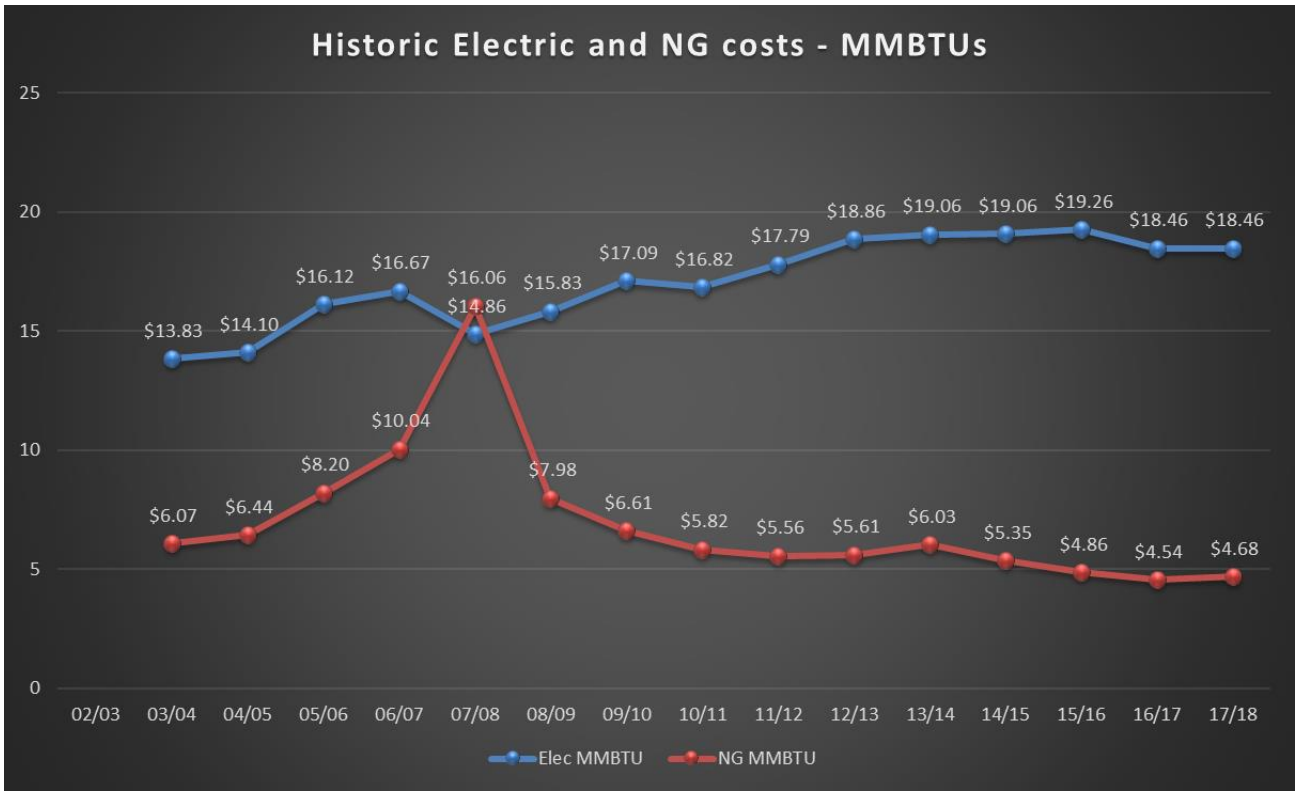
Compared to baseline FY 2002/2003



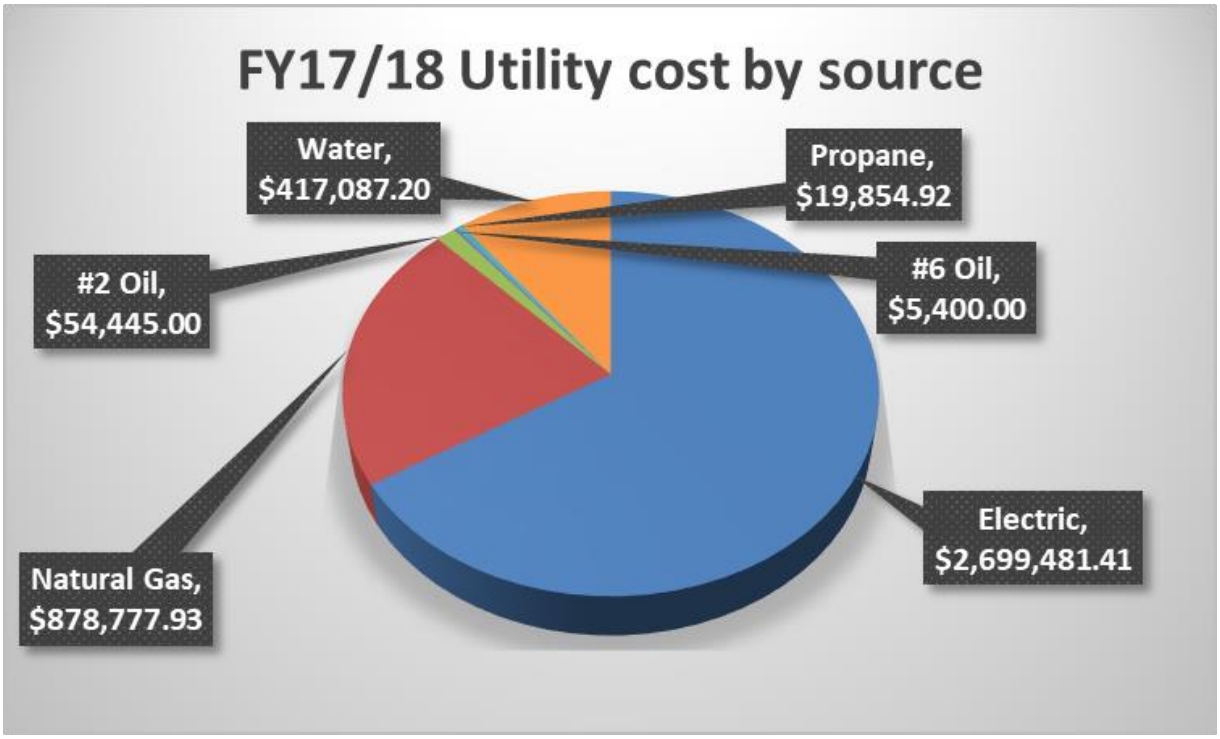
Compared to baseline FY 2002/2003; One BTU is equal to the energy in one match, WCU used the equivalent of 102,809 matches per square foot in FY17/18.



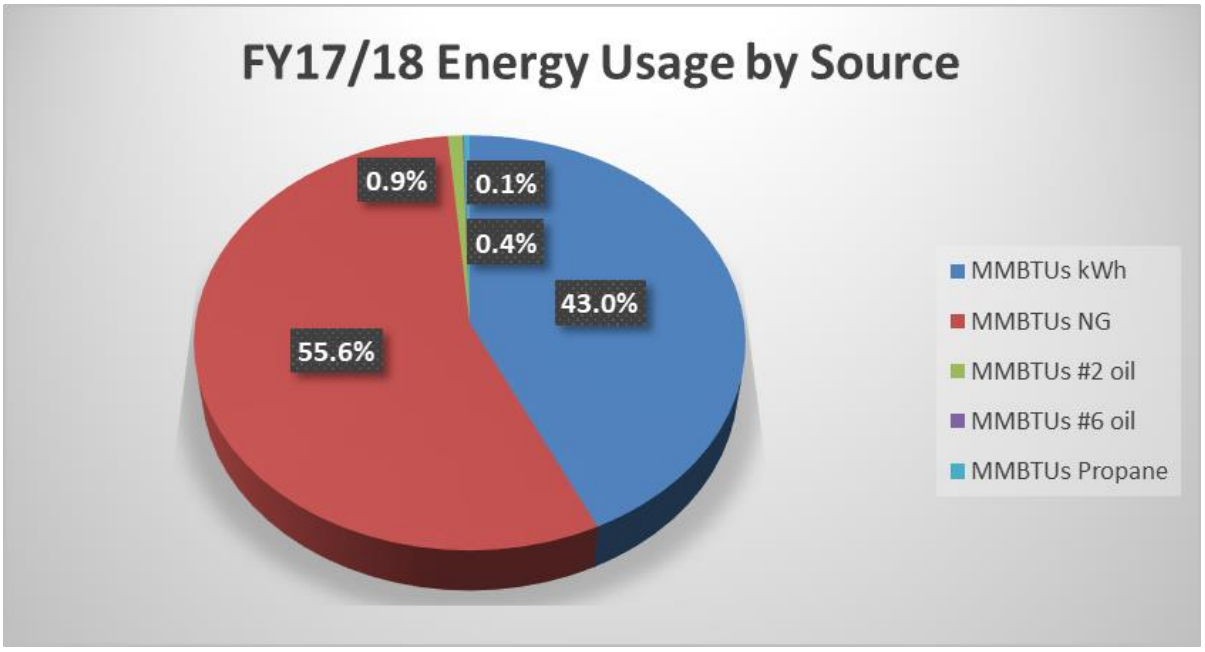
Electric cost per kWh and Natural Gas cost per Dekatherm (DTH)



Cost comparison for equal amount of energy (1,000,000 BTUs) ; electric almost 4x the cost to provide same amount of heat



Electric accounts for 66% of all utility costs ($2,699,481 / $4,075,046)



However, electric accounts for only 43% of campus usage compared to natural gas (NG) at 55.6%. Greater cost savings achieved by reducing electrical usage, while there are greater BTU savings in reducing natural gas usage

Fiscal Year	Total Utilities	Gross Square Footage	Total Utility Cost per Gross ft2	Total MMBTUs	$ / MMBTU	% change MMBTU	kBTU/ft2	% change kBTU/ft2
2002-03	$3,075,813	2,355,330	$1.31	420,668	$6.36	0	178,603	0
2003-04	$3,300,828	2,355,330	$1.40	321,653	$9.19	-24%	136,564	-24%
2004-05	$3,798,840	2,734,121	$1.39	355,204	$9.60	-16%	129,915	-27%
2005-06	$4,385,079	2,734,121	$1.60	317,233	$12.81	-25%	116,027	-35%
2006-07	$4,404,131	2,843,308	$1.55	349,747	$11.66	-17%	123,007	-31%
2007-08	$4,878,278	2,790,749	$1.75	353,251	$12.90	-16%	126,579	-29%
2008-09	$4,388,322	2,863,949	$1.53	357,698	$11.36	-15%	124,897	-30%
2009-10	$4,187,337	2,798,946	$1.50	331,504	$11.71	-21%	118,439	-34%
2010-11	$4,175,587	2,911,228	$1.43	354,487	$10.92	-16%	121,766	-32%
2011-12	$4,293,145	2,954,814	$1.45	343,751	$11.51	-18%	116,336	-35%
2012-13	$4,572,035	3,105,538	$1.47	362,137	$11.78	-14%	116,610	-35%
2013-14	$4,912,535	3,103,210	$1.58	369,976	$12.39	-12%	119,224	-33%
2014-15	$4,682,160	3,103,210	$1.51	366,611	$11.77	-13%	118,139	-34%
2015-16	$4,099,823	3,103,210	$1.32	323,352	$11.59	-23%	104,199	-42%
2016-17	$4,001,151	3,223,781	$1.24	321,023	$11.19	-24%	99,580	-44%
2017-18	$4,075,046	3,282,381	$1.24	337,458	$10.84	-20%	102,809	-42%

Historic Utility Costs

Western Carolina University

1292 Carry Forward

Project	Description	FY12/13	FY13/14	FY14/15	FY15/16	FY16/17	FY17/18	Total to date
HFR renovation	*HVAC / controls upgrade*	$ 12,349.00	$ 12,097.00	$ 13,518.00	$ 12,481.00	$ 12,673.00	$ 12,193.00	
Make-up water savings	*Campus wide condensate repairs*		$ 3,482.00	$ 7,783.00	$ 15,118.00	$ 15,893.16	$ 10,297.23	
Make-up water savings BTU savings	*Campus wide condensate repairs*		$ 6,878.00	$ 16,694.00	$ 25,806.00	$ 24,645.71	$14,949.49	
HHS Savings	*Retuning and Scheduling projects*				$ 10,786.00	$ 37,184.14	$ 41,532.68	
Fine and Performing Arts	*Scheduling improvement*					$ 12,639.99	$ 13,473.75	
Belk AHU schedule	*Scheduling improvement*						$ 4,150.05	
Forsyth AHU programming	*Programming modification*						$ 6,233.40	
		$ 12,349.00	**$ 22,457.00**	**$ 37,995.00**	**$ 64,191.00**	**$ 103,036.00**	**$ 102,829.60**	**$ 330,508.60**

House Bill 1292 Energy Carry Forward Savings – an additional $10,383 picked up with improvements at Belk and Forsyth helped offset losses in steam condensate system

Recovered Steam Revenue

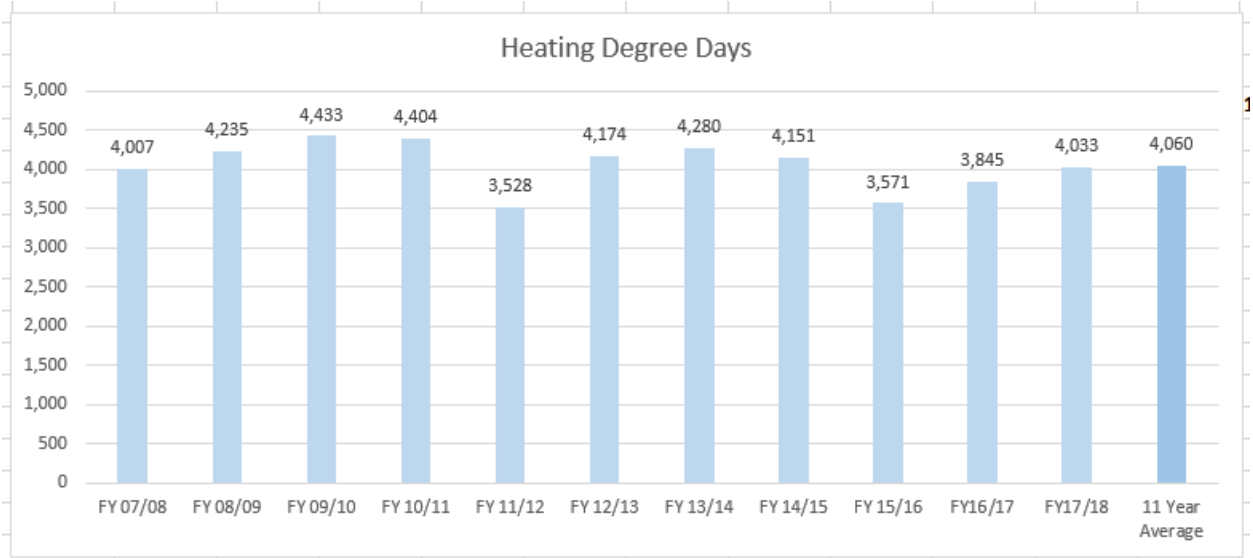
	FY15/16 (10 months)*	FY16/17	FY17/18	Total to Date
Albright Benton	$ 16,977.64	$ 14,473.66	$ 15,752.49	$ 47,203.79
Balsam	$ 7,659.29	$ 12,991.98	$ 15,306.29	$ 35,957.56
Blue Ridge	$ 3,220.14	$ 1,244.33	$ 2,987.01	$ 7,451.47
Central Drive	$ 15,121.23	$ 19,247.58	$ 22,007.90	$ 56,376.71
Courtyard	$ 37,841.16	$ 34,576.95	$ 50,434.20	$ 122,852.31
Scott	$ (1,324.95)	$ (336.29)	$ (462.10)	$ (2,123.34)
Walker	$ 14,636.66	$ 15,452.59	$ 26,862.85	$ 56,952.10
University Center	$ (1,334.15)	$ (7,729.62)	$ 2,533.34	$ (6,104.56)
	$ 92,797.03	**$ 89,921.17**	**$ 135,421.98**	**$ 318,566.05**
FY NG cost per DTH	$ 4.86	$ 4.63	$ 4.73	

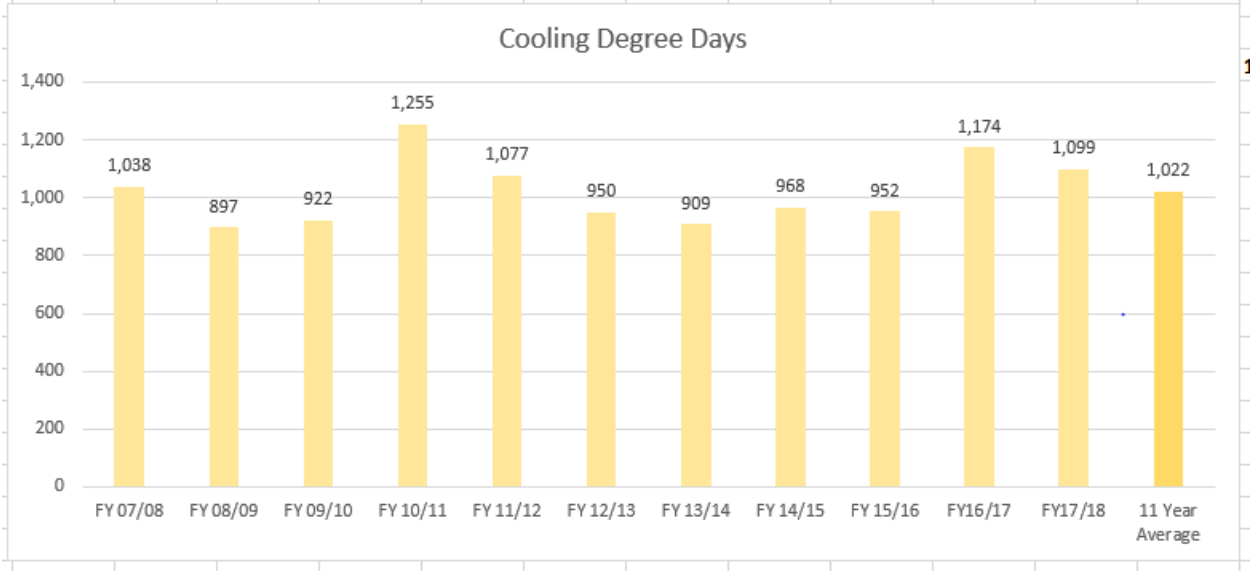
**savings achieved despite 11.5% decrease in natural gas cost compared to previous FY14/15*

Recovered Steam Revenue from campus wide meter upgrade

Building	17/18 Total
FPAC	7,767,064
Stillwell	7,261,513
Hunter Library	7,170,635
Courtyard Dining	7,105,057
Scott Hall	6,578,244
Belk	4,639,776
NSB	4,415,448
Walker	4,399,929
Albright-Benton	4,164,479
Reynolds Hall	3,064,454
HF Robinson Building	2,875,555
Reid Gym	2,635,780
Central Drive	2,631,970
Balsam Residence	2,224,240
Brown Cafeteria	2,002,664
Killian	1,937,581
Blue Ridge Residence	1,673,439
Campus Rec Center	1,545,311
McKee Building	1,310,421
Forsyth Building	1,216,216
UC Hinds	805,130
Madison Hall	767,572
Killian Annex	703,395
Robertson Hall	402,530
Hoey Auditorium	327,657
Bird	251,790

Steam usage (lbs.) for FY17/18, five of the top ten buildings previously not metered; 12 months of data not available for buildings in gray


Heating Degree Days
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
4,007
4,235
4,433
4,404
3,528
4,174
4,280
4,151
3,571
3,845
4,033
4,060
FY 07/08
FY 08/09
FY 09/10
FY 10/11
FY 11/12
FY 12/13
FY 13/14
FY 14/15
FY 15/16
FY16/17
FY17/18
11 Year Average


Cooling Degree Days
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1,200
1,000
800
600
400
200
0
1,038
897
922
1,255
1,077
950
909
968
952
1,174
1,099
1,022
FY 07/08
FY 08/09
FY 09/10
FY 10/11
FY 11/12
FY 12/13
FY 13/14
FY 14/15
FY 15/16
FY16/17
FY17/18
11 Year Average