Updated Strategic Energy Plan

With Usage from FY 2018-2019

Submitted August 29th, 2019

Office of Sustainability & Energy Management

Facilities Management

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Special thanks to Duane Strain, our new Controls Technician, as well as our HVAC, Plumbing, and Electric Shops

Western Carolina UNIVERSITY

Executive Summary

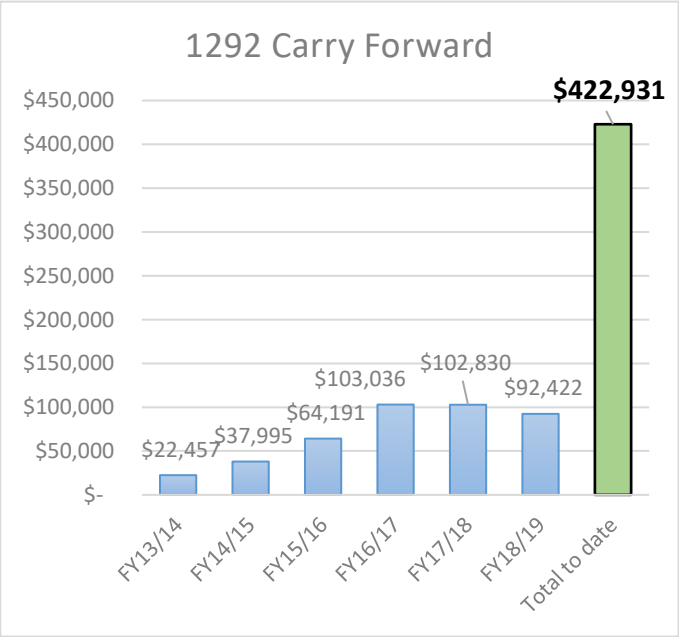
Approach

Commercial buildings waste on average 30% of their energy (*DOE, 2019*). WCU's approach to Energy Management therefore focuses 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 completed, **WCU is now able to benchmark energy usage for 95% of the 40 largest buildings on campus compared to 12% of buildings in FY12/13.** This has brought to light that six buildings account for 30% 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 $900,000.**

Summary of Fiscal Year 18/19:

- HB 1292 Carry Forward which documents energy saving projects has grown from $12,349 in FY12/13 to $92,420 in FY18/19 **($422,931 to date)**
- Recovered steam revenue in FY18/19 was $114,162 **($472,728 over the past four years since upgrading to ultra-sonic).**
- **Duane Strain was awarded the Outstanding Staff Award** in his first year as a dedicated Controls Technician for furthering efforts to identify energy and mechanical issues before costly breakdowns.
- The addition of Events2HVAC scheduling software at the Health and Human Science Building (HHS) has reduced usage by 12% in the first 12 months.



- HHS is now at an ENERGY STAR level for an office building which is noteworthy considering it houses an anatomy lab, data servers for campus, multiple kitchen and fume hoods, and PT clinic with hydrotherapy pool. **Total annual savings of $50,000; $238,525 in FY12/13 reduced to $187,938 in FY18/19 despite 8% increase in resale electric rate over the same period.**
- Total Utilities for **FY18/19 - $4,126,076** (Electric - $2,656,420, Natural Gas - $880,348, Water - $515,916)

This document summarizes the past fiscal year's usage along with an update on past goals and future focus.

FY18/19 Usage

WCU currently stands at a 43% reduction in energy usage intensity (EUI) compared to the baseline year of 2002-2003 and is currently exceeding the State Energy Office's Utility Savings Initiative of 40% by 2025. Executive Order 80 calls for a 40% reduction in CO2 emissions compared to a base year of 2005. WCU is currently at a 7% reduction (see page 25 for details).

To reduce campus EUI by 1% (kBTUs / ft^2) it would require a reduction of 6,000,000,000 BTUs (1 match represents the equivalent energy in 1 BTU). For perspective, that's roughly the same reduction as 1,800,000 kWh (over $100,000 in electrical usage) or 60,000 therms (almost $30,000 in natural gas).

Rough projections show the next milestone of a 50% reduction to be feasible with the replacement of older residence halls (addition of Allen and Lower Campus and removal of Scott and Walker) along with 10-20% savings from BAS upgrades. However, the addition of the Apodaca Science Building even with its aggressive energy target (138 kBTUS/ft^2) could bring campus usage back to 45%. Despite this, including the steam plant replacement in the projection (which could bring plant efficiency from roughly 60% up closer to 80%) puts WCU back up to a 50% reduction.

Overall, the utility cost per square foot (electric, natural gas, and water) increased slightly from last year to $1.26/$ft^2$ (natural gas usage decreased slightly and electric usage decreased for the fifth year in a row). The only increase was in water cost up from $417,087 in FY17/18 to $515,916 in FY18/19. This is more than a 20% increase in cost despite only a 3.5% increase in usage (99,586 kgal to 103,077 kgal) and is related to a current rate agreement at Noble Hall which is now the fifth most expensive building on campus in terms of total utilities (see pg. 4).

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	$4,085,004	3,282,381	$1.24	338,789	$10.83	-19%	103,214	-42%
2018-19	$4,126,076	3,282,381	$1.26	332,683	$10.85	-21%	101,354	-43%

Building	Built/Renovated	Building cost	% of Campus Utilitie
Hunter Library	1982	$279,313	6.8%
Courtyard Dining Hall	2009	$232,220	5.6%
Ramsey Center	1986	$220,533	5.3%
FPAC	2004	$204,623	5.0%
Noble Residence Hall	2016	$200,343	4.9%
Health and Human Science	2012	$189,427	4.6%
Stillwell	2008	$169,516	4.1%
Belk	1971	$161,036	3.9%
Scott Residence Hall	1969	$130,547	3.2%
NSB	1977	$124,986	3.0%
Coulter	1978	$109,007	2.6%
Balsam Residence Hall	2009	$103,831	2.5%
UC Hinds	1968	$99,437	2.4%
Campus Rec Center	2008	$88,959	2.2%
Walker Residence Hall	1972	$83,799	2.0%

Top 6 buildings represent 32% of campus utilities $1,326,459

Top 15 buildings represent 58% of campus utilities $2,397,577

Of the forty largest buildings on campus, six account for more than 30% for all utility costs. Focusing first on this top tier of usage will yield the greatest financial and energy savings. Opportunities for the top 6 buildings are as follows:

- Hunter Library - Steam usage increased by $30,000 and needs investigation. An engineering study is underway for the Hunter Chiller Plant before any BAS upgrades are undertaken. The building itself requires a major mechanical renovation and BAS installation.

- Courtyard Dining – A feasibility study is needed to see if make-up air can be provided directly to the existing kitchen hoods. Currently all make-up air for the kitchen area is conditioned air (heated and cooled) provided by the building's two air handlers. This creates comfort issues when hot, humid outside air must be conditioned and supplied to the kitchen, in addition to the full load created by occupants. A BAS upgrade is also on the horizon.

- Ramsey Center – Second phase of VFD / BAS controls upgrade is underway. The newly installed VFDs have already allowed us to slow a handful of the air handlers down (60 Hz to 50 Hz for single zone AHUs) and is on track to save $25,000 or roughly 10%, before the BAS upgrade has taken place.

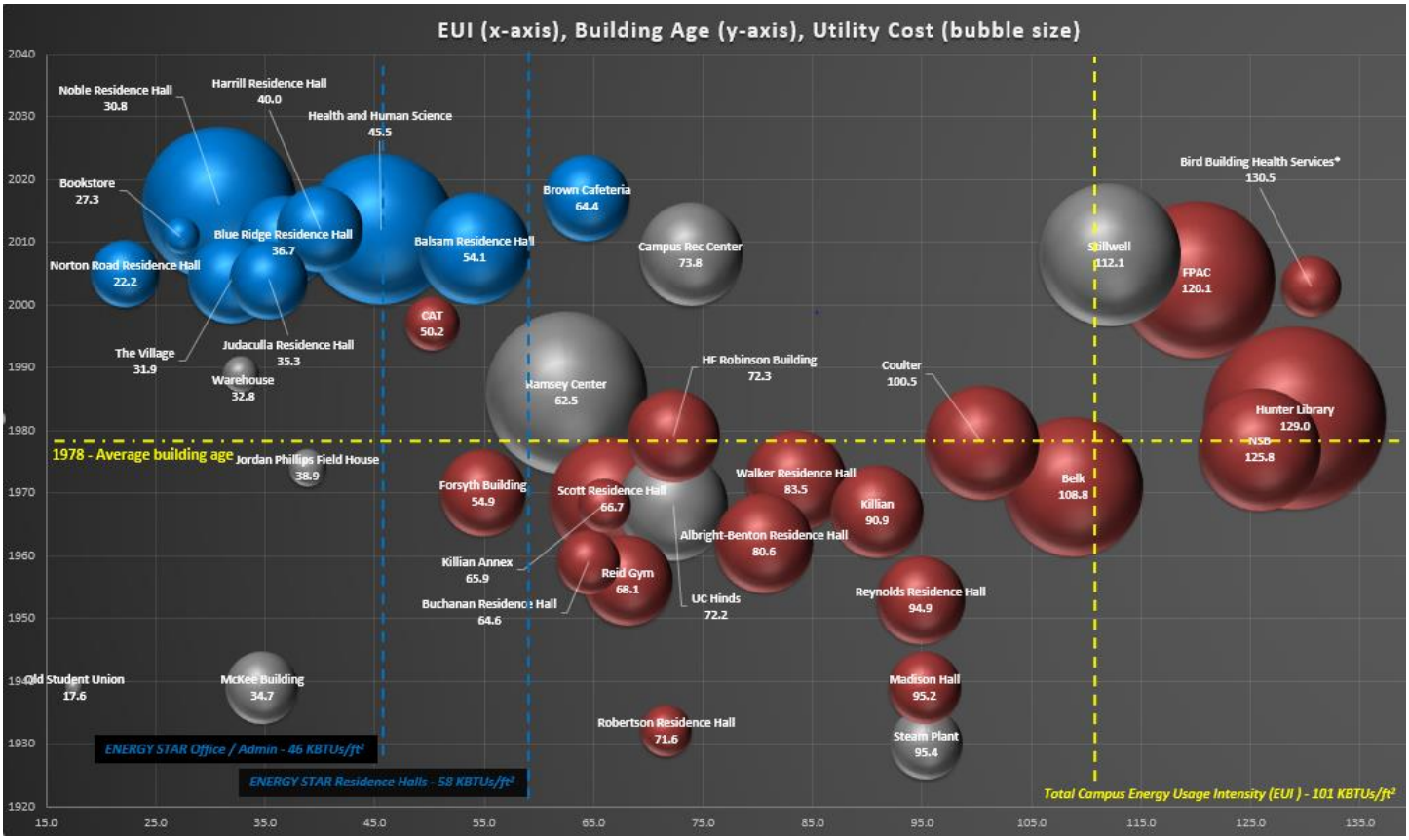
- Fine and Performing Arts / Bardo Center – Additional programming software and training has been purchased to initiate a building tune-up. The test, adjustment, and balancing (TAB) training this October through the University of Wisconsin will also greatly help the building tune-up process. FPAC is currently the third highest user of steam behind Hunter Library and Stillwell.

- Noble Residence Hall – Residential Living / TWSA renegotiate water rate?

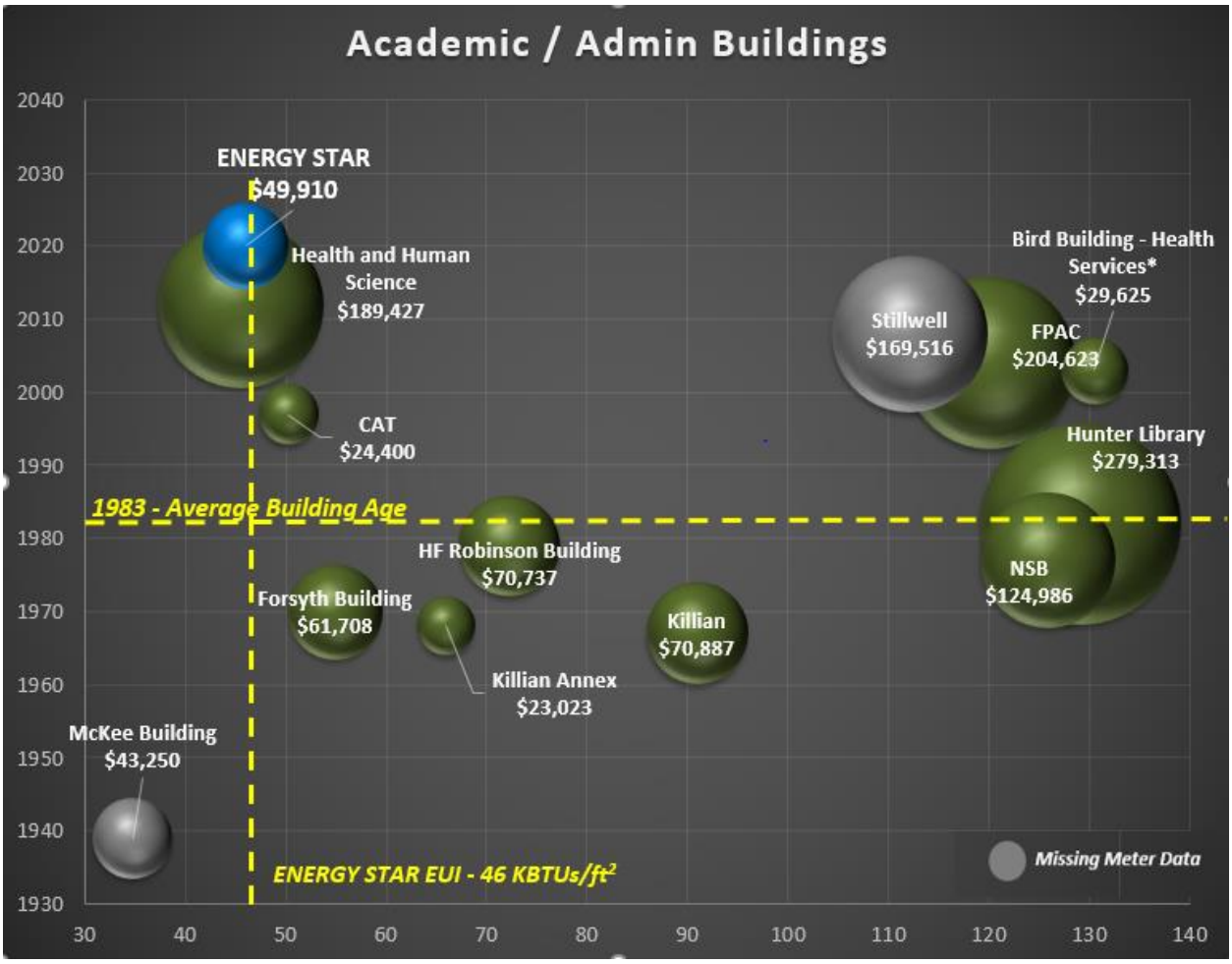
- Health and Human Science Building – Currently at ENERGY STAR level for an office building (25th percentile of energy usage compared to similar building stock). While the addition of Events2HVAC has placed HHS at this level, the oversized chiller and needs of the Anatomy Lab still requires vigilance to balance dehumidification and prevent over-cycling of chiller.

ENERGY STAR Buildings / Targets

Of the 40 largest buildings, 10 (or 25%) are currently at ENERGY STAR performance level (25th percentile of energy usage compared to similar building stock). The majority of which are newer residential living buildings built after 1978. The X axis represents the energy usage intensity (kBTUS/ft^2), the Y axis is the age of the building and the size of the globe represents utility cost. ENERGY STAR buildings are in blue, buildings without an ENERGY STAR category in gray, buildings not at ENERGY STAR level in red.



A closer examination of the Academic and Administration Buildings shows that HHS is the only building currently at ENERGY STAR performance level. A 100,000 ft^2 hypothetical ENERGY STAR building is shown below with an annual utility cost of $49,910 based on the past fiscal year cost of $10.85 per MMBTU. The next section provides an update on FY2018/2019 and goals for the coming FY2019/2020 that will address the top tier of most expensive buildings so that we can move closer to ENERGY STAR usage levels.



Update for past FY2018/2019

- Continue to work with engineering team on building control strategies for Apodaca Science Building. *Ongoing, upgraded Automated Logic's WebCTRL to version 7 as part of the requirement for the latest controls version for the Apodaca Science Building.*

- Install VFDs (variable frequency drives) on 25 air handlers at Ramsey as part of tiered controls upgrade project. *Completed. Second phase underway.*

- Replace electric meter at Ramsey to track energy savings for controls upgrade. *Completed, discovered existing CTs were improperly sized and will need to be addressed.*

- Roll-out Events2HVAC at the Health and Human Science Building (approximately 30 spaces currently reserved through 25Live). *Events2HVAC was launched in October and has reduced usage 10% compared to the previous 10 months of usage. See cash flow diagram p.10.*

- Purchase and obtain training on Schneider's Workplace Technician to increase in-house ability to resolve BAS issues and initiate re-tuning projects (i.e. FPAC). *Software purchased, training scheduled for first week in September 2019.*

- Prioritize buildings in need of BAS upgrades that no longer have building level controllers available or lack manual over-ride ability. *Three-year plan underway.*

- Start new controls technician position on alarm management optimization of critical equipment (i.e. chillers, boilers, and air-handlers). *Duane Strain started November 1st, 2018 and has already established a track record of energy and maintenance savings.*

- Integrate electric vehicle charging station meters with building automation system for data collection and make data available to students and classes. *Completed, also provides ability to determine true cost of charging if charging coincides with monthly demand peak period. See Addendum pg.23.*

- Full credit to Lee Smith, Director of Operations, his interest in purchasing a 3-year natural gas strip at $2.66 DTH (dekatherm) has saved $136,338 over the past three years and prevented unexpected utility cost spikes during high winter demand. A new 3-year strip has been purchased through December of 2021 at $2.86 DTH (under $3.00 DTH is generally considered a bargain).

- Presented *Data Visualization* webinar for the Appalachian Energy Summit Group.

- Met with Buncombe County Schools to discuss best practices, Events2HVAC, and HHS re-tuning project.

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

Goals for FY2019/2020

- Prioritize buildings in need of BAS upgrades that no longer have building level controllers available or lack manual over-ride ability. *Three-year plan underway.*

- Install four BTU meters for Hunter Library chiller plant. Currently no way of measuring chilled water usage at Hunter, Stillwell, Hoey, or McKee (placement of meters to be confirmed by engineer during BAS upgrade). *Three of the four meters are mounted, waiting on power.*

- Attend University of Wisconsin training on testing, adjustment, and balancing (TAB) to improve in-house capacity instead of relying on outside contractors and their schedule of availability. One week of training is less than the cost of having a TAB contractor on-site for the week. *Approved for training session in October*

- 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. *Pending. Additional meter has been mounted at FPAC where make-up water has never been tracked, waiting on power.*

- Correct humidity control issues with BAS and mechanical upgrade at Bardo Arts Center (BAC) Museum (funding pending). *Completed late August, 2019. Upgraded system will improve control of temperature and humidity, a crucial part of the Museum's approaching accreditation process.*

- Obtain a copy and training on Schneider's Workplace Technician to increase in-house ability to resolve BAS issues and initiate re-tuning projects (approved April, 2019). *Software purchased, training scheduled for first week in September 2019.*

- Continue to work with engineering design team on building control strategies and energy optimization opportunities for the Apodaca Science Building.

Project Summaries

Project - Health and Human Science Building - Events2HVAC **Initiated : 10/9/2018**

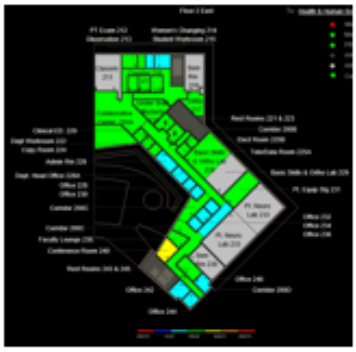
Updated 10/18/2019

Events2HVAC was implemented in October of 2018 and has reduced energy usage 12% in the first 12 months. The Health and Human Science Building is now at ENERGY STAR level for an office building (25th percentile of energy usage compared to similar building stock) which is noteworthy considering it houses an anatomy lab, campus data servers, mutiple kitchen and fume hoods, and a PT clinic with hydrotherapy pool. Events2HVAC takes the classroom schedule from 25Live and pushes it out to the individual controllers at the building level. The result is that classrooms are heated/cooled based on actual class schedule (i.e. 8am-10am and 1pm-3pm) instead of a general schedule at the building level (7am-11pm).

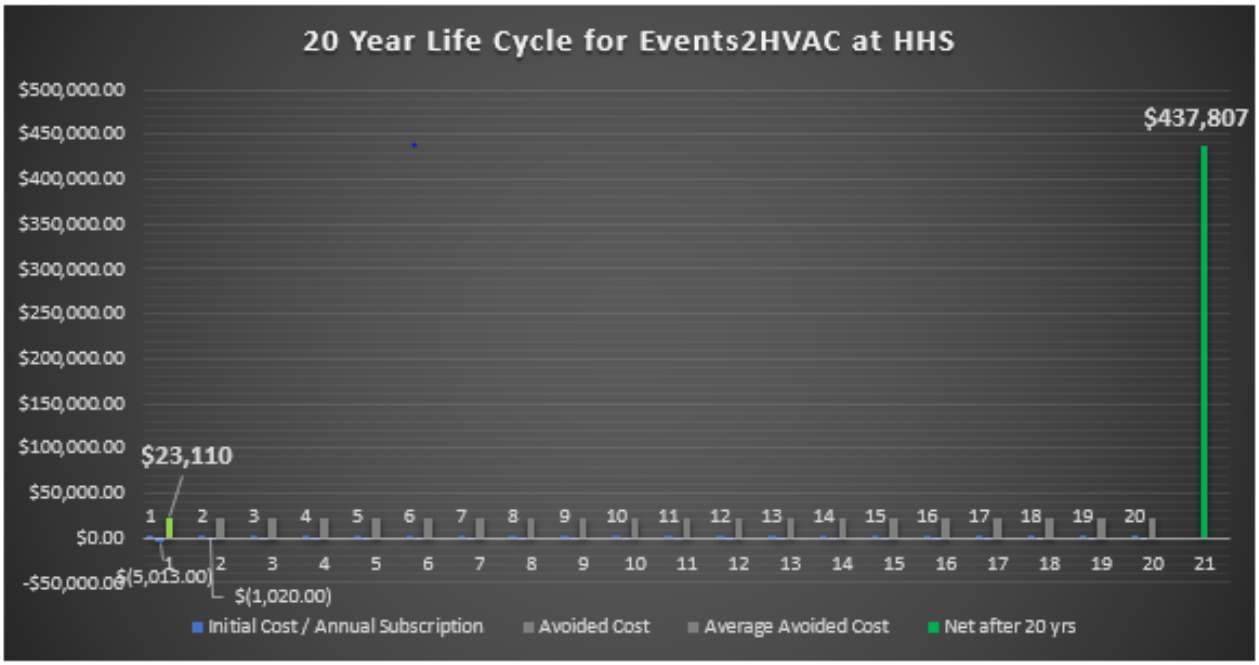
Initial Cost	$	5,013	
Annual Savings	$	23,110	*$0.086/kWh*
Savings to Date	$	23,110	
Simple payback		0.2	*yrs*
ROI		461.0%	
Net - 20 Year Life Cycle	$	437,807	

The 268,719 kWh saved would require $400,000 in solar panels to generate the equivalent energy (200 kW system installed at $2,000 a kW)

PVWatts.com



Unoccupied areas in gray



- Year one savings ($23,110) used to estimate 20 year cash flow

- Annual subscription fee of $1,020

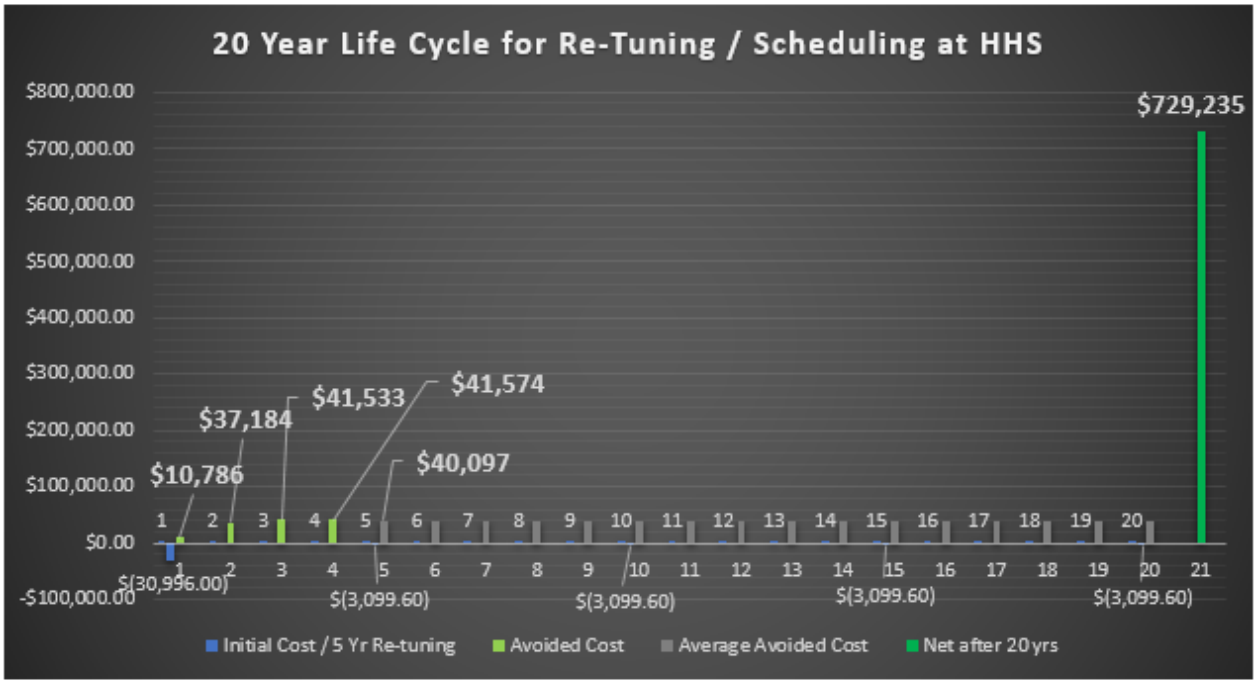
Project - HHS - Re-tuning and Scheduling Improvements

Initiated : 5/2/2016

Re-tuning of existing building automation system (BAS) that controls HVAC system at HHS has reduced energy usage 15% and reduced the number of chiller starts by 77%. This results in a 21% reduction when combined with the scheduling improvements in August of 2015. The 400,000 kWh saved from the re-tuning project would require over $500,000 in solar panels to generate the equivalent energy

Initial Cost	$	30,996	
Annual Savings	$	40,097	*3 yr avg*
Savings to Date	$	120,291	*3 yrs*
Simple payback		0.8	*yrs*
ROI		129.4%	
20 Year Life Cycle	$	729,235	

Typical air handler at HHS



- Three year average ($40,097) used to estimate 20 year cash flow

- 10 % of initial cost used to estimate 5 year re-occuring retuning

Project - Campus-wide upgrade to ultra-sonic meters

Initiated : October, 2015

Completion : 31 of 32 buildings

Previously, condensate from steam was captured using turbine meters that couldn't withstand the caustic environment of the condensate that is returned from the building back to the steam plant. Ultra-sonic meters reside on the exterior of the pipe, don't require additional flanges or bypass piping, and can be installed without a steam shutdown.

Initial Cost	$	230,400	
Annual Savings	$	118,182	*4 yr avg*
Savings to Date	$	472,728	*4 yrs*
Simple payback		1.9	*yrs*
ROI		51.3%	
20 Year Life Cycle	$	2,110,200	

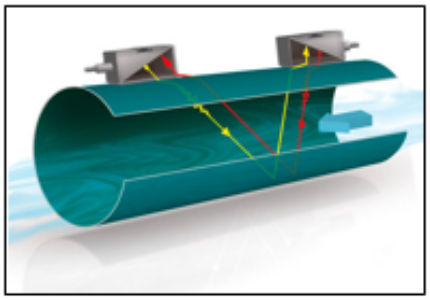
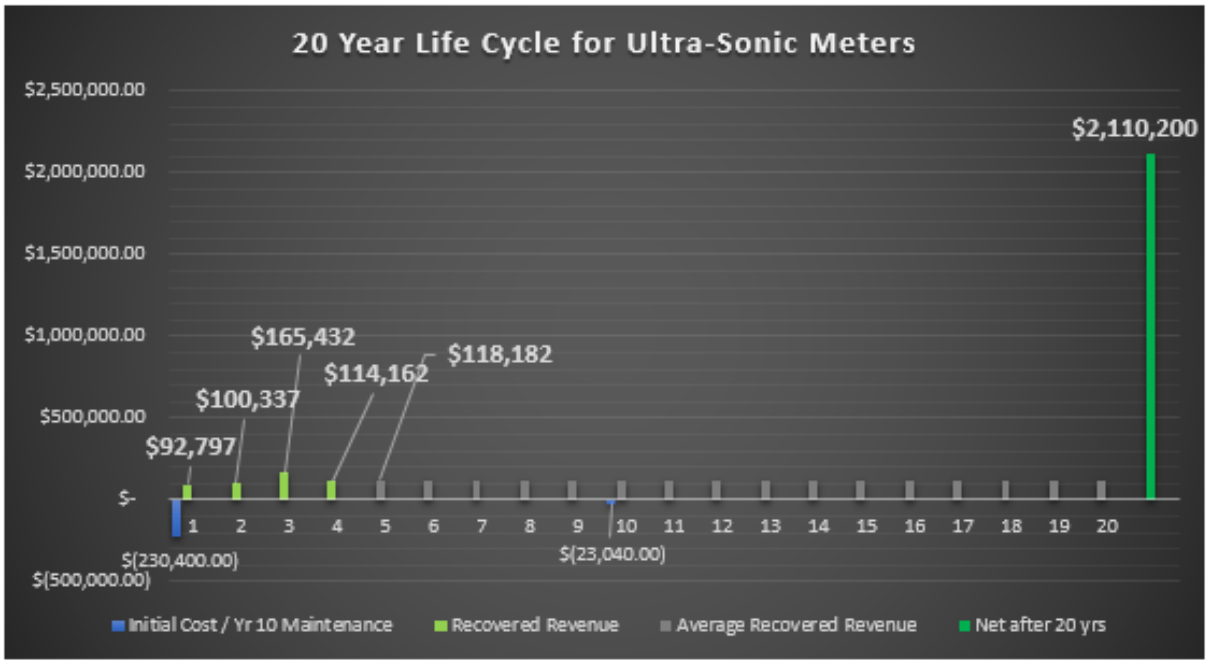


Image : Directindustry.com



- Four year average ($118,162) used to estimate 20 year cash flow

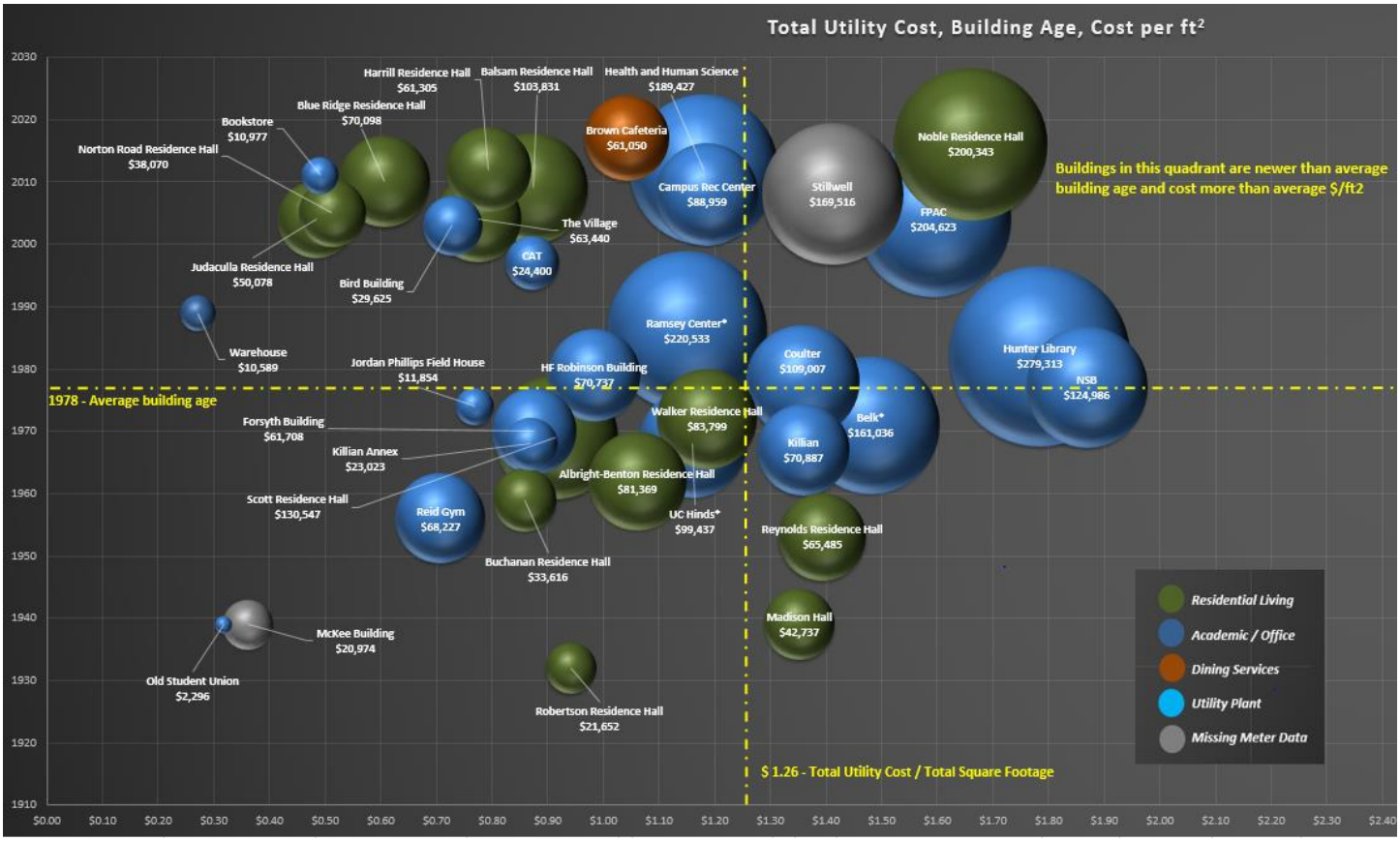
- 10 % of initial cost used to estimate Year 10 maintenance / replacement cost

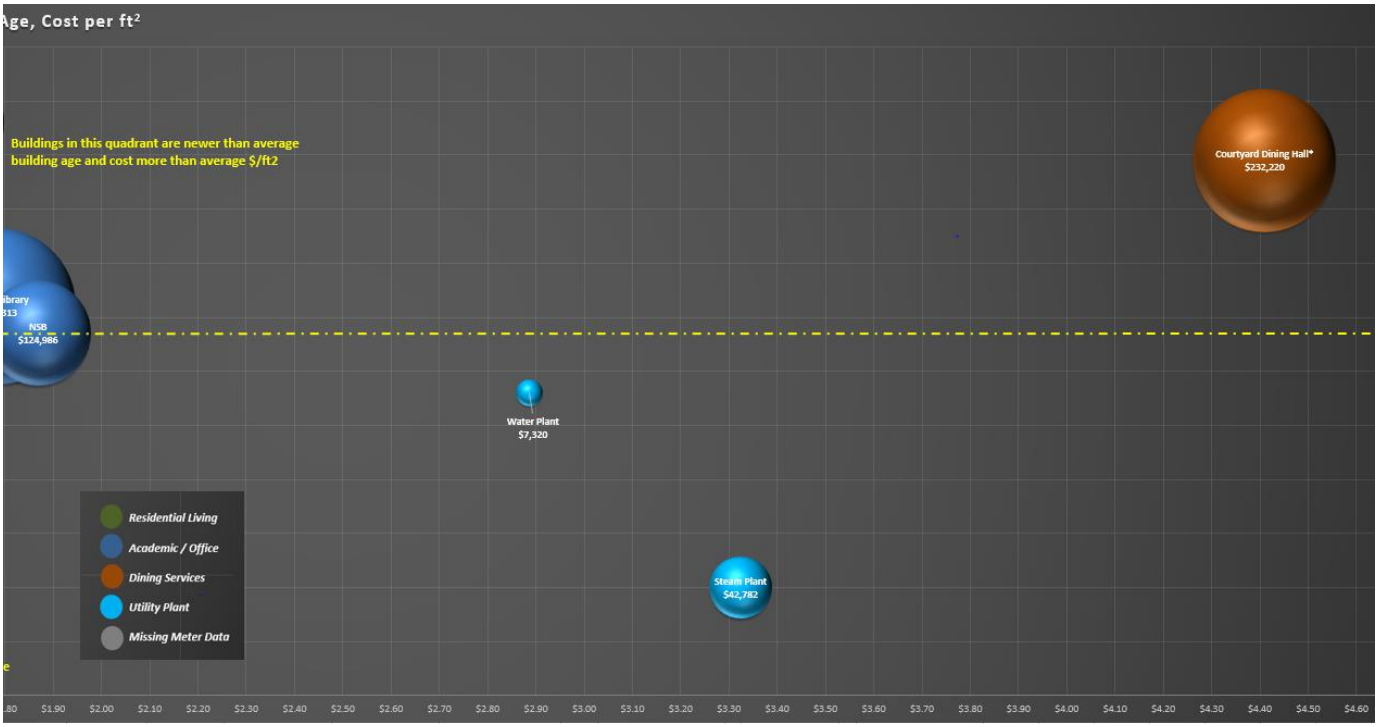
Addendum / Updated Data

Compared to other universities in the UNC system and based on the latest available data, 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, comparisons 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 data available, we have a more complete picture of total energy usage and can examine the relationship between building age, energy usage and associated costs.

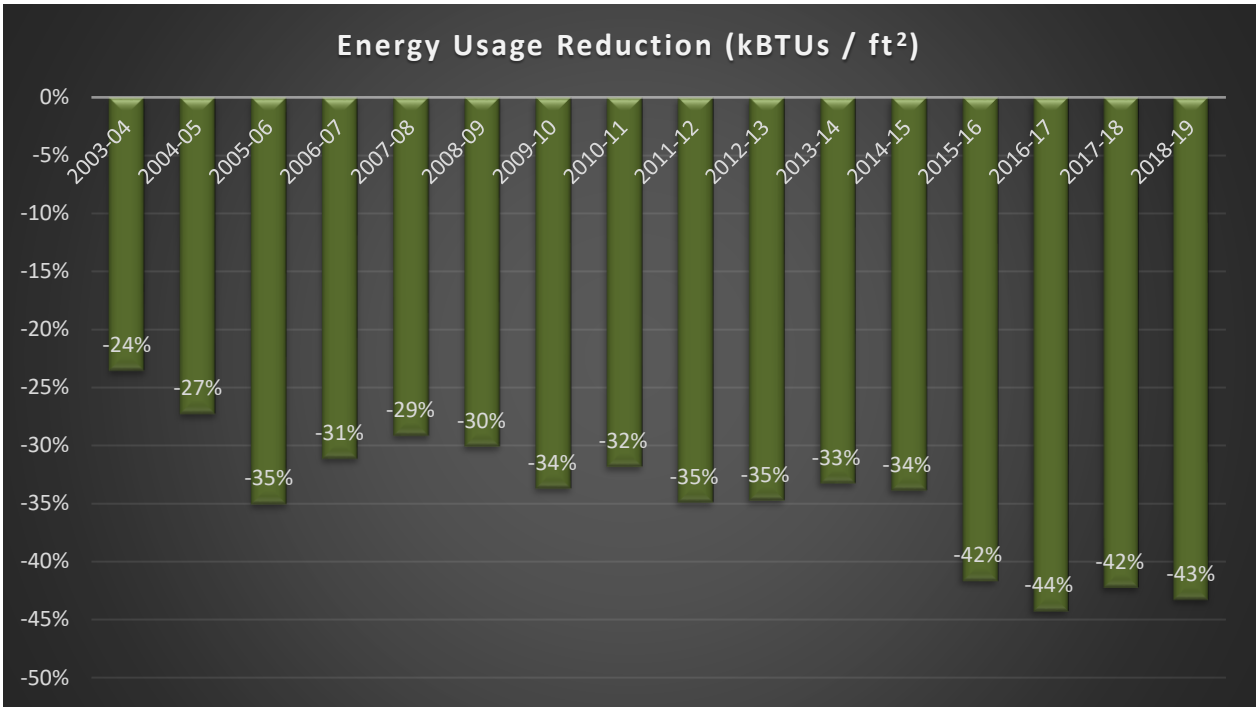
When the average age of the 40 largest buildings on campus (1978) is graphed against the energy cost per square foot, we can see a building like the Fine and Performing Arts Center (FPAC) is newer than 1978, yet costs much more than the campus average of $1.26/ft^2 to operate. The size of the globe represents the total utility cost (i.e. $204,533 for FPAC). The larger the globe the larger the opportunity for fiscal and energy savings. Note that on pg. 5, Norton Residence Hall has the lowest energy usage intensity of all residence halls, yet Judaculla Residence Hall costs less to operate per square foot based on utilities.



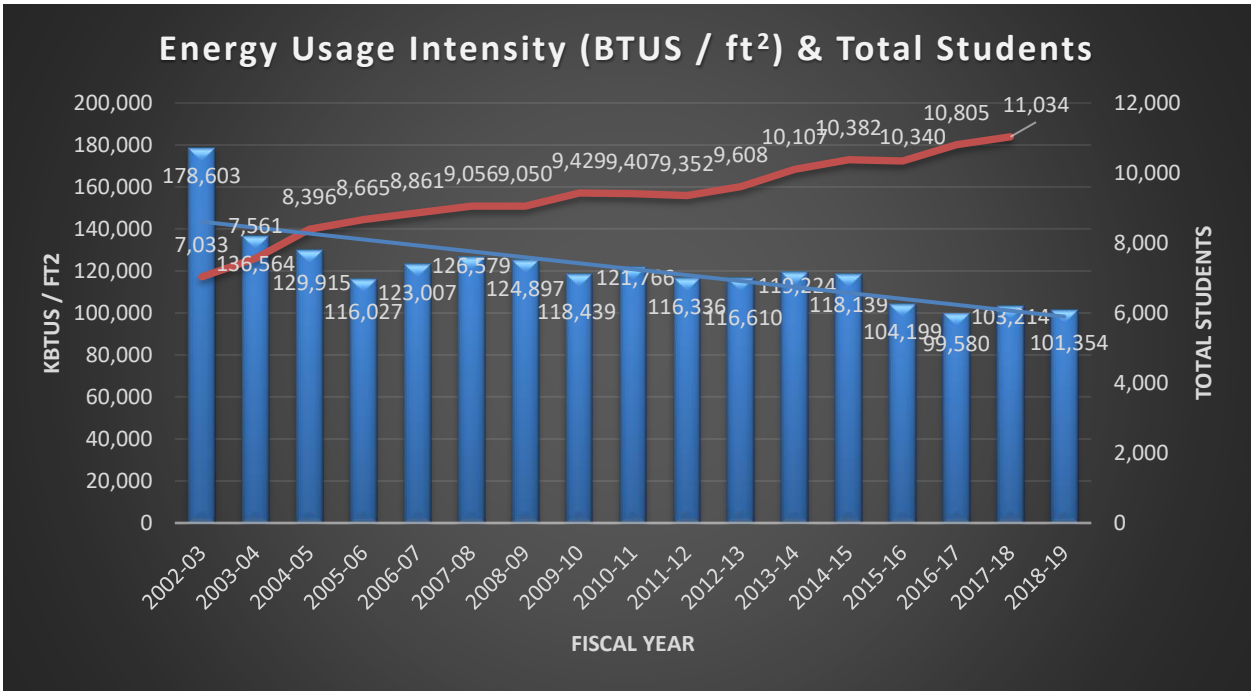


Buildings above the average age and to the right of the campus average merit further investigation. Dining services, lab buildings, and utility plants not surprisingly cost more per square foot to operate and should be compared to buildings of similar end use. However, note on the continuation of this 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.

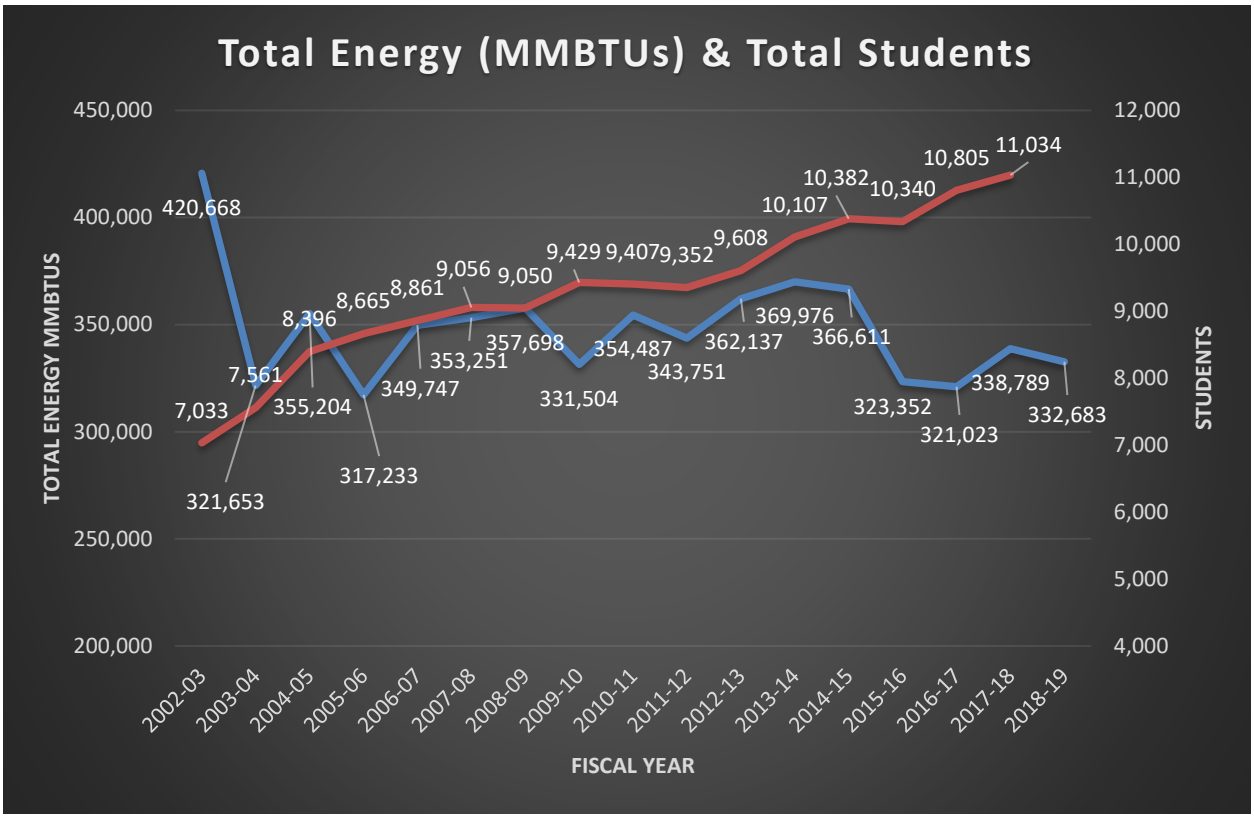
This analysis brought to light that the six most expensive buildings represent more than 30% of campus utilities.



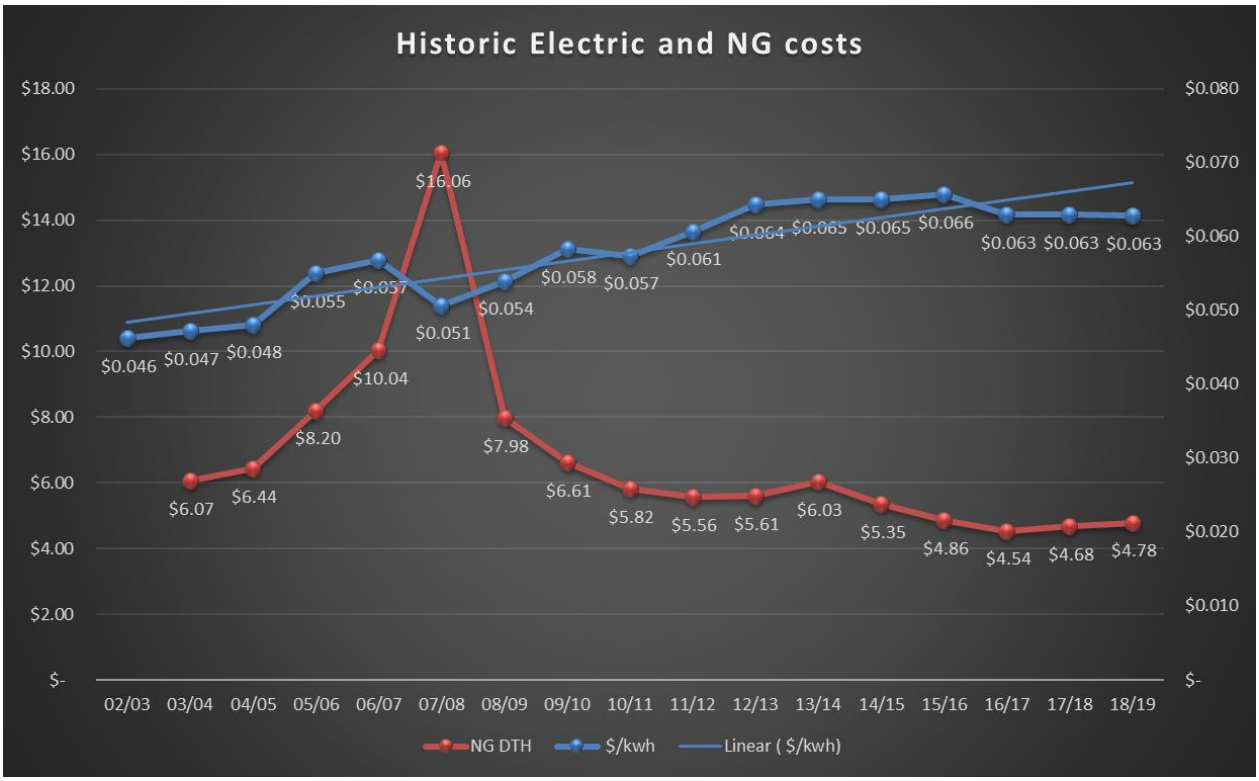
Compared to baseline FY 2002/2003



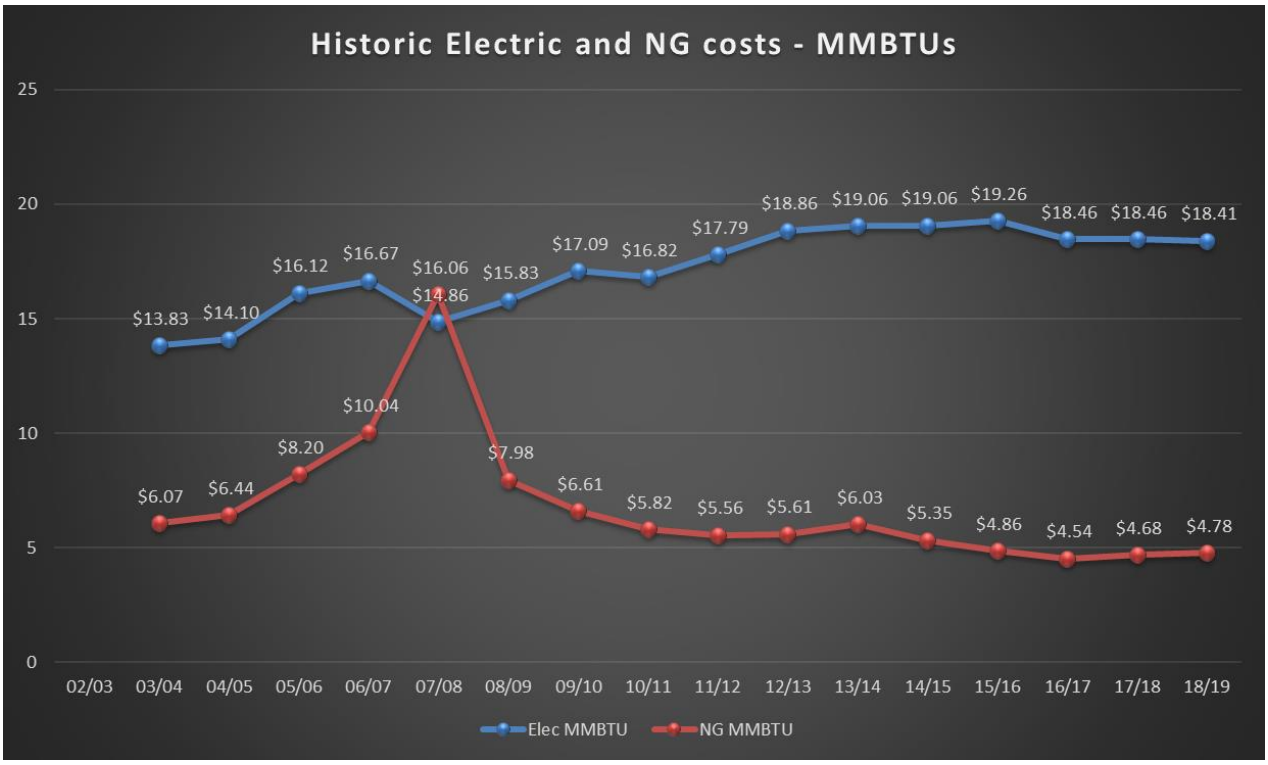
EUI and student growth compared to baseline FY 2002/2003; One BTU is equal to the energy in one match, WCU used the equivalent of 101,354 matches per square foot in F18/19.



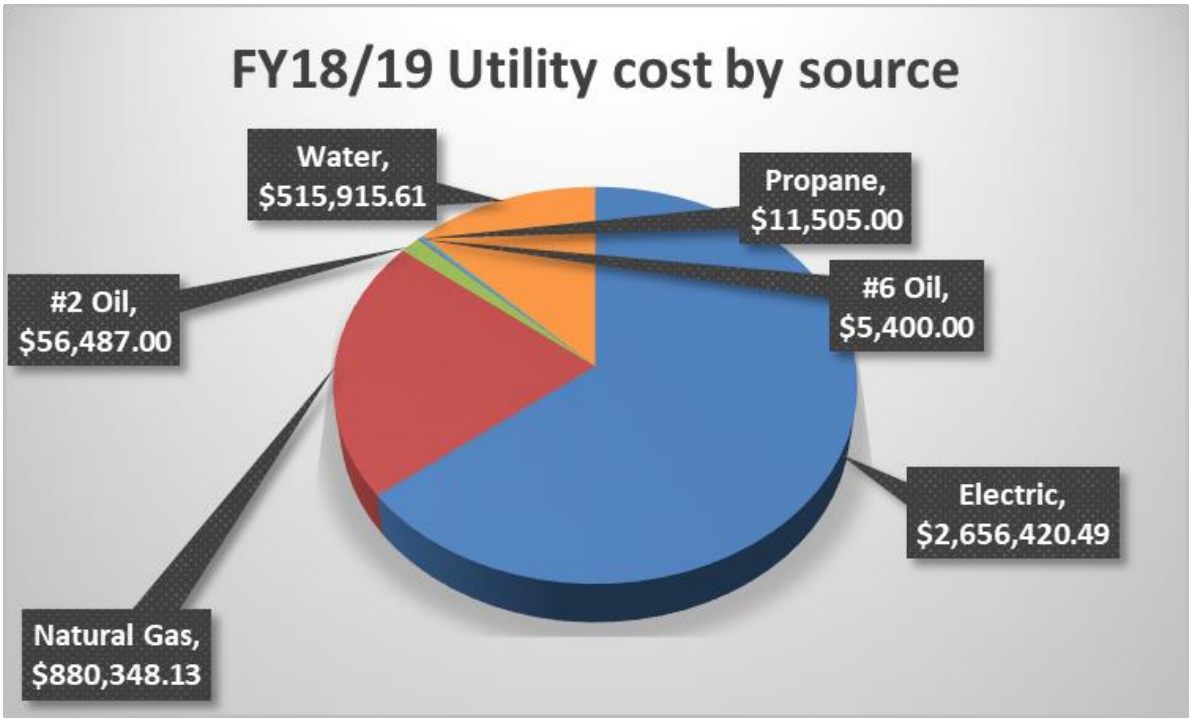
Total energy usage (MMBTUs = million BTUs) has also dropped over the last four years despite a 56% increase in students and almost 40% growth in campus square footage compared to baseline year of 2002/2003.



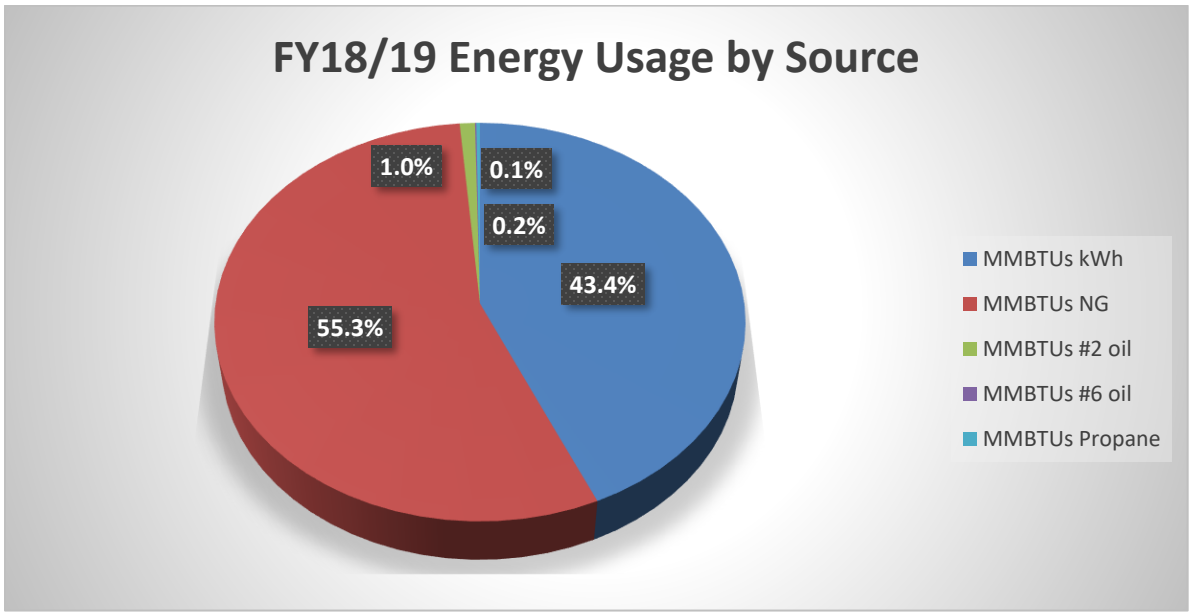
Electric cost per kWh and Natural Gas cost per Dekatherm (DTH)



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 64% of all utility costs ($2,656,420 / $4,126,076)



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, but greater energy savings in reducing natural gas usage

1292 Carry Forward							
Project	**FY13/14**	**FY14/15**	**FY15/16**	**FY16/17**	**FY17/18**	**FY18/19**	**Total to date**
HFR renovation	$ 12,097.00	$ 13,518.00	$ 12,481.00	$ 12,673.00	$ 12,193.00	$ 12,193.27	$ 75,155.27
Make-up water savings	$ 3,482.00	$ 7,783.00	$ 15,118.00	$ 15,893.16	$ 10,297.23	$ 5,053.97	$ 57,627.35
Make-up water savings BTU savings	$ 6,878.00	$ 16,694.00	$ 25,806.00	$ 24,645.71	$ 14,949.49	$ 7,546.98	$ 96,520.18
HHS Savings			$ 10,786.00	$ 37,184.14	$ 41,532.68	$ 41,573.58	$ 131,076.40
Fine and Performing Arts				$ 12,639.99	$ 13,473.75	$ 10,493.50	$ 36,607.24
Belk AHU schedule					$ 4,150.05	$ 4,150.05	$ 8,300.10
Forsyth AHU programming					$ 6,233.40	$ 8,178.41	$ 14,411.81
Facilities Boiler replacement						$ 3,232.26	$ 3,232.26
	$ 22,457	**$ 37,995**	**$ 64,191**	**$ 103,036**	**$ 102,830**	**$ 92,422**	**$ 422,931**

House Bill 1292 Energy Carry Forward Savings – additional projects have helped offset loss of previous condensate savings which were as high as $40,000 in FY16/17 down to $12,000 by FY18/19.

Recovered Steam Revenue					
	FY15/16 (10 months)*	**FY16/17**	**FY17/18**	**FY18/19**	**Total to Date**
Albright Benton	$ 16,978	$ 14,474	$ 15,752	$ 14,476	$ 61,680
Balsam	$ 7,659	$ 12,992	$ 15,306	$ 13,961	$ 49,918
Blue Ridge	$ 3,220	$ 1,244	$ 2,987	$ (1,240)	$ 6,212
Judaculla	$ 15,121	$ 19,248	$ 22,008	$ 20,616	$ 76,993
Courtyard	$ 37,841	$ 34,577	$ 50,434	$ 30,395	$ 153,248
Scott	$ (1,325)	$ (336)	$ (462)	$ (2,552)	$ (4,676)
Walker	$ 14,637	$ 15,453	$ 26,863	$ 18,170	$ 75,122
University Center	$ (1,334)	$ (7,730)	$ 2,533	$ (7,401)	$ (13,931)
Reynolds		$ 10,416	$ 20,736	$ 16,725	$ 47,877
Madison			$ 7,315	$ 9,668	$ 16,983
Robertson			$ 551	$ (3,796)	$ (3,245)
Bird			$ 1,409	$ 4,947	$ 6,355
Buchanan				$ 192	$ 192
	$ 92,797	**$ 100,337**	**$ 165,432**	**$ 114,162**	**$ 472,728**
FY NG cost per DTH	*$ 4.86*	*$ 4.63*	*$ 4.73*	*$ 4.82*	
	**11.5% decrease in natural gas cost in 9 months comparison*				

Recovered Steam Revenue from campus wide meter upgrade

Building	January	Februar	March	April	May	June	Total	% of Produ ion
Hunter Library	769,932	805,106	899,298	678,592	400,791	601,118	9,274,124	11.5%
Stillwell	1,091,231	811,974	953,604	533,301	219,922	410,715	7,612,346	9.4%
FPAC	590,031	1,104,574	856,441	539,359	360,314	392,665	7,609,150	9.4%
Scott Hall	910,494	1,037,162	1,186,540	292,934	147,151	117,452	6,531,353	8.1%
Reid Gym	1,103,716	627,068	65,002	45,828	79,505	-4,187	5,014,110	6.2%
Belk	719,224	542,918	693,788	254,762	145,950	146,866	4,697,137	5.8%
Walker	498,157	474,638	488,741	237,682	150,153	108,462	3,774,639	4.7%
Coulter	412,021	412,822	478,349	246,430	96,994	242,202	3,677,294	4.6%
Balsam Residence	305,878	261,701	282,034	181,103	707,641	64,110	2,751,384	3.4%
NSB	366,935	287,905	390,932	188,498	49,962	55,272	2,741,257	3.4%
Reynolds Hall	437,975	395,766	322,474	144,249	67,270	35,811	2,718,697	3.4%
HF Robinson Building	212,557	223,236	240,079	148,149	108,848	103,292	2,443,461	3.0%
Benton	379,578	391,104	327,654	139,453	46,003	20,975	2,368,760	2.9%
Central Drive	327,795	313,797	267,717	225,297	170,717	90,513	2,346,224	2.9%
McKee Building	310,567	164,068	237,572	79,243	30,546	64,691	1,641,786	2.0%
Albright	263,235	262,268	213,079	91,506	34,377	14,920	1,613,760	2.0%
Killian	185,448	158,201	185,982	107,152	51,158	51,466	1,587,434	2.0%
Campus Rec Center	213,162	139,403	143,306	71,232	52,400	148,927	1,583,251	2.0%
Buchanan	348,077	353,658	295,782	110,851	55,215	25,640	1,507,488	1.9%
Madison Hall	176,391	188,801	154,490	109,429	81,023	29,782	1,463,703	1.8%
Blue Ridge Residence	221,711	238,549	173,664	104,619	28,421	18,023	1,396,850	1.7%
Courtyard Dining	365,709	364,414	-153,996	-818,102	-484,341	74,573	1,318,752	1.6%
Brown	100,906	128,778	155,007	142,506	90,948	52,323	1,241,165	1.5%
Old Student Union	97,661	108,003	93,575	71,390	73,892	40,532	1,006,555	1.2%
Robertson Hall	148,218	133,590	111,097	63,818	39,206	12,673	1,005,324	1.2%
Killian Annex	146,375	106,185	134,224	58,121	18,657	37,138	860,354	1.1%
Bird	98,244	72,229	84,841	48,156	18,651	34,769	792,525	1.0%
CAT	no meter	27,617	23,476	8,762	2,723	0	62,578	0.1%
UC Hinds	142,000	0	0	0	0	0	55,331	0.1%
Breese	no meter	no meter	no meter	no meter	no meter	no meter	0	
Forsyth Building	216,348	153,248	167,959	73,934	-1,378,886	44,411	-6,180	
Hoey Auditorium	20,391	6,247	12,293	-55,019	-283,116	-2	-282,641	
							80,696,792	

Steam usage (lbs.) for FY18/19; 12 months of data not available for buildings in red

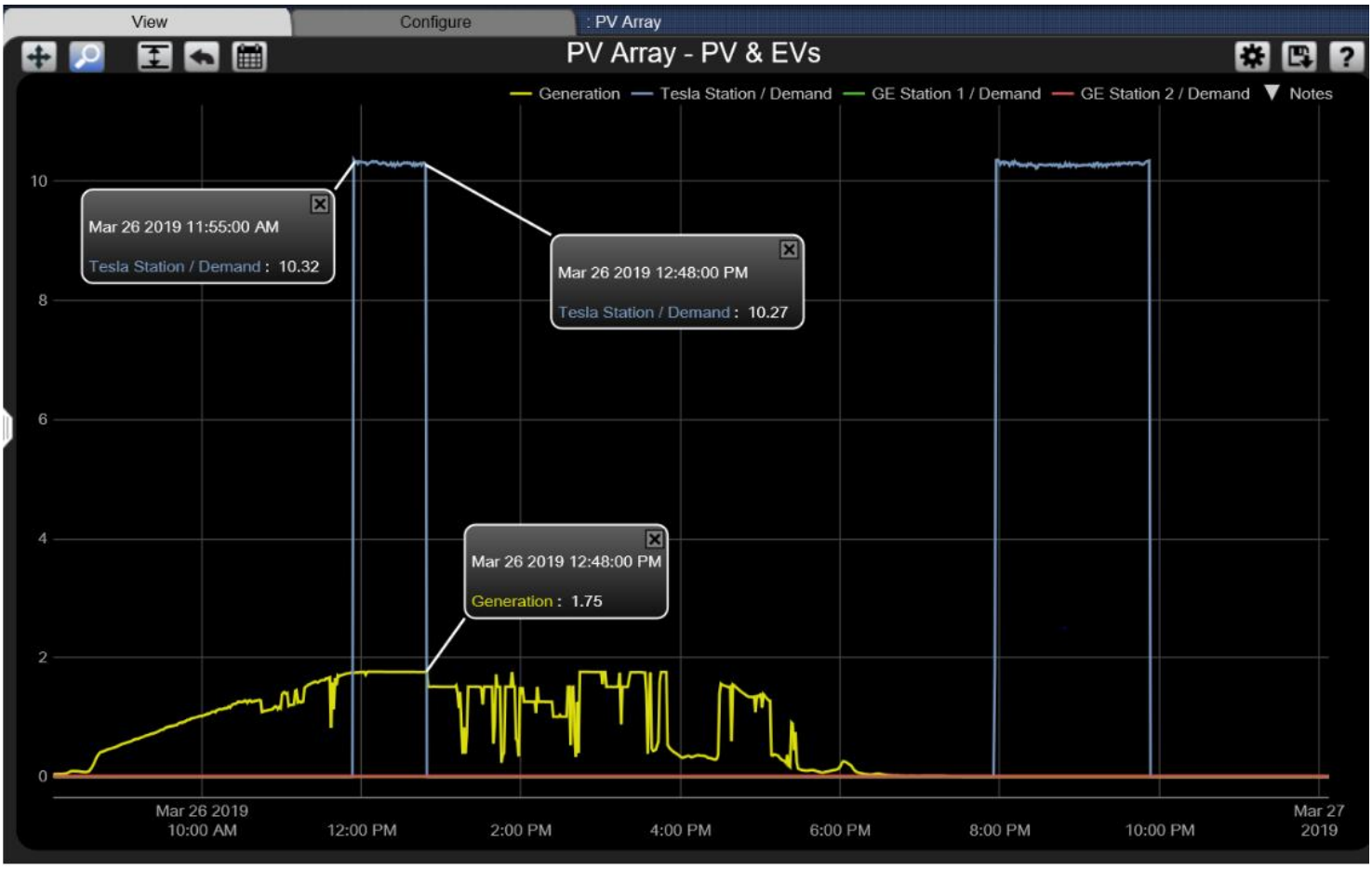
We measured 80,696,792 lbs. of steam at the building condensate meters compared to 116,193,884 lbs. produced at the steam plant. Considering that the steam charts at the plant over-estimate production and the building condensate meters won't capture what's flashed off or diverted down the drain when a leak is identified, this represents 69.4% of production (lbs. at condensate meters / steam charts at plant)

If you use the steam plant production data, it results in a plant efficiency of 73% (BTUs in lbs. of steam produced / BTUs in natural gas consumed). Based on the steam condensate meters at the buildings you have a plant and system efficiency of 51% (BTUs based on gallons measured at building level / BTUs in natural gas consumed). The true number is likely somewhere between, perhaps 60% which is what we've used in past evaluations.

In the next two years or so we'll lose Scott, Walker, and NSB which are the 4th, 7th, and 11th highest consumers of steam on campus.

Additional notes:

- Hunter Library - $30,000 increase in steam usage compared to previous year
- Reid had a leak back in March, still showing signs of steam in the line in June
- Courtyard Dining, usage declined due to scaling, line replace during shutdown
- UC loss of power at meter – sent back to Flexim
- Hoey – scaling inside pipe, moved transducers to new section of pipe in July
- Forsyth – one month of large negative usage – cause TBD

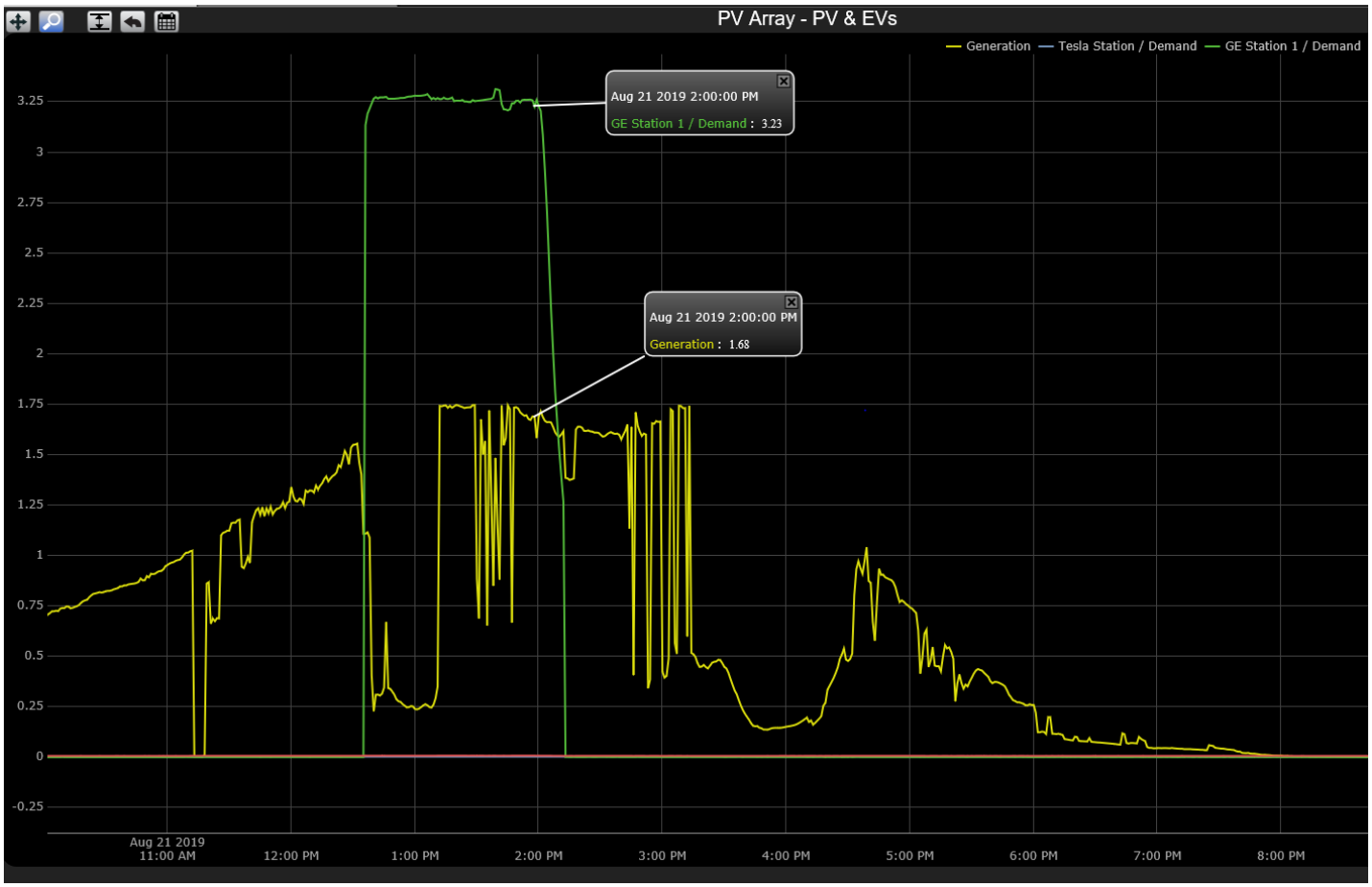


Tesla Model 3 charging compared to solar generation (units in kW)

In the past 11 months that we have had data available for the electric vehicle (EV) charging station, usage there has overlapped five times (out of just under 500 charges or 1%) with the peak demand period set by Duke for the highest 30-minute average of demand for the month. This creates a large variation in cost for electric vehicle charging. In the example above, WCU pays a demand charge of $5.79 for every kW over 5,000 kW during peak hours for winter months (6am-1pm, October-May) and $0.0613 per kWh for on-peak energy charges. For the example above this results in a total cost of $58.51 for roughly an hour of charging (10 kW x $5.79) + (10kW x 1hr x $0.0613). Factoring in the solar offset of 1.75 kW reduces the cost to $48.27.

The second charging period in the example above costs a total of $0.60 (10 kW x 2hrs x $0.03) as it occurs outside of peak hours when there is no demand charge and off-peak energy costs $0.03 kWh. The most expensive scenario would be a Tesla Model S charging at 15 kW during summer peak hour demand period (1pm-9pm, June-September) when the peak charge is $10.62 for every kW over 5,000 kW of demand. A typical two-hour charge at these rates would cost $161.14 (15 kW x $10.62) + (15 kW x 2hr x $0.0613). Outside peak hours it would cost only $0.90 (15 kW x 2hr x $0.03).

The two GE level 2 chargers, charge at a more moderate rate of 3-6 kW which would cost $0.09 for an hour of 3kW charging outside peak hours and up to $60.61 for an hour of 6kW charging during summer peak demand period (example below). *In general, charging that occurs during highest 30-minute peak demand period (monthly) changes the cost by a factor of 100*. Students living on campus have expressed interest in level 1 charging (120V standard outlet) for weekend and non-commuting driving.



Level 2 GE charger partially offset by solar generation (units in kW)

So how effective and efficient are electric vehicles? For a standard gasoline vehicle that gets 33 MPG, 10 gallons would represent a 330-mile range. A Tesla Model S 100 kWh battery has a similar range of 330 miles. For the gas vehicle, it would use 1.2 MMBTUs across that 330-mile range (120,000 BTUs / gallon x 10 gallons). For the Tesla, it would use 0.3412 MMBTUs for the same 330 miles (3,412 BTUs x 100 kWh). However, accounting for the efficiency of a power plant (30-45%) that's typically used for level 2 charging, the Tesla would require closer to 1.0 MMBTUs (0.3412 MMBTUs / 0.33 power plant efficiency) when you factor in the total power required at the source (power plant) and not just the site (electric vehicle charging station).

This is a 20% improvement over the gasoline engine for the same range and doesn't account for potential renewable offset (above) or charging from battery storage. To completely offset a Tesla Model S charging at 15 kW would require a 15 kW solar photovoltaic system, roughly 60 panels. The existing solar lounge on campus has 40 panels.

year	gsf	gsf % change	construction gsf	Students		CO2 lbs. kWh	CO2 lbs. NG therms	CO2 lbs. #2 Oil	CO2 lbs. #6 Oil	CO2 lbs. Propane	CO2 lbs. Total	CO2 % change
2004-05	2,734,121		85,586	8,396								
2005-06	2,734,121		14,655	8,665		68,538,629	5,257,404	759,830	20,029,542	320,510	94,905,915	
2006-07	2,843,308	4.0%	0	8,861	2.3%	65,882,093	20,665,539	731,002	3,817,034	357,454	91,453,121	-3.6%
2007-08	2,790,749	2.1%	0	9,056	4.5%	65,006,558	23,934,327	625,231	92,014	302,945	89,961,075	-5.2%
2008-09	2,863,949	4.7%	0	9,050	4.4%	66,456,162	23,750,925	809,899	765,050	1,114	91,783,149	-3.3%
2009-10	2,798,946	2.4%	0	9,429	8.8%	69,653,626	20,087,158	588,213	195,000	382,213	90,906,210	-4.2%
2010-11	2,911,228	6.5%	0	9,407	8.6%	69,937,987	22,517,452	1,010,464	78,000	335,979	93,879,881	-1.1%
2011-12	2,954,814	8.1%	0	9,352	7.9%	71,157,749	21,109,898	884,995	0	313,850	93,466,492	-1.5%
2012-13	3,105,538	13.6%	0	9,608	10.9%	73,898,717	22,768,116	523,248	26,000	357,638	97,573,720	2.8%
2013-14	3,103,210	13.5%	0	10,107	16.6%	74,817,034	21,782,005	442,225	2,548,468	389,486	99,979,218	5.3%
2014-15	3,103,210	13.5%	0	10,382	19.8%	73,486,895	22,803,832	501,939	1,040,000	269,582	98,102,247	3.4%
2015-16	3,103,210	13.5%	0	10,340	19.3%	67,959,905	19,803,062	471,363	52,000	316,827	88,603,157	-6.6%
2016-17	3,223,781	17.9%	120,571	10,805	24.7%	67,853,607	19,649,696	534,038	52,000	153,929	88,243,271	-7.0%
2017-18	3,282,381	20.1%	58,600	11,034	27.3%	66,301,919	22,128,996	510,720	52,000	172,493	89,166,128	-6.0%
2018-19	3,282,381	20.1%	0			65,906,644	21,543,836	545,552	52,000	108,908	88,156,939	-7.1%
2019-20	0		0									
2020-21	0		0		*North Carolina's greenhouse gas (GHG) emissions goal under EO80 is to reduce emissions by 40% from*							
2021-22	0		0		*all economic sectors by 2025.*							
2022-23	0		0									
2023-24	0		0									
2024-25	0		0									

1.559 lbs CO_2 / kWh
11.71 lbs CO_2 / CCF or 1 therm
22.4 lbs CO_2 / gallon of #2 oil
26 lbs CO_2 / gallon of #6 oil
12.7 lbs CO_2 / gallon of propane

https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references
https://www.eia.gov/environment/emissions/co2_vol_mass.php
https://www.epa.gov/sites/production/files/2015-07/documents/emission-factors_2014.pdf

WCU's CO_2 emissions have decreased 7.1 % compared to the baseline year of 2005. Student growth has increased by 27% and campus square footage by 20% in the same period. Executive Order 80 calls for a 40% reduction in CO_2 emissions by 2025. WCU would need to cut its total electrical usage by 50% in order to meet EO80.