Ursinus College

THE STONE HOUSE GROUP
BUILDING STEWARDSHIP

Making Your Campus More Financially and Environmentally Sustainable through Grants, Incentives and Third-Party Financing

THE STONE HOUSE GROUP
BUILDING STEWARDSHIP

July 25, 2019

Who We Are

Steve Gehringer, Ursinus College

James Hayes, The Stone House Group

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Ursinus College

- 1,500 students from 31 states and 22 countries
- 170-acre suburban campus located 25 miles from downtown Philadelphia
- Residential, private, liberal arts college
- 11:1 Student – faculty ratio
- Ursinus is consistently ranked in the top tier of National Liberal Arts Colleges and was one of five schools designated an “Up and Coming” college by U.S. News & World Report.

The Stone House Group

- 20 Years
- 300+ Clients
- 2 Offices

- 4 Countries
- 15+ States
- 15,807,400 SF commissioned
- 84 FCAs
- 83 LEED Projects
- 79 Energy Models

Our Higher Ed clients include:

Gettysburg College

Moravian College

Penn

Dickinson

Princeton University

Lehigh University

Muhlenberg College

Albright College 1856

Penn State 1855

Juniata College Pennsylvania 1876

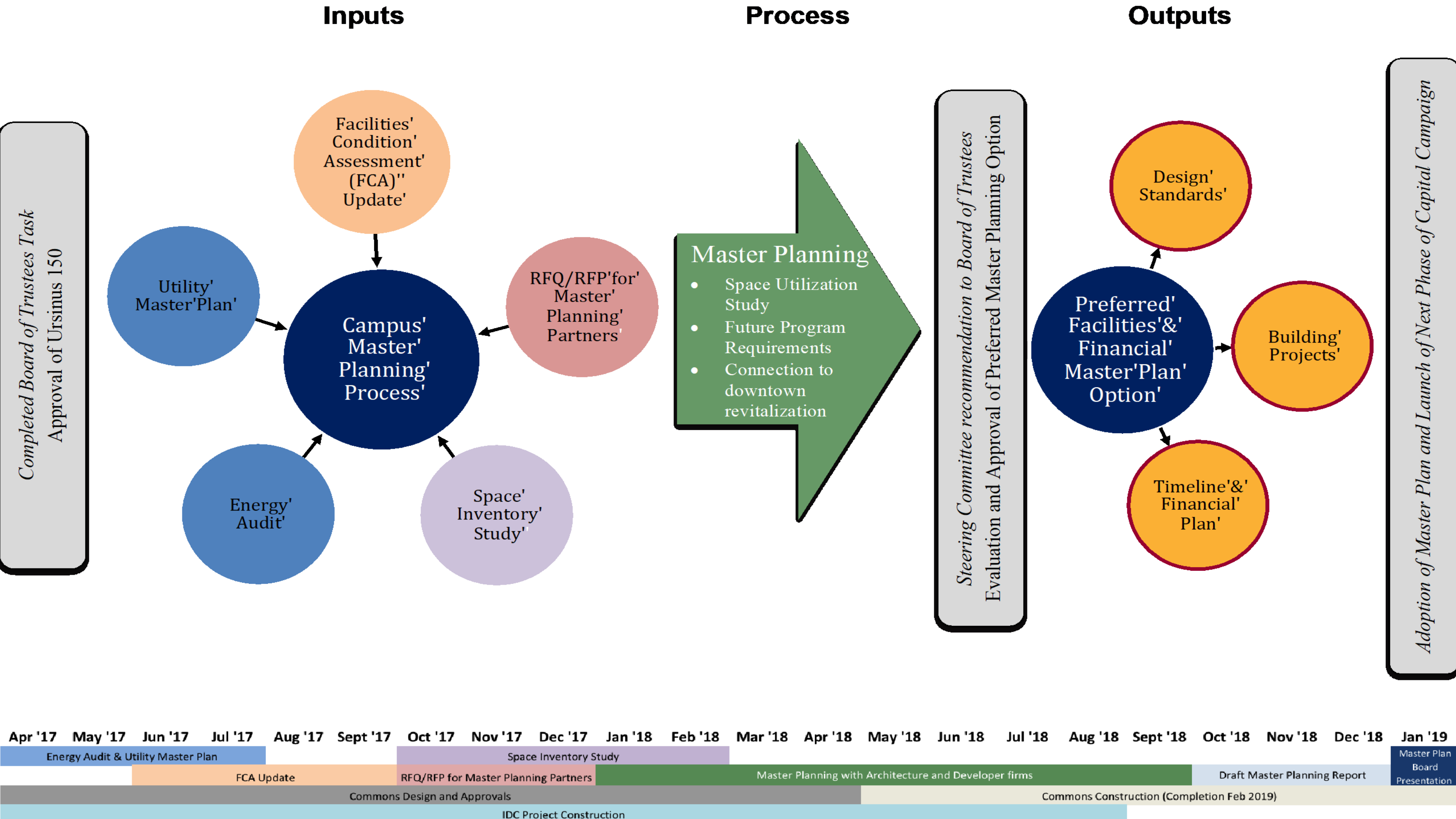
SJU Saint Joseph's University

Swarthmore

Ursinus College

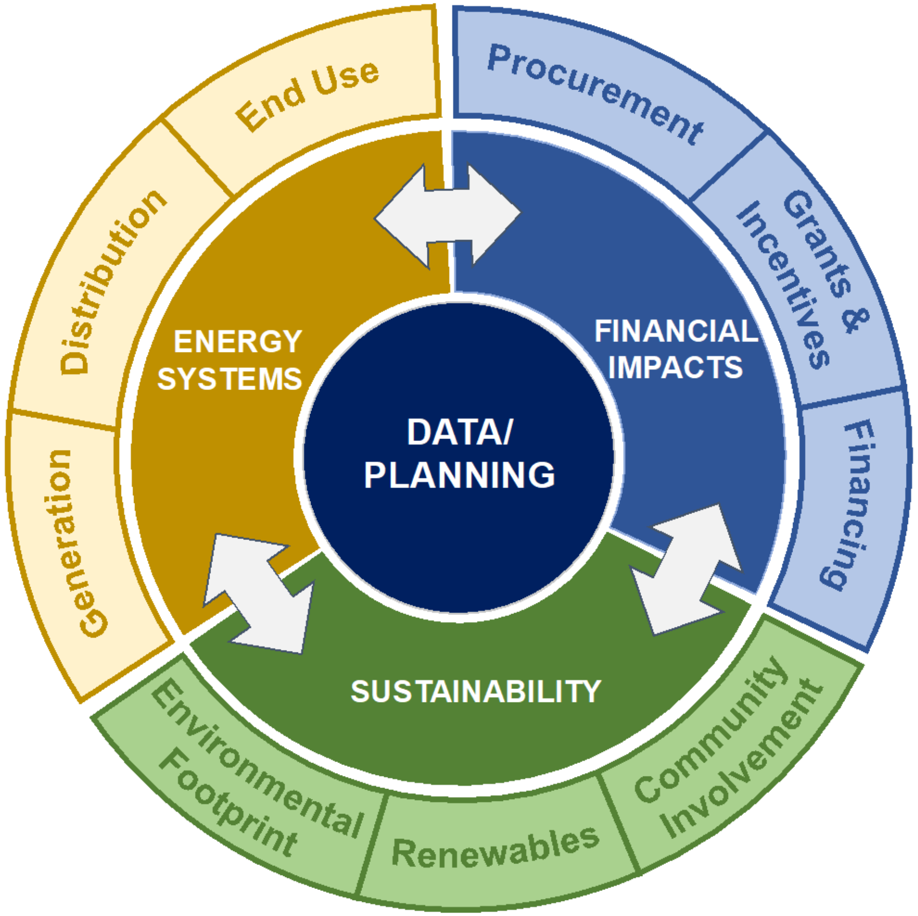
Haverford College

Villanova University



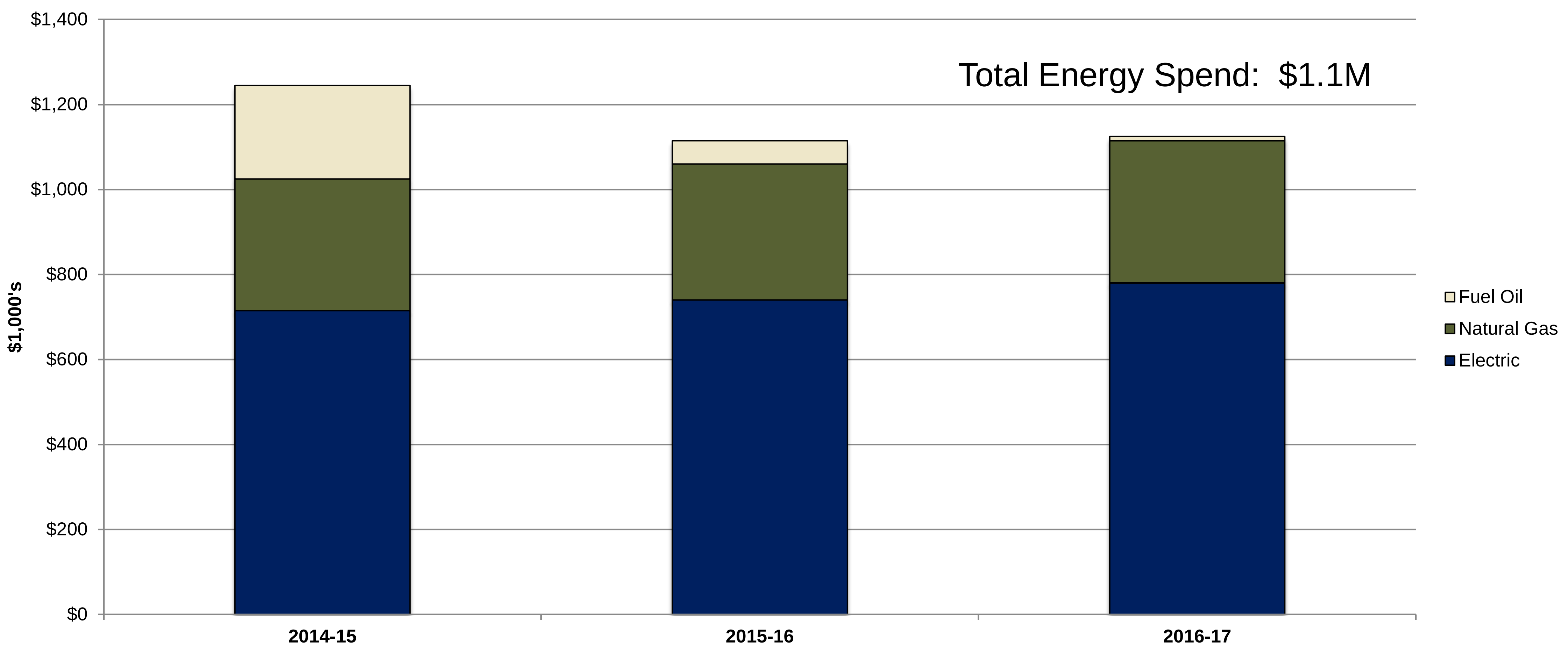
Inputs
Process
Outputs
Completed Board of Trustees Task
Approval of Ursinus 150
Facilities' Condition' Assessment' (FCA)'' Update'
Utility' Master'Plan'
Campus' Master' Planning' Process'
RFQ/RFP'for' Master' Planning' Partners'
Energy' Audit'
Space' Inventory' Study''
Master Planning
Space Utilization Study
Future Program Requirements
Connection to downtown revitalization
Steering Committee recommendation to Board of Trustees
Evaluation and Approval of Preferred Master Planning Option
Design' Standards'
Preferred' Facilities'&' Financial' Master'Plan' Option'
Building' Projects'
Timeline'&' Financial' Plan'
Adoption of Master Plan and Launch of Next Phase of Capital Campaign
Apr '17
May '17
Jun '17
Jul '17
Aug '17
Sept '17
Oct '17
Nov '17
Dec '17
Jan '18
Feb '18
Mar '18
Apr '18
May '18
Jun '18
Jul '18
Aug '18
Sept '18
Oct '18
Nov '18
Dec '18
Jan '19
Energy Audit & Utility Master Plan
Space Inventory Study
Master Plan Board Presentation
FCA Update
RFQ/RFP for Master Planning Partners
Master Planning with Architecture and Developer firms
Draft Master Planning Report
Commons Design and Approvals
Commons Construction (Completion Feb 2019)
IDC Project Construction

SHG Approach to Energy Management

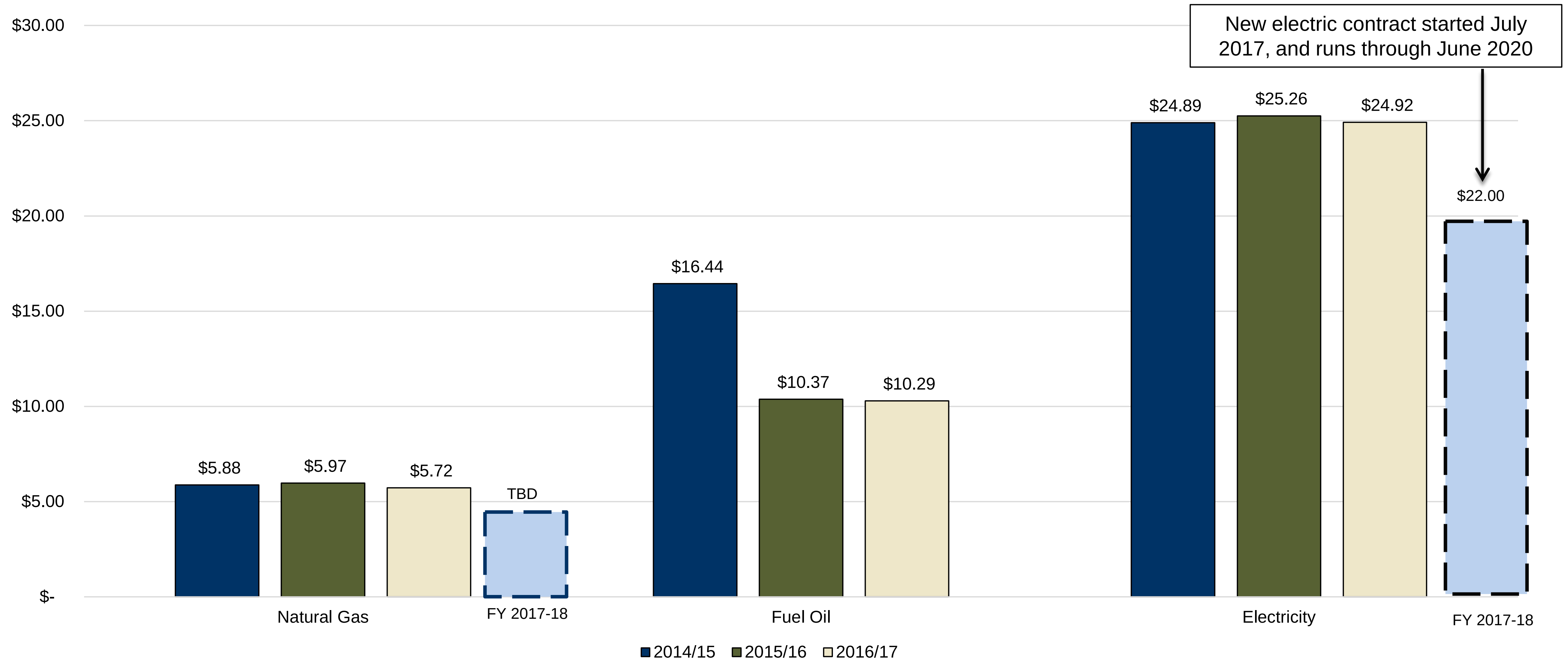


- View energy management from 4 main perspectives to ensure a comprehensive approach
- Find the balance between financial and environmental sustainability

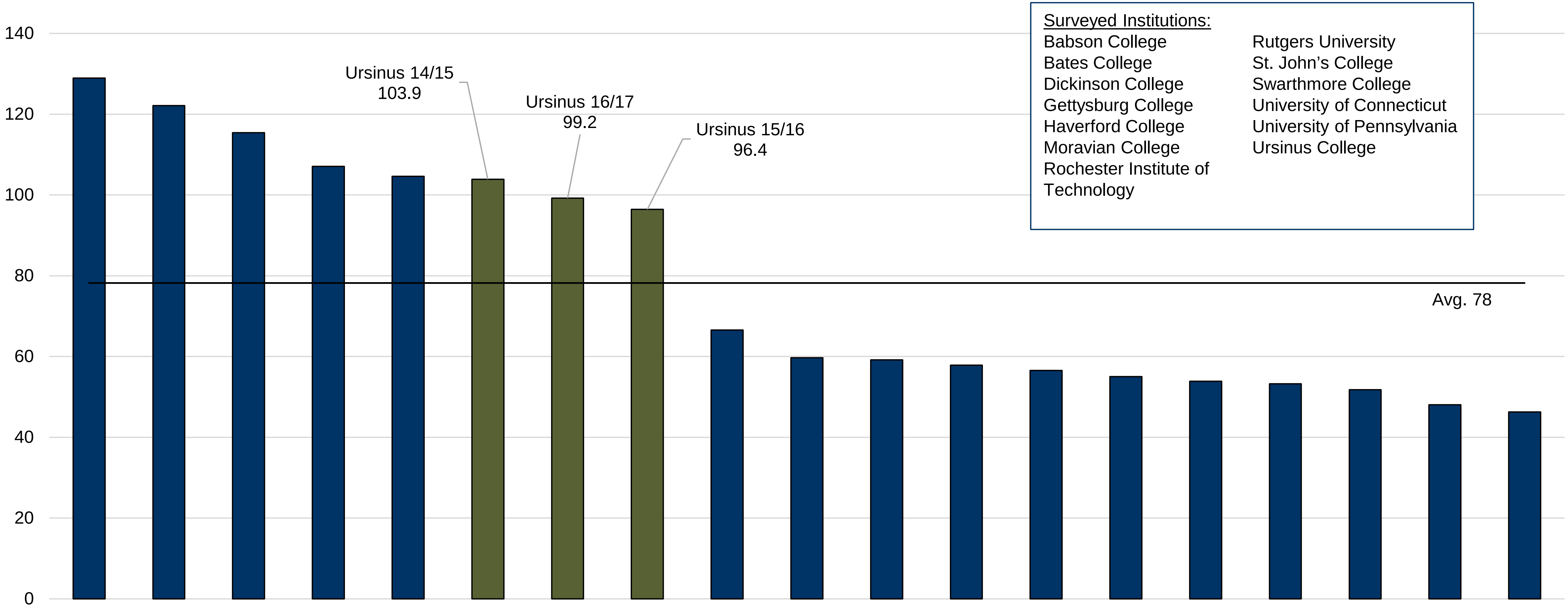
Annual Main Meter Energy Costs by FY



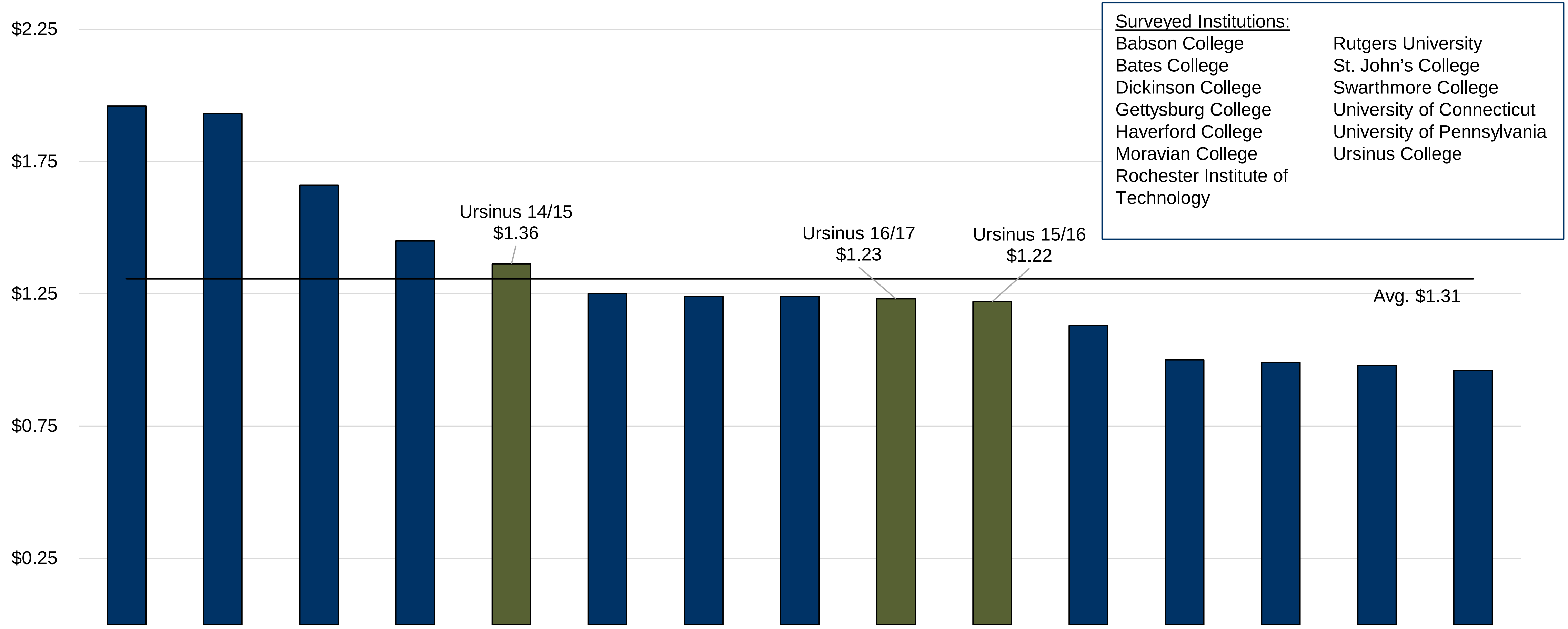
Unit Cost of Fuels ($/MMBTU)



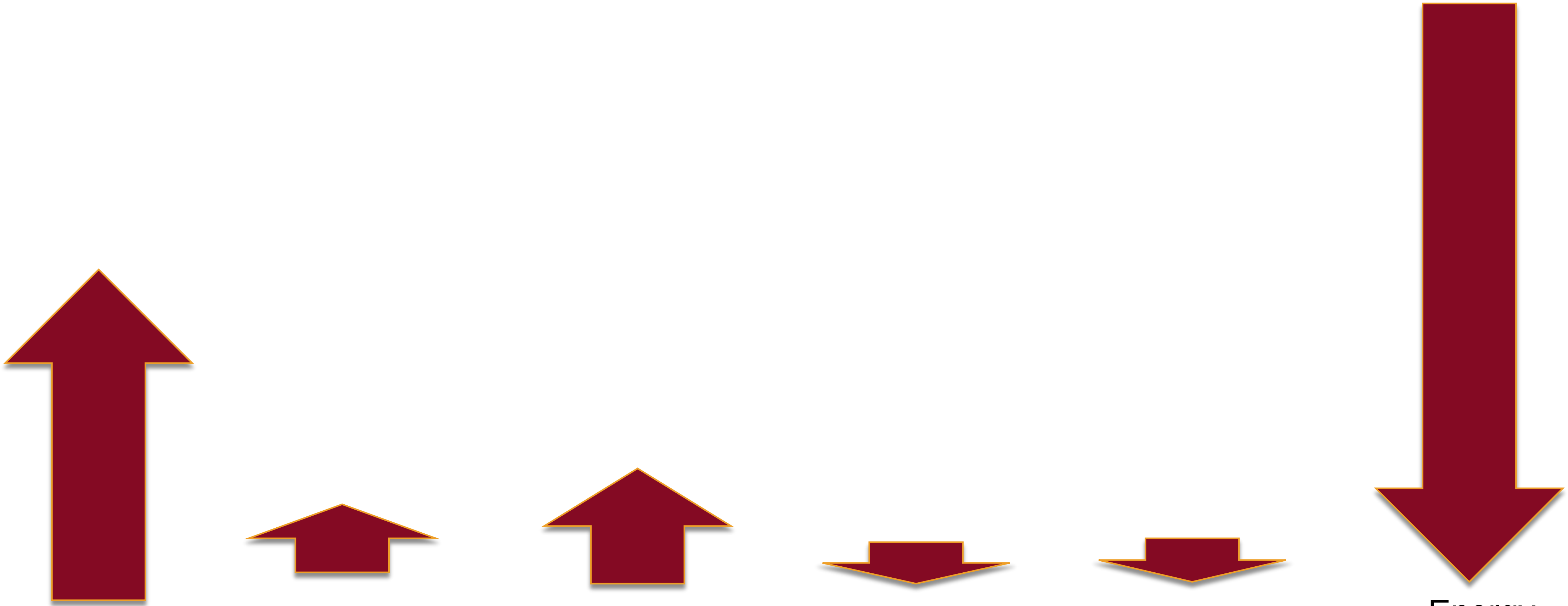
MBTU per GSF: Colleges and Universities



Energy $/GSF: Colleges and Universities



Upcoming Changes to Campus Energy Costs



IDC
+$100k

BPS & BWC
AC
+$17k

Commons
+$36k

New Chiller
-$13k

Natural Gas
Contract
-$14k

Energy
Projects
-$210k

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Utility Master Plan

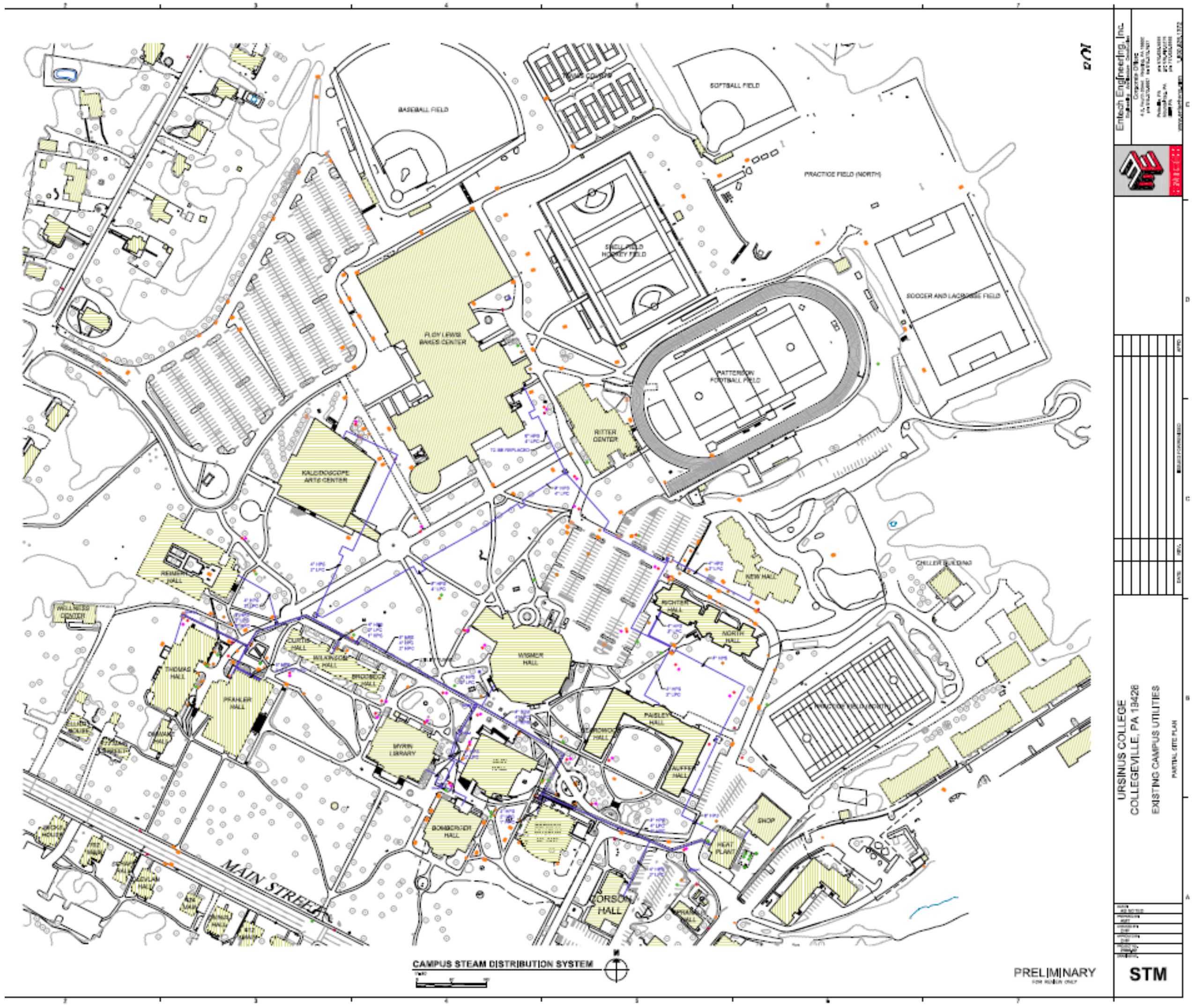
Summary of Findings

Considered and NOT Recommended

- Monetizing heating and cooling plants by selling energy infrastructure
- Combined Heat and Power (micro-turbine and back-pressure turbine)
- Conversion from steam to hot water distribution
- Full decentralization of boilers
- Conversion from natural gas to biomass or biofuel

Campus Steam System

- Good condition + efficient operation = no major changes
- Recommendations:
  - Reduce outgoing steam pressure
  - Phased transition to decentralized domestic hot water systems with a summer boiler in the Central Boiler Plant to provide steam for re-heats
  - Replace the burner on Boiler #1 with a dual-fuel burner

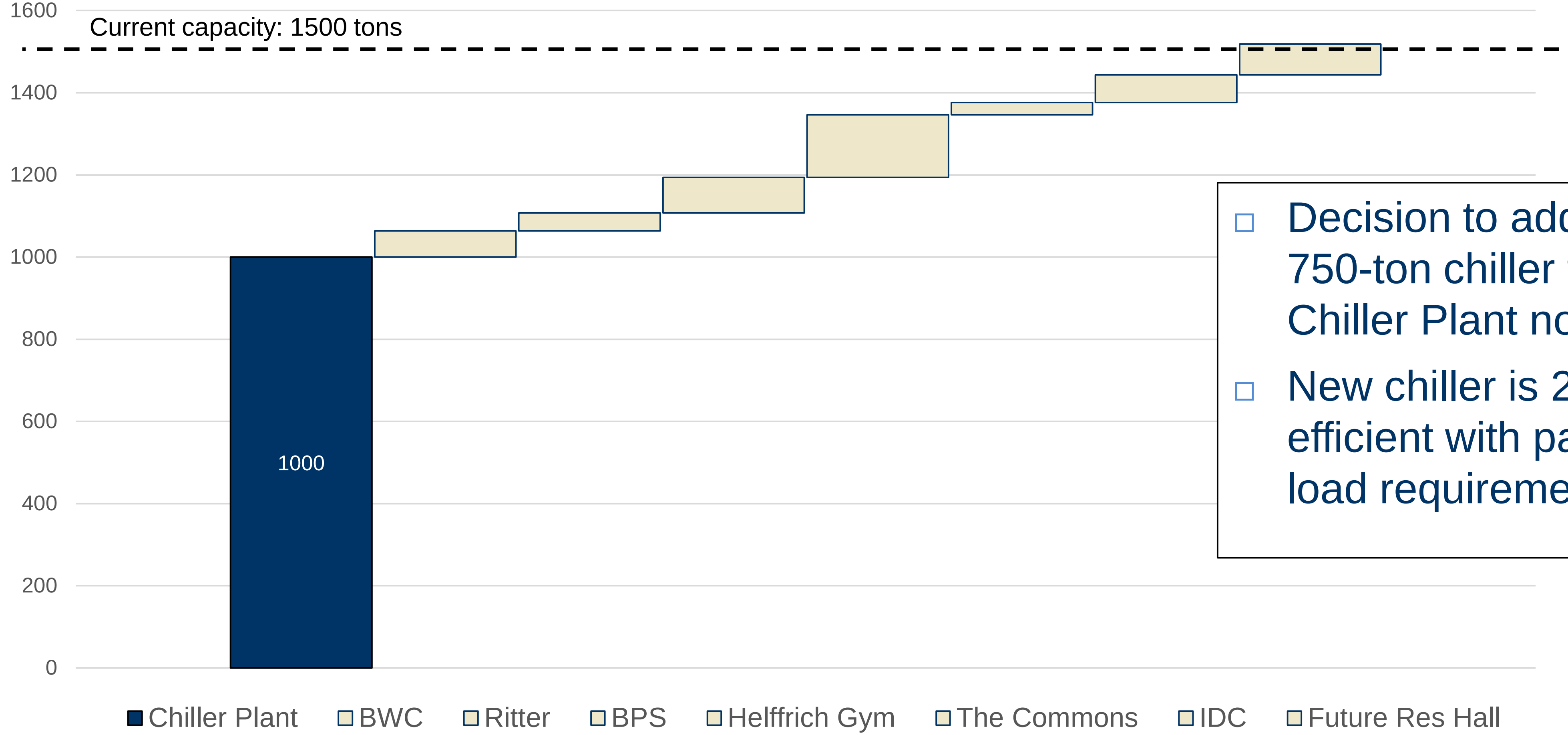


Campus Electric System
Capacity and Description

- Local Utility Service from PECO, provided at 33,000 Volts

Current limits of PECO peak demand contract:	2,592 KW
2016/17 Ursinus peak demand	2,310 kW
Projected 2019 peak with IDC, Commons, and a new chiller	2,700 kW
Capacity of College’s primary utility transformer (College distribution at 4,160 Volts)	4,750 kW
Capacity of PECO’s metering equipment Ability to upgrade PECO’s CT’s to provide additional capacity	4,100 kW

Campus Chilled Water System
Current & Future Capacity requirements



- Decision to add one (1) 750-ton chiller to the Chiller Plant now
- New chiller is 20% more efficient with part and full-load requirements

GSF	667,685		42,716	29,145	57,778	101,714	20,000	45,000	50,000
GSF/TON	668		668	668	668	668	668	668	668
PEAK TONS	1000		64	44	87	152	30	67	75

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Energy Efficiency and Conservation Measures

Summary of Energy Efficiency Measures

- Building Automation System (BAS) upgrades, expansion, and optimization
- Complete campus lighting upgrades
- Perform Retro-Commissioning at several facilities
- Reduce steam pressure at Central Heating Plant
- Decentralize water heating during summer months
- Convert constant volume systems to VAV's (Bakes, Thomas, Berman, etc)
- Create energy & temperature policies
- Install a new chiller at Central CHW Plant

Energy Capital Investment Plan

ITEM NUM.	BUILDING	ENERGY SUB-SYSTEM	TRADE	PROJECT DESCRIPTION	ECM COST	INCENTIVE SAVINGS	EFF. COST	N.G. REDUCT. MBTU	ELEC. REDUCT. KWH	ANNUAL EMISSIONS REDUCTION MT CO_2e	ANNUAL SAVINGS	PAYBACK PERIOD	ROI %	STATUS	INCL	COMMENTS
74	Heating Plant	Generation	IH	Optimize the steam plant operation.	$0	$0	$0	1,987,206		105.7	$10,135	0.00	NA	Open	Yes	Reduce steam pressure (currently 90 psi constant) and reset to lower values based on time of day (when autoclaves are not in use). Identify the limiting factor related to steam pressure (may vary based on OA conditions/load): •Water carryover at higher velocity •Increased steam pipe velocity and condensate pipe/pump capacities •Minimum firing requirements of the active boiler(s) •Derating factor associated with water tube boilers (may prompt pressure reset based on load), as applicable •Level of superheat desired (if any) to prevent condensation in distribution system SHG 05/03/18: Meeting discussion questions capability at boilers to operate at reduced pressure. Opportunities to reduce pressure at the plant have been discussed. This will reduce energy losses assocatied with distribution and condensation.
15	Berman	End Use	IH	Provide a setback schedule for AHU-1 (new entryway/stairway), AHU-2 (front lobby) and AHU-4 or associated non-critical VAVs if space use permits. At a minimum, allow closure of the AHU-4 OA damper and AHU-3 OA damper during unoccupied hours.	$300	$150	$150	105,882	15,841	27.3	$1,781	0.08	1187%	Open	Yes	Cost analysis includes reduced OA and some reduced fan runtime. ECM savings will vary based on implementation approach.
39	Campus	Distribution	IH	Consider reviewing opportunities for HVAC optimization, particularly at AHUs providing ventilation air. Only a few schedules are identified as 'Optimal.' Savings will be maximized if units are provided with corresponding warm-up/cool-down sequences.	$1,000	$500	$500	397,800	33,647	35.0	$4,665	0.11	933%	Open	Yes	Alternately, consider scheduling fixed warm-up/cool-down periods (with commensurate delay in occupied start time) to pre-condition space without undesirable introduction of OA.
				Multiple BMS schedules are in question. Reduced scheduling is not apparent for summer months, and sample schedules include significant durations: •Berman TOD lights: 4:30pm - 11:55pm •Berman Master schedule: 24/7 (two start times daily, no stop time) •BOM FCUs: 24/7												CONTINUED: •Myrin: extended schedule •North AHUs: 24/7 •Pfahler FCUs: 24/5 •Pfahler Office Tucs: 24/7 •Riemert EF schedule: beginning 2am daily •Ritter Art AHUs: 24/7 •Thomas AC-2: beginning 4am

Sample detail of Energy Capital Investment Plan

Energy Capital Investment Plan

ITEM NUM.	BUILDING	ENERGY SUB SYSTEM	TRADE	PROJECT DESCRIPTION	ECM COST	INCENTIVE SAVINGS	EFF. COST	N.G. REDUCT. MBTU	ELEC. REDUCT. KWH	ANNUAL EMISSIONS REDUCTION MT CO_2e	ANNUAL SAVINGS	PAYBACK PERIOD	ROI %	STATUS	INCL	COMMENTS
47	Campus	Distribution	ATC	Provide CO2 control at the identified AHUs (breathing zone). Cycle AHUs off when temperature and CO2 concentration are acceptable at the breathing zone (reduce zone damper minimum to zero where terminal units apply).	$24,000	$2,533	$21,467	921,600	50,659	72.3	$7,875	2.73	37%	Open	Yes	NOTE cost analysis excludes entries identified elsewhere as independent ECMs (e.g. Olin, Myrin and Wismer). Excluding noted buildings, 13 AHUs (19 sensors) and 192 equivalent motor HP remain. Include duty cycling at any instances not yet implemented where zone CO2 sensors already exist. $25 per ton DCV incentive from PECO
9	Athletics	Distribution	IH	Install VFDs at AHU-3 and AHU-4 (coordinate with separate recommendation for change of hot/cold deck sequencing). Operate fan speed based on the highest zone error (offset from setpoint).	$15,000	$2,686	$12,314		53,712	9.0	$4,208	2.93	34%	Open	Yes	Estimated (rough) savings only. Project will require further analysis if desirable related to savings and potential control measures. $25 per HP VFD incentive from PECO
89	Myrin	Distribution	IH	Install CO2 sensors at enclosed building zones to control the OA dampers at all units and VAV minimums at the basement and 3rd floor.	$7,500	$625	$6,875	330,000	5,280	25.8	$2,097	3.28	30%	Open	Yes	Ensure any make-up/pressurization requirements are maintained. Return air measurement may be suitable for large, open area. $25 per ton DCV incentive from PECO.
64	Chiller plant	Generation	IH	Optimize the chiller plant operation.	$3,500	$60	$3,440		11,700	1.2	$917	3.75	27%	Open	Yes	Use both cells regardless of number of chillers in operation. Control for an approach temperature rather than a constant condenser LWT setpoint (set at 75 F). Lower the minimum condenser LWT setpoint to the manufacturer's minimum limit. Improve ChW pump unloading (at low load, both pumps observed in operation at minimum speed). Review/tune the bypass valve PID loop control to reduce hunting (controls for evaporator dP). Implement a chilled water reset based on building demand. Optimize chiller loading and unloading via RLA/demand. Calibrate the flow meter (not accurate).
62	Campus	End Use	Misc	Complete "ECM Incl" items of the Operation and Control Recommendations.	$20,000	$1,750	$18,250	300,000	35,000	16.3	$4,272	4.27	23%	Open	Yes	Savings are estimates only--measures generally apply to systems not operating per a defined basis.
109	Richter/ North	End Use	Elec	Retrofit building fixtures utilizing CFLs and linear fluorescents with LEDs.	$16,786	$4,433	$12,353		33,952	0.2	$2,660	4.64	22%	Open	Yes	See lighting table summary for operating hours and values used. Favorable payback ties largely to areas with the greatest usage. $5 per screw-in LED and $7 per linear fixture incentive from PECO.
4	Athletics	End Use	Elec	Replace/retrofit building lighting fixtures.	$200,974	$17,093	$183,882		341,853	29.0	$35,604	5.16	19%	Open	Yes	Cost analysis per Greenleaf findings. Note savings are not linked to update based on varying electricity unit costs. SHG 04/27/18: Fitness Center complete.
58	Campus	Distribution	Mech	Install jackets at building service entrance steam gate valves throughout.	$5,300		$5,300	199,428		33.6	$1,017	5.21	19%	Open	Yes	See Thermaxx or UniTherm product lines or similar
128	Wismer	End Use	Elec	Upgrade lighting throughout facility to LED	$39,000	$2,500	$36,500		53,000	1.2	$6,100	5.98	17%	Open	Yes	
122	Wismer	End Use	IH/Misc	Provide variable speed exhaust for the bake shop fan.	$5,800	$500	$5,300	105,826	3,820	5.6	$839	6.32	16%	Open	Yes	Heat and/or smoke sensors. Combine with static pressure control for AC-2. UPDATE: Standing pilots may affect feasibility. $500 per HP incentive from PECO for kitchen exhaust VFD. UPDATE: Cost adjusted (lowered) per updated information received.
76	Heating Plant	Generation	Mech	Provide O_2 trim control for boiler B-2 (dual fuel) to maintain peak combustion efficiency during continuous stack measurement.	$30,000	$0	$30,000	927,363		49.8	$4,730	6.34	16%	Open	Yes	Applies to dual-fuel (lead) boiler. Review boiler/burner capabilities with manufacturer as applicable.
83	Musser	Distribution	Various	Insulate the boiler room heating and domestic hot water piping. Block the open louver to the exterior if not utilized.	$900	$41	$859	14,000	812	8.6	$135	6.36	16%	Open	Yes	
73	Facilities	End Use	Elec	Upgrade lighting throughout facility to LED	$5,000	$300	$4,700		8,000	23.0	$700	6.71	15%	Open	Yes	
85	Musser	End Use	Elec	Retrofit building fixtures utilizing CFLs and linear fluorescents with LEDs.	$2,250	$764	$1,486		2,796	0.7	$219	6.78	15%	Open	Yes	See lighting table summary for operating hours and values used. Favorable payback ties largely to areas with the greatest usage. $5 per screw-in LED and $7 per linear fixture incentive from PECO.

Building	Priority 1-4 (1 high)	Energy Impact	Issue		Updates	Status
Chiller Plant	3		Review the condenser water conductivity. Displayed values were at alarm conditions.	Review condenser water conductivity.		Open
Berman	1	High	Raise the AHU-4 dehumidification setpoint from 40%. It appears this is maintaining the DAT at the low end of the reset (55 F) while all terminal units downstream demand heat (note type of reset not apparent to indicate the extent to which the DAT will increase).	Raise the dehumidification setpoint.		Open
Berman	2	Low	Consider reviewing ventilation control at AHU-4 and sensor (CO2 and AFMS) calibration: •The BMS indicates a RA CO2 in excess of 1,000 while the OA damper remains fully open. This likely exceeds the design intent. •The OA cfm indicates a value averaging approximately 30 cfm (damper position 100% open) compared to a setpoint of approximately 300 cfm and a scheduled design of 900 cfm. •The AFMS input fluctuates rapidly between zero and 60 cfm.	Rectify control.		Open
Berman	3		AHU-4 zone 1 displays a high humidity condition while indicating the lowest of the three duct sensors.	Investigate point.		Open

Sample Detail of BAS Control Recommendations

Provide demand-controlled ventilation

- Myrin Library
- Air handling unit ventilation rates are designed to maintain adequate ventilation during design occupancy levels. DCV sequencing through zone CO_2 sensors enables reductions in ventilation air (and associated heating and cooling loads).
- This ECM can provide a rapid payback due to the large, open nature of the spaces.

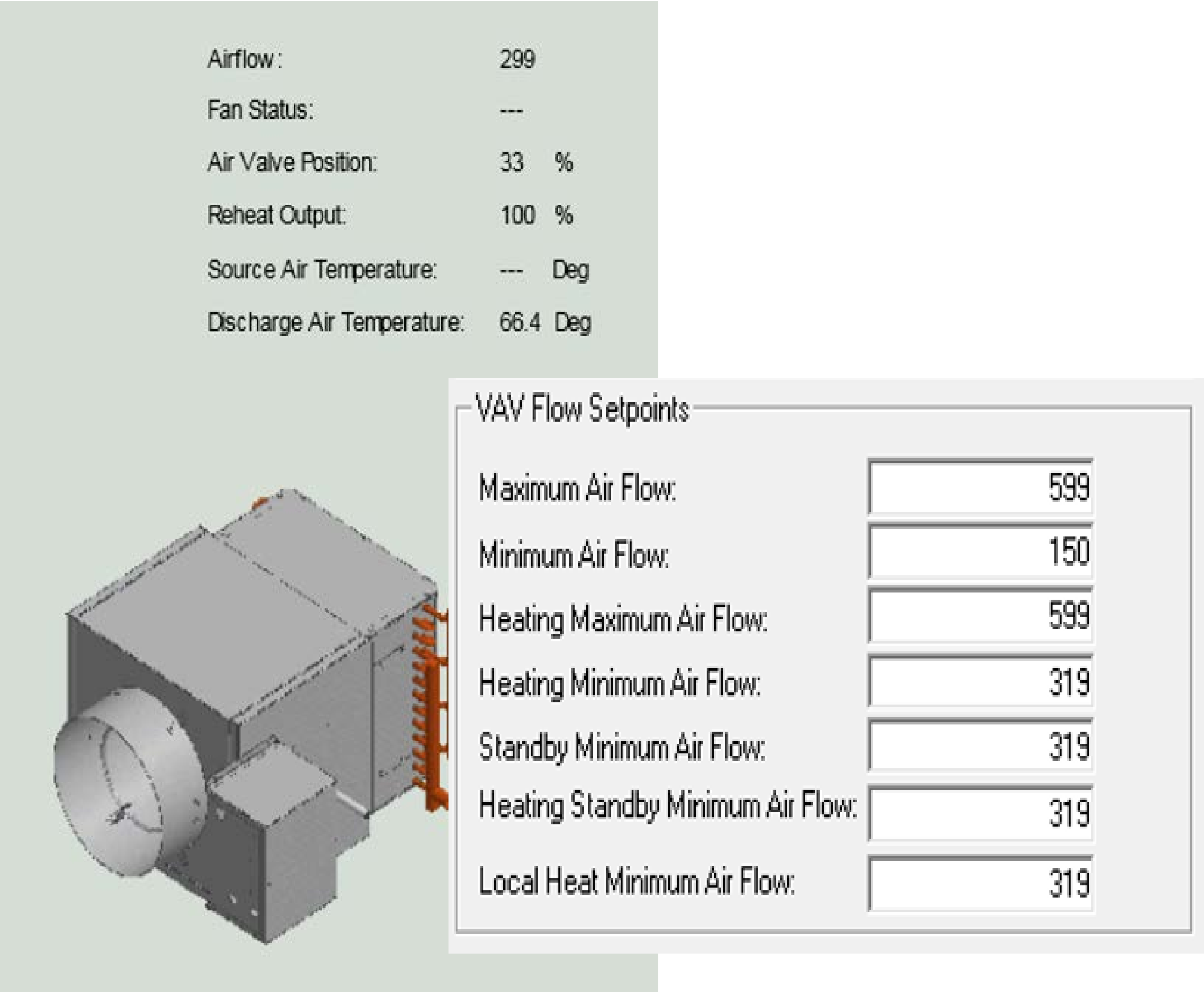
Replace the track metal halide lighting with LEDs

- Replacing the current 1,500 W fixtures with LED fixtures (567 W each) will provide immediate energy savings. Additional savings will be realized through a reduced re-lamping frequency.
- Opportunities may also exist for bi-level lighting to provide safety while increasing output as needed. Lights currently operate all evenings.

Provide occupancy-based operation at the Field House

- Occupancy sensors are recommended at the field house to limit space lighting and index AHUs to a standby mode with relaxed setpoints and reduced fan energy.
- These control measures will be coupled with related components (eg daylight sensors for perimeter lights, CO_2 sensors for ventilation savings).

Optimize VAV Control



- VAVs observed throughout use a staged method of heating in which airflow is increased when heating is required. While this can increase the VAV capacity, it also consumes a greater amount of energy input (related to heating, cooling and fan energy) per BTU of heat provided to the space.
- Optimized control can increase airflow only when this capacity is required or as needed to prevent stratification by supply air that is excessively warm.

Energy Efficiency Measures Savings

Energy Projects, Total Cost	$1,300,000
15% Electric Savings	($91,000)
25% Natural Gas Savings	($69,000)
Electric Procurement Savings (after 2020)	($50,000)
Estimated Annual Energy Savings	**($210,000)**

Financing Options that were quickly eliminated

- ESCO / PPA / ESA
  - High cost of implementation
  - Burdensome contracting process
  - High cost of on-going M&V
  - Less flexibility to substitute projects
  - Less ability to self-perform work

Energy Lease or Energy Projects Loan

Identified as the preferred structure.

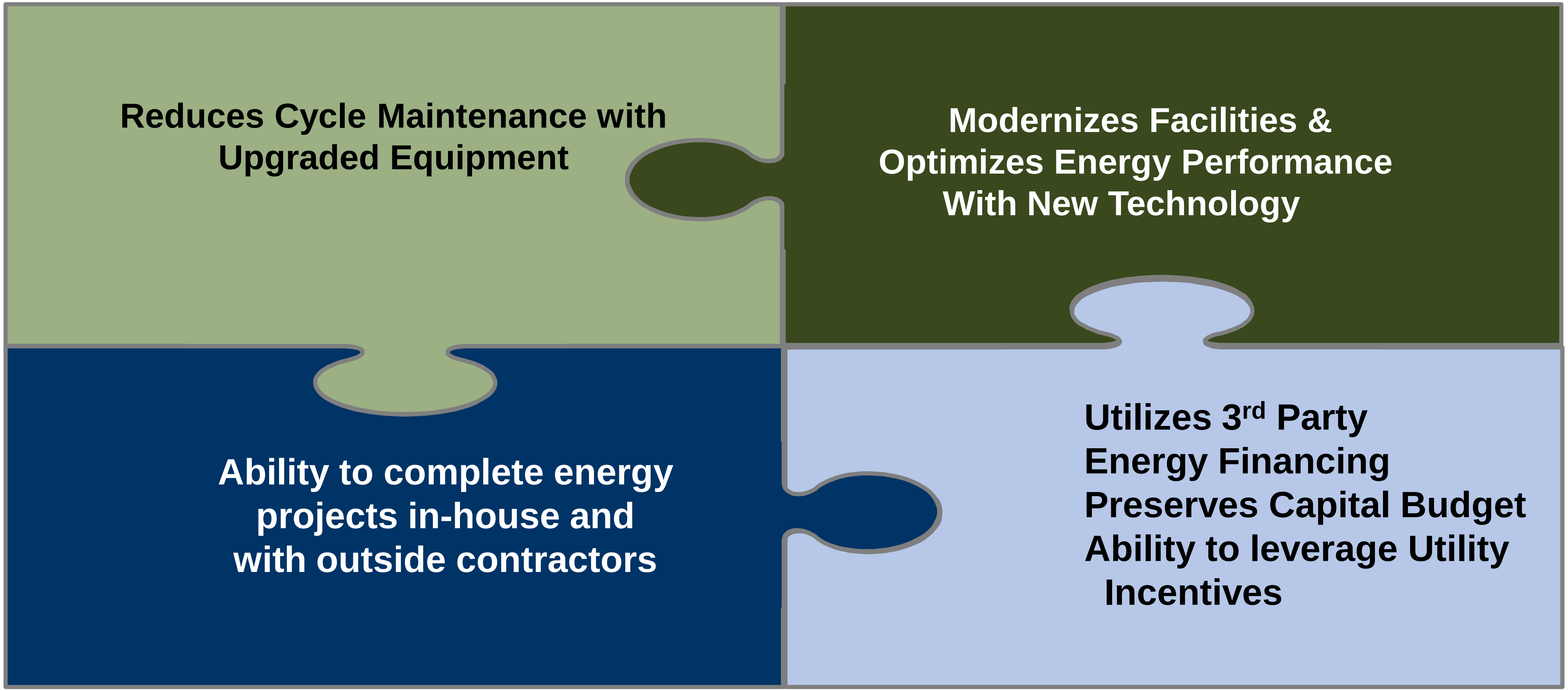
Energy Financing Options (2017)

Ursinus College Self-Finance	Borrow from Unrestricted Reserves and Payback Energy Savings
Line of Credit, Existing Bank	Creates lack of alignment with sources and users
Energy Lending Firm # 1, Capital Lease	4.25% over 5 years
Energy Lending Firm #2, Energy Loan	9.43% over 7 years
Sustainable Energy Fund	4% over 5 years
Energy Lending Firm #3, Energy Loan	5.75% over 10 years

Borrowing from the SEF allows Ursinus to meet Bond Covenants

- Non-recourse financing
- Secured against equipment installed
  - Not borrowed against existing buildings or property
- Cash flow positive
- No prepayment penalty
- Preserves Ursinus Capital for other projects identified in the Campus Master Plan

Advantages to Financed Energy Project Implementation



Projects Completed to Date

- LED Lighting Upgrades:
  - Floy Lewis Bakes
  - Bomberger
  - Richter/North
  - Musser
  - BPS
  - BWC
  - Olin
  - Facilities
  - Kaleidoscope
  - New Hall
  - Off-Campus Houses

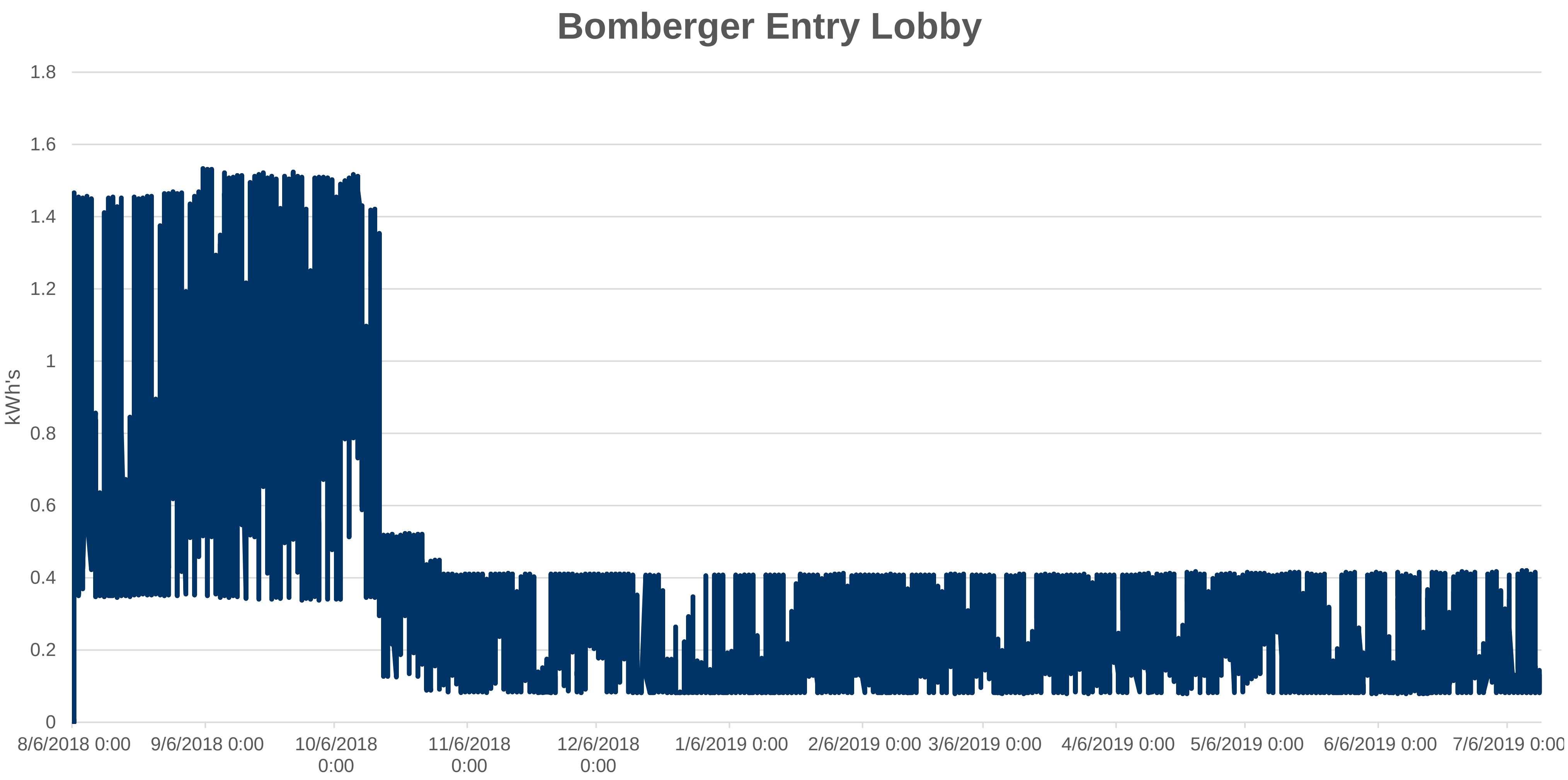
HVAC / Controls:

- Steam pipe insulation
- VFD Drives
- Boiler #1 Conversion to Gas

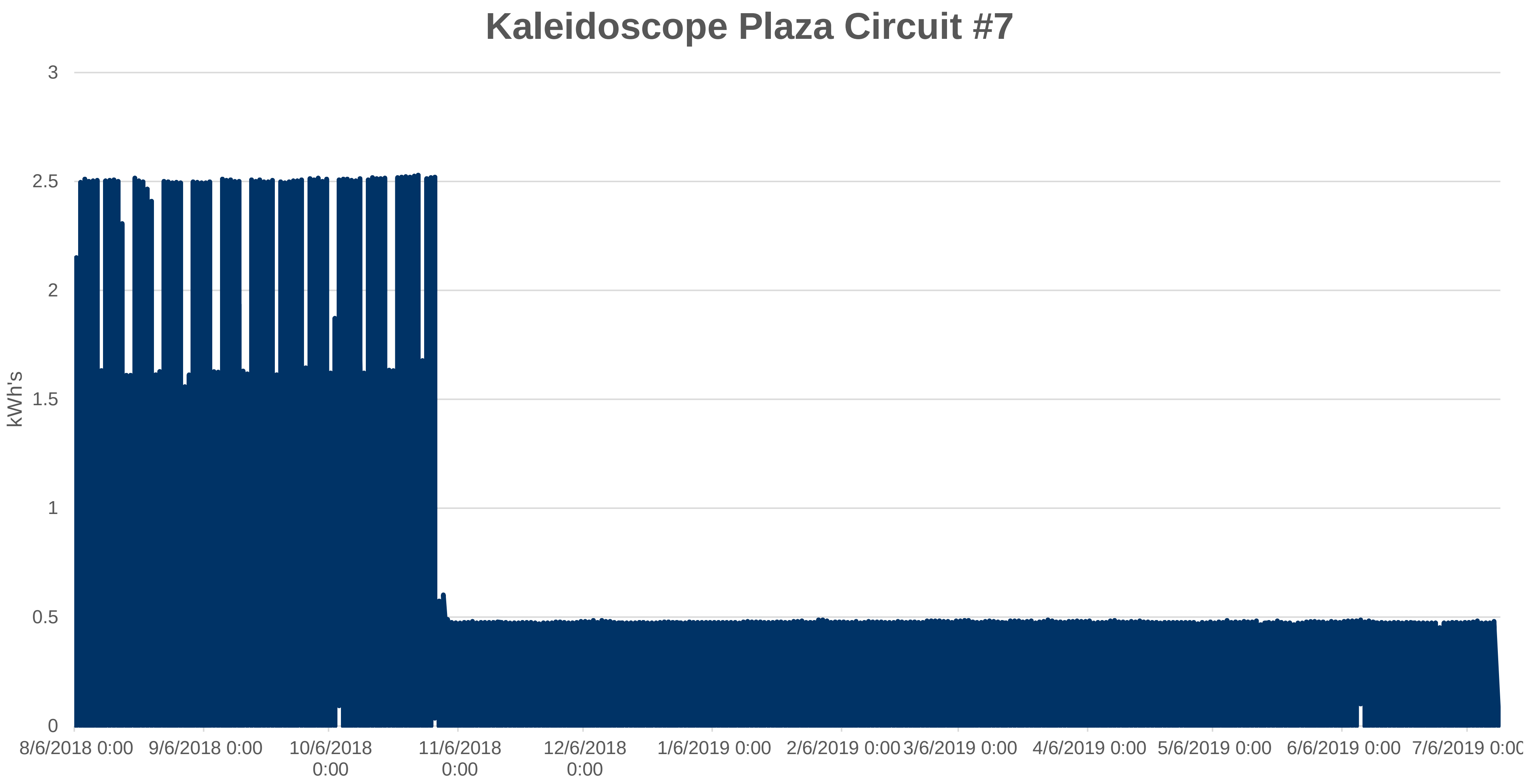
Next Up:

- RCx
- Chiller Plant Optimization

Measurement & Verification: Lighting



Measurement & Verification: Lighting



Thank you! Questions?

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Please visit The Stone House Group's booth in the Reception Gallery!