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ILAPPA
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Utility Management for the ISU Campus

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2020 ILAPPA CONFERENCE

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Illinois State University

- Our objective is to maximize occupant comfort while simultaneously reducing utility consumption, utility procurement costs and long term cost of facility operations

- In the past the utility cost savings were used to fund equipment improvements thus increasing the reliability of university utility infrastructure systems.
  - These improvements also reduced deferred maintenance and improved the campus environment.
  - We hope to have this budget flexibility in the future

Management Strategy

1. Implement data collection, analysis and reporting systems to facilitate optimum allocation of resources
2. Minimize total cost of ownership including first cost and operating costs while maximizing occupant comfort
   - Considerations
     - Reliability / Durability
     - Serviceability
     - Utility Costs
     - Maintenance & Repair Costs
     - Control Capabilities
   - We continually compare keeping and optimizing what we have versus installing new equipment & systems
3. Procure Utilities Considering Both Cost and Carbon Footprint

The Magnitude of Utility Costs Provides Opportunities for Significant Savings

FY 19 Utility Cost Consumption

Electricity	**Cost**		**$5,959,926**
	Consumption (kWh)	85,749,274	
Natural Gas	**Cost**		**$2,386,374**
	Consumption (Therms)	5,285,627	
Water	**Cost**		**$1,940,799**
	Consumption (Gallons)	168,978,916	
Total	**Cost**		**$10,287,099**

Efficiency Ideas

- Look for heat being lost
  - Stack Economizers - Boilers
  - Oxygen Trim - Boilers
  - Steam Trap Failures – Steam Distribution
  - Excess “Reheat” – Campus HVAC Systems
- Look for energy used when not needed
  - Night, Weekend and Holiday Temperature Setbacks
  - Air quality controls
    - Excess Outside Air
    - Excess Zone Air Flows
  - Occupancy Sensors
- Look for more efficient equipment
  - Higher efficiency lights
  - Variable speed drives on fans and pumps
  - Higher efficiency chillers
  - Higher efficiency air handlers
- Improve controls to make it all work as efficiently as possible

Additional Building Automation Can Provide Energy Savings and Comfort Benefits

- Advantages compared to stand alone systems:
  - Allows building systems to be controlled remotely via computer
  - Allows energy saving control strategies such as temperature setbacks and fan shutdown
  - Provides for alarms to catch problems quickly
  - Provides data to significantly reduce troubleshooting time and expense
- The majority of campus equipment has building automation
- Recent & Potential Building Automation Projects –Annual Utility Costs
  - Student Accounts $10k
  - Professional Development Building $10k
  - Ropp Ag $15k
  - Nelson Smith (6 air handlers) $95k
- Estimated annual utility cost $130k
- Estimated annual utility savings 10% = $13K

  Energy payback 10 years

  Project timeline 18 months

  - Projects would also provide maintenance savings and reliability improvements

The East Campus Housing Complex Chilled Water System Upgrade – In Process

- Hewett and Manchester have large fans providing HVAC to the resident rooms
- These air handlers did not have valves on the cooling coils resulting in overcooling **– often putting out 48° air in the summer!**
- Steam coils are used to reheat the air back to a comfortable temperature for the residents **– typically had to heat it back up to 60°**
- Estimated annual energy cost savings from upgrading the system is $30,000
- Estimated project cost to correct this $360k

Energy payback 12 years

Project timeline 2 years

- Project would also provide improved comfort for the residents. In addition this project would reduce the peak load on the SLB chilled water plant by 120 tons which is important because this 1,800 ton capacity plant is loaded to maximum capacity during hot weather and has no redundancy

Building Envelope Upgrades - Windows

- Single pane glass has low insulating value   R-Value .9
- Double pane glass can increase the insulation valve   R-Value 3.2
- Heating BTU Loss / Sq. Ft. per year for single pane is 140,000 BTU given ISU typical outdoor temperatures
- Cooling BTU Loss/ Sq. Ft. per year for single pane is 24,000 BTU
- These savings are likely doubled due to poor window seals on old windows
- Annual energy savings to install new windows estimated at $1.02 / sq. ft.
- Cost per square foot to replace windows estimated at $40

Energy payback 39 years

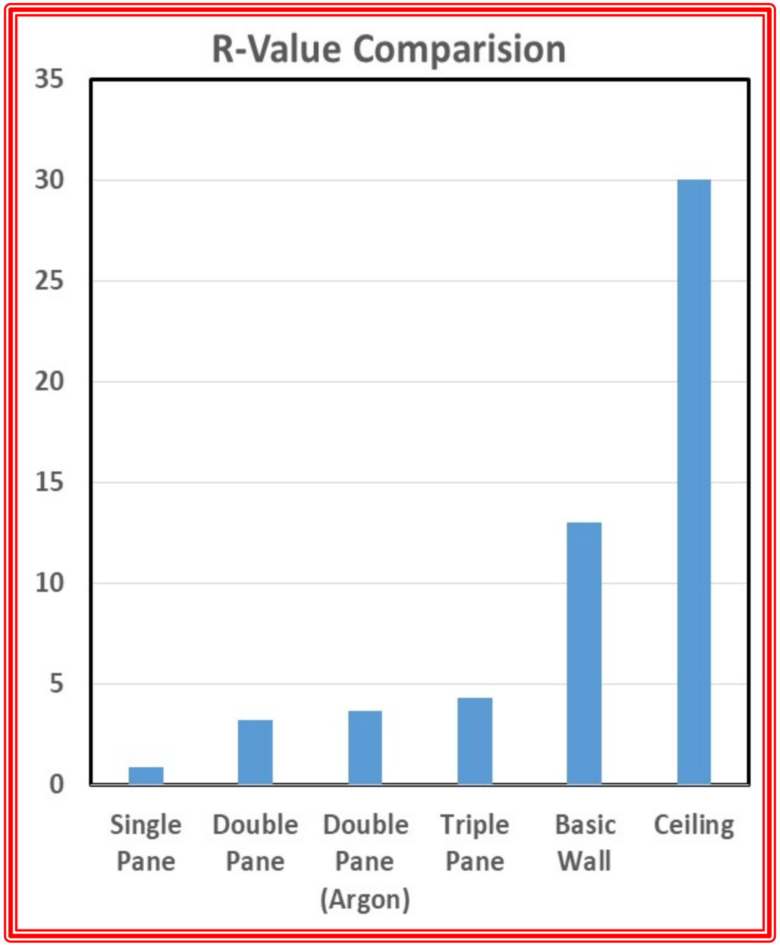
Project timeline 2 years

- This project would also provide improved comfort for students, faculty and staff, reduced noise and greatly improved aesthetics

- **Another option is to install window film on existing windows**. This can be done quickly and provides a quick payback
- Estimated cost is $10 per sq. ft.
- Estimated savings is $.80 per square foot

Energy Payback 12.5 years

Project Timeline 6 Months



Lighting & Control Upgrades

- ISU Lighting consumes an estimated 25% of campus electricity = 22.5 million kWh per year costing approximately $1.5 million per year
- Lighting that comes on when it is dark outside uses approximately 2.5 million kWh per year
- Lighting for indoor spaces consumes approximately 20 million kWh per year costing $1.35 million per year ($.20 / sq. ft. per year on average)
- The cost to install new fixtures and controls is an estimated $2.70 / sq. ft.
- In those areas without occupancy controls or with incandescent lighting we can get a good payback by installing LED lights and occupancy control switches
- Estimated project cost is $2.70 / Sq. Ft. for re-lamping and as low as $.50 / Sq. Ft. for occupancy / light level switches
- We are currently auditing our buildings to find the best applications

Energy payback for areas in need of upgrades 5 – 10 years

Project timeline 2 years to get all appropriate areas

- Some incentives are available from our utility (Ameren) on smaller accounts

Renewable Energy – Wind Turbine

- Wind energy is becoming increasingly competitive with other energy sources
- The cost to purchase and install a 2 MW wind turbine is estimated at $6 million including distribution wiring
- Based on the Heartland College wind turbine the average output would be approximately 33% of rated capacity resulting in 5.4 million kWh per year worth $378K

Energy payback 16 years

Project timeline 3 years

- This project would also provide an on site laboratory for Renewable Energy students and faculty
- Project economics could be improved if grants are available

Reducing Energy Lost to "Reheat" Can Save Significant Money

- Buildings with constant volume reheat waste energy from cooling and then reheating HVAC air. Stevenson Hall is an example of a building like this
  - Stevenson Hall Annual Energy Cost - $327K
    - Building Electricity $205k
    - Chilled Water Electricity $38k
    - Building Steam $84k
- Conversion to a VAV (Variable Air Volume) system would save an estimated 25% of steam and chilled water energy and 10% of other building electricity
- Annual energy savings estimated at $51K
- Stevenson Project cost estimated at $1.0 MM

Payback 20 years

Project timeline 2 years

- Other buildings for this initiative
  - Williams
  - Hovey Annex
  - Edwards (In Process)
- This also significantly improves temperature control for better comfort
- Typically provides significant additional cooling capacity since cooling is not wasted

Renewable Energy – Solar Power

- Solar energy is becoming increasingly competitive with other energy sources
- The Future Energy Jobs Act provides great incentives for solar power
- If we can site the system within our delivery loop we believe we can break even with current supply costs
- We are currently working on an RFP for up to 2 MW of solar generation
- This project would also provide an on-site laboratory for Renewable Energy students and faculty

Chiller Interconnect & Optimization

- ISU Chilled Water operations use approximately 16 million kWh per year costing $1,040k per year in electricity (18% of electricity)
- We are working to interconnect the chilled water loops to provide:
  - Redundancy (benefits of interconnection were recently demonstrated when the SLB Chiller Plant failed and the existing interconnect to the Southeast chillers was in place)
  - An estimated 5% energy savings
- Estimated annual energy cost savings from remaining chiller plant interconnect projects is $52k
- Estimated project cost for remaining interconnects $1.3 million

Energy payback 25 years

Project timeline 3 years

ISU Main Chilled Water Loops

The Science Lab Building Has High Energy Consumption Due to The Large Amount of Lab Exhaust

- The SLB annual energy consumption cost is $445K (5% of Campus Energy Expense From 2% of Campus Sq. Ft.)
  - $89K Chilled water electricity cost (SLB share of chiller plant electricity)
  - $264K Other building electricity – HVAC Fan Energy is Very High
  - $93K Steam energy
- Energy cost with new fume hood systems could be reduced by an estimated 20% saving $89K per year
- Current fume hoods are obsolete and need replaced in coming years

Estimated project cost is $4,000,000

Energy payback 45 years

- Project timeline 3 years
- Project would provide maintenance savings and reliability improvements

Upgraded Data & Analytics System

- A key OEM initiative is improving our data system to aid in decision making
  - Currently upgrading with Microsoft Power BI for Analytics
  - Data files include utility bill data and internal University meter data
  - Building automation systems provide 15 minute interval data for deep dives
  - We are developing reports on utility cost and usage by square foot, building type, weather etc.

Metering Is Key To Our Efforts!

- We are in the final year of a multi year program to install steam, chilled water and electricity meters on all major campus buildings
  - While meters do not in themselves provide savings they provide the information required to effectively manage utility consumption
- Project costs for meter tied into campus building automation system:
  - Steam Meter $14,000 – Rosemont conditioning orifice plate
  - Chilled Water Meter $5,500 – Onicon insertion mag meter
  - Electric Meter $5,000 – Shark BACnet/IP (Previously Siemens digital energy monitor)
  - Condensate Meter $8,500 – Onicon insertion mag meter

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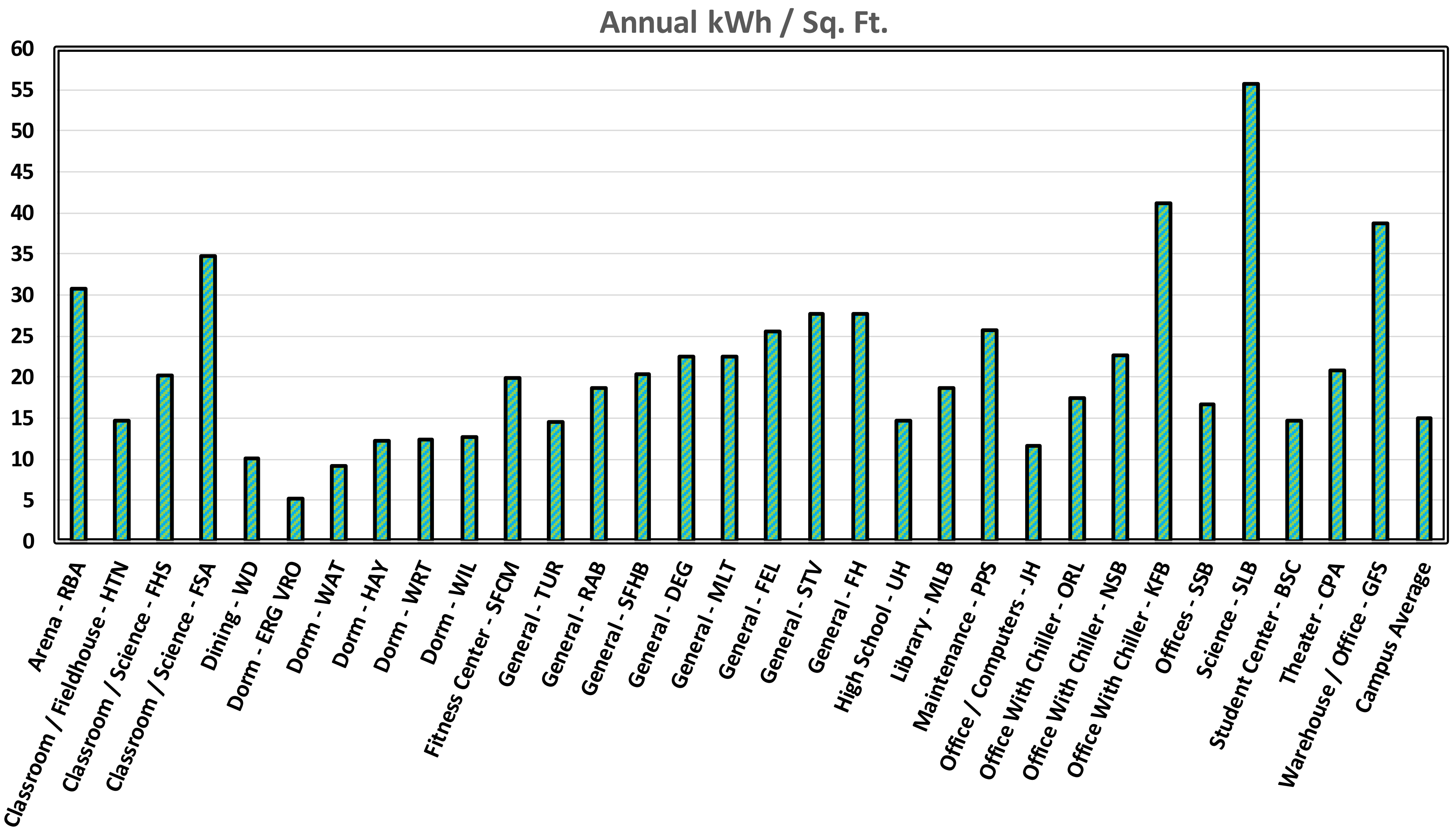

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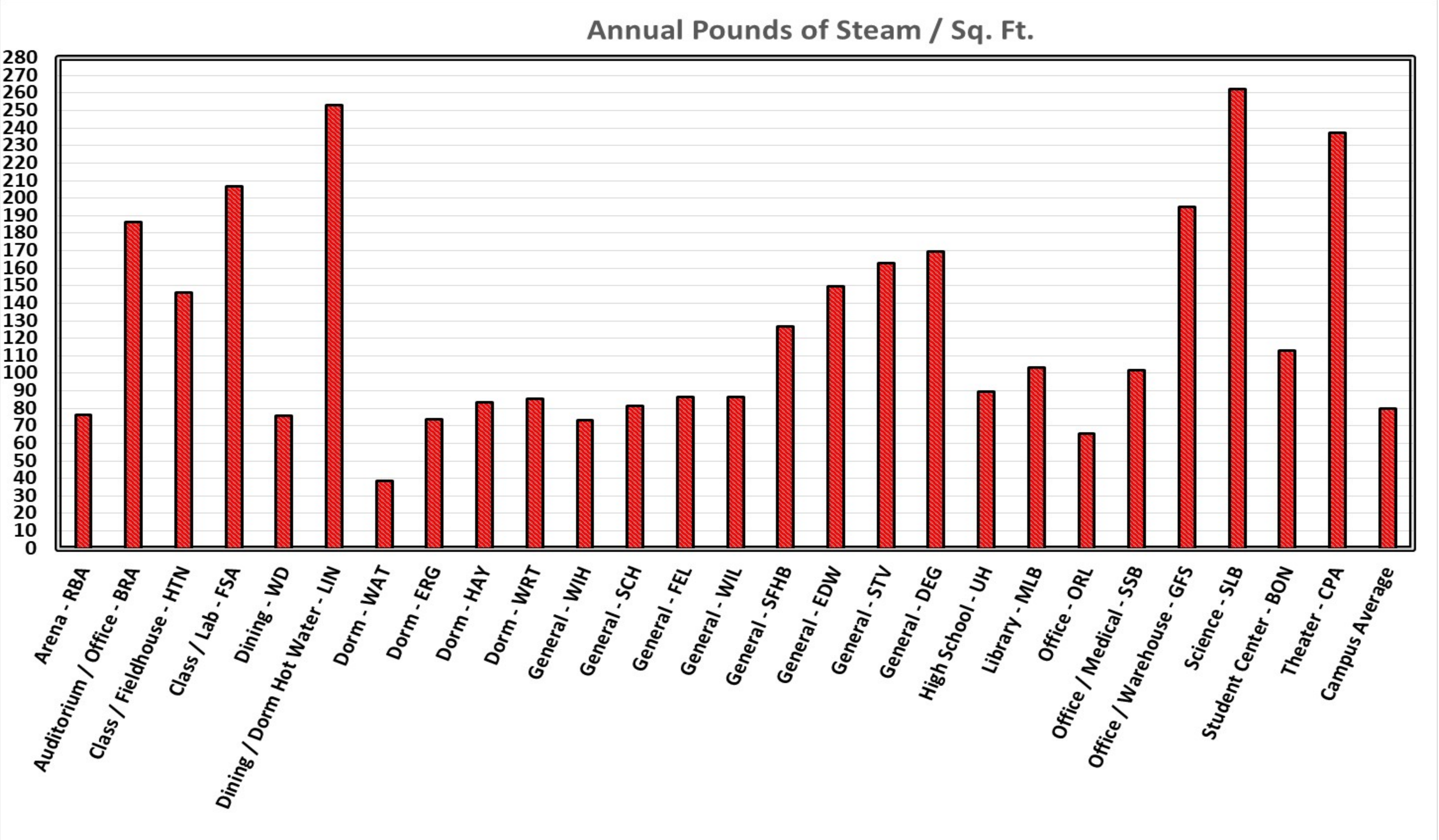


Energy Intensity Data Must Be Interpreted Based on Knowledge of the Buildings

- Example – State Farm energy intensity is relatively high for a newer building but it has a high amount of wall and glass area per square foot

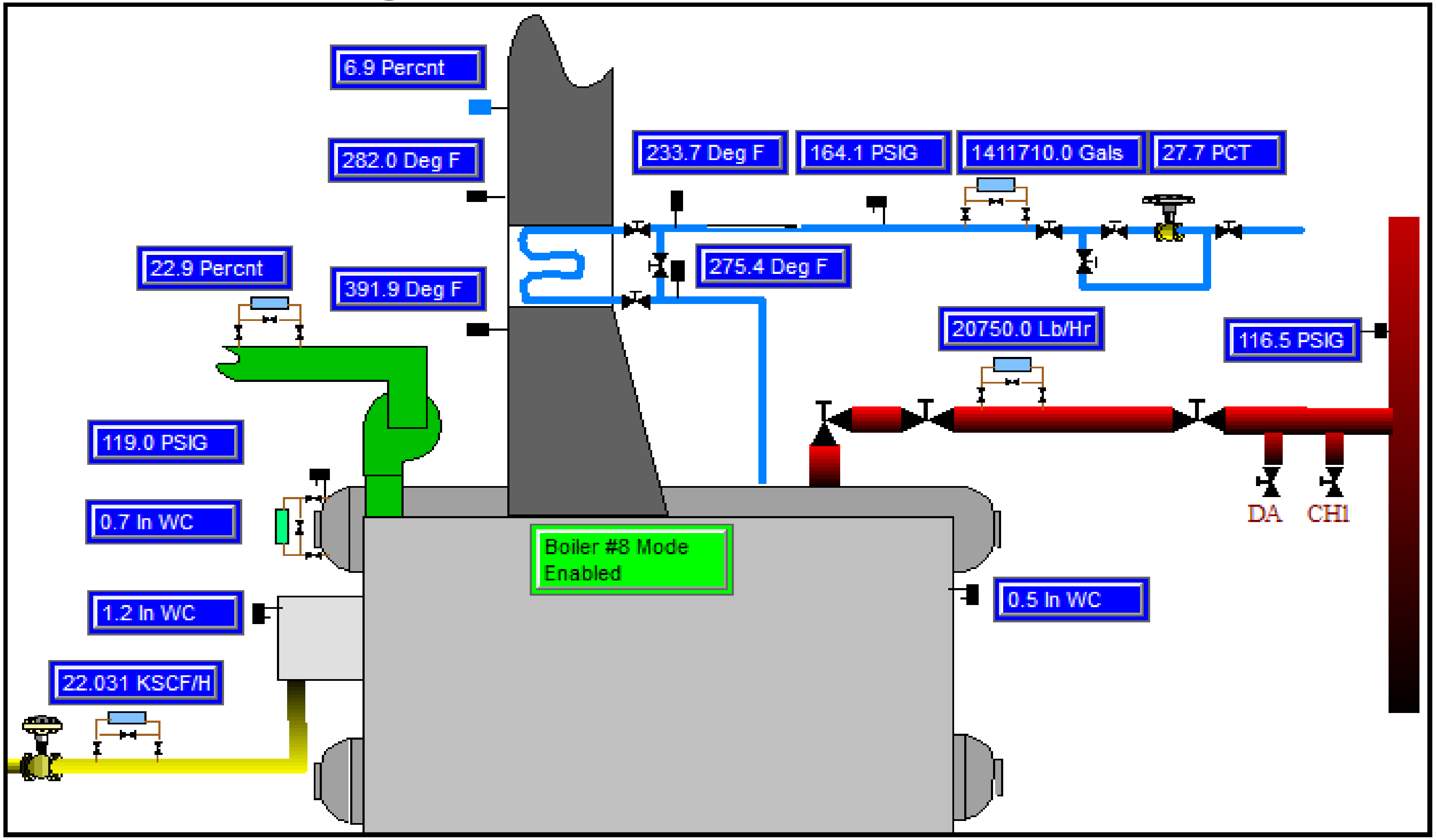
HVAC Retro-Commissioning Can Provide Excellent Return on Investment

- The campus HVAC system consumes a large percentage of campus utilities
- Leaking dampers and valves and poorly operating controls can lead to high levels of energy waste
- Upgraded metering and analytics can provide:
  - Information required to identify where retro-commissioning would be beneficial
  - Information required to maintain the gains
- Cost varies depending on the findings
  - New dampers $2k to $5k per air handler
  - New valves $1k to $2k per air handler
  - Labor $2k per air handler

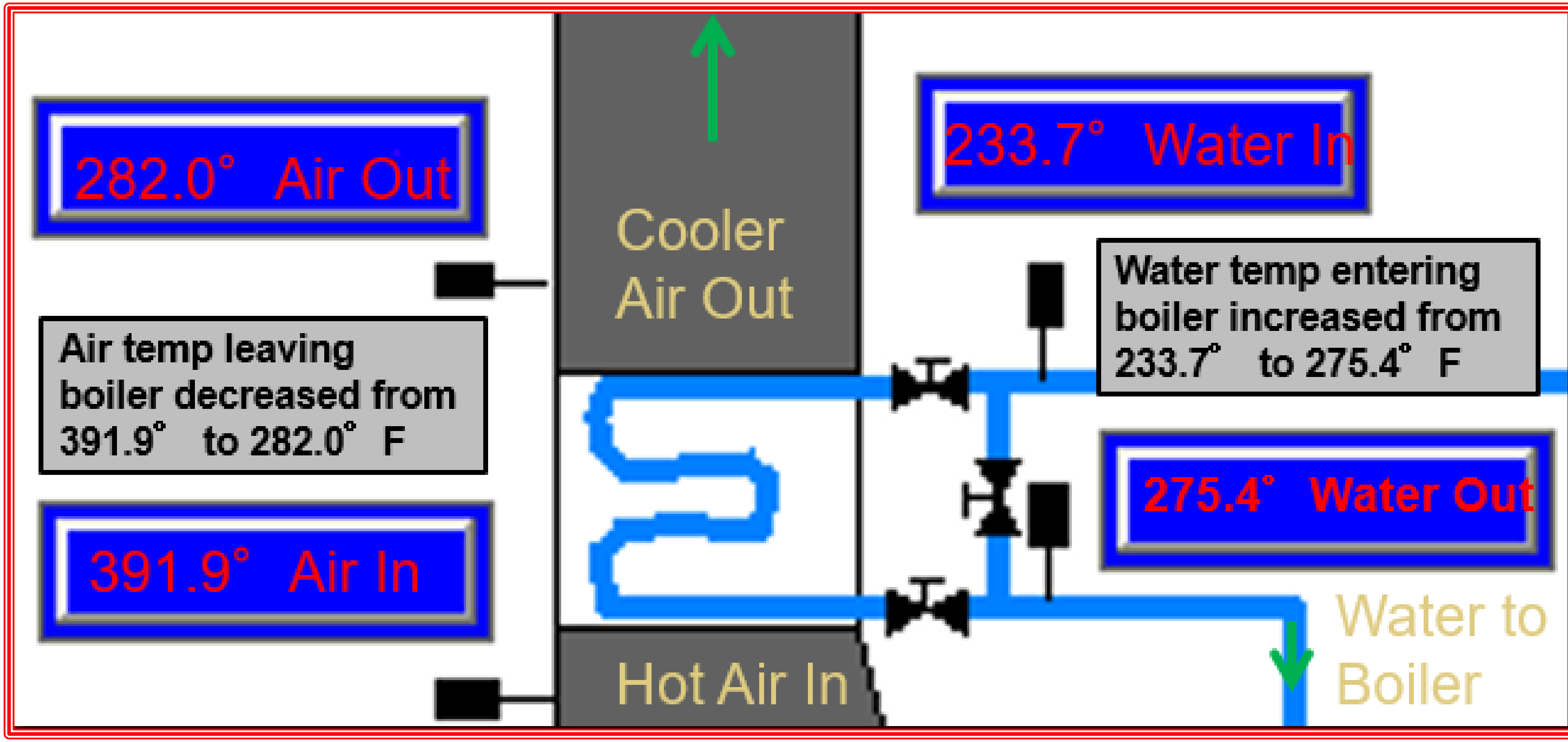
Payback 2 years or less depending on types of problems

Project timeline 1 year

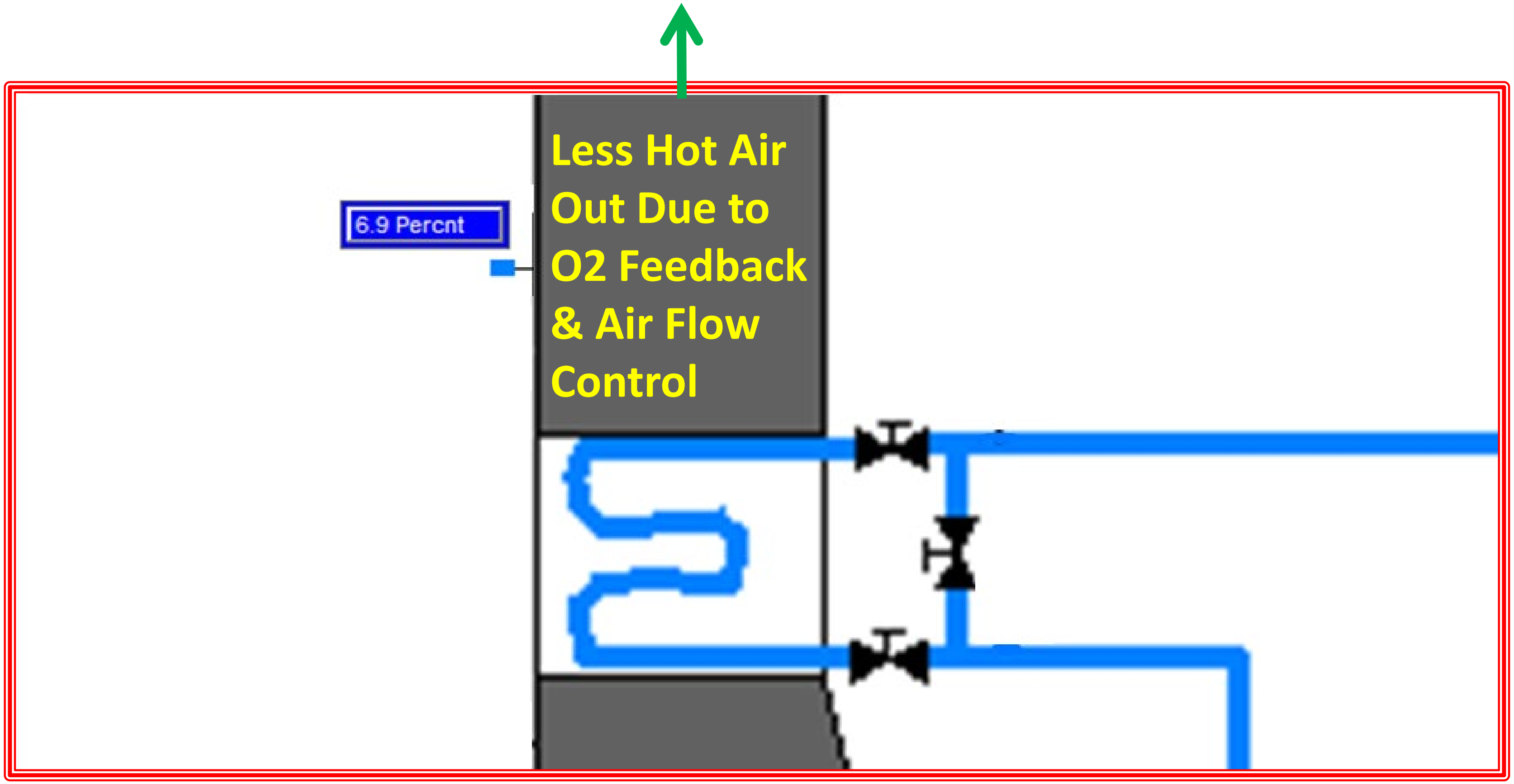
Savings From Boiler Economizers



Boiler Energy Savings from Stack Economizers



Boiler Energy Savings from O2 Trim System

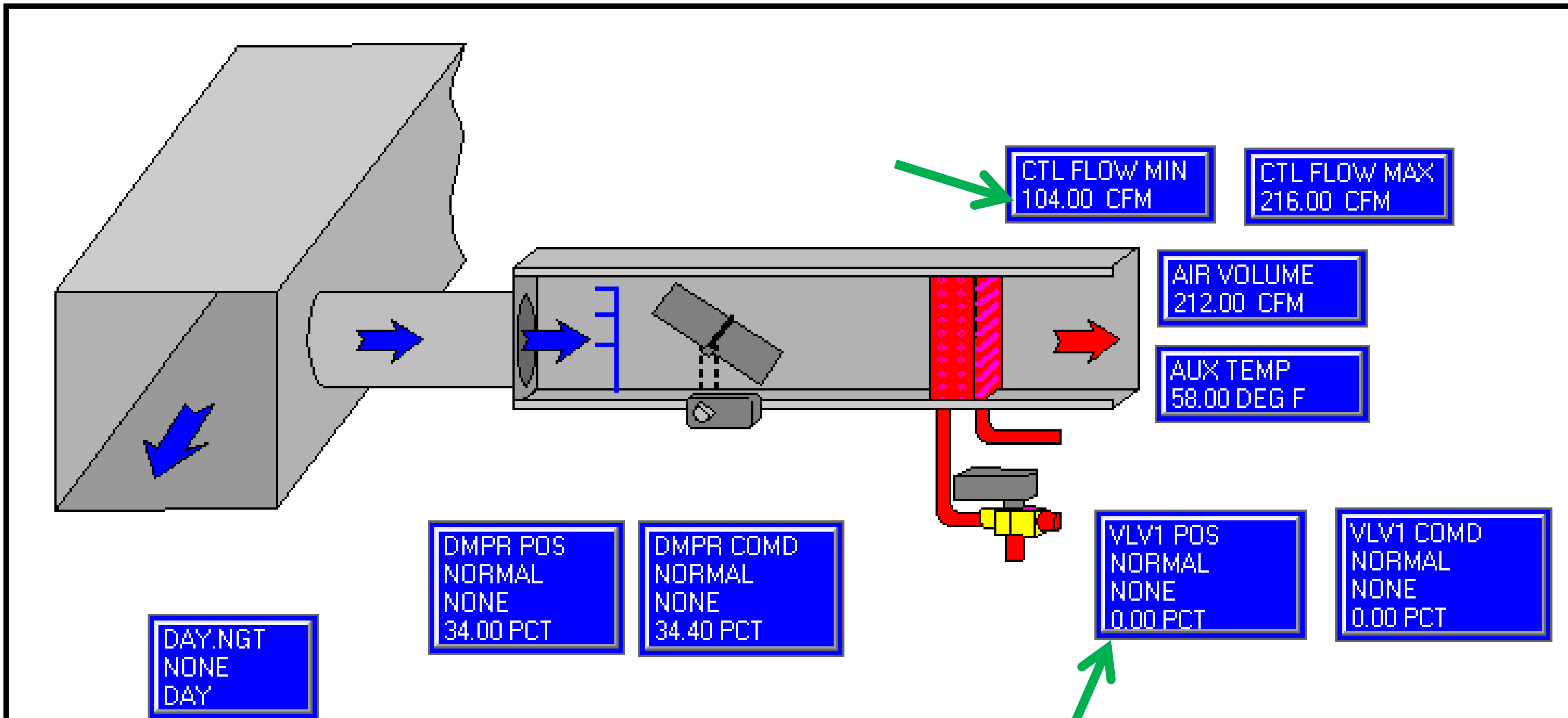


Steam Trap Monitoring Program

(If you see steam vapor energy is being lost)

Steam Trap & Remote Monitoring Device

Excess Reheat Has Been Reduced



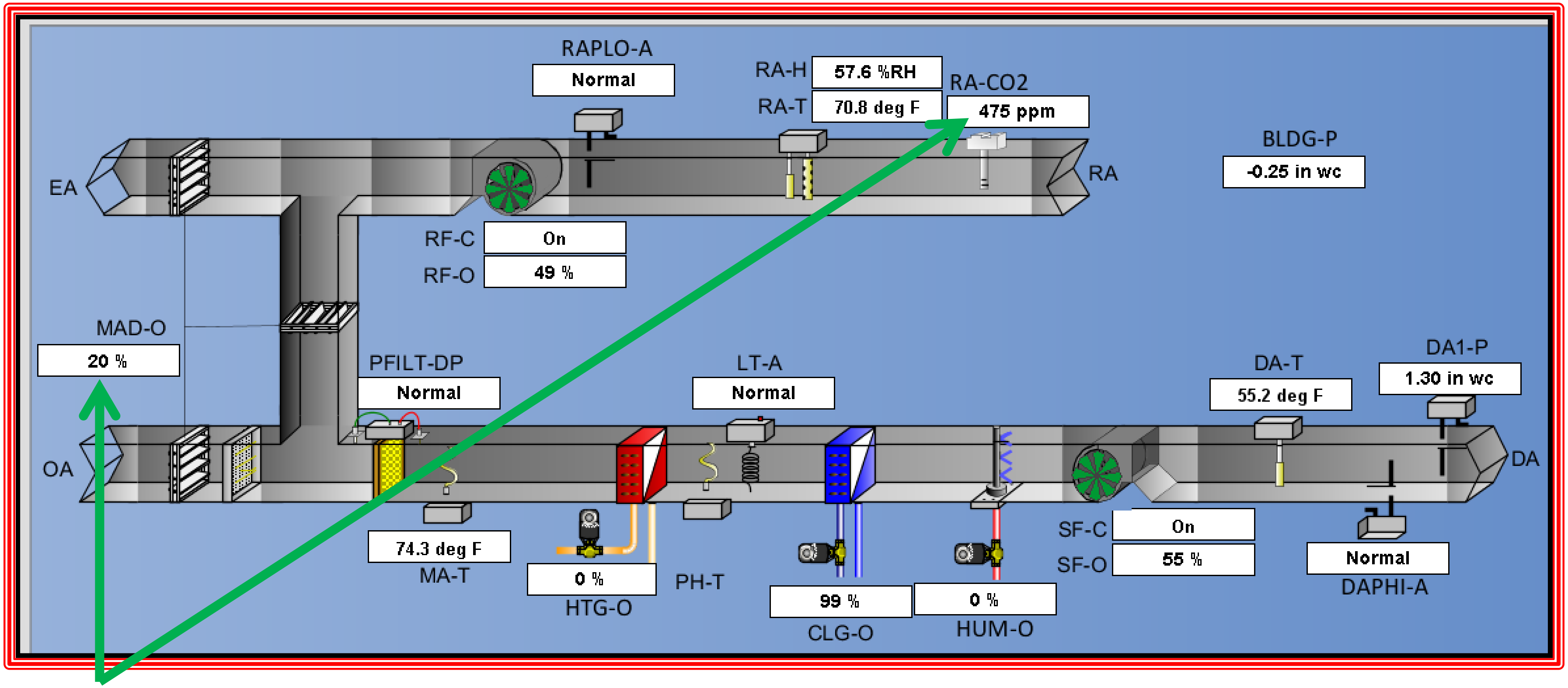
If heat is being added via "reheat" energy is being wasted. Much work was done to reduce this

Nighttime, Weekend & Holiday Setback & Occupancy Sensors

Use occupancy sensors to turn off lights in empty classrooms

Use building automation to program hours and days of operation and turn things down during nights and holidays

Excess Outside Air Costs Money



We add more outside air if the return air CO2 gets above set point indicating poor air quality. When the CO2 sensors fail or get out of calibration it can lead to much higher amounts of outside air being introduced into the building often requiring much more heating and cooling.

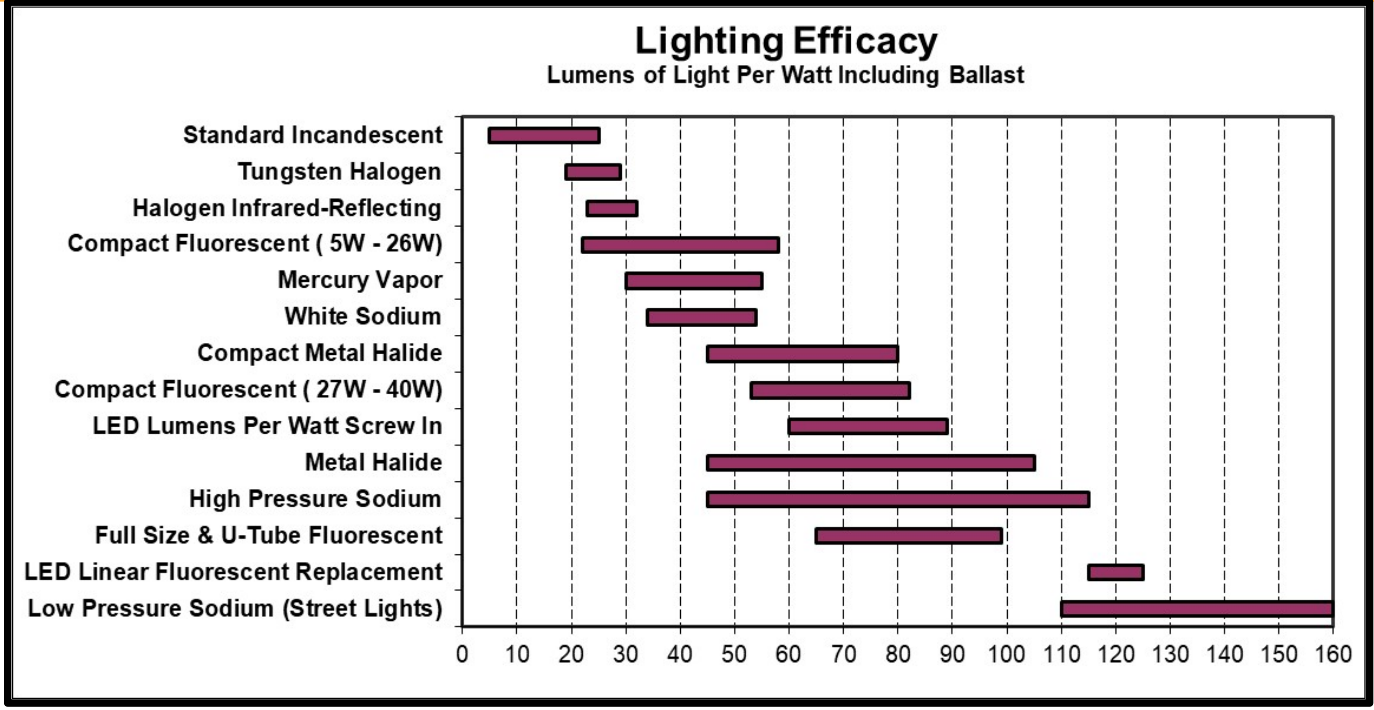
Excess Exhaust Wastes Energy

All these exhaust fans were running when the building was not in use. This required massive heating and cooling energy. Now fans are turned off when they are not needed for cooking.

New District Chiller Plants Were Constructed

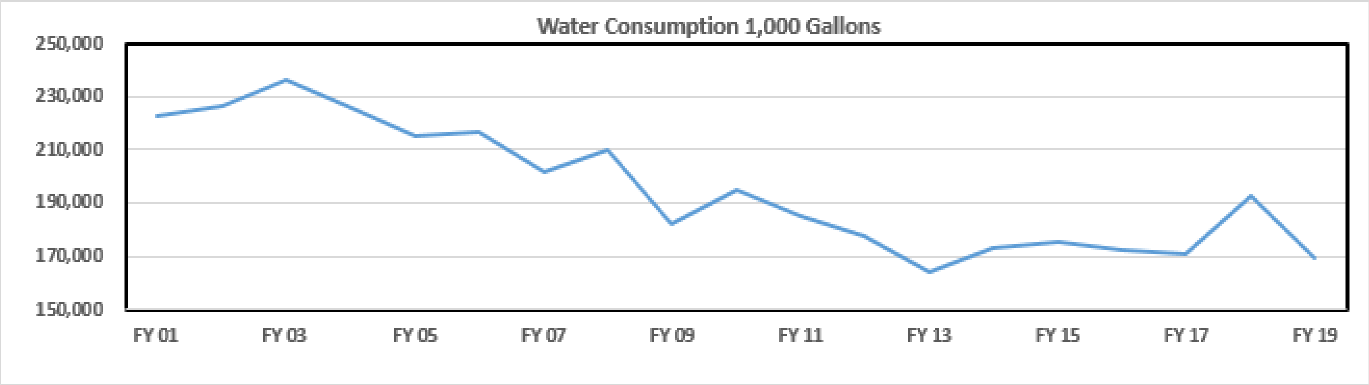
We have 6 high efficiency chilled water plants on campus. These plants replaced old technology chilled water plants that had poor efficiencies.

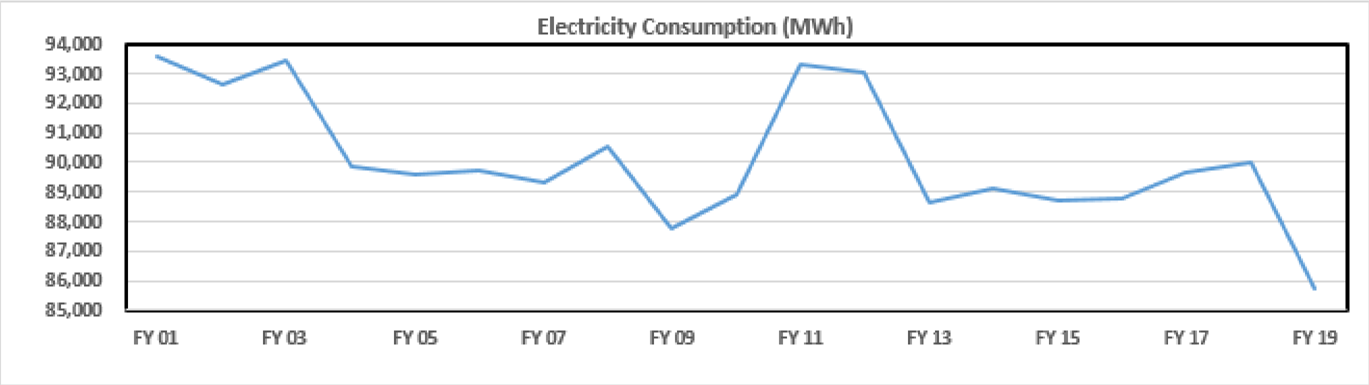
Lighting Upgrades Have Been Implemented at Numerous Buildings

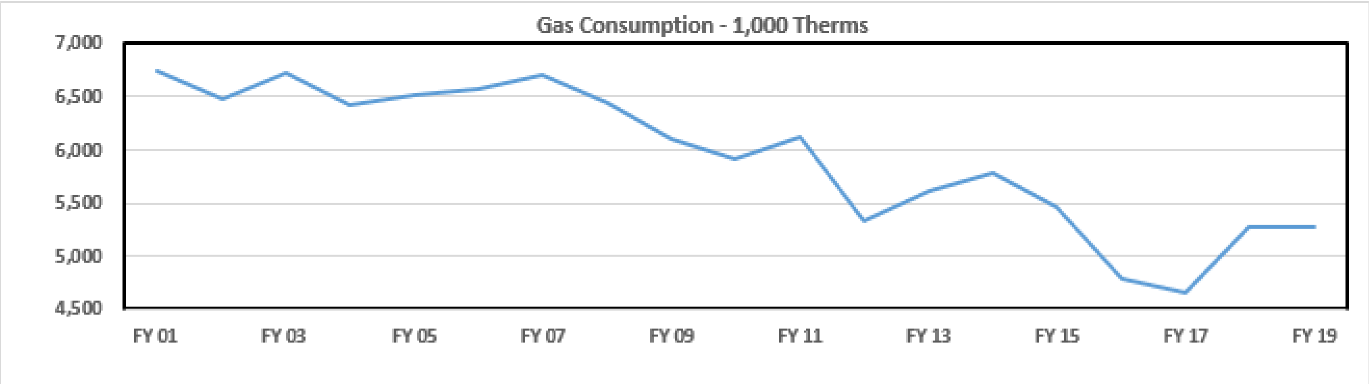


Important note

Not all lumens are equal. LED lights are focused on the area needing light while most other lights go in all directions. LED lights also have a high CRI (Color Rendering Index) The end result is that less lumens are needed for equivalent vision

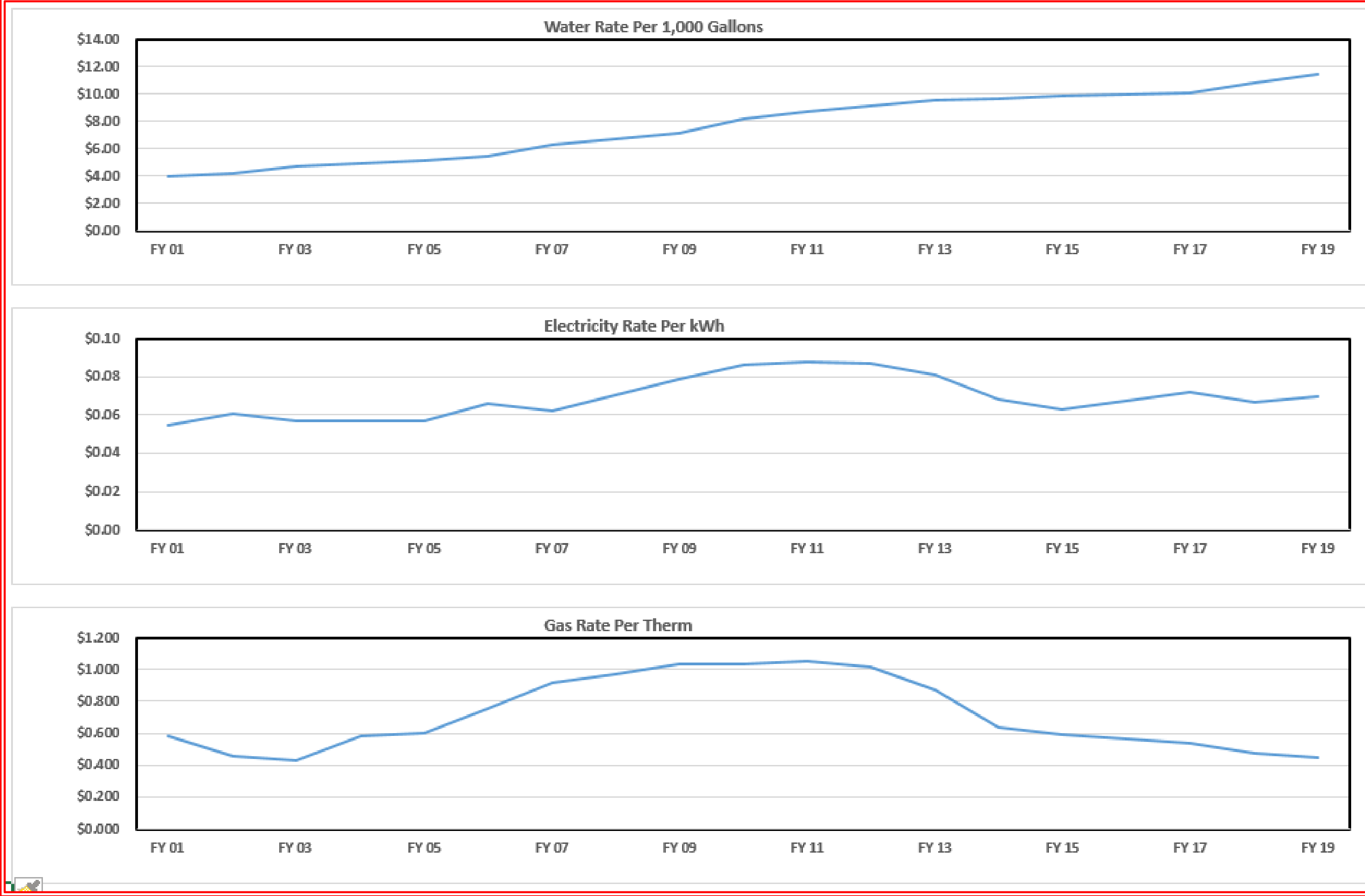




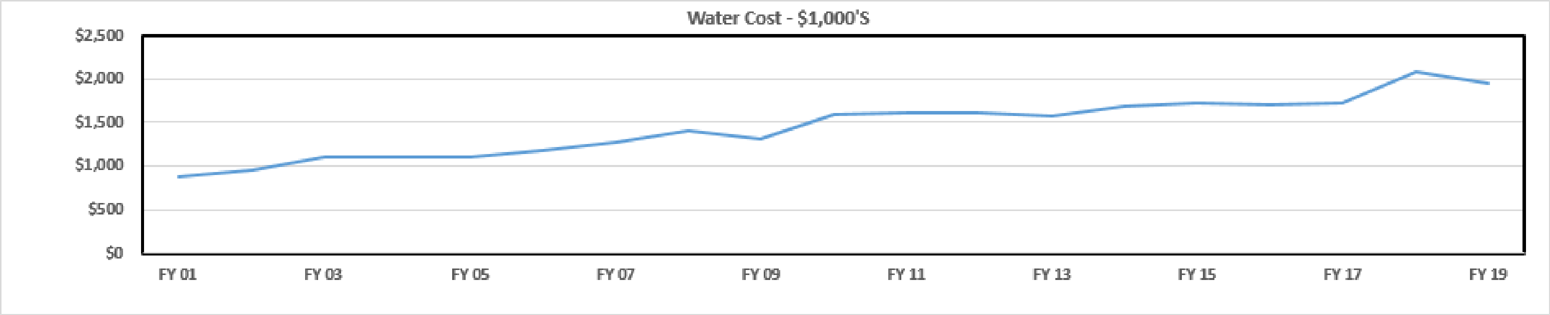


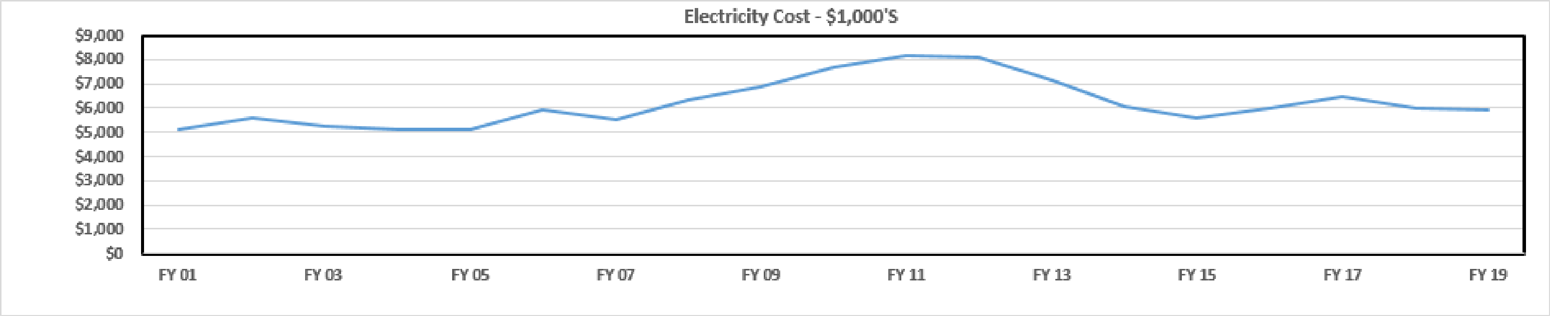
Utility Consumption is Trending Down

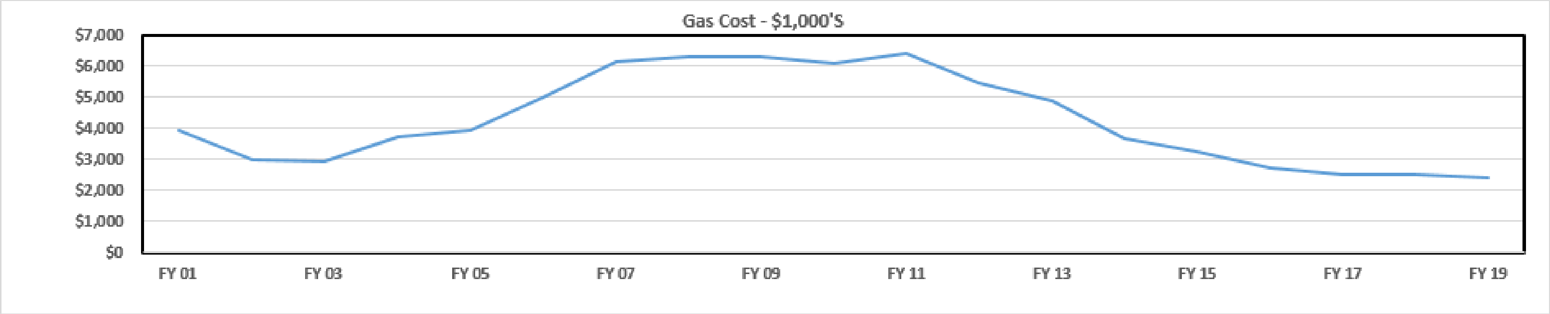
Utility Rate Trends

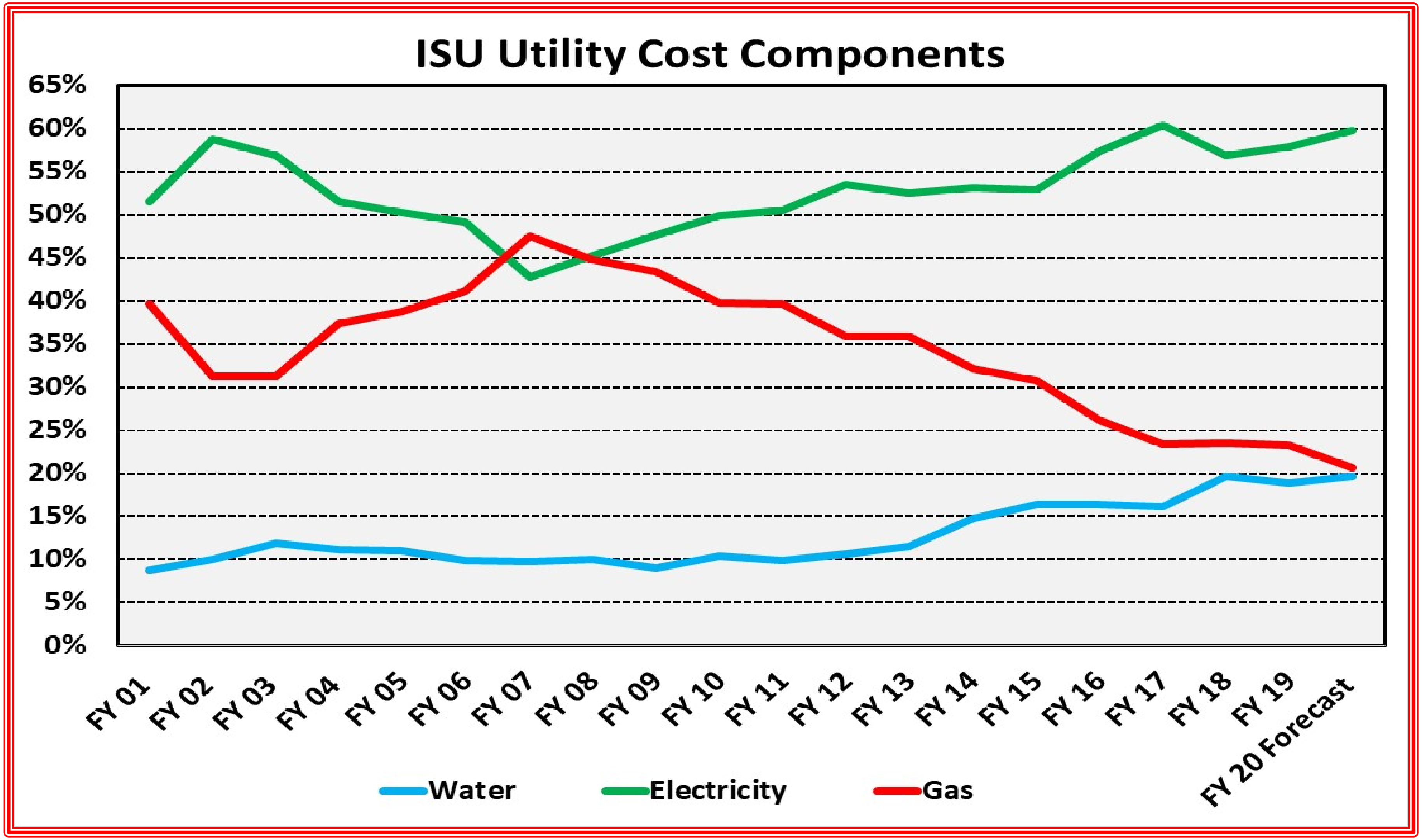


Total Costs by Utility in $1,000's

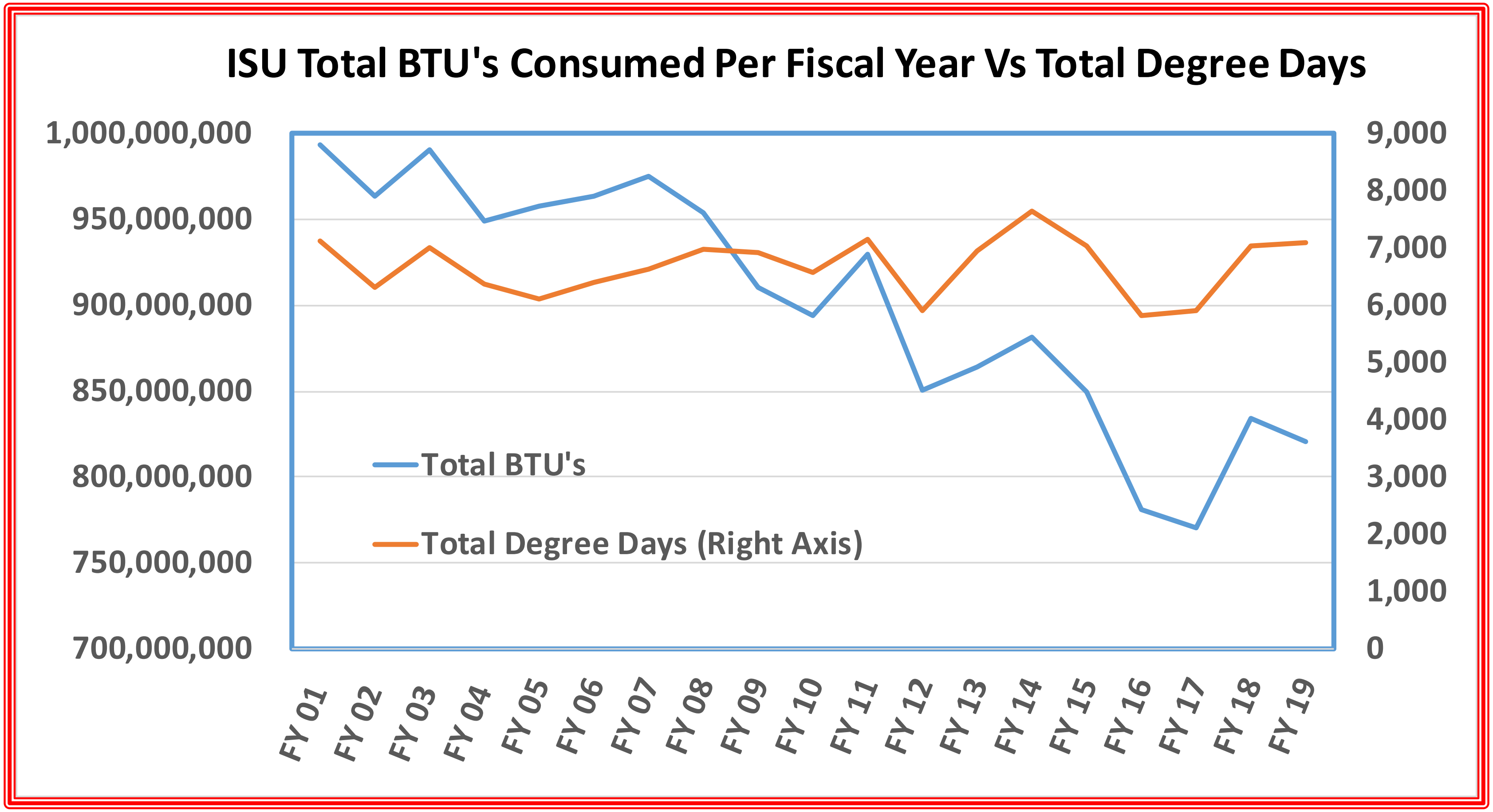


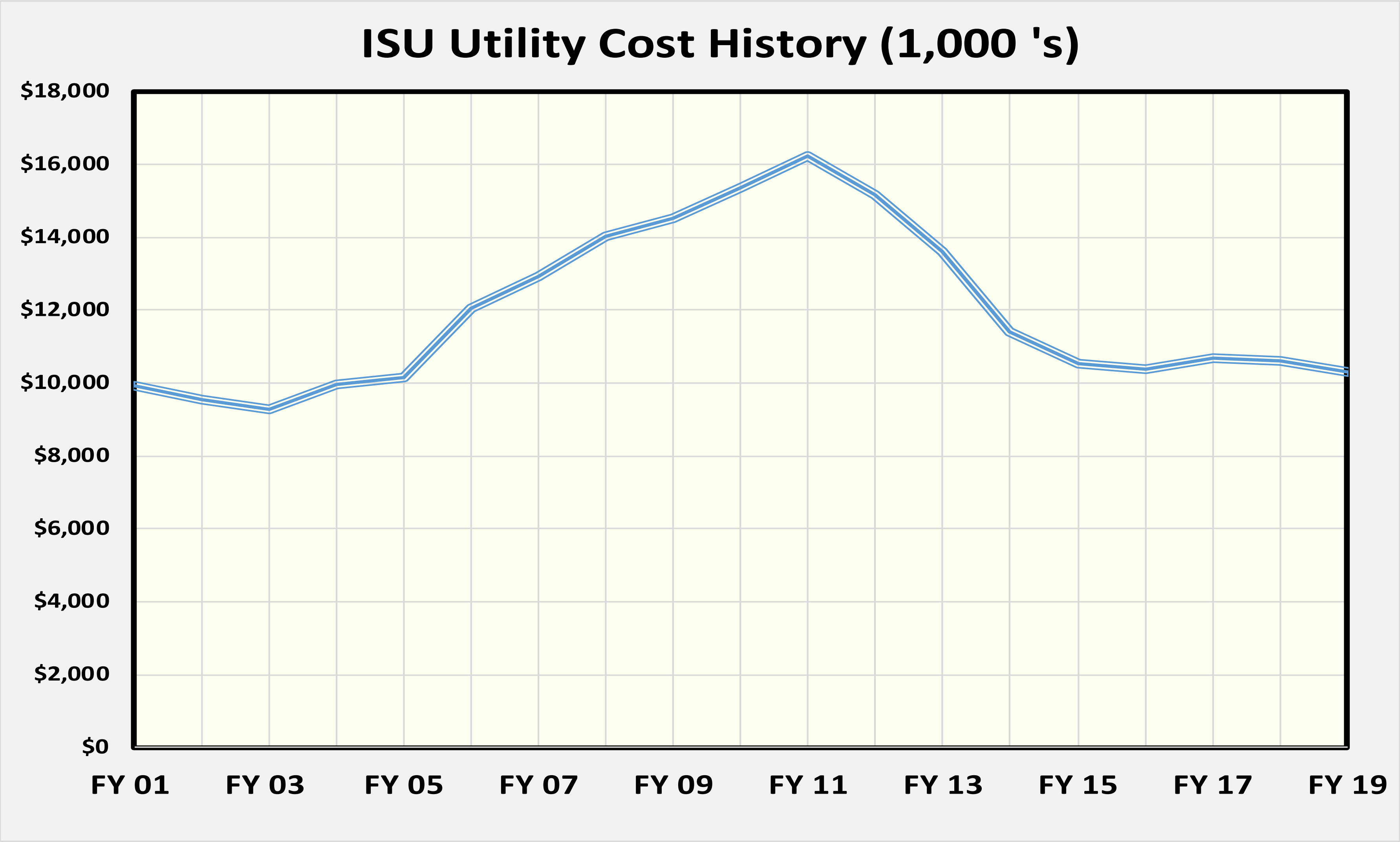





ISU Utility Cost Components
65%
60%
55%
50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
FY 01
FY 02
FY 03
FY 04
FY 05
FY 06
FY 07
FY 08
FY 09
FY 10
FY 11
FY 12
FY 13
FY 14
FY 15
FY 16
FY 17
FY 18
FY 19
FY 20 Forecast
Water
Electricity
Gas

Outdoor Temps Affect Energy Consumption But Overall Trend is Down




ISU Utility Cost History (1,000 's)
$18,000
$16,000
$14,000
$12,000
$10,000
$8,000
$6,000
$4,000
$2,000
$0
FY 01
FY 03
FY 05
FY 07
FY 09
FY 11
FY 13
FY 15
FY 17
FY 19

Questions?