ENERGY MANAGEMENT ASSOCIATION

WEBINAR

AIA Provider Number: 50111116

Course Number: EMA2003L

Improving Energy Efficiency, Sustainability and Resiliency Using FCAs, Retro-Cx and an Energy Road Map

With your speakers

Bill Bradford, P.E.
Sr. Vice President
Hanson Professional Services Inc.

Wade Conlan, P.E., CxA, LEED AP
Cx and Energy Discipline Manager
Hanson Professional Services Inc.

AIA Continuing Education Provider

Improving your customer's energy efficiency, sustainability and resiliency through the use of facilities condition assessments, energy audits, retro-commissioning and implementation of an energy roadmap

HANSON

Learning Objectives

AIA Continuing Education Provider

- Participants will learn how to assist their stakeholders to gain a better understanding of their equipment and systems; and be able to help them develop a record of their equipment and assist with CapEx and O&M budgeting.
- Participants will learn techniques and methods to help stakeholders improve the efficiency and operating effectiveness of their systems.
- Participants will gain an understanding of how to guide their stakeholders as they work to achieve their long-term energy, sustainability and resiliency goals.
- Understand how retro-commissioning and energy audits can be used in concert to identify facility improvement measures that can be implemented to reduce energy costs and improve environmental conditions

Why don’t buildings perform as expected?

- Owner’s / User’s Requirements not addressed
- Design Errors & Misapplication of Technology
- Contractor Errors & Poor Workmanship
- Miscommunication
- Equipment Coordination Problems
- Lack of Proper Checkout and Start-up
- Controls’ Programming Errors
- Building O&M personnel inadequately trained

Agenda

STEP 1 Utilizing facility condition assessments (FCA)

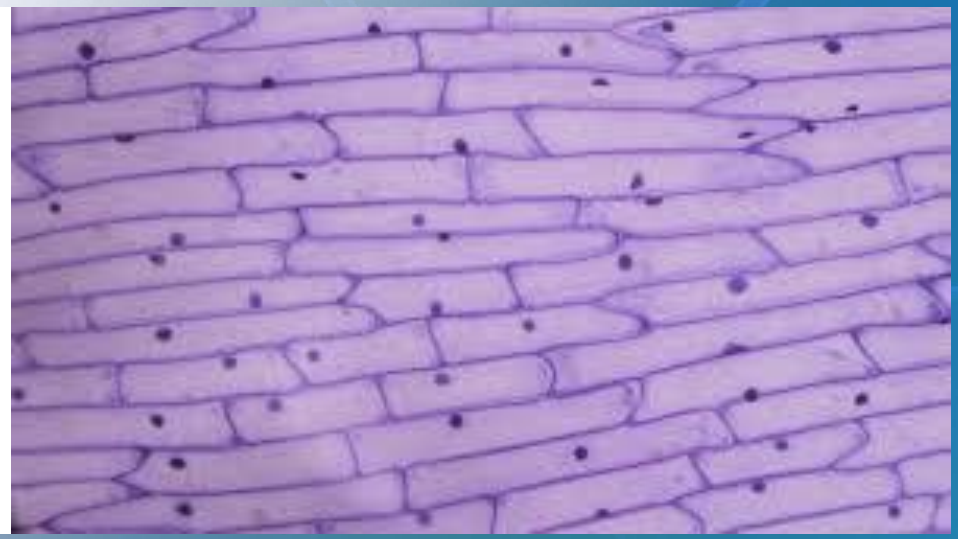
STEP 2 Implementing energy savings through energy audits (EA) and retro-commissioning (RCx)

STEP 3 How the FCAs, EAs (CEA) and RCx can be used to develop an energy masterplan/energy roadmap

STEP 4 Questions

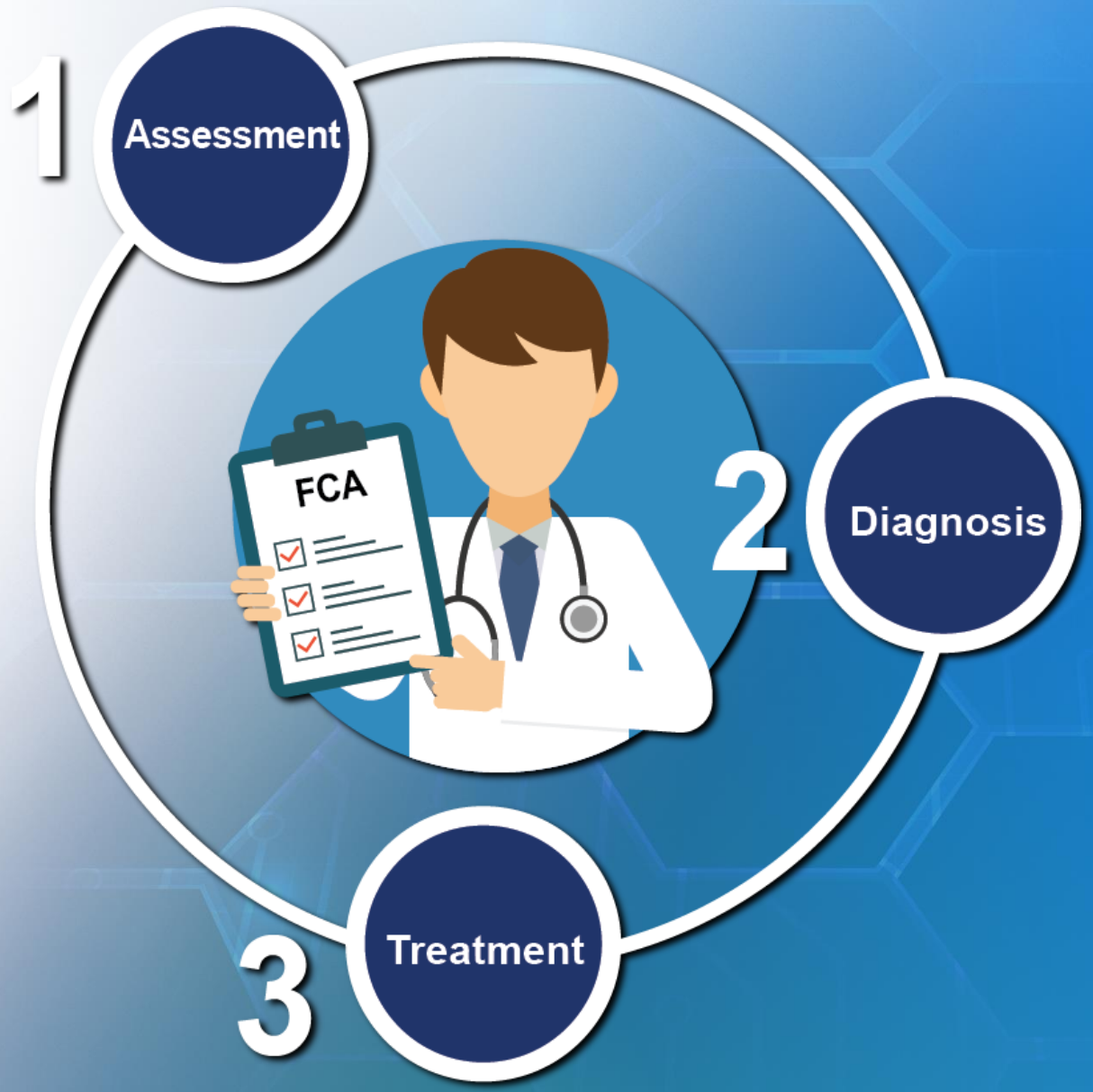
What FCAs, EAs and RCx do:

- FCA looks at the outer skin of the onion
- EA looks at outer skin of the onion and possibly one more layer
- RCx slice into the onion and analyzes each layer



Comparisons to medical field:

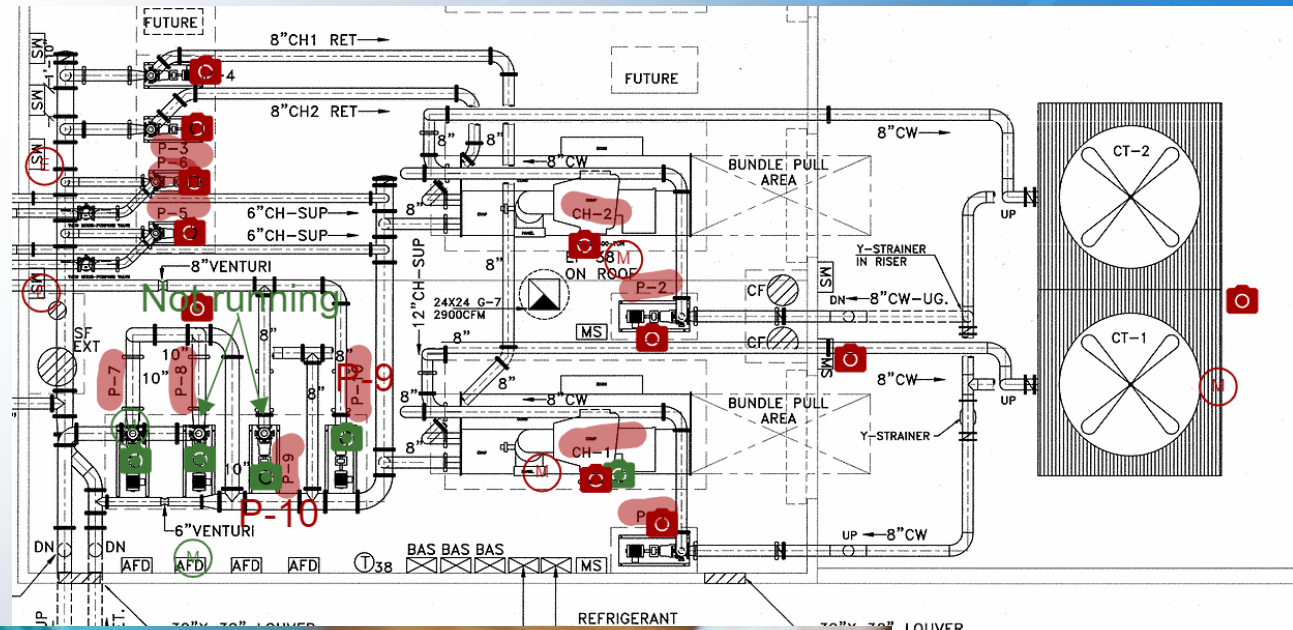
- Facility Condition Assessment - notes that the "patient" feels sick
- Energy Audit (or CEA) - takes "patient's" vital signs and tells the "patient" what type of doctor they need
- Retro-commissioning - attempts to find out what is causing the patient's symptoms and then recommends "treatment" for your ailments
- Energy masterplan – takes your doctor's orders and helps you plan for your upcoming 5k road race (or marathon!)



Different levels and types of FCAs

- Property Condition Assessments (PCAs)
- ASTM E2018 – 15
  - Standard Guide for Property Condition Assessments: Baseline Property Condition Assessment Process
- Equipment Condition Assessments (ECA)
- USACE Builder Sustainment Management System
  - Web-based software application developed by the Construction Engineering Research Laboratory (CERL)

Step 1 - Utilizing FCAs (or finding out what you have)



Utilizing facility condition assessments

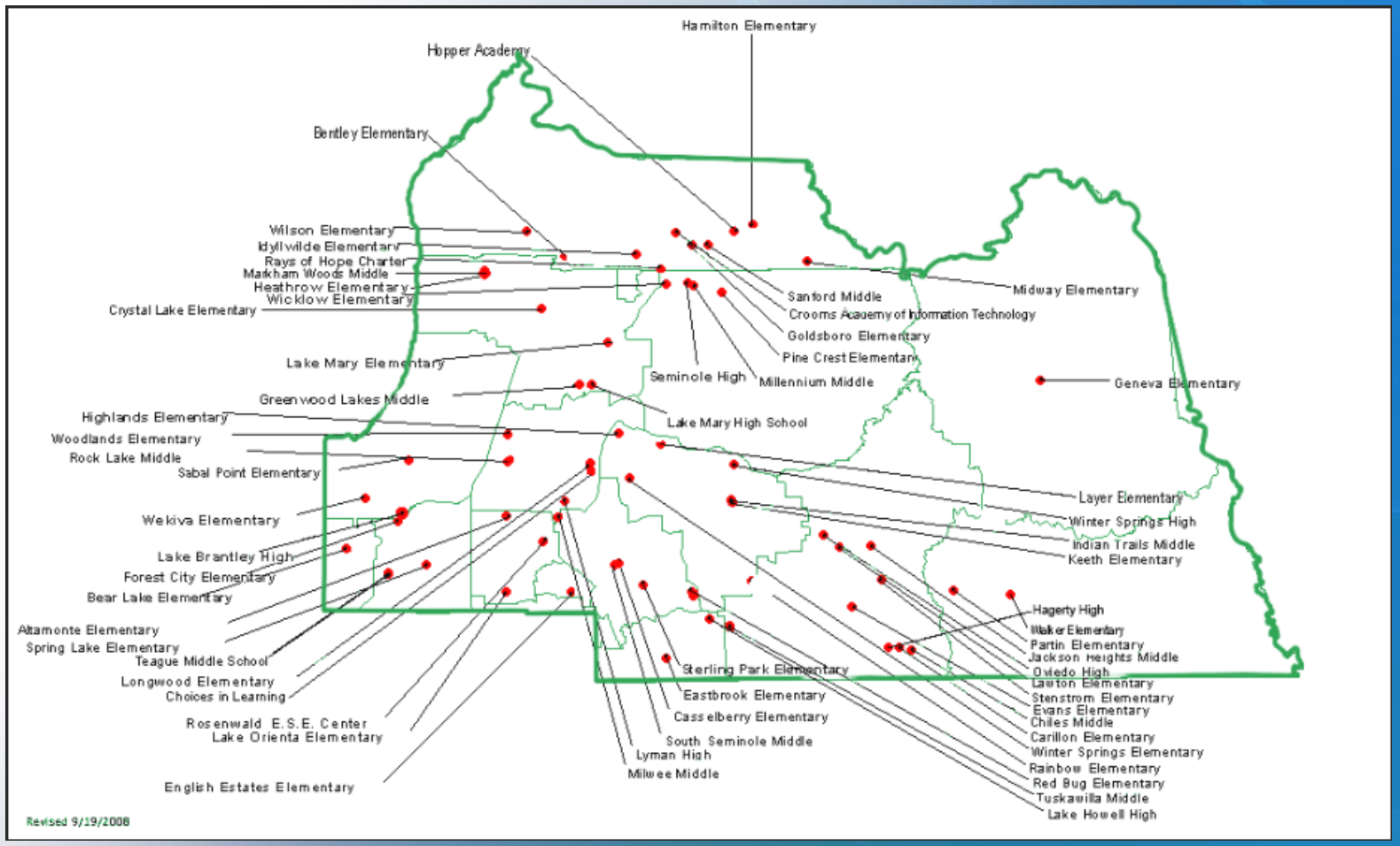
- Analysis of the **condition** of a **facility** (or **equipment** serving the facility) in terms of age, nameplate data, condition, estimated remaining life, etc.
- Performed by engineers and skilled-trade technicians

Basic outcomes of our Equipment Condition Assessments:

- Owner asset data collection and sharing
- Tracking maintenance requirements
- Identify deferred maintenance backlog
- Tracking CapEx budgets
- Property/Equipment Condition Reports (PCR/ECR)

Seminole County Public Schools (SCPS)

- Total of 61 facilities:
  - 33 elementary schools
  - 11 middle schools
  - 7 high schools
  - 10 additional SCPS facilities

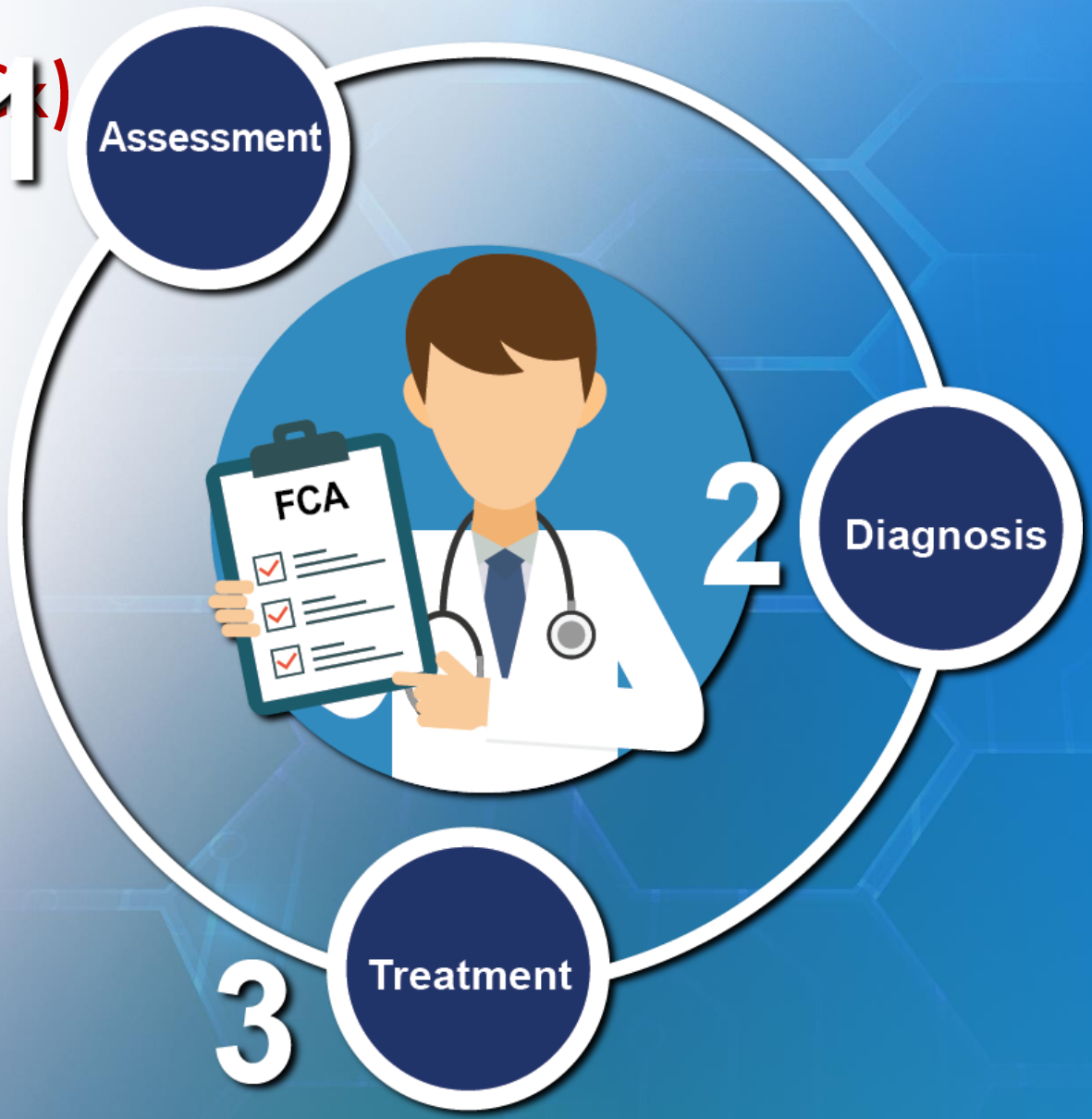


University of Central Florida (UCF)

- Total of 60 buildings:
  - Buildings > 5 years old
  - Survey of:
    - All major equipment
    - Sample of one piece of each different type of smaller equipment per floor
  - Develop cost to replace for required equipment

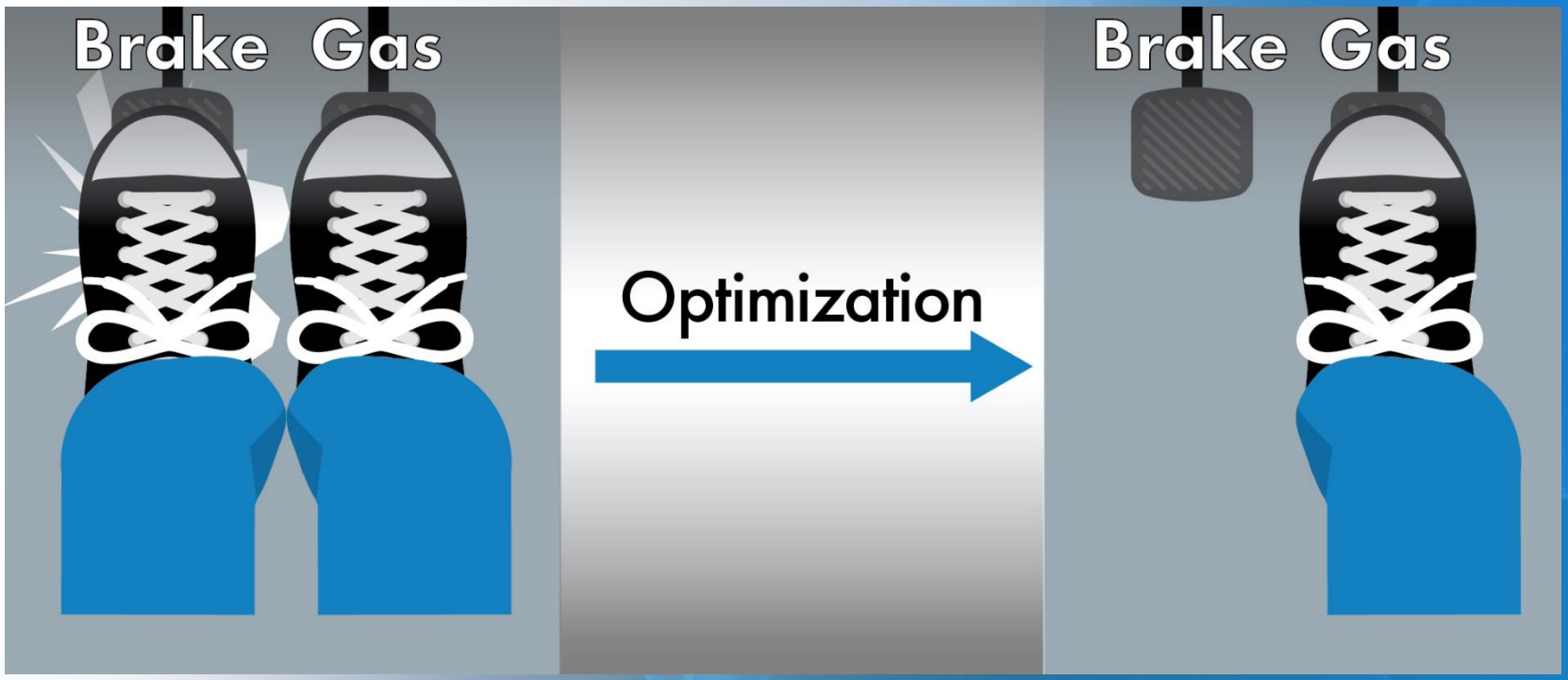
FCAs and Retro-Commissioning (RCx)

- FCAs are good at providing data
- No testing is involved with FCAs
- May lead to replacement of individual pieces of equipment under CapEx plans
- Helps develop O&M budgets
- SCPS and UCF needed both:
  - FCAs - understanding of what they have
  - RCx - problems that need to be resolved



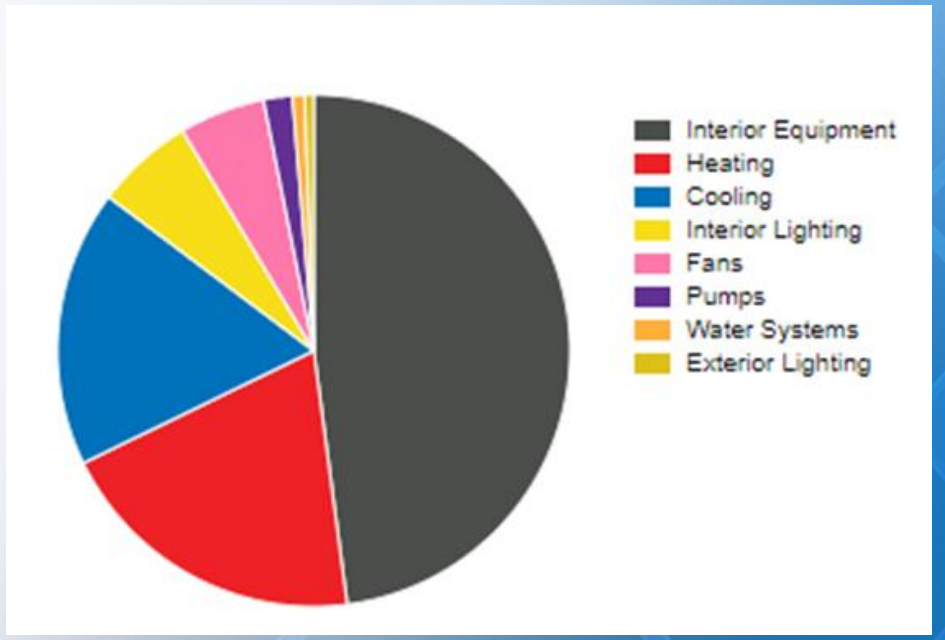
Step 2 - Implementing energy savings through energy audits and retro-commissioning:

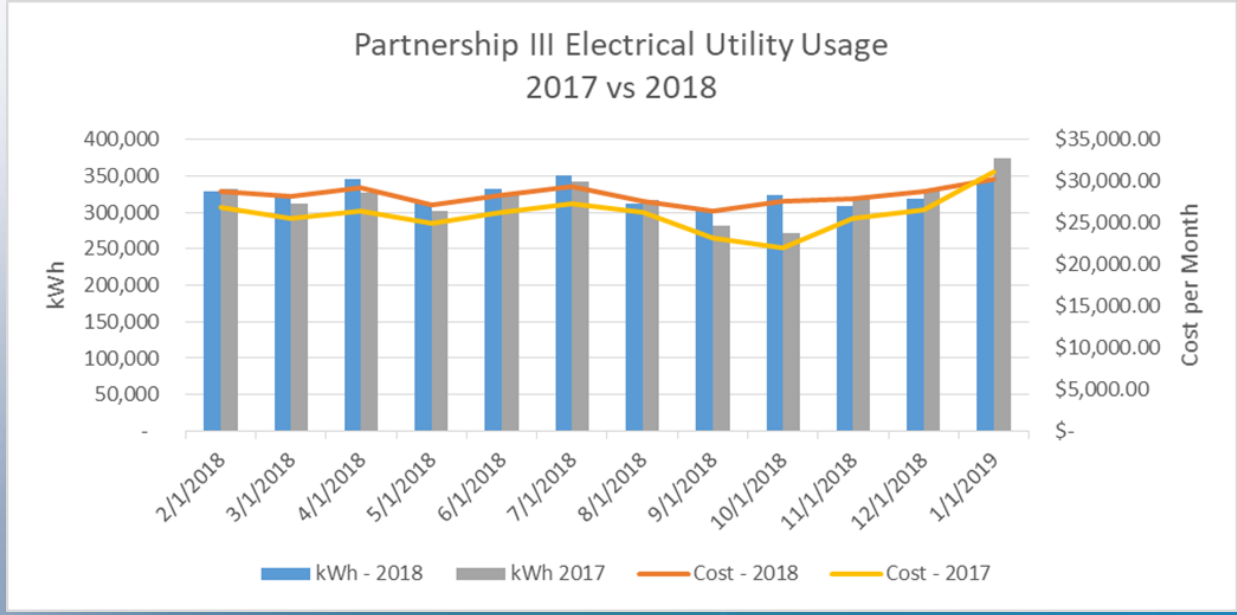
- Definitions of each strategy
- Comparison of strategies
- Steps of Retro-Commissioning
- Facility Improvement Measures



Definitions

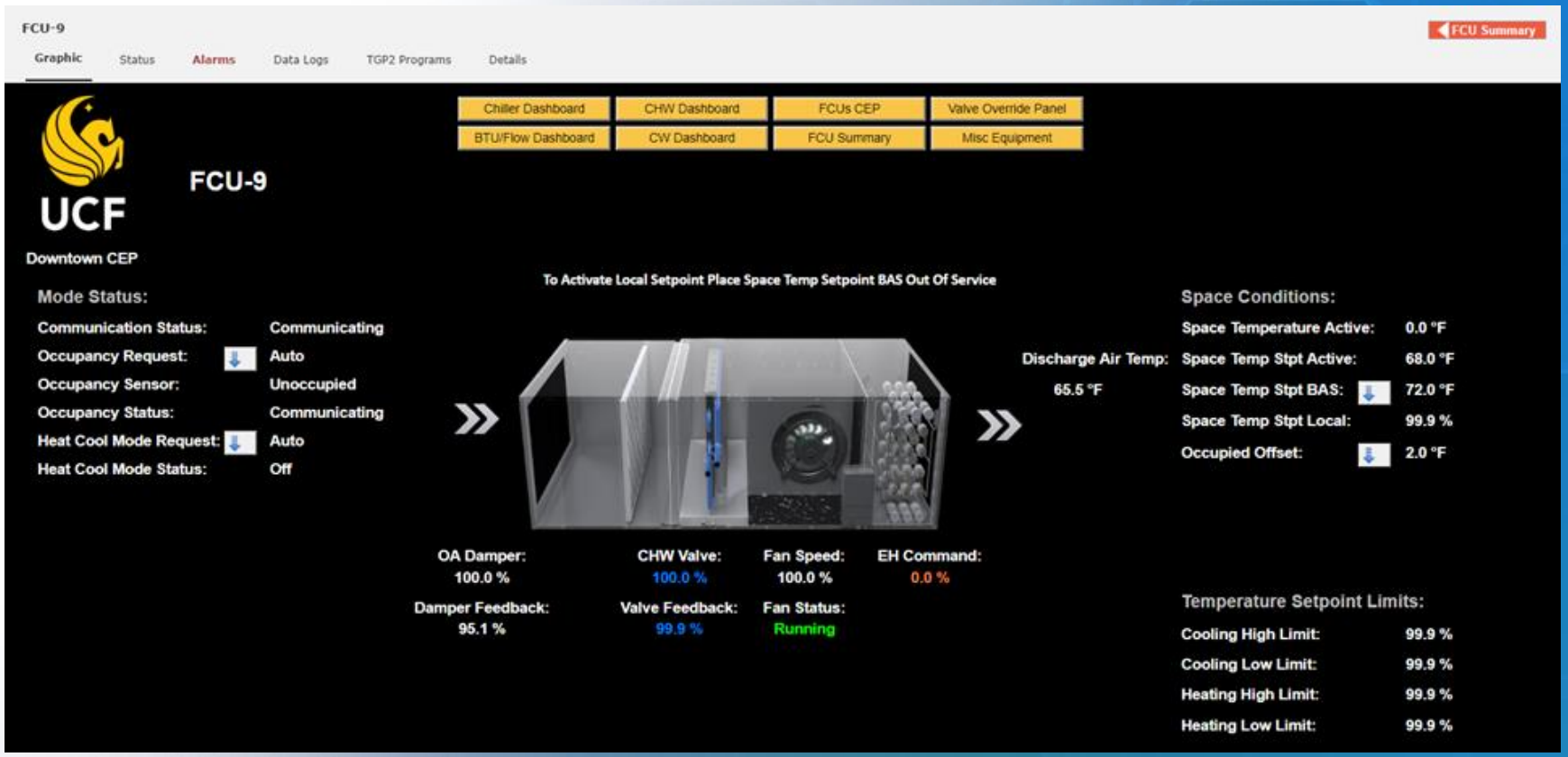
- Energy Audits (EA):
  - Benchmark energy use,
  - Evaluate potential need for Capex spending,
  - Evaluate potential rebates
- Hanson Twist to EAs
  - Most EA typically do not look deeper
  - Hanson does Retro-Commissioning
  - Becomes a Comprehensive Energy Analysis





Definitions

- Retro-commissioning (RCx) Process:
  - Assessment
  - Investigation
  - Implementation
  - Hand-off
  - On-Going RCx



Steps of Retro Commissioning (RCx):

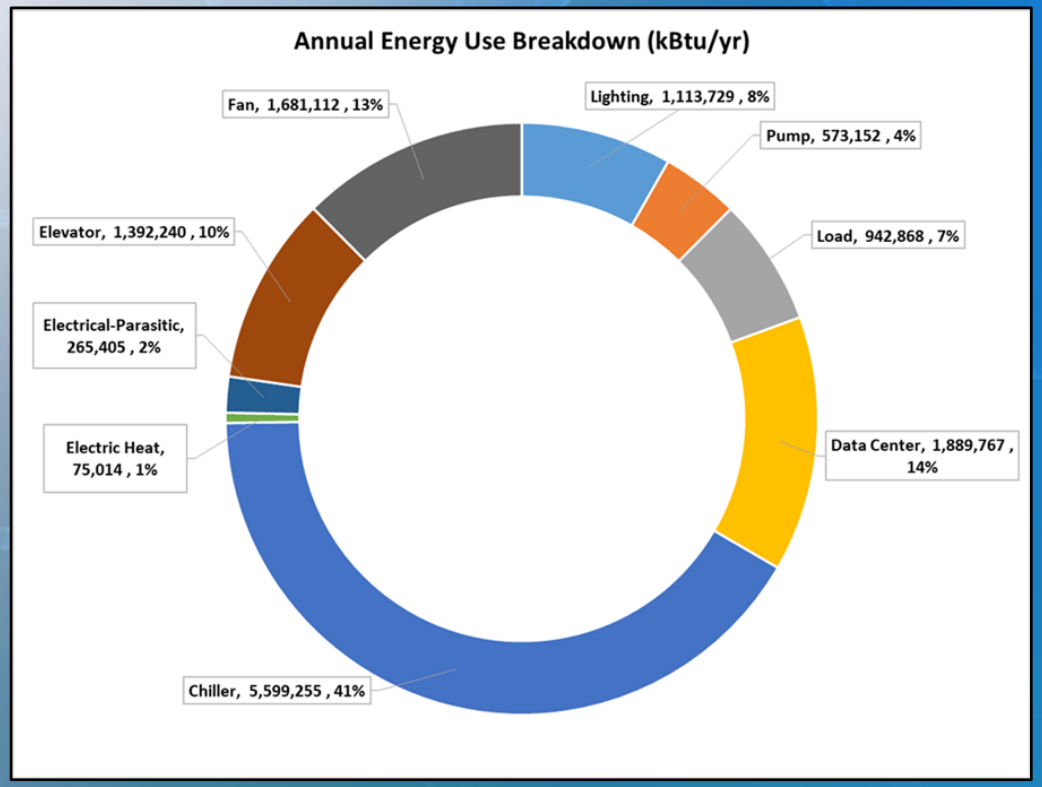
- Identify why the work is being requested
  - Energy consumption
  - Failing equipment
  - Maintenance call levels
- Identify the equipment and systems to be analyzed
  - Meet with the Owner and Facility Staff
  - Review Existing Information (drawings, TAB, BAS submittal, trends, etc.)
  - Interrogate the Building Automation System (BAS)
- Identify Facility Improvement Measures (FIMs) in a Report
- Discuss FIMs with Owner to develop the implementation strategy
- Implement FIMs

Definitions

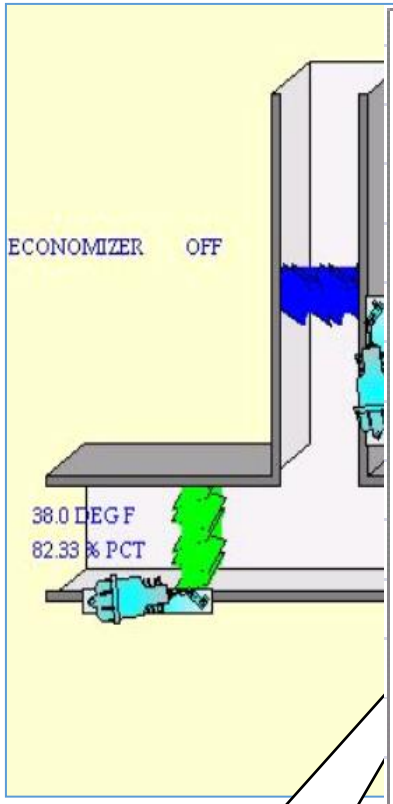
- Facility Improvement Measures
  - vs. Energy Conservation Measures
  - vs. Energy Efficiency Measures
- Categories
  - No / low cost
  - CapEx < # years
  - CapEx > #years
  - Further analysis required
  - Not feasible
- Measuring Results

Rule of Thumb for Energy Savings

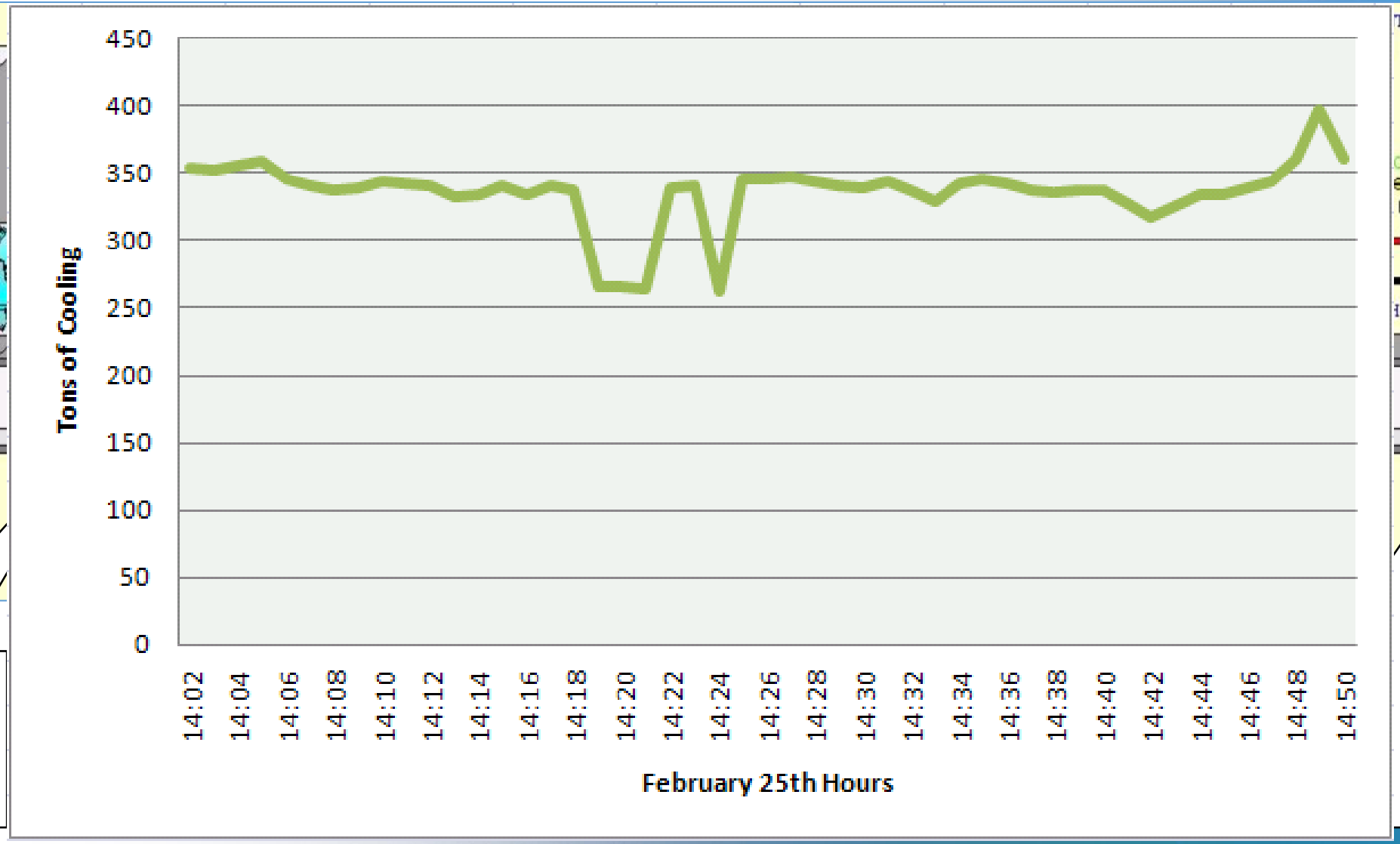
Item	Annual Cost (Rounded)
1 hp motor (24/7)	$ 500
1 Ton Cooling (MA Unit)	$ 900 (Dx) $ 600 (CHW)
1,000 CFM OA (8 tons)	$ 7,300 (Dx) $ 5,000 (CHW)
1 degree Setpoint on AHU	7% cooling capacity

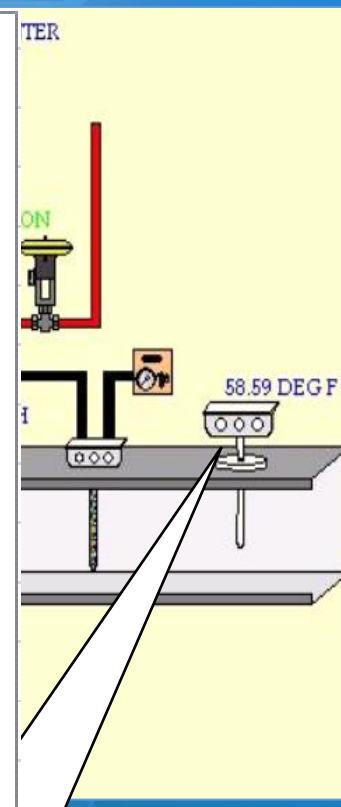


Audit Process – BAS Interrogation (Simultaneous Cooling and Heating)

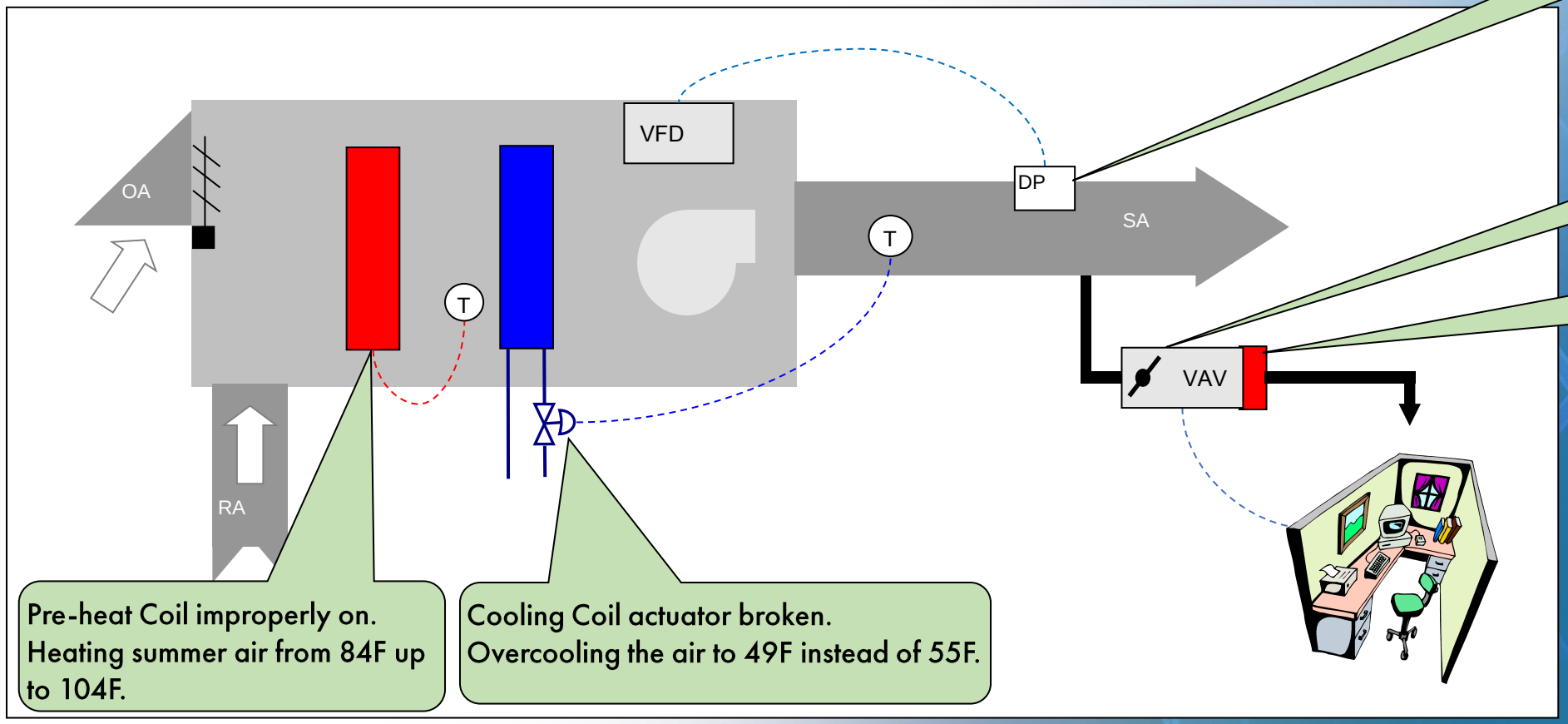


42.4 F
Mixed Air





University Biological Sciences Building: Fan Frame



Static pressure setpoint set too high at 2.2" , instead of 1.0".
Fan always at 60Hz.

2-position VAV box closing more than necessary to 'eat' excess static pressure.

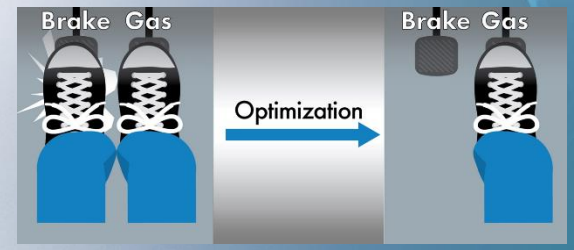
Re-heat coil required to heat the overcooled air.

Water Side

Gas: pre-heat coil

Brakes: cooling coil

Gas: re-heat coil

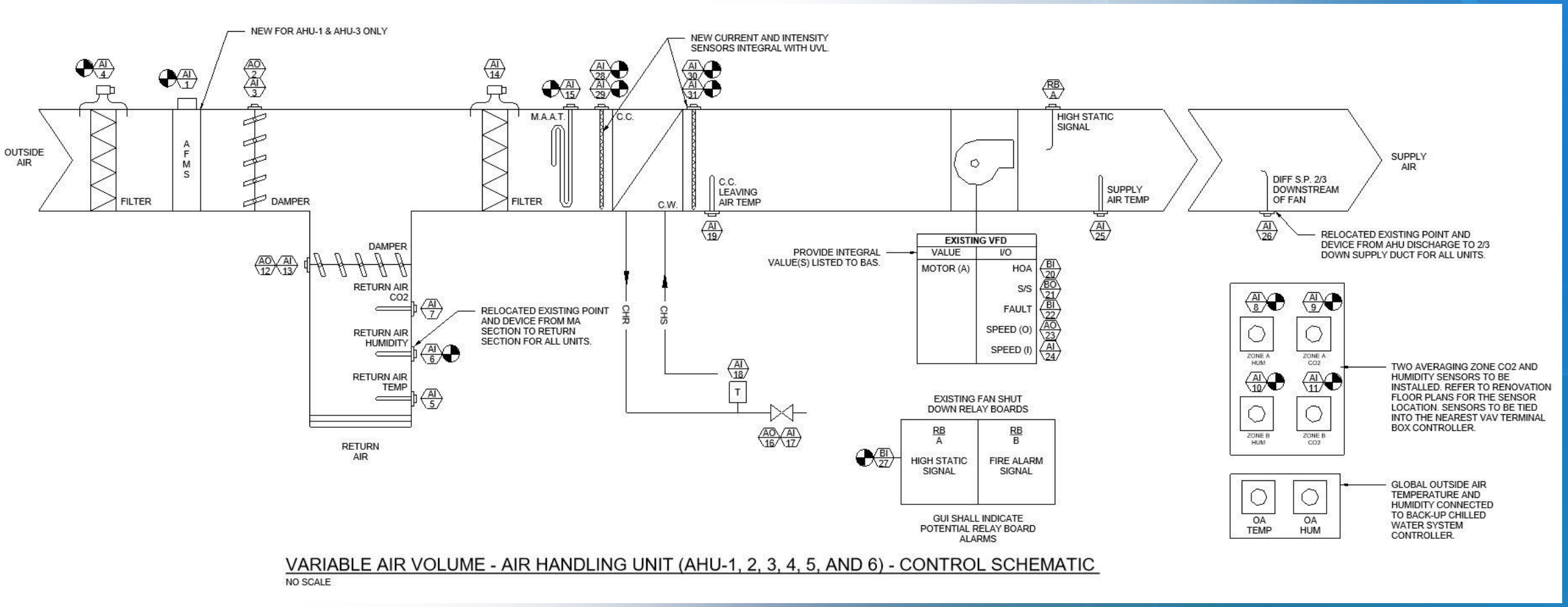


Air Side

Gas: Supply fan

Brakes: VAV damper

AHU Optimization Strategies



VARIABLE AIR VOLUME - AIR HANDLING UNIT (AHU-1, 2, 3, 4, 5, AND 6) - CONTROL SCHEMATIC

NO SCALE

Dirty Strainers

STORY:
Uncomfortable space conditions

SYSTEM: HW reheat coil, 2-way valves
2-way control valves modulate the flow of hot water across the reheat coils

IMPROVEMENT: Flush Strainers
Tests of the HW valve validated that the actuator moved as commanded but no hot water flowed through the coil when the valve was open.

Coil strainer blown down revealed sludge and pipe shavings blocked the flow of water through the coil.

Coil performance returned to design after blow down.

Systems Manual (Living Document)

2. Systems

The Systems Manual is organized by each type of equipment for the project.

2.1 AHU-A3 (100% Outside Air Handling Unit)

The only Air Handling unit serving the 3rd floor labs is a single pass unit delivering 100% outside air. The air is cooled via chilled water and pre-heated via electric heat. The supply fan is connected to a variable speed drive (VSD) that delivers the air to the lab air valves based on a duct static pressure sensor approximately 2/3 down the duct. The shut-off valves are located in the 3rd floor ceiling below the unit.

Name	CFM-Submitted	Cooling Coil Airside Pressure Differential - Submitted	Cooling Coil Entering Air Temperature DB - Submitted	Cooling Coil Entering Air Temperature WB - Submitted	Cooling Coil Leaving Air Temperature DB - Submitted	Cooling Coil Leaving Air Temperature WB - Submitted	Cooling Sensible Capacity - Submitted	Cooling Total Capacity - Submitted	E.S.P (in. wg) - Submitted
AHU-A3	8000	.792	84	77	52	52	373.68	683.5	2 in. wg

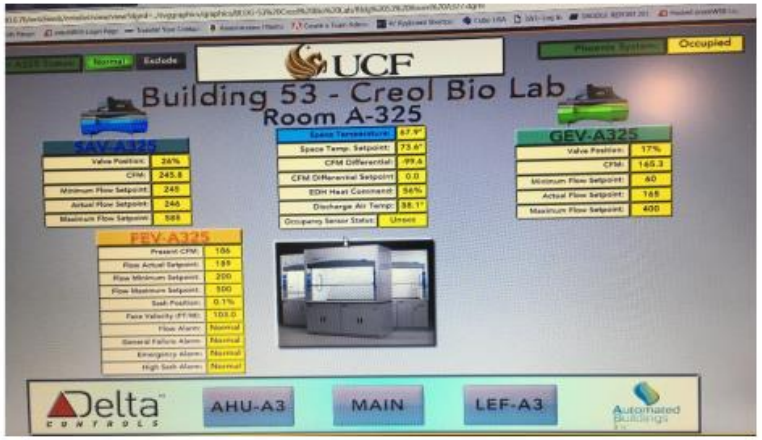
Entering Air Temperature (Degs) - Submitted	Heating Capacity (KW) - Installed	Heating Coil Airside Pressure Differential - Submitted	Leaving Air Temperature - Submitted	Manufacturer - Installed	Model Number - Installed	Outdoor Air CFM - Submitted	Supply fan motor horsepower - Installed	T.S.P (in. wg) - Submitted	Volts / Phase - Installed
32 Degs	77	.101	62.43	Trane	CSAA021UBL00	8000 CFM	15 hp	4.831	480/3

Sequence of Operations

The building is occupied 24 hours per day, 365 days a year and so the AHU and LEF is always in the Occupied Mode. However, each lab space has an occupancy sensor to indicate that the lab was unoccupied and allows for temperature setback.

Room Control priority is as follows:

- Fume Hood Control (if applicable)
- Room Pressurization Control
- Room Temperature Control

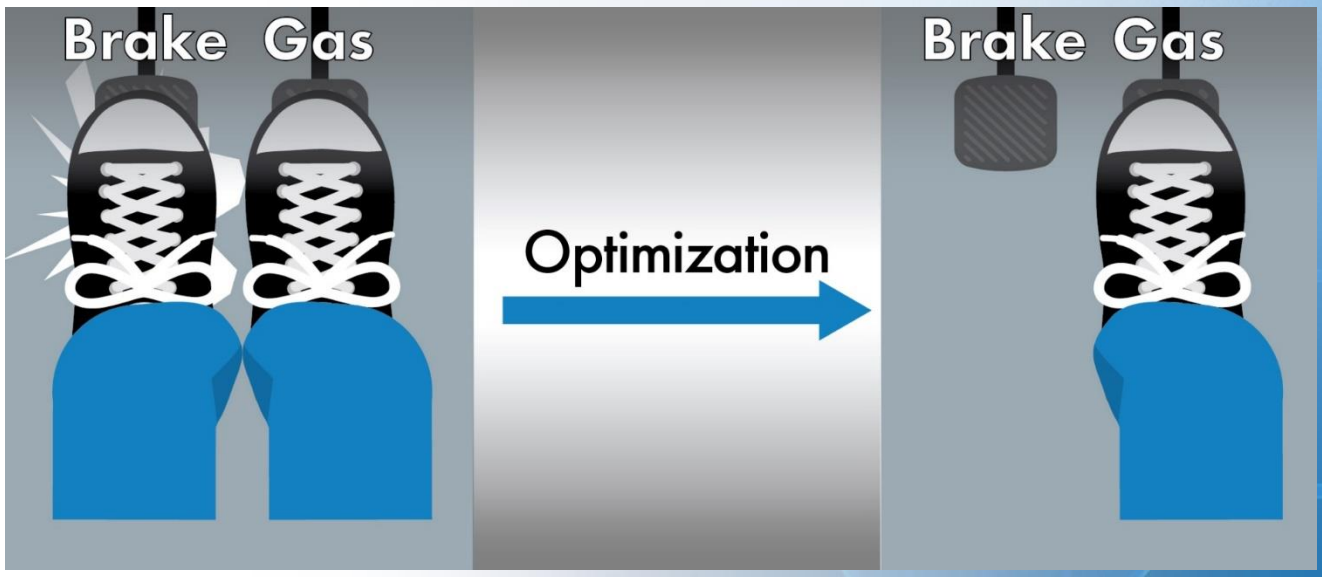


The air valves work in series to maintain the room pressurization room offset as setup in the Phoenix system. The electric heat is staged to maintain space temperature when it goes below the 70°F setpoint. The SAV is controlled to maintain 72°F space setpoint or the required airflow for FEVs that exceed that cooling airflow. The GEV is a slave to the FEV and SAV and is controlled to maintain the room offset.

FIM Tracker

Table of Recommended Facility Improvement Measures					
Tag	Measure Description	Implementation Costs	Projected Annual Savings	Simple Payback (years)	Comments and Recommendations
1.1	Replace pneumatic controls with DDC BAS controls	$ 665,000.00	$ 56,900.0	11.7	
1.2	Implement optimal start routine and keep OA air at minimum	Included in FIM 1.1	$ 11,800.0	Included in FIM 1.1	Requires FIM 1.1
1.3	Reduce minimum flow settings in VAV terminals	Included in FIM 1.1	$ 19,700.0	Included in FIM 1.1	Requires FIM 1.1
1.4	Relax zone cooling setpoints	Included in FIM 1.1	$ 15,300.0	Included in FIM 1.1	Requires FIM 1.1
1.5	Implement dynamic SA duct static pressure setpoint reset	Included in FIM 1.1	$ 4,500.0	Included in FIM 1.1	Requires FIM 1.1
1.6	Tune VFD and actuator PID loops to match span range	Included in FIM 1.1	$ 1,600.0	Included in FIM 1.1	Requires FIM 1.1
1.7	Implement demand-control ventilation	$ 8,000	$ 4,900.0	1.6	Requires FIM 1.1
1.8	Implement supply air temperature setpoint reset	$ 2,500	$ 2,700.0	0.9	Requires FIM 1.1. Implementation cost assumes two zone relative humidity sensors per AHU
1.9	Link occupancy sensors with VAV systems to set back temperatures	$ 6,500	$ 8,000.0	0.8	Link to lighting occ sensor fim, Requires FIM 1.1

RCx Tips

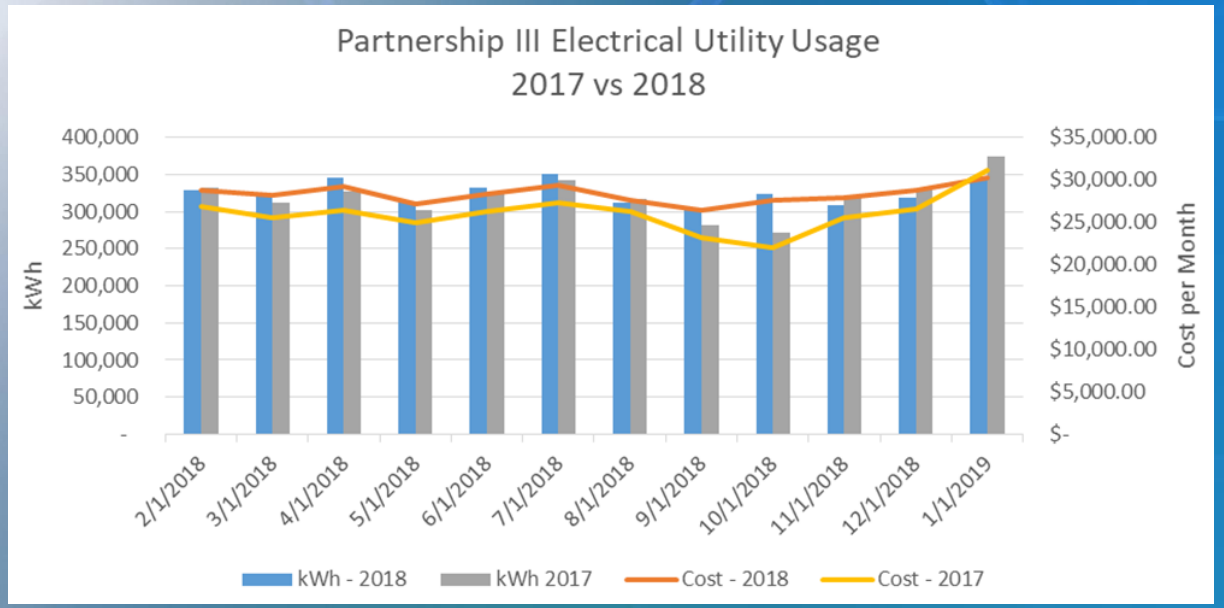


- LOOK FOR:
  - "Variable" systems and their set points
  - Gas/Brake systems – pre/re-heat, humidity, VAV, parallel equip
  - Starters in 'Hand' mode because a control device isn't working
  - 'HVAC loads'. CEP's can only meet loads.
  - BAS Computer Screens = anything at 100% capacity

Step 3 - How the above tools can be used to develop a corporate energy masterplan/energy roadmap:

- Already have a list of Facility Improvement Measures
- Energy Benchmark created and able to be updated

Table of Recommended Facility Improvement Measures					
Tag	Measure Description	Implementation Costs	Projected Annual Savings	Simple Payback (years)	Comments and Recommendations
1.1	Replace pneumatic controls with DDC BAS controls	$ 665,000.00	$ 56,900.0	11.7	
1.2	Implement optimal start routine and keep OA air at minimum	Included in FIM 1.1	$ 11,800.0	Included in FIM 1.1	Requires FIM 1.1
1.3	Reduce minimum flow settings in VAV terminals	Included in FIM 1.1	$ 19,700.0	Included in FIM 1.1	Requires FIM 1.1
1.4	Relax zone cooling setpoints	Included in FIM 1.1	$ 15,300.0	Included in FIM 1.1	Requires FIM 1.1
1.5	Implement dynamic SA duct static pressure setpoint reset	Included in FIM 1.1	$ 4,500.0	Included in FIM 1.1	Requires FIM 1.1
1.6	Tune VFD and actuator PID loops to match span range	Included in FIM 1.1	$ 1,600.0	Included in FIM 1.1	Requires FIM 1.1
1.7	Implement demand-control ventilation	$ 8,000	$ 4,900.0	1.6	Requires FIM 1.1
1.8	Implement supply air temperature setpoint reset	$ 2,500	$ 2,700.0	0.9	Requires FIM 1.1. Implementation cost assumes two zone relative humidity sensors per AHU
1.9	Link occupancy sensors with VAV systems to set back temperatures	$ 6,500	$ 8,000.0	0.8	Link to lighting occ sensor fim, Requires FIM 1.1

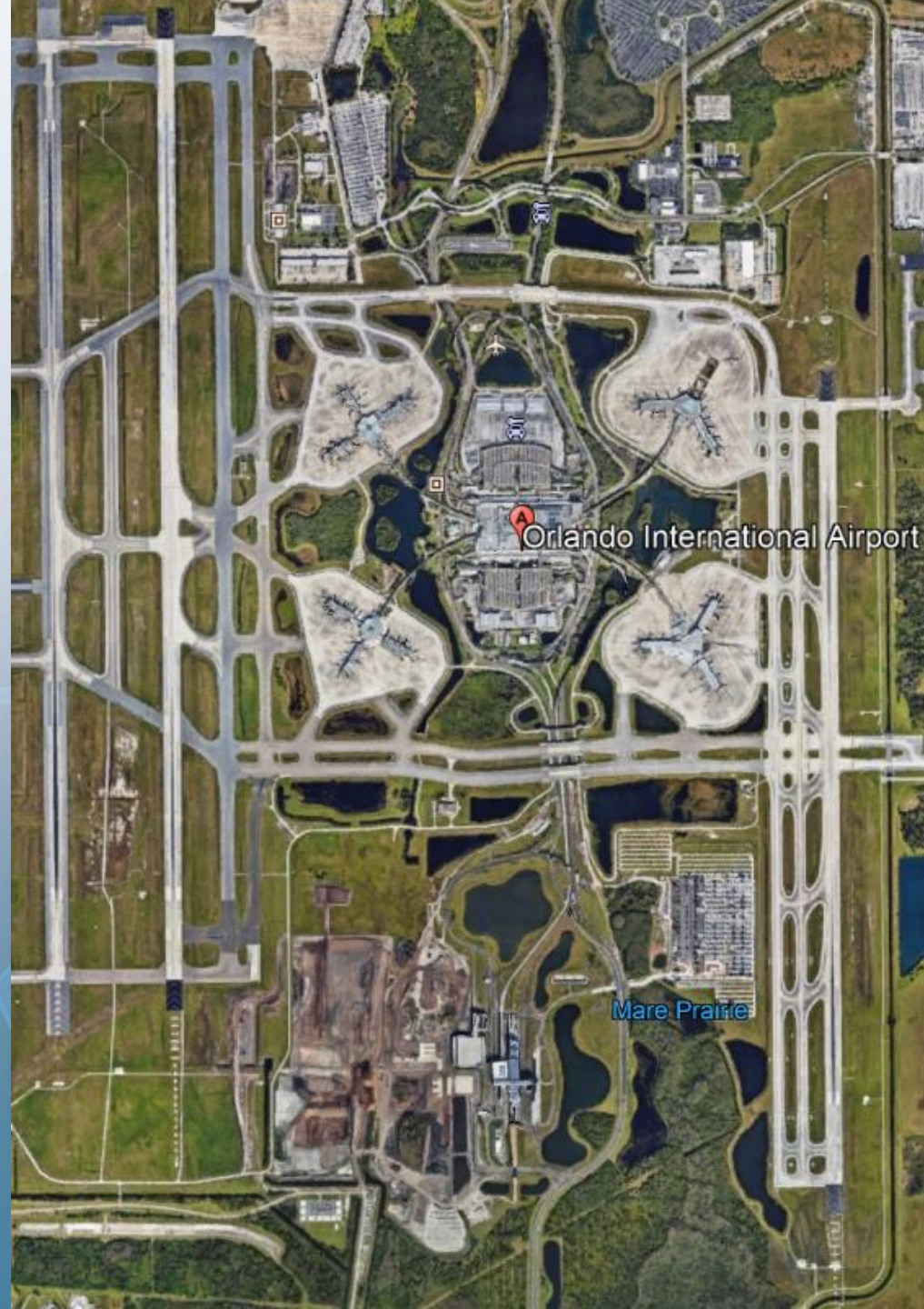


Energy roadmaps …

- … go beyond FCAs and RCx and evaluate both long term fixes and identify how to pay for the proposed fixes
- …can also include developing or updating energy, sustainability and resiliency design standards
- … compile and analyze other info that has already been completed and give it an implementation plan
- …work with utilities and identify planned rate increases, changes, etc.

An Energy Roadmap:

- Begins with the end in mind
- Looks at renewable technologies and storage (www.eere.energy.gov)
- Analyzes energy procurement to determine potential options
- Is a "Living Document" which will assist management and facilities operations in :
  - Forecasting
  - Prioritizing
  - Budgeting



An Energy Roadmap:

- Intended to:
  - reduce energy consumption,
  - advance energy generated by renewable sources; and
  - decrease the production of greenhouse gases (GHGs)

Energy Roadmap:

- Outlines a proposed energy management program based on industry best practices and concentrates on:
  - Energy planning and coordination
  - Energy efficiency in buildings
  - Transportation efficiency
  - Energy distribution and supply

Energy Roadmap includes:

- Identifying key partners
- Identifying funding sources
- Developing an implementation timeframe
- Identifying next steps

Energy Roadmaps / Strategic Energy Plans include:

1. Energy forecasting
    1. Identify where your energy costs are headed (www.eia.doe.gov)
2. Financial Incentives
    1. State and local government agencies, as well as local utilities, offer incentives and rebates (www.dsireusa.org)
3. Other Funding Opportunities

Key elements of a successful energy roadmap

- Goals – identify clear, concise and quantifiable targets
- Milestones – assign interim performance dates for each target
- Gaps and barriers – list potential gaps in knowledge, technology, market barriers, regulatory limitations, public acceptance
- Action items – identify actions that can be taken to overcome gaps or barriers
- Priorities and timelines – list the most important actions that need to be taken

Conclusion

- FCA's help Owners with asset management, deferred maintenance and determining existing conditions of equipment
- EA's and performing RCx helps Owners troubleshoot building issues and implement energy savings
- Energy masterplans or energy roadmaps help you increase your overall energy efficiency, sustainability and resiliency

ENERGY MANAGEMENT ASSOCIATION

QUESTIONS?

Bill Bradford: BBradford@hanson-inc.com
Wade Conlan: WConlan@hanson-inc.com
Sam Schwarz: Sam@energymgmt.org

AIA Provider Number: 50111116
Course Number: EMA2003L

Thank you to our Sponsor:

BlueRithm Commissioning Software

Utilizing Digital Twins of Operational Data

July 23, 11am Eastern

www.energymgmt.org/digitaltwinswebinar

JOIN EMA

Corporate and Associate Membership Available

www.energymgmt.org/membership

AIA Continuing Education Provider