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Commissioning: Are you getting what you paid for?

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Objectives

- Learn how retro-commissioning can help you identify projects and how to incorporate commissioning into your projects.

- Provide an overview of retro-commissioning, re-commissioning, and commissioning. Follow the commissioning process and learn how to interact with commissioning agents and develop a successful implementation strategy. You will understand how to maintain persistence of savings, learn from past issues, and obtain project acceptance.

Agenda

- Commissioning definitions
- Commissioning process
- Process differences and similarities
- Choose the right building for retro-commissioning
- Retrocommissioning in practice
- Sustaining the results
- Owner/commission agent interaction

Types of Commissioning

- Commissioning (Cx) - new building or major renovation
- Existing Building Commissioning (EBCx)
  - Retro-Commissioning (RCx) – no previous Cx
  - Re-Commissioning (ReCx) – previous Cx
- Ongoing Commissioning - *same concepts continued over time*
  - Continuous Commissioning ™ (CC) - Texas A&M University

Building Commissioning

"Building commissioning is an intensive quality assurance process that begins during design and continues through construction, occupancy, and operations. Commissioning ensures that the new building operates as the owner intended and that building staff are prepared to operate and maintain its systems and equipment.."

www.cacx.org

Retro-commissioning

"The commissioning process applied to existing buildings that have never been commissioned to restore them to optimal performance. Retro-commissioning (RCx) is a systematic, documented process that identifies low-cost operational and maintenance improvements in existing buildings and brings the buildings up to the design intentions of its current usage."

www.cacx.org

Recommissioning

"Recommissioning is another type of commissioning that occurs when a building that has already been commissioned undergoes another commissioning process. The decision to recommission may be triggered by a change in building use or ownership, the onset of operational problems, or some other need."

www.cacx.org

Commissioning Process Overview

Pre-Design Phase

- Select a commissioning lead
- Pre-Design Phase commissioning meeting
- Begin developing *Owner's Project Requirements*
- Develop initial *Commissioning Plan* outline

Design Phase

- Design Phase commissioning meeting (If Pre-Design meeting didn't occur)
- Perform commissioning-focused design review
- Update *Commissioning Plan*
- Develop commissioning requirements for the specification
- Begin planning for verification checklists, functional tests, *Systems Manual*, and training requirements

Construction Phase

- Construction Phase kick-off meeting
- Review submittals, monitor development of *Shop and Coordination Drawings*
- Review *O&M Manuals*
- Perform ongoing construction observation
- Perform verification checks
- Perform diagnostic monitoring
- Perform functional testing
- Develop *Commissioning Report* and *Systems Manual*
- Develop *Recommissioning Plan*
- Verify and review training of owner's staff

Occupancy and Operations Phase

- Resolve outstanding commissioning issues
- Perform seasonal /deferred testing
- Perform near warranty-end review

Retrocommissioning Process Overview

Planning Phase

- Select the project
- Set project objectives and obtain support
- Select a commissioning lead
- Document the current operating requirements
- Perform an initial site walk-through
- Develop the *Retrocommissioning Plan*
- Assemble the retrocommissioning team
- Hold a project kick-off meeting

Investigation Phase

- Review facility documentation
- Perform diagnostic monitoring
- Perform functional tests
- Perform simple repairs
- Develop *Master List of Findings*
- Prioritize and select operational improvements

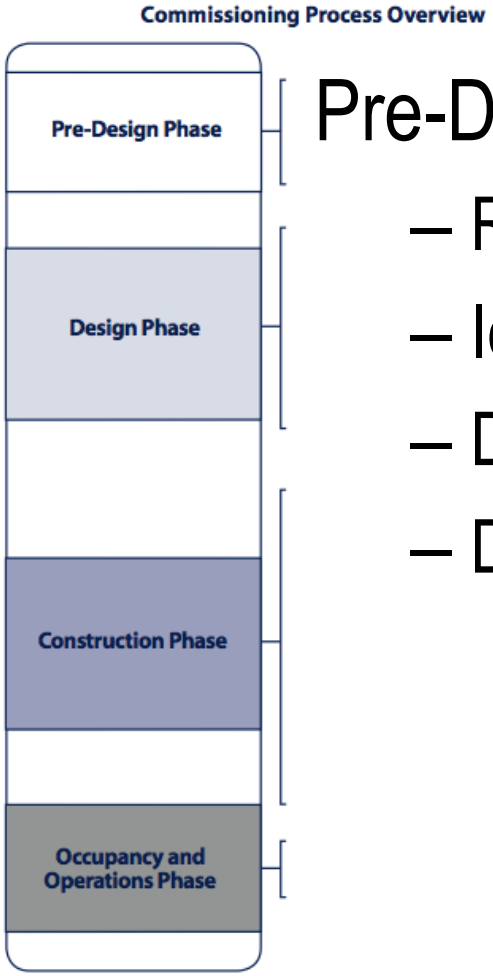
Implementation Phase

- Develop *Implementation Plan*
- Implement selected operational improvements
- Verify results

Hand-Off Phase

- Develop *Final Report*
- Compile a *Systems Manual*
- Develop *Recommissioning Plan*
- Provide training
- Hold close-out meeting
- Implement persistence strategies

New Building Commissioning



Pre-Design Phase

- Retain the services of a commissioning agent
- Identify commissioning team/lead
- Define Owners Project Requirements (OPR)
- Develop preliminary commissioning plan

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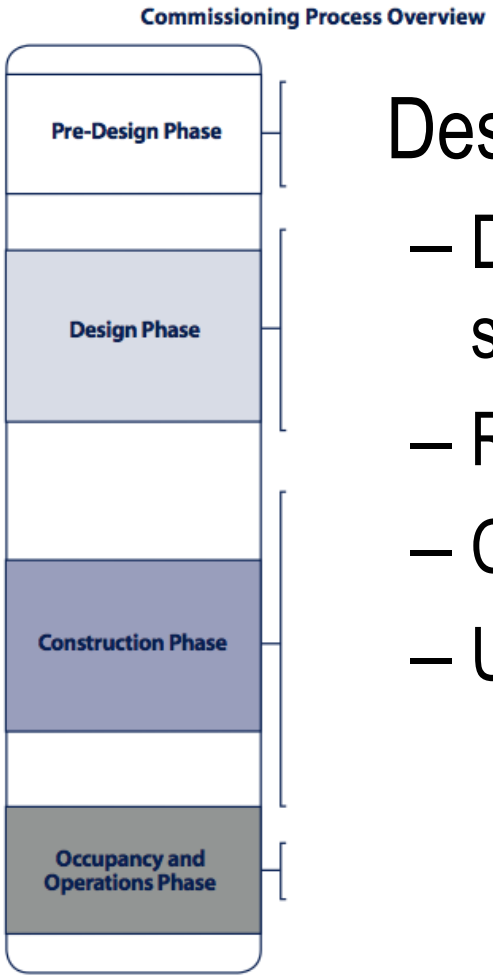
New Building Commissioning



Design phase

- Develop commissioning requirements for specifications
- Review owner requirements
- Conduct design reviews
- Update the commissioning plan

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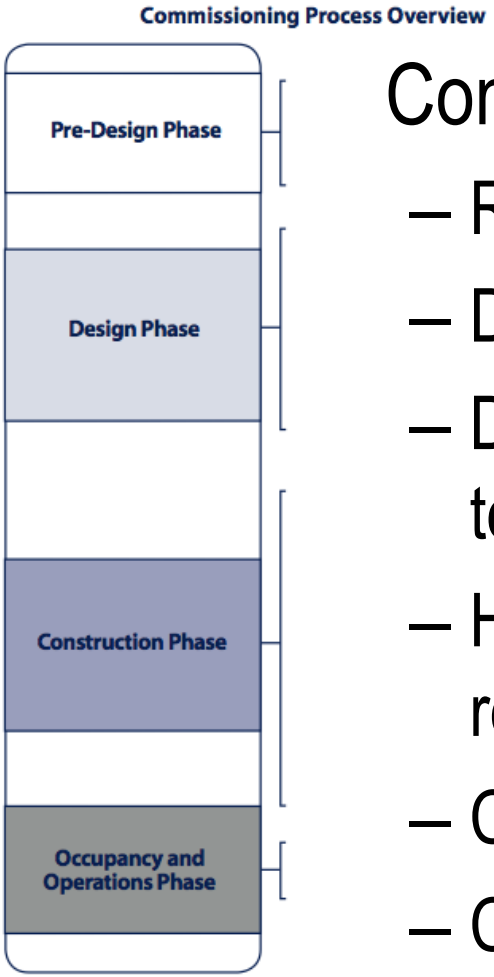
New Building Commissioning



Construction stage

- Review submittals for performance parameters
- Develop construction checklists
- Develop and perform functional performance tests
- Hold Cx team meetings and deliver progress reports
- Conduct owner training
- Commissioning report and systems manual

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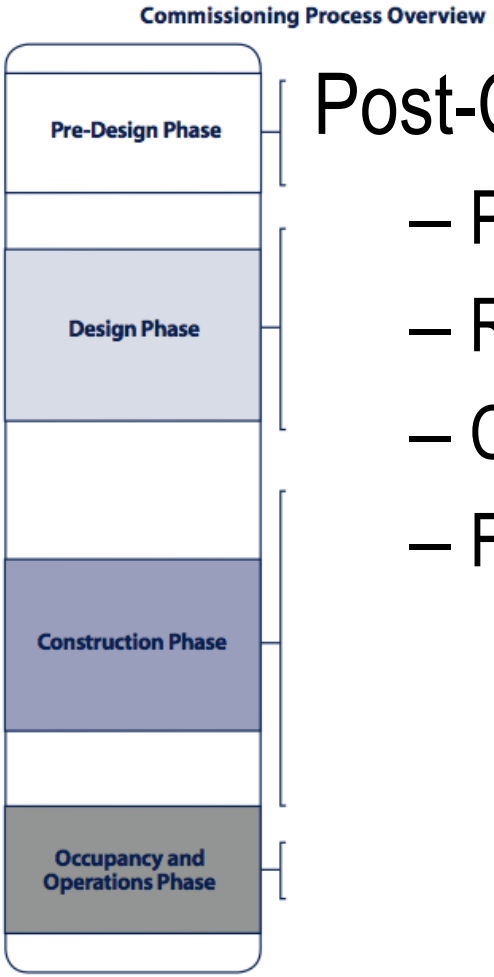
New Building Commissioning



Post-Construction stage

- Perform deferred and seasonal testing
- Reinspect performance before warranty end
- Complete final commissioning report
- Final satisfaction review with owner

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Cx/RCx Similarities and Differences

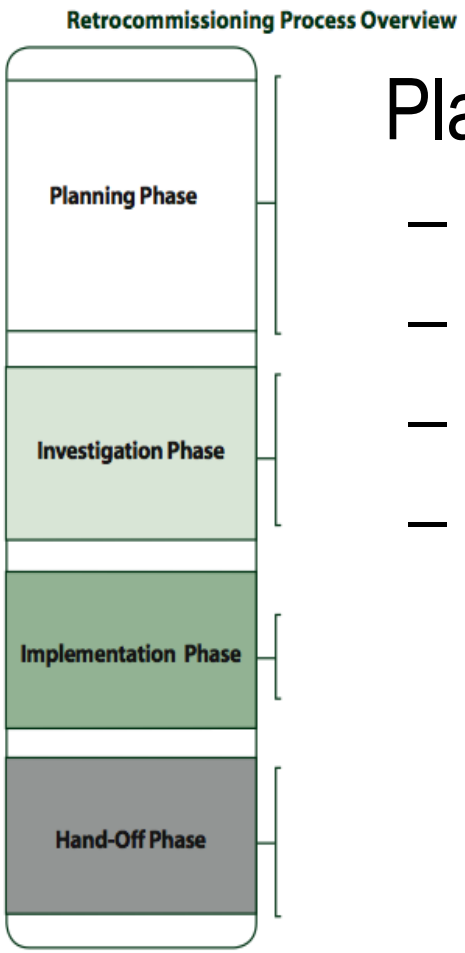
- Similar
  - Construction and implementation stage
  - Post-Construction and Hand off stage
- Different
  - Cx Planning vs RCx planning stage
  - Design vs Investigation stage

OPR vs CFR

- **Owner's Project Requirements (OPR)** A written document that details the functional requirements of a project and the expectations of how it will be used and operated.

- **Current Facility Requirements (CFR)** A written definition of the goals, objectives, and limitations of the project that account for the current and evolving needs of all of the stakeholders associated with the building (owner, manager, maintenance personnel, occupants).

Retro-commissioning



Planning stage

- Hold a project kick-off meeting
- Perform an initial site walk-through
- Document the current facility requirements
- Develop the Retro-commissioning Plan

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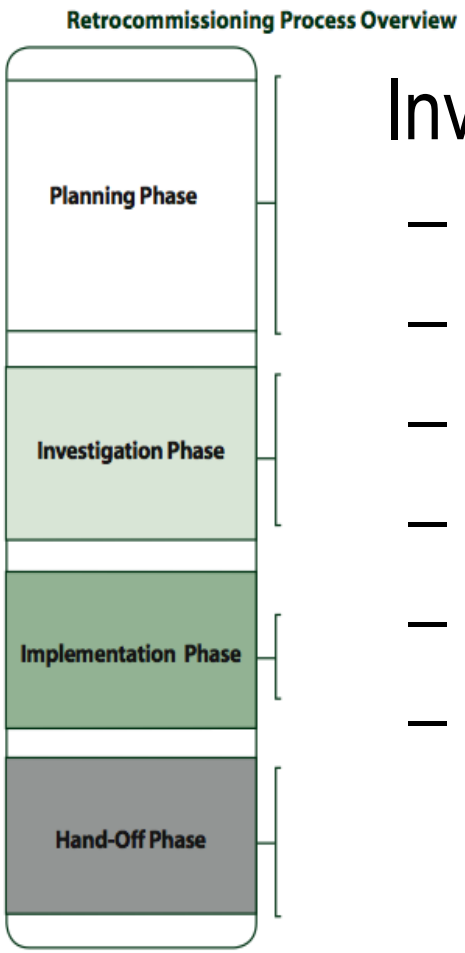
Retro-commissioning



Investigation Phase

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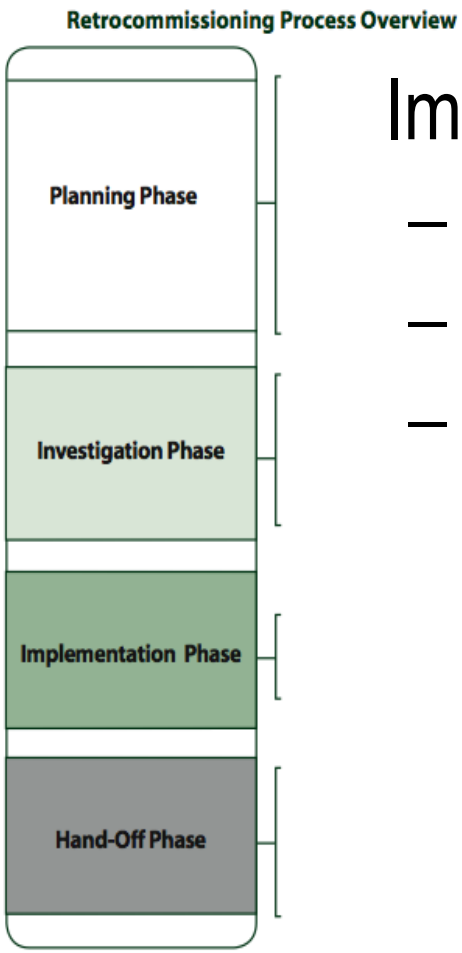
Retro-commissioning



Implementation Phase

- Develop Implementation Plan
- Implement selected operational improvements
- Verify results

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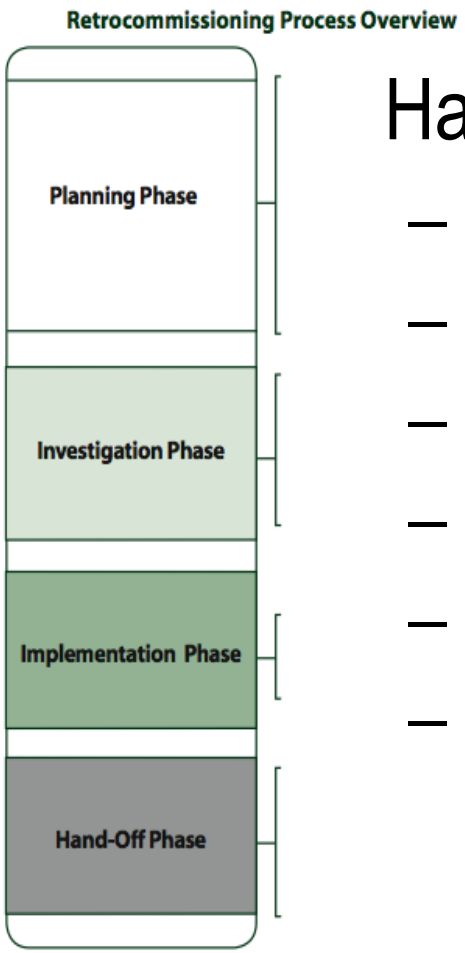
Retro-commissioning



Hand off Phase

- Develop Final Report
- Compile a Systems Manual
- Develop Re-commissioning Plan
- Provide training
- Hold close-out meeting
- Implement persistence strategies

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Return

*Median Values	Whole Building Energy Savings	Payback (yrs)
New Building Cx	13%	4.2
Existing Building Cx	16%	1.1

*Lawrence Berkeley Lab, Evan Mills, Ph.D.

http://cx.lbl.gov/2009-assessment.html

- High-tech buildings are particularly cost effective
- Non-energy benefits are extensive

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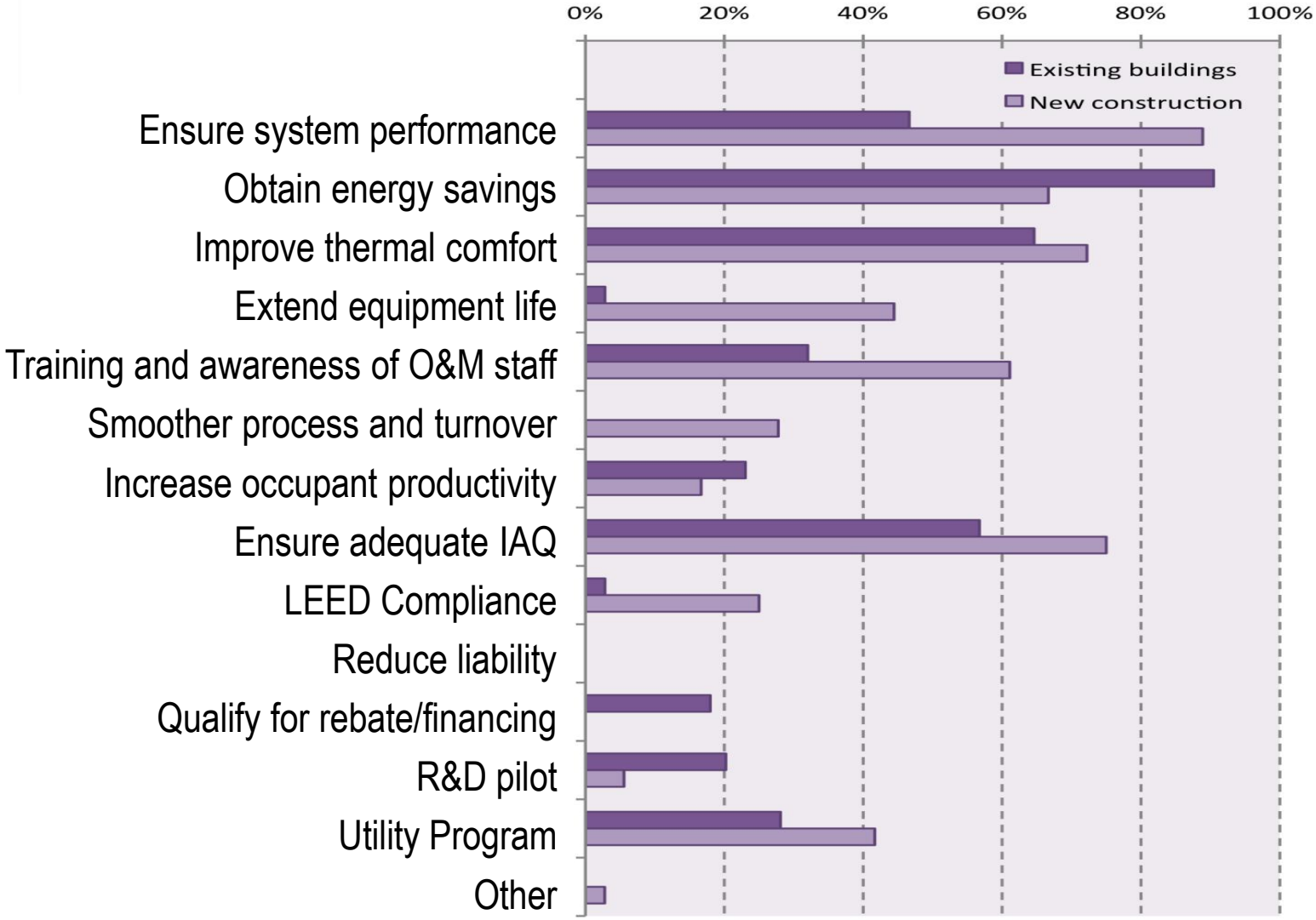
Benefits

- Arguably the single-most cost-effective strategy for reducing energy, costs.
- Energy savings tend to persist well over at least a 3- to 5-year timeframe.
- Non-energy benefits are extensive and often offset part or all of the commissioning cost.
- Comprehensive approach to commissioning attained nearly twice the overall median level of savings, and five-times the savings of projects with a constrained approach.

Cx Reasons: New & Existing Buildings



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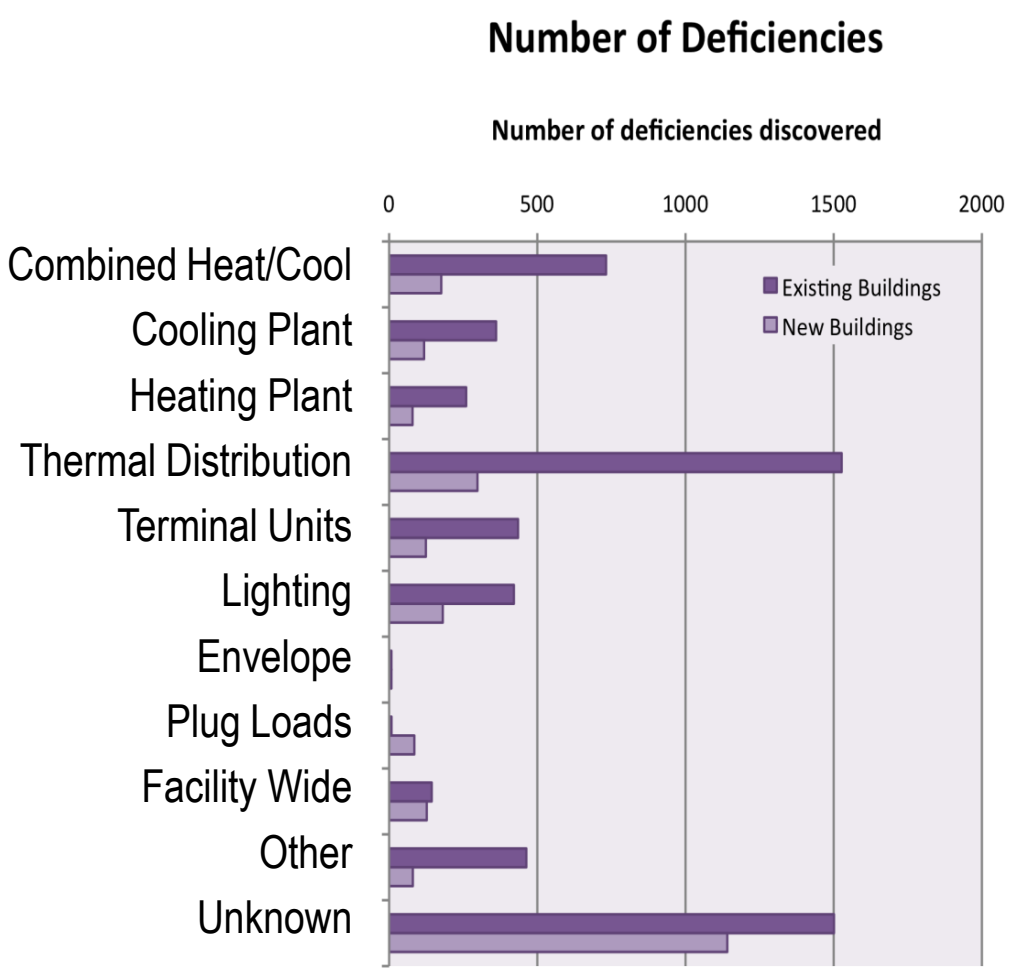
Deficiencies Discovered …



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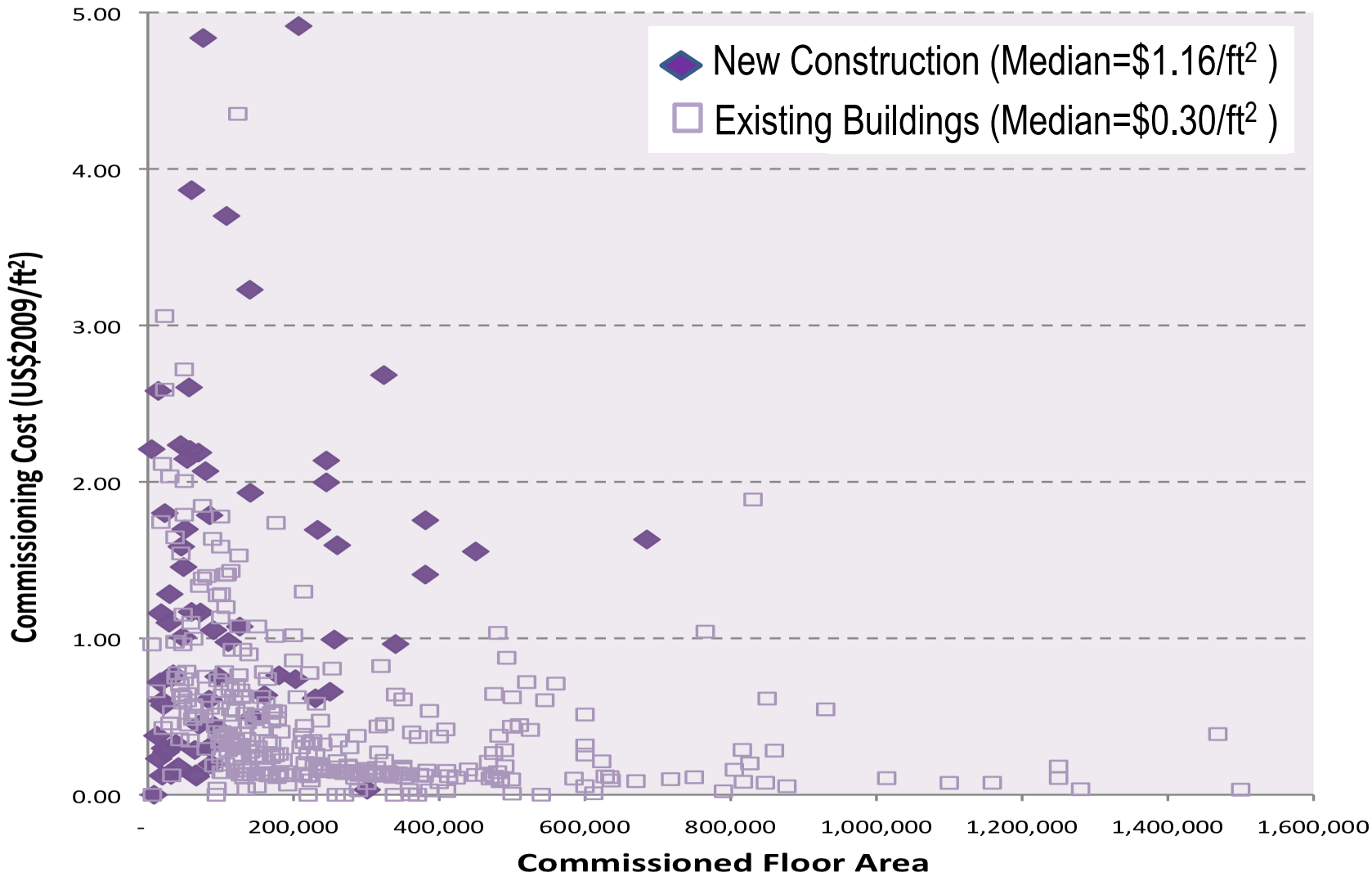
Cx Costs: New & Existing Buildings



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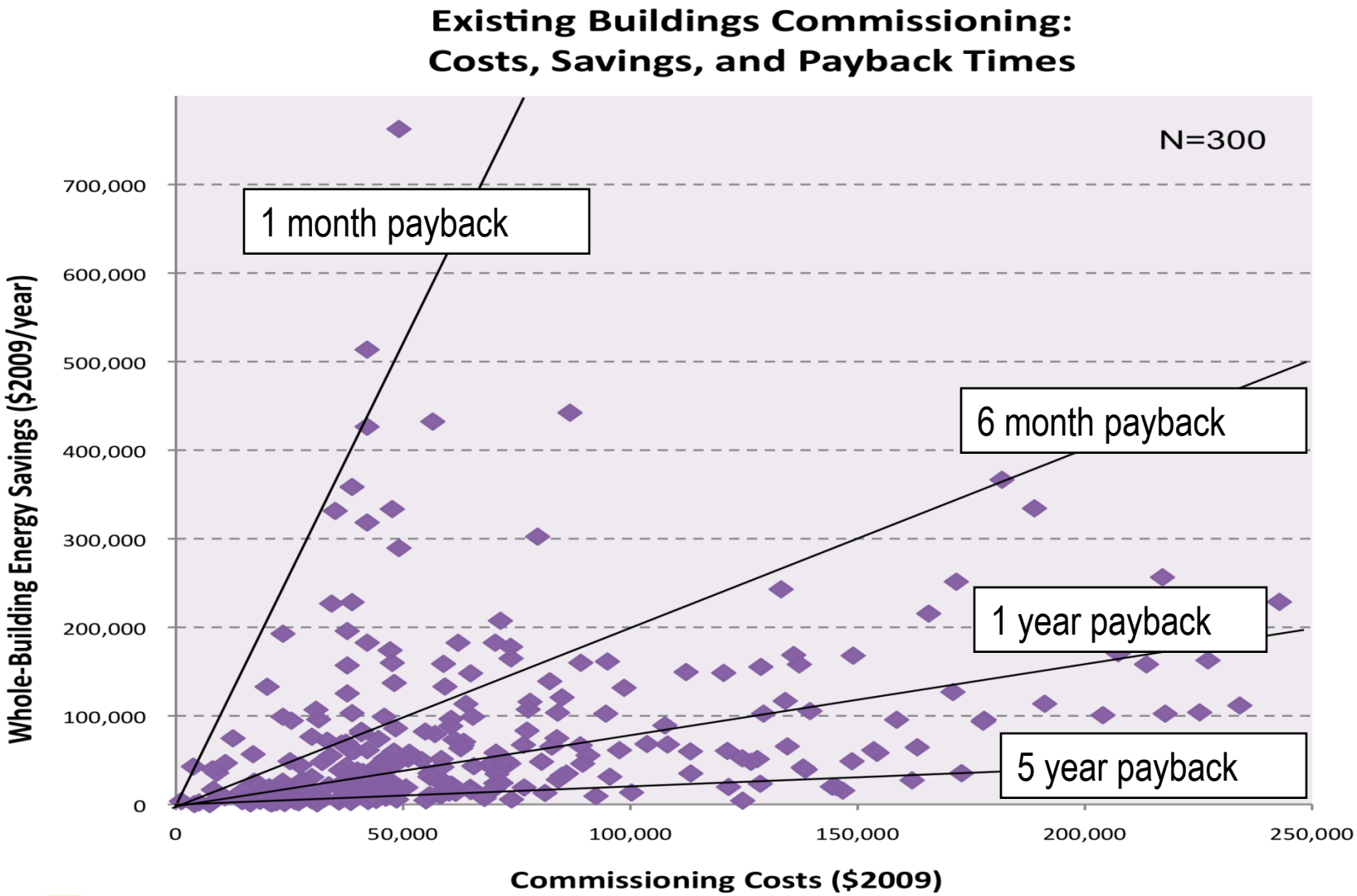
Payback : RCx



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RCx Building Selection

- Best candidates
  - Large buildings with distributed HVAC systems
    - Chillers, boilers, multiple air handlers, VAV systems
  - Functional EMCS
  - High energy intensity
  - Multiple tenant improvements or remodels
- What about the other buildings?
  - Most buildings or systems can benefit
  - The question becomes will it be cost effective

RCx Building Scoping

- Planning
  - Future remodel/retrofit or mission change?
- Equipment Condition
  - Near end-of life equipment may not be appropriate
  - EMCS
- Operation and Maintenance Staff
  - Capable and willing to participate
  - Key to sustainability of improvements

RCx Building Scoping

- Size
  - Level of effort largely determined by quantity, size, and complexity of equipment
  - Many costs independent of square footage
- Benchmarking
  - Energy Utilization Index (EUI)
  - Energy Star Rating - Portfolio Manager tool
  - Commercial Building Energy Consumption Survey (CBECS)

RCx Contracting

- Consider Reasons
  - Energy savings
  - Occupant comfort
  - Building Tune-Up / Maintenance
- Statement of Work
  - Matches intent
  - Consider LOE vs Cost/Payback
  - Single project or 2-stage approach
  - Provide as much building information as possible

Retrocommissioning in Practice

Necessary Documentation

- Utility data
- Control drawings and points list
- Sequence of operations
- As-built drawings as available
- TAB Reports
- Existing energy audit reports
- Original equipment submittals

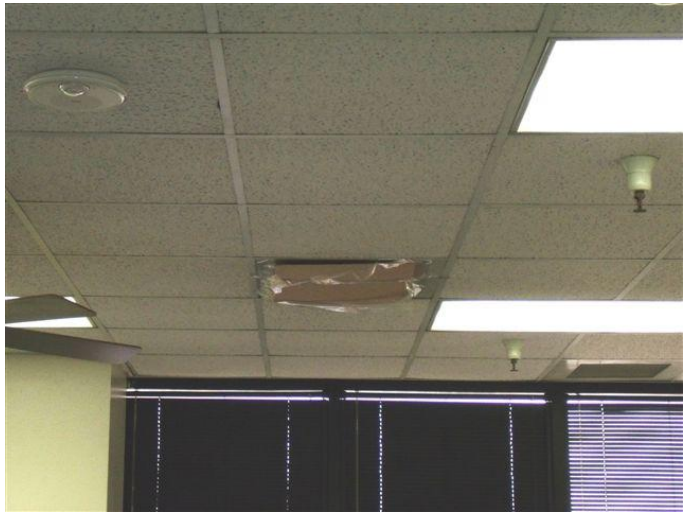
RCx Candidates

- VFDs at 100%
- Broken linkages on dampers
- Valve actuators disconnected or inoperative
- Low delta T on chillers
- Hot and cold areas throughout the building
- Occupant complaints

Common Retrocommissioning Findings

- Variable speed drives no longer modulate appropriately
- Controls are circumvented or set up improperly
- Equipment runs more than necessary or runs inefficiently because of improper sequences of operation
- Controls were never tuned or require retuning to provide appropriate response time or to avoid hunting

RCx Opportunities

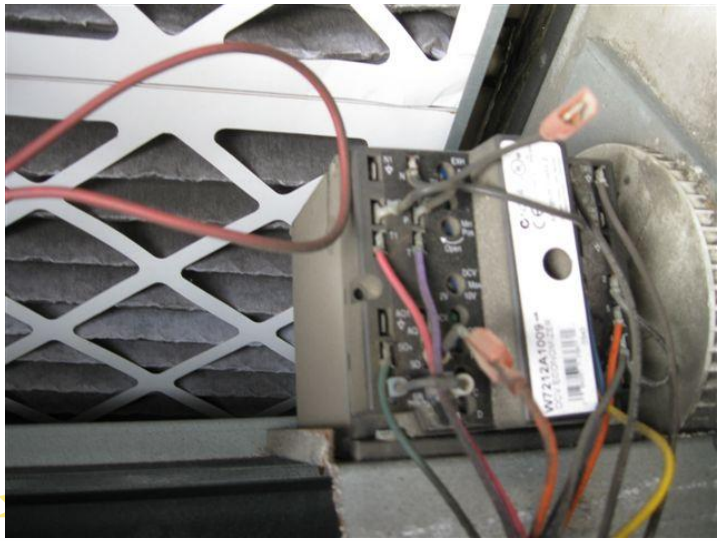


- Blocked air register

- Windows open, AC running

RCx Opportunities

- Heater on in shop during summer time

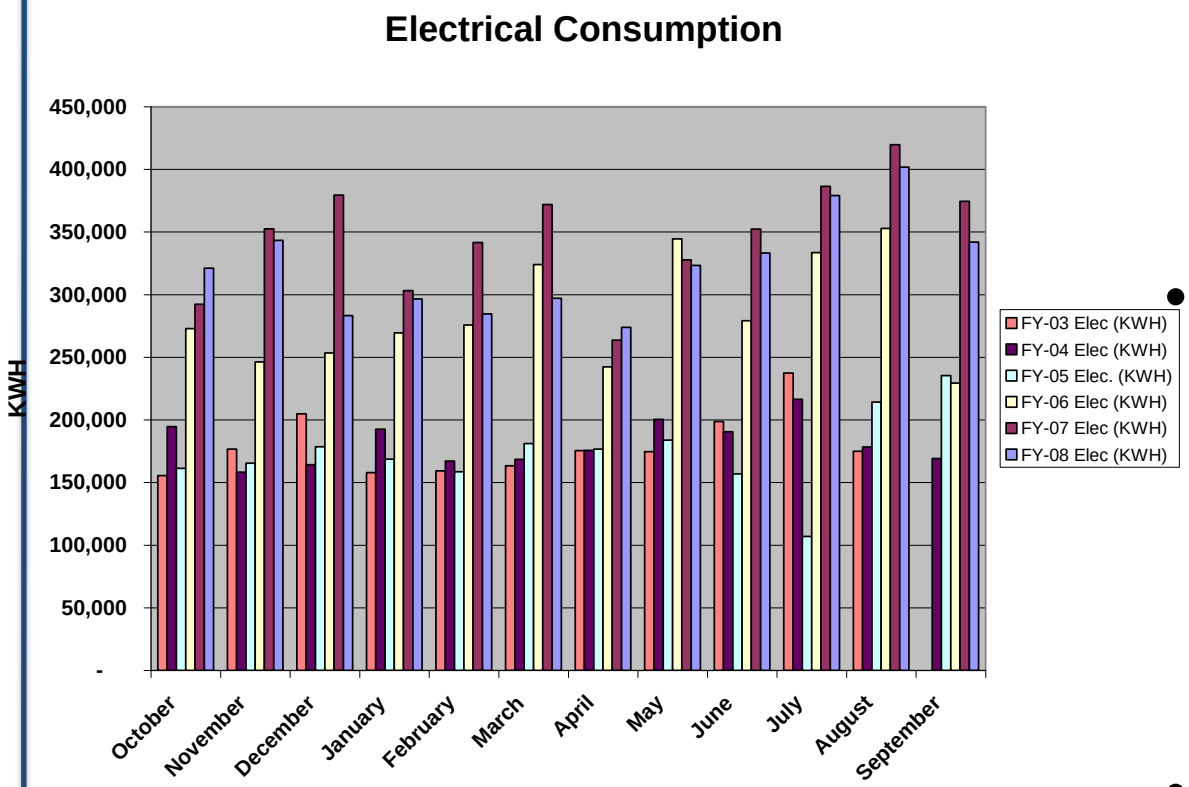


- Economizer controls bypassed

RCx Opportunities

- Frozen suction line on condensing unit
  - Low refrigerant
  - Air filters clogged

Utility Analysis



- Data does not have a typical usage pattern
  - i.e. higher peaks in summer season due to cooling
- FY06 – 08 data shows a 2-fold increase
  - Meter change (analog to digital)?
  - Increase in building or mission requirements?
  - Increased lighting load for aircraft canopies?
- Advanced metering will help to identify high usage buildings

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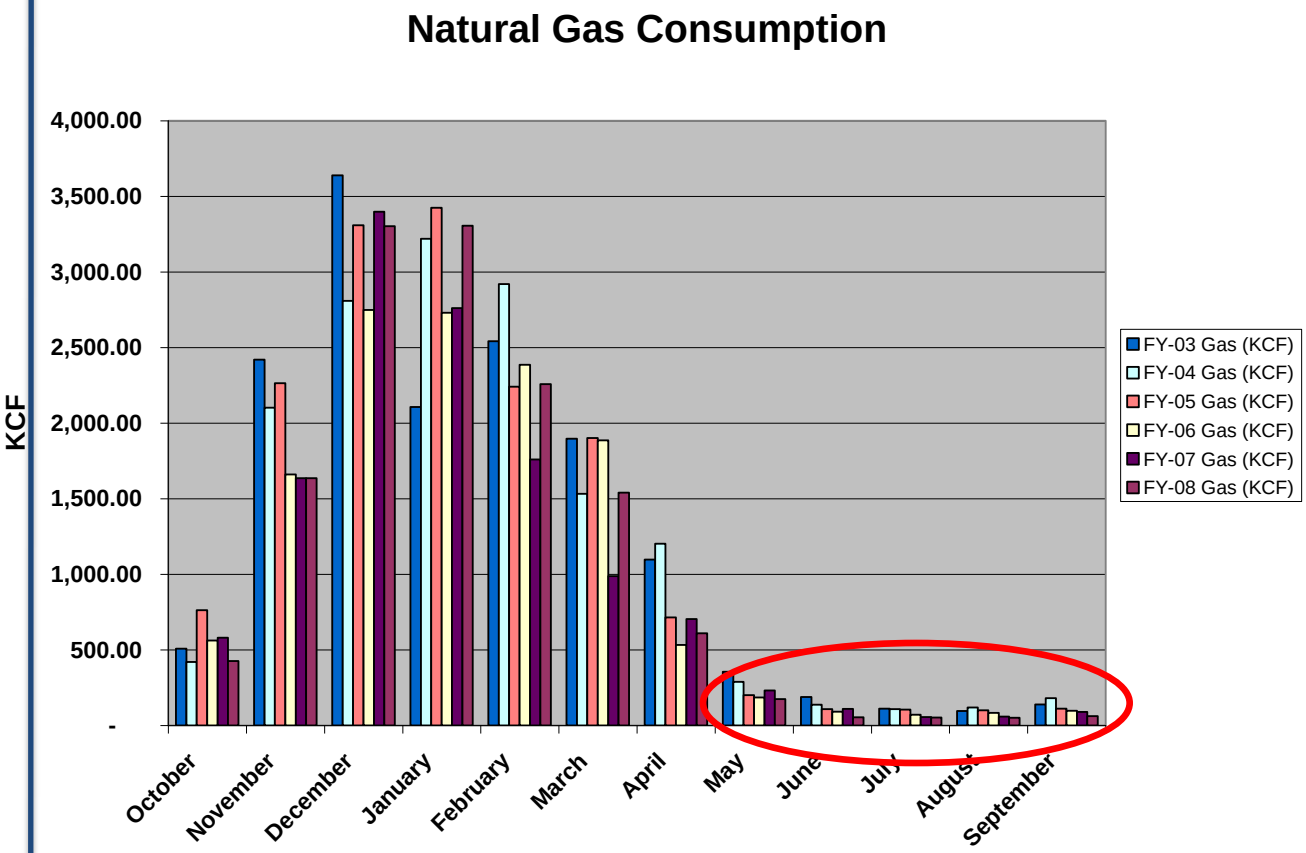
Utility Analysis



- Typical usage pattern
- Boilers secured during summer months
- Notice domestic hot water production

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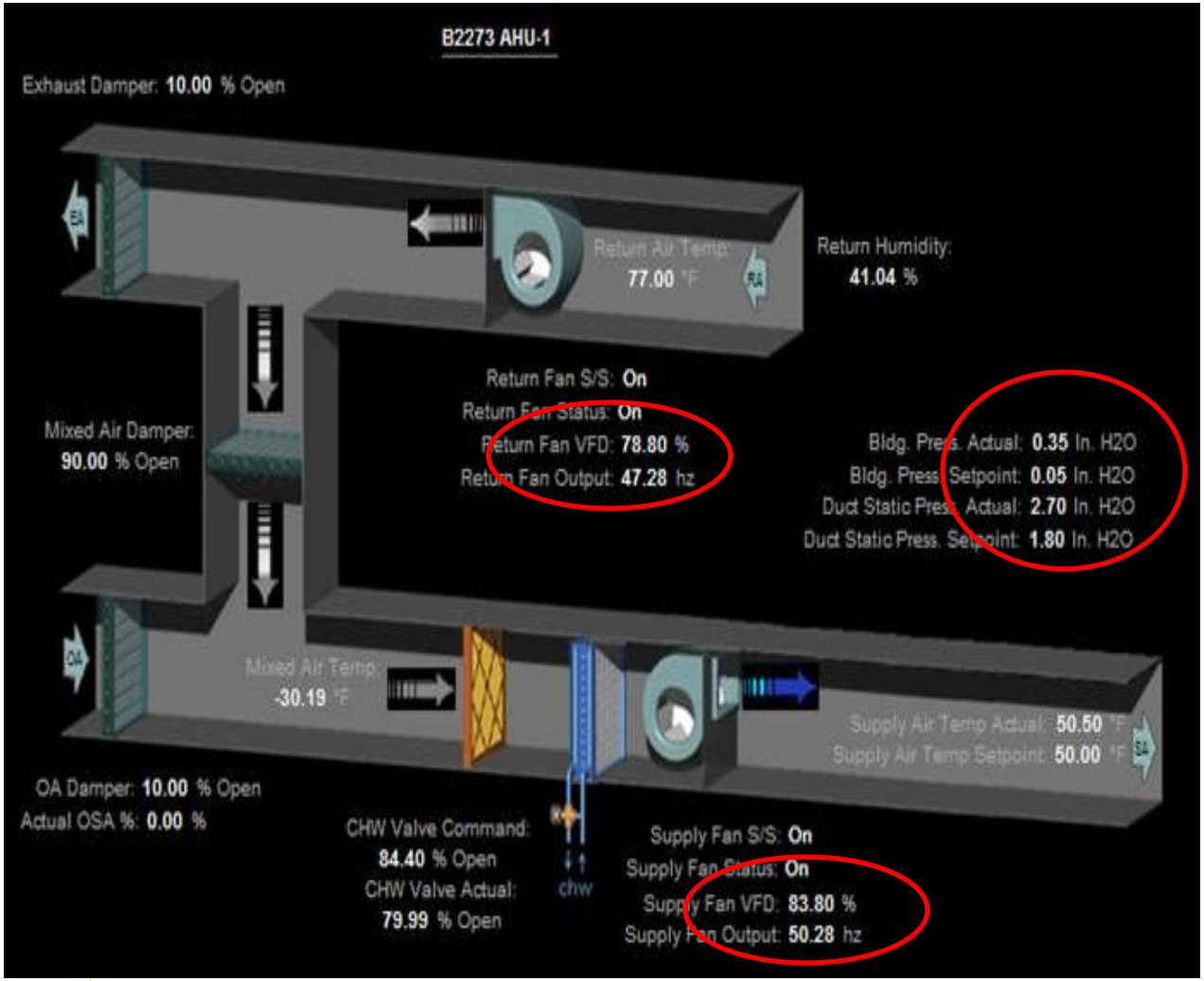
EMCS Analysis



- Duct pressure setpoint exceeded, VFD at 83%
- Bldg pressure setpoint exceeded, RF VFD at 78%

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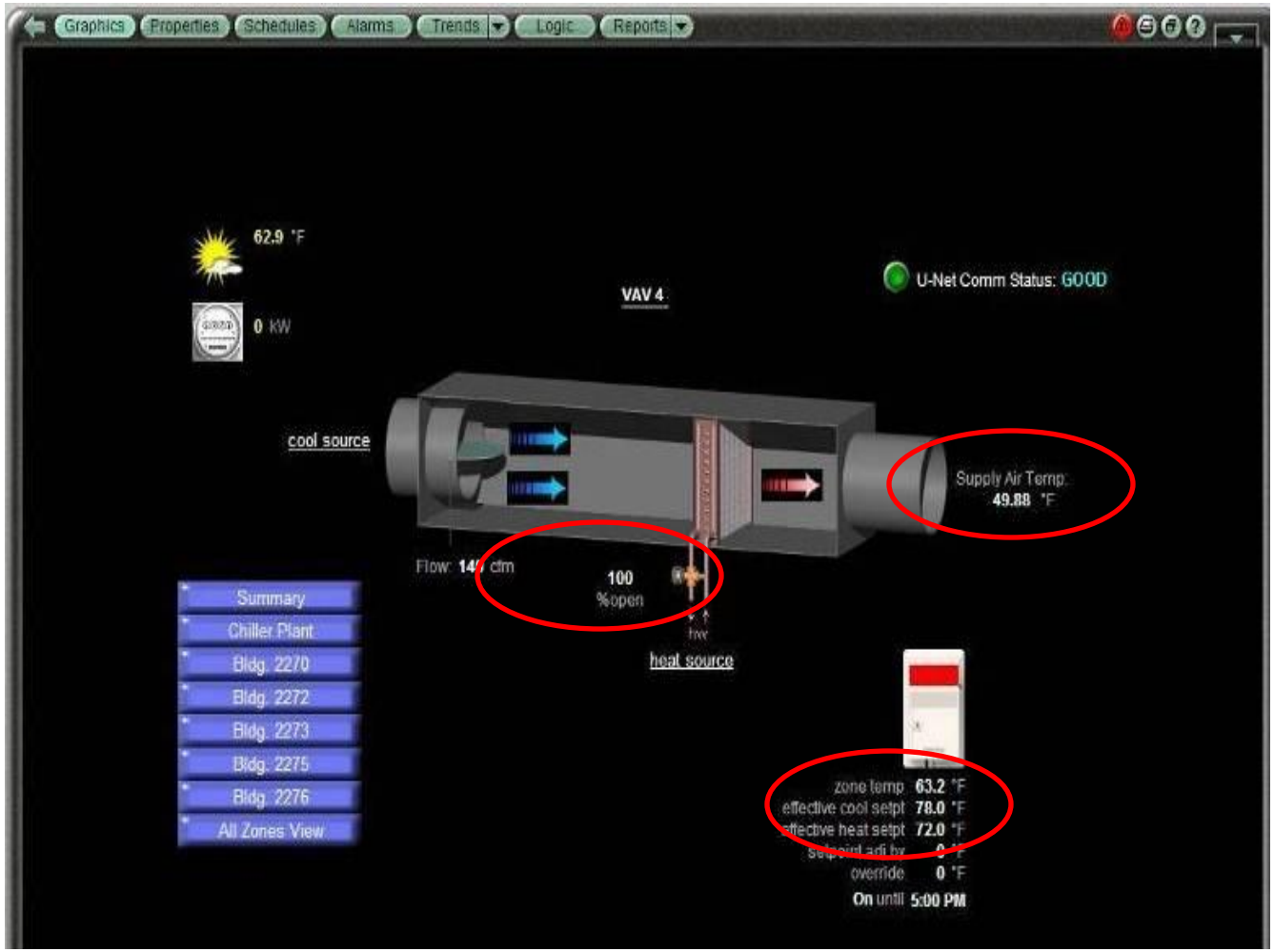
EMCS Analysis



- VAV supply air temp at 49 degrees
- HW valve at 100%
- OA temp at 63 degrees
- Zone temp at 63 degrees

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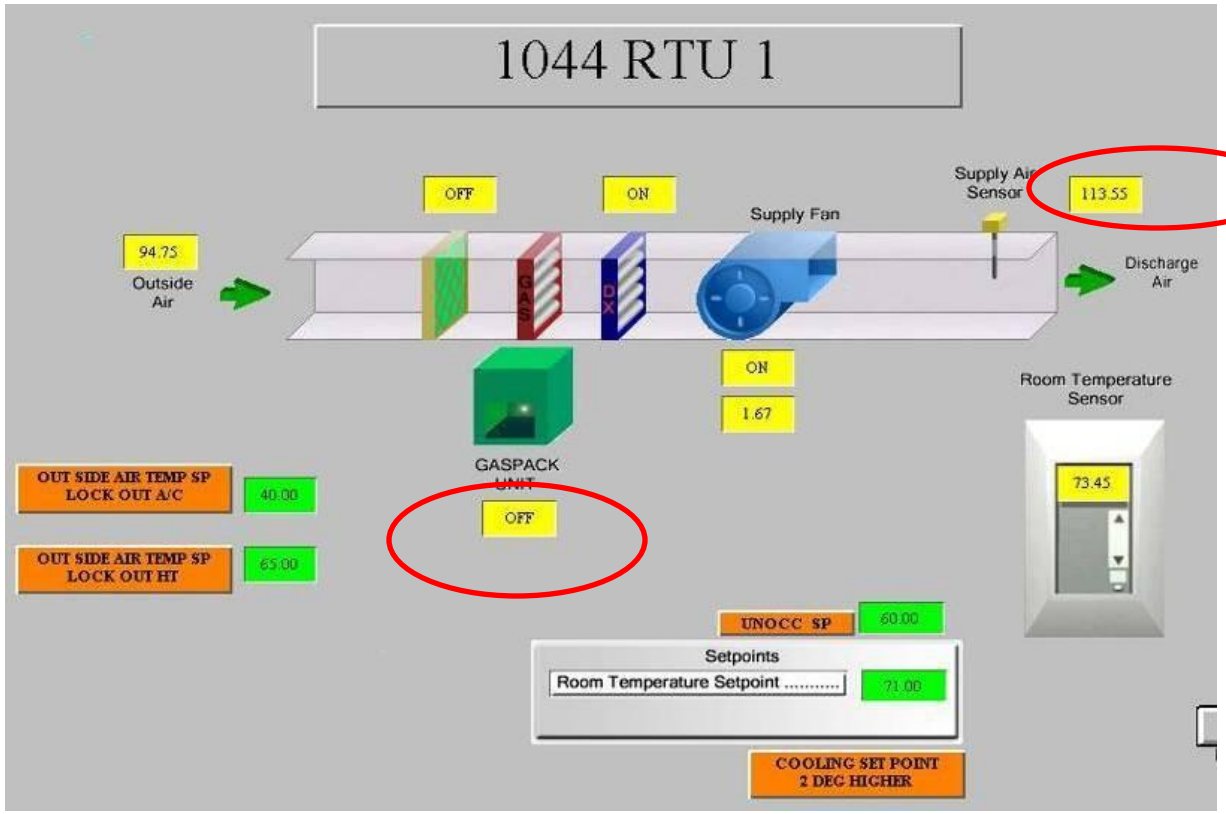
EMCS Analysis



- Gaspack unit off
- Cooling coil on
- DA temp 113 degrees

EMCS Analysis

Status	Item	Description	Value	Units
	OCC-C	OCCUPANCY COMMAND	OCC	
	TEMP-OCC	TEMPORARY OCCUPANCY MOI	UNOCC	
	TOCC-PER	TEMP OCCUPANCY PERIOD	60	MIN
	RM-T	ROOM TEMP	65.4	DEG F
	ACTCLGSP	ACTUAL COOLING SETPOINT	78.0	DEG F
	ACTHTGSP	ACTUAL HEATING SETPOINT	67.0	DEG F
	SA-T	SUPPLY AIR TEMP	57.1	DEG F
	SF-SS	SUPPLY FAN START/STOP	ON	
	SF-CSR	SUPPLY FAN STATUS	ON	
	REV-VLV	REVERSING VALVE	HTG	
	CMP-SS	COMPRESSOR START/STOP	START	
	CMP-AMP	COMPRESSOR CURRENT	0.03	AMPS
	FLTR-DP	FILTER DIFF PRESS (AI)	0.01	IN WC
	CS-MODEL	OCCUPANCY STATUS	Occ	
	--	OPTIMAL START/STOP	--	
	PC-ENBLD	PRE COOL ENABLED	NO	
	PH-ENBLD	PRE HEAT ENABLED	NO	
	PHTLM-SP	PRE HEAT LIMIT SETPOINT	70.0	DEG F
	PC-TARGT	PRE COOL TARGET SETPOINT	74.0	DEG F
	PH-TARGT	PRE HEAT TARGET SETPOINT	70.0	DEG F
	PC-TIME	PRE COOL START TIME	5.1	
	PH-TIME	PRE HEAT START TIME	5.1	
	--------	DEMAND LIMITING	------	
	DL-S	DEMAND LIMITING STATUS	Off	

Room temp low

Supply air temp is low for heating mode

System appears to be in heating mode and receiving start command

No current, Compressor off or CT is bad

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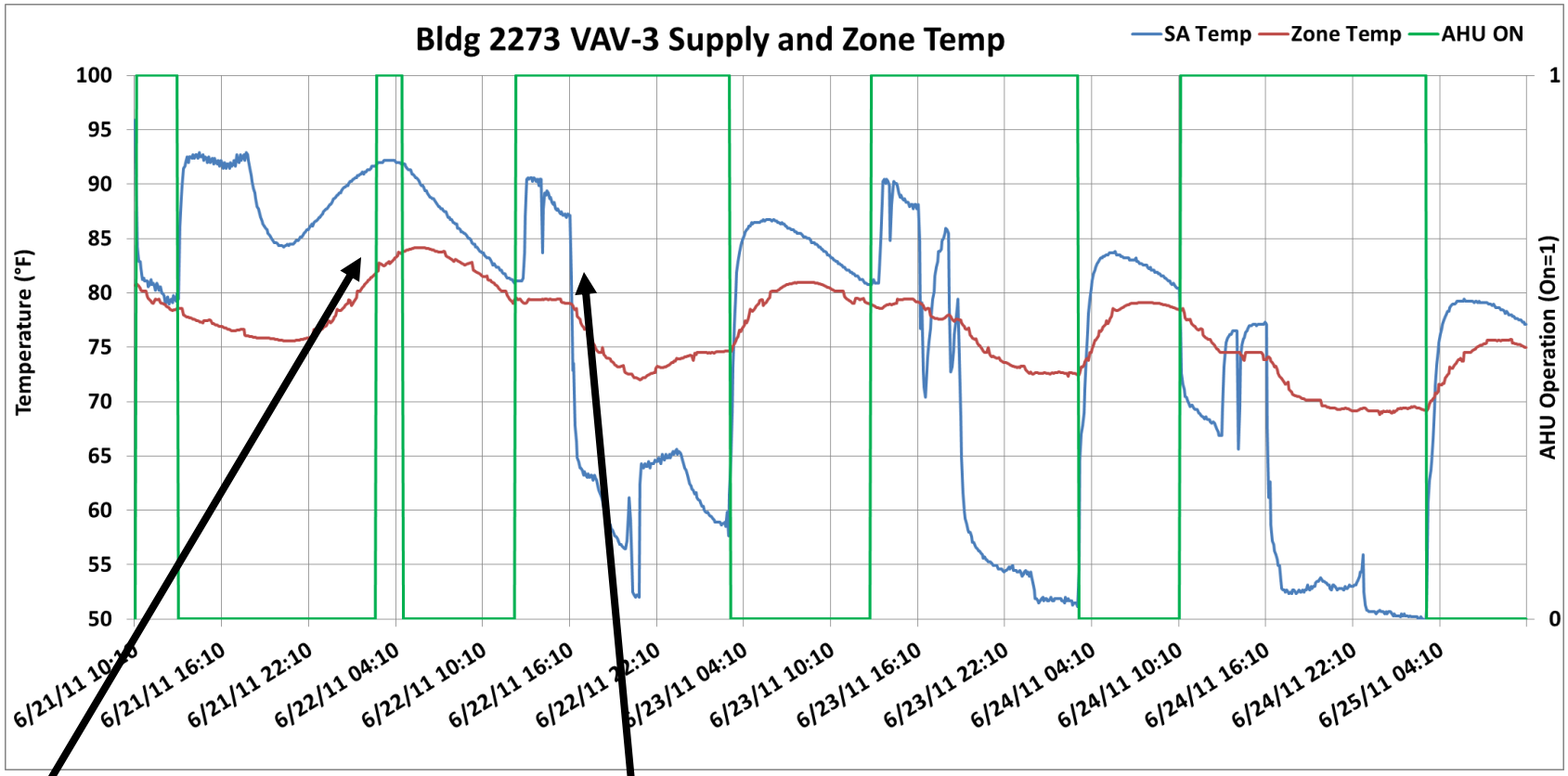
Trend Analysis



- AHU startup during unoccupied hours
- VAV goes to heating upon startup

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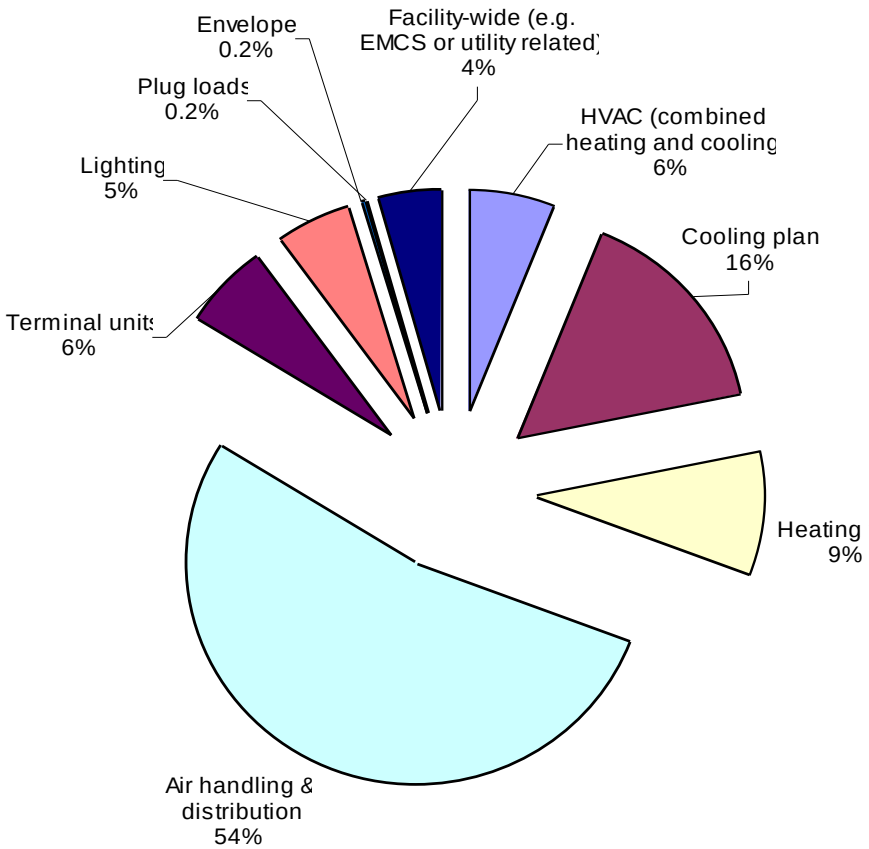
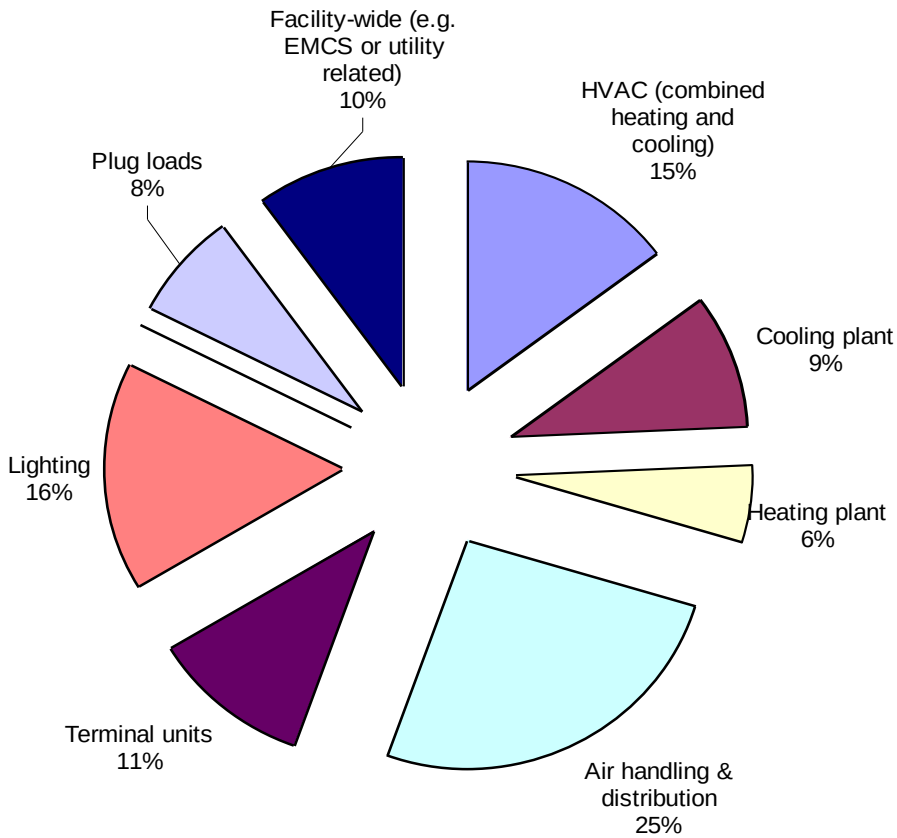
Types of Deficiencies Discovered

Existing (N=3500)



New (N=3300)



http://www.cacx.org/resources/documents/CA_Commissioning_Guide_Existing.pdf www.cacx.org

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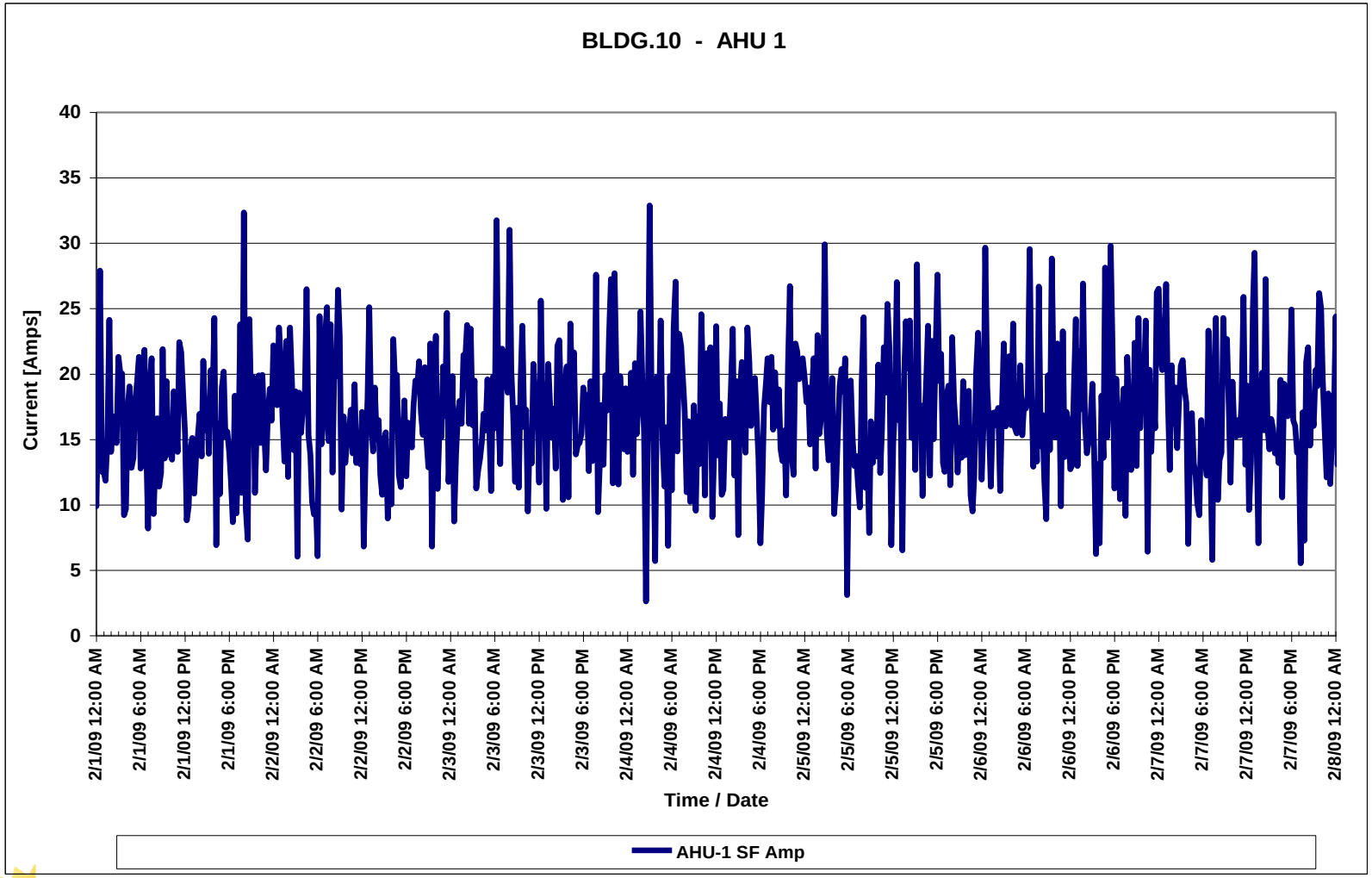
Top Measures

- Improved scheduling
- Improved outside airflow control
- Manage simultaneous heating and cooling
- Temperature resets
- Reset/reduce supply air static pressure setpoint
- VFDs – restore or install
- Repair controls hardware (dampers, valves, sensors)
- Improve chiller/boiler sequencing (including lockout control)

Example RCx Measures



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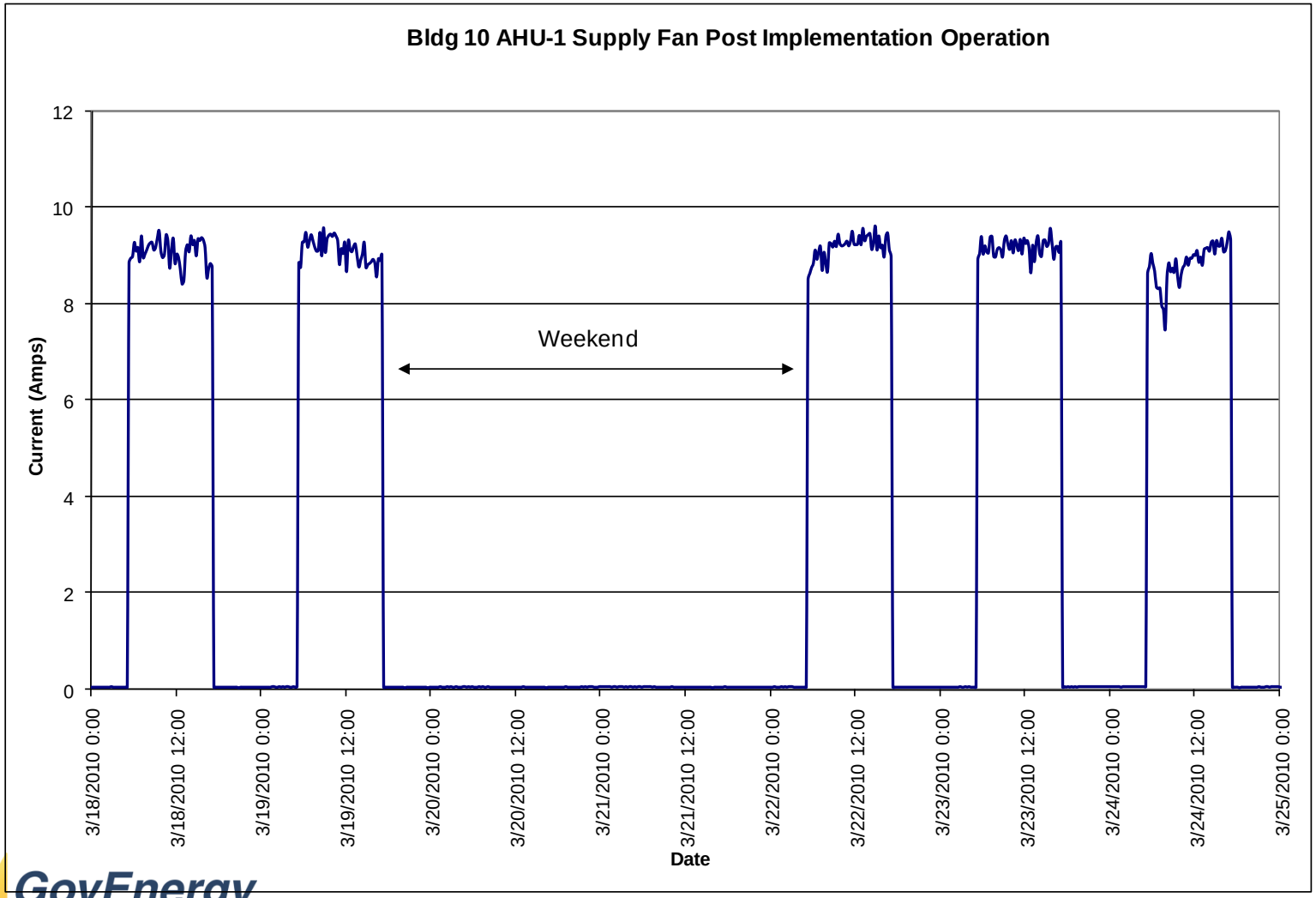
Example RCx Measures



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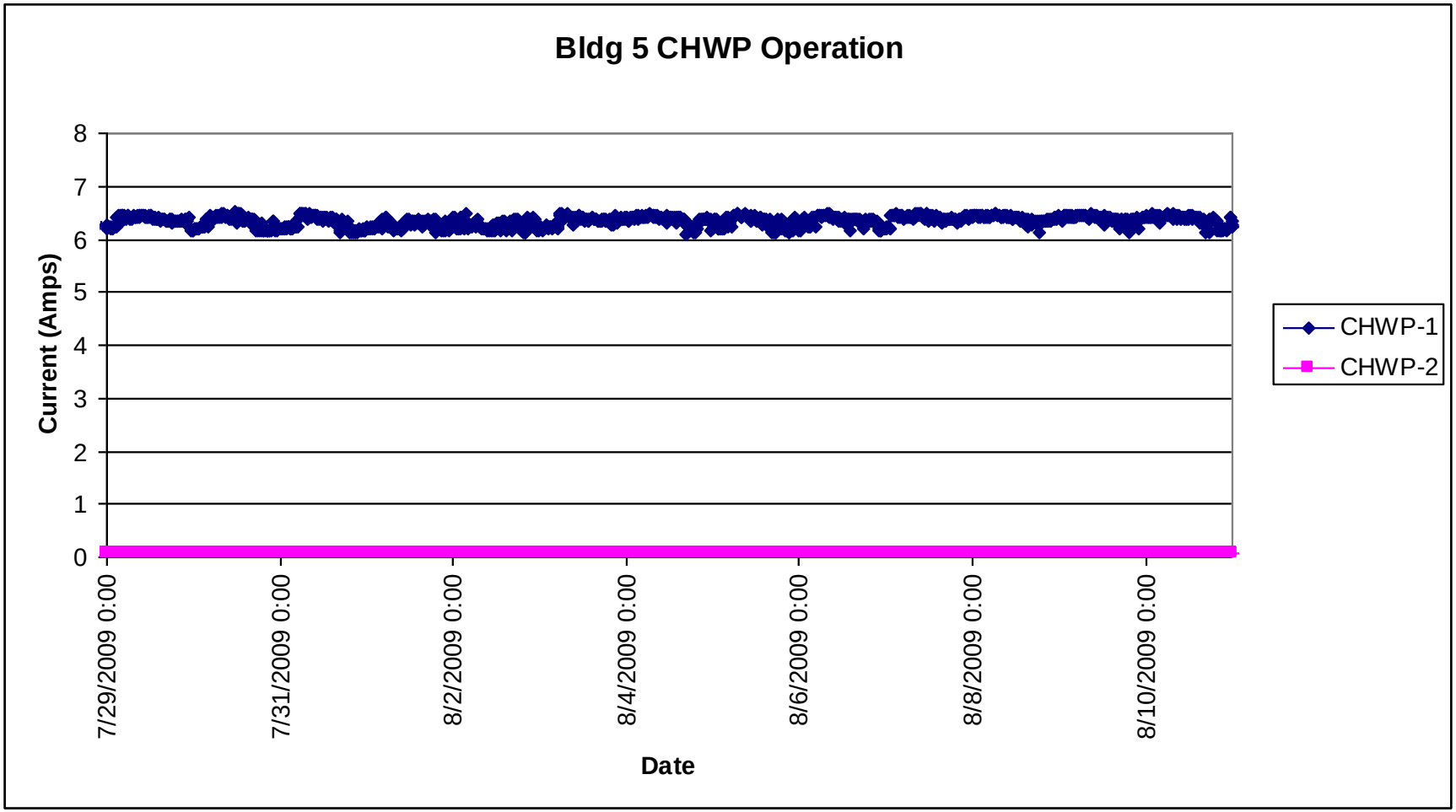

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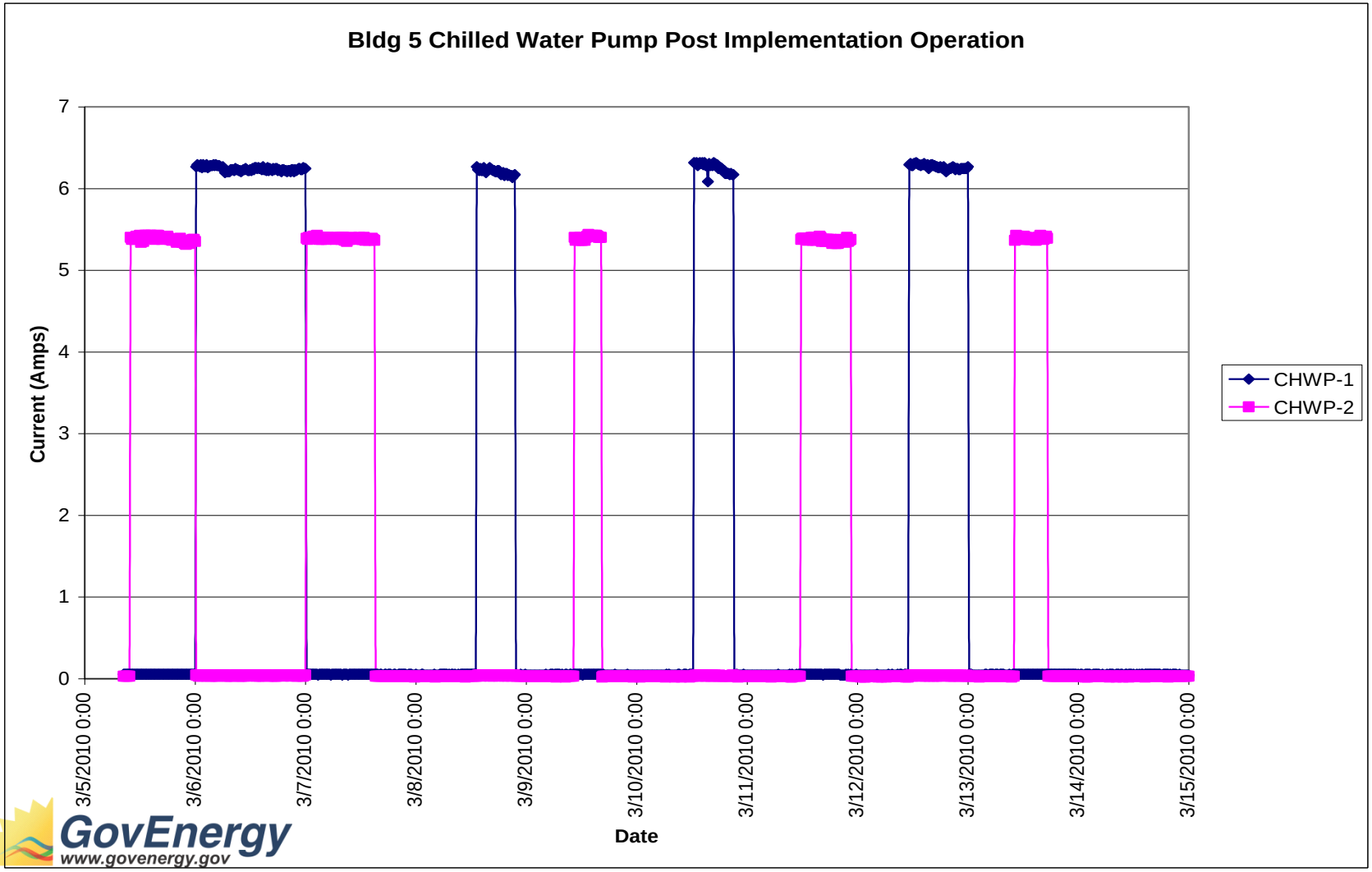

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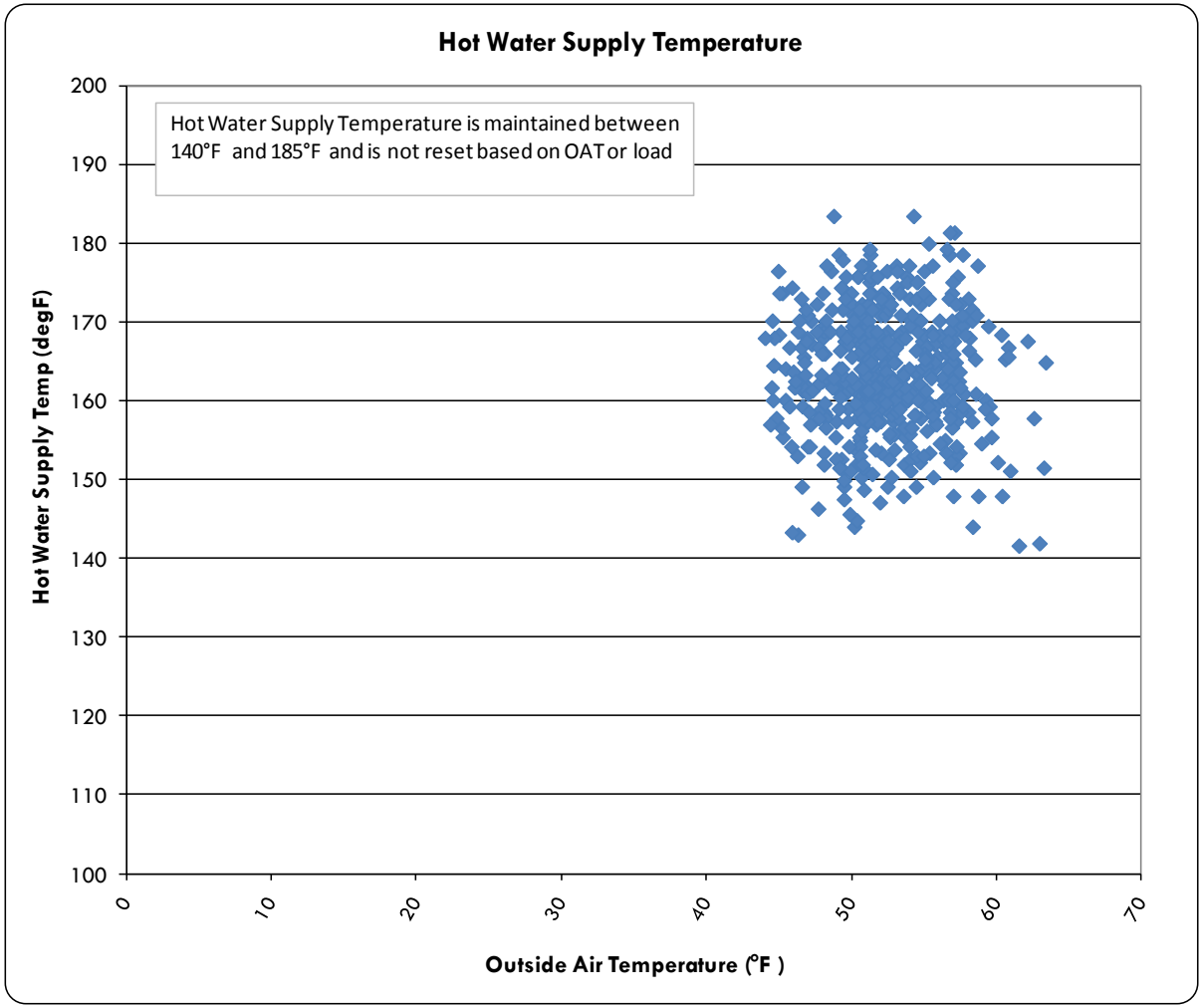

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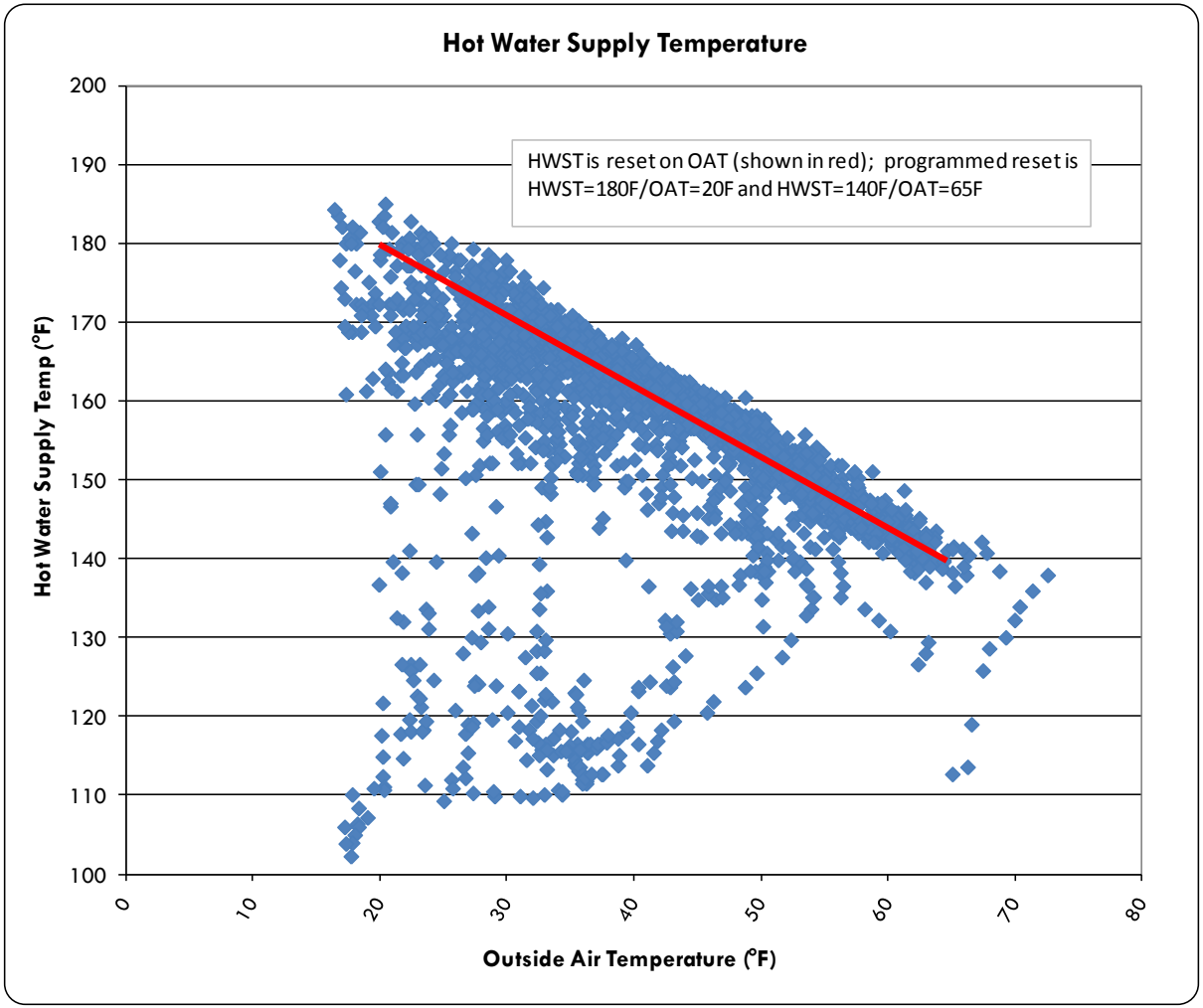

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Sustaining the Results

- Maintain and utilize trend data used during Cx
- Provide ongoing training to site personnel
- Document changes to systems
- Implement Cx strategies in the O&M of the facility
- Perform re-commissioning of systems

Preventive Maintenance Isn't Enough

- Preventive maintenance tends to focus on component-by-component care, rather than taking the holistic view that *operation* is of equal importance to *maintenance*.
- Preventive maintenance measures, such as cleaning coils, changing filters, tightening belts, and calibrating strategic sensors, are essential to the ongoing operations of a facility. Still, performing these tasks alone is not enough.

Owner/Cx Agent Interaction

- Key to the success of the project
- Consider and Relay your expectations
- Dedicate personnel to the process
- Early and persistent engagement is necessary
- Learn from the commissioning agent
- Utilize the tools provided by the commissioning agent

Summary

- Types of commissioning
- Commissioning process
- Process differences and similarities
- Contracting and building selection
- How the process works and results
- Sustaining the results
- Owner/commissioning agent interaction

References

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- CA Commissioning Guide Existing Buildings - www.cacx.org
- National Environmental Balancing Bureau - *www.nebb.org/*
- Commissioning for Federal Facilities - www1.eere.energy.gov/femp/
- *ASHRAE Guideline 0*-2005 - *www.ashrae.org*
- *ASHRAE Guideline 1.1*-2007- *www.ashrae.org*

Questions?

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