Getting the Most Out of Facility HVAC Systems

Midwest Healthcare Engineering Conference & Tradeshow
Indianapolis, IN
October 26, 2016

Joe Cantwell, Johnson Controls
joe.cantwell@jci.com

What trend has most impacted how you use your BAS?

- Internet of Things
- Cybersecurity
- Workforce attrition
- Energy initiatives

Agenda

- Finding facility inefficiencies
- 3 Key Maintenance Activities for Every Building Automation System
- 3 Key Enhancements To Building Operations
- Steps to creating a BAS maintenance strategy

METASYS

Finding facility inefficiencies

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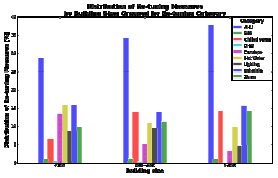
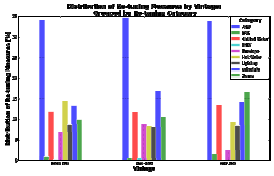
State of Commercial Buildings Efficiency

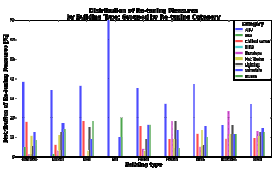
- U.S. DOE Pacific Northwest National Laboratory (PNNL)
  - Richmond, WA
- Analyzed ~ 100 buildings over 8 – 10 years
  - Commercial buildings were half of the study sample
- 5% to 30% potential energy savings by simple BAS re-tuning changes
  - Re-tuning: "*Systematic process to identify & correct building operational problems that lead to excess energy use.*"

PNNL Study Results

- Consistent distribution of issues within each category:
  - Building Vintage
  - Building Size
  - Building Type



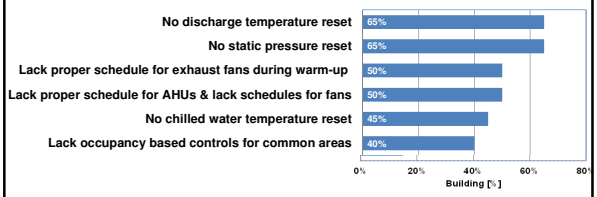




Note: These are Controls Issues associated with equipment, NOT equipment issues
Largest % Distribution of Re-Tuning Measures: ***1. AHU's*** *2. Zones 3. Schedule 4. Chilled Water*

Common Controls & Lighting Issues Summary

Building % Where Issue Found ≥ 40% of the Time



Static Pressure Reset Guide: http://buildingretuning.pnnl.gov/documents/pnnl_sa_84187.pdf

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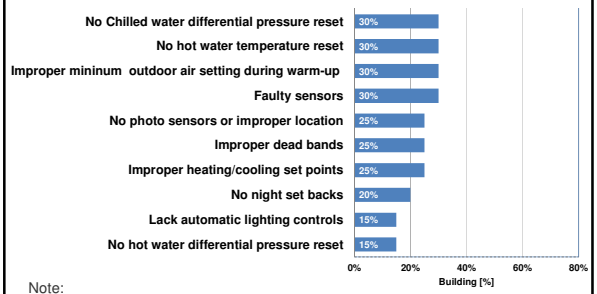
Common Controls & Lighting Issues Summary

Building % Where Issue Found < 40% of the Time



Note:
Only two (2) Issues relate to lighting (40% total)
Above %'s are NOT related to associated energy savings

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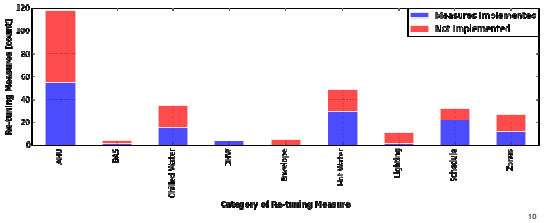
Common Issues Summary (Cont.)

- Annual Energy Savings ranged between 2% to 26%, median 15%
- Annual normalized cost savings range between 0.0$/sf to 0.60$/sf, median 0.12$/sf

- If all identified measures were implemented → possibly larger savings



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AHU Discharge Temperature Reset

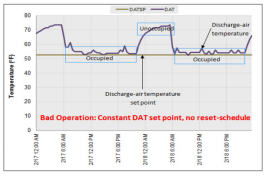

Figure 1: No discharge-air reset-schedule in place.

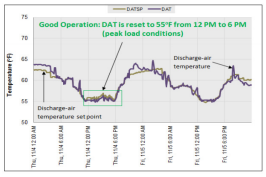

Figure 2: Air-handler with good discharge-air reset-schedule.

Source: http://buildingretuning.pnnl.gov/

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AHU Static Pressure Reset

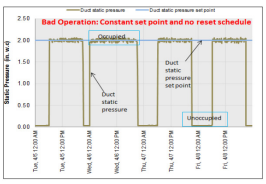

Figure 1: Constant static pressure (no reset).

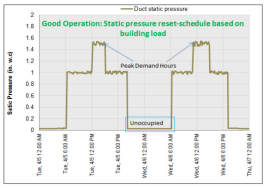

Figure 2: Static pressure reset-schedule in place.

Source: http://buildingretuning.pnnl.gov/

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US GOV PNNL Conclusions

- Nearly *every* building has BAS operational improvements opportunities
- Re-tuning BAS systems can yield 5% and 20% energy savings (*often through very low-cost actions)*
- *Without regular review*, these benefits may not continue because of the "human factor" (overrides…) and system changes (sequence, retrofit…)
- Having a trained controls specialist routinely review the system can maintain these savings.

References:
Dr. Srinivas Katipamula PNNL Staff Scientist HPAC Engineering Presentation 07/22/2015
http://retuningtraining.labworks.org/training/lms/
http://buildingretuning.pnnl.gov/

3 Key Maintenance Activities for Every Building Automation System

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3 Key Maintenance Activities for Every Building Automation System

1. **System Verification**
2. **Sensor Calibration**
3. **Database Backups**

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What is system verification?

- **Thoroughly check all control sequences & points associated with a piece of equipment**
  - Central cooling/heating plants
  - Air handlers
  - Packaged units
  - VAV systems
  - Terminal units
- **What should you check for?**
  - Point communication
  - End device response
    - Is the damper moving?
    - Does the economizer work?
  - Sequences still appropriate for building use today?
  - Generating excessive alarms?
    - Indicate equipment problem or too tight thresholds?

These checks can help identify the common issues that waste energy – doing them routinely helps ensure persistence

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Why is system verification important?

Why?

- 72% of issues found in retro-commissioning are in Operations/Controls
- Energy saving opportunities

Value

- **Keep productive environments**
- **Flag energy efficiency opportunities**
- **Reduce future repairs**
- **Extend equipment life**

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Why calibrate sensors?

Why?

- Sensor error is one of the **top 5 causes of operational energy waste**
- Sensor error can also affect comfort and ability to meet load
- **Note: PNNL Study = 30% of buildings had faulty sensors**

Value

- **Keep productive environments**
- **Reduce occupant complaints**
- **Potential energy savings**
- **Better information for making decisions**

Source: Northwest Energy Efficiency Alliance, http://betterbricks.com/articles/common-opportunities-top-five

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How often should you calibrate sensors?

Critical control sensors have the biggest impact on overall energy waste and should be **calibrated 2x/year**

Other sensors should be **calibrated 1x/year**

Which sensors are critical?

- Mixed-air temperature sensor
- Return-air temperature sensor
- Outside-air temperature sensor
- Supply-air temperature sensor
- Chilled-water temperature sensor
- Hot-water temperature sensor
- Humidity sensors
- Carbon dioxide sensor
- Carbon monoxide sensor

Strategic Approach: Start with Humidity & CO_2 Sensors (Likelihood & Impact)

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Top 5 O&M Energy Wasters

BETTERBRICKS
Powerful Energy Ideas. Delivered by NEEA.

- Trivia: What are the Top 5 O&M Energy Wasters?
  "Most O&M-related energy waste falls into these major categories:…"

- **Envelope Integrity** Envelope leakage allows for uncontrolled energy losses.
- **Equipment Scheduling** - Equipment runs when it is not needed.
- **Sensor Error** - Erroneous sensor data causes increased heating, cooling, or equipment operation, which can affect occupant comfort.
- **Simultaneous Heating and Cooling** - The same air gets heated and cooled, or hot and cold air streams get mixed together to make warm air.
- **Outside-Air Usage** - Economizer does not functioning optimally, or excessive outside air causes increased heating and/or mechanical cooling, and sometimes too little air compromises indoor air quality.

http://betterbricks.com/articles/common-opportunities-top-five

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Why are database backups critical?

Why?
- Maintain business continuity in cases of system failure or physical damage

What?
- Create backup of the system database
- Store locally or offsite

Value
- **Quickly restore order in an emergency**
- **Minimize downtime and related losses**
- **Reduce costs of restoring system**

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3 Key Enhancements To Building Operations

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3 Key Enhancements To Building Operations

1 **Operator Training & Technical Support**

2 **Remote Monitoring**

3 **Technology Upgrades**

Additional services to complement your staff's capabilities

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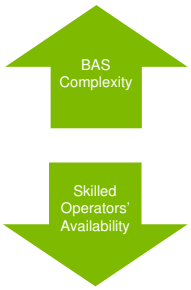
Operator Training & Technical Support

The challenge



The solutions

Operator training:

- Classroom training
- One-on-one operator training tailored to individual's specific problems and issues
- Efficient use of time – training and problem-solving happen together

Technical support:

- Online access to database of troubleshooting and product information
- Phone support from national support center

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Remote Monitoring

Why?

- Alert onsite personnel to issues
- Troubleshooting assistance from trained building operators

What?

- 24/7 monitoring by UL/Factory Mutual certified remote operations center
- Notification of issues per customer-defined plan
- Optional troubleshooting and system reviews

Value

- Peace of mind
- **Minimizes risk of downtime and system failures**

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Why update your building automation system technology?

New technology can improve **productivity, environmental control** and **energy efficiency**

IT and **security enhancements** to keep pace with ever-changing standards

Upgrading/updating software is one of 5 key security countermeasures recommended by the Department of Homeland Security Control Systems Security Program

Source: https://ics-cert.us-cert.gov/Recommended-Practices

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Advances in BAS technology

Device agnostic, mobile-optimized systems

One seamless experience.
No software installed on the client device.

Benefits:
- Eliminates time spent installing or updating software
- Reduces learning time
- Accessible from any device

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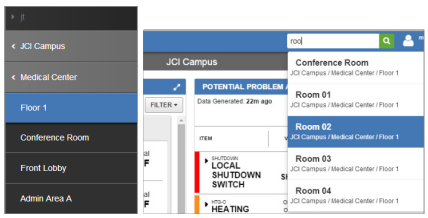
Advances in BAS technology

Intuitive user interface
based on how users actually work

Space-based navigation. With relationship-based displays and interactive reports.

Benefits:
- Eliminates extensive training
- Faster troubleshooting
- Faster completion of tasks



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Steps to creating a BAS maintenance strategy

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Steps to creating a BAS maintenance strategy: **First,** evaluate your in-house capabilities

Does in house capabilities have:

- Capacity?
- Privilege of focus?
- Capabilities?
- Skills?
- Desire?

… to execute the 3 key maintenance activities?
(System Verification, Sensor Calibration & Database Backup)

- What areas make sense to supplement with additional services?

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Steps to creating a BAS maintenance strategy: **Next**, evaluate potential partners

- Do they have processes and skills to execute the 3 key maintenance activities?
- Can they tailor a maintenance program to meet your specific needs?
- Can they work with your staff to share responsibilities?
- Can they provide supplemental services?
  (technical support, onsite training and remote monitoring?)
- What is their record on safety and customer satisfaction?

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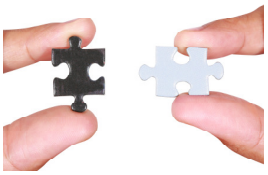
Finally, Create a plan

- Identify which systems will be reviewed at what frequency
- Determine responsibilities split between in-house and external partner to perform
- Document, track and manage



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Summary

- Nearly every building has 5% to 20% energy waste from BAS systems (regardless of age, size or type / *often through very low-cost actions)*
- *Trained controls specialist regular review* can maintain these savings
- 3 Key Maintenance Activities for Every BAS for productive environments, savings opportunities and minimize risk (system verification, sensor calibrations and database backups)
- 3 Key Enhancements to Operations increased productivity and efficiencies (training & technical support, remote monitoring, technology updates)
- Technology updates also help protect against cybersecurity risks
- BAS maintenance strategy that works well between in-house and external partner's capabilities and then executing the plan.

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Question & Answer Discussion

What questions can we answer?

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