Remote Coaching with Performance Data for Enhanced Building Operations

(Building Re-tuning and On-going Commissioning)

BUILDINGCOACH

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Project Summary

Objective and outcome

Data-driven coaching of building operators and energy managers to yield persistent energy savings from efficient operations.

Team and Partners

City University of New York Building Performance Lab (lead), with partner Intellimation, LLC.



<u>Stats</u>

Performance Period: 06/01/20 – 05/31-2024 DOE budget: \$500k, Cost Share: \$134k Milestone 1: Building web platform Milestone 2: Develop content Milestone 3: Outreach, Industry Advisory Board Milestone 4: Sustainability – Bus model/planning Milestone 5: Pilot – currently here Milestone 6: Business support Milestone 7: Final reporting

Problem

- Relatively easy and inexpensive improvements to operational efficiency are typically not pursued, and...
- ... when they are, savings typically don't persist.
- Building Re-tuning, with no-cost / low-cost changes, has yielded an average of 14% energy savings.



Source: Katipamula, Srinivas, and Nick Fernandez. "PNNL-SA-156277 Improving Commercial Building Operations through Building Re-TuningTM: Meta-Analysis." Slide show, n.d.

https://buildingretuning.pnnl.gov/documents/PNNL-SA-156277_RetuningMeta-Analysis_2020-09-05.pdf

Alignment and Impact - Outcomes



- Engaging building operators and energy managers in optimizing their own buildings can create measurable and lasting energy savings.
- While the percentage energy savings is not yet quantified, we believe local awareness will cause persistent savings.
- Bonus: participants will carry these skills and knowledge to subsequent buildings.

Alignment and Impact - Outcomes



The intended outcome is lasting, onsite attention to:

- Maintenance issues (e.g., sensor calibration, actuator operation)
- Scheduling, setbacks, and set points





Also, coaching identifies and explains opportunities for low-cost controls upgrades e.g., dynamic resets

When implemented, operators are more likely to understand the new sequences, and less likely to override



Alignment and Impact - Cost

Cost:

- Data acquisition and tagging (one time) \leq \$5k per building
- Subscription to maintain data access $\leq \frac{1}{y}$
- Initial coaching cost \approx \$2k/person
- Optional ongoing periodic coaching, e.g., one hour session every five weeks \approx \$3k/yr





Approach – Typical Approaches Today



Opportunities abound for significant energy savings from operational changes.

How they are often pursued today:

- Generalized training for operators
- Cloud-based analytical tools with AFDD
- Retro-commissioning, or...
- Nothing savings are not pursued.

Approach – BuildingCoach

- BuildingCoach gives operators and energy managers access to clear trend charts lacksquarefor their own HVAC equipment.
- Participants are coached to find opportunities by reviewing the charts and the questions posed.
- The hypothesis: finding their own opportunities creates a sense of ownership, \bullet increases follow-through and gives rise to behavioral change.

Check to see if...

- 1. Fans are scheduled properly
- 2. Fan speed command is being followed
- 3. Any unique schedule for this unit is considered

SF Speed



Approach – Process Flow



After the initial coaching, a subscription service provides:

- Ongoing access to live data on trend charts
- Periodic coaching sessions (e.g., an hour once every five weeks) for follow-through, finding new issues related to seasonal changes, wear, and tear

Example: Minimum OA Damper Position

- 1. The maximum CO2 level exceeds 900ppm (you are under-ventilating)
- 2. The maximum CO2 level never exceeds 750 ppm (you are over-ventilating)
- 3. The OAD position is responding to CO2 spikes over 900 ppm (if you have DCV, it's working)



Example: Zone CO₂

- 1. The maximum CO2 level exceeds 900ppm (you are under-ventilating)
- 2. The maximum CO2 level never exceeds 750 ppm (you are over-ventilating)
- 3. The OAD position is responding to CO2 spikes over 900 ppm (if you have DCV, it's working)



Example: Hot Water Reset

- 1. The boiler has a HW reset (it's good to have one!)
- 2. The HWST is following the reset schedule
- 3. The HW reset is aggressive (minimum HWSTs that still meet zone temps on coldest / warmest days)



Example: Zone Temperatures

- 1. The ZT is meeting its occupied ZT-SP
- 2. The ZT is floating toward the setback temperature during unoccupied times (when it's hot or cold out)
- 3. The unoccupied ZT-SP setback is appropriate for the zone



So Many Opportunities...

Scores of organized preset trends for:

- Zones
- Air handlers/RTL
- Chiller plant
- Boiler plant

	All onders		Schedding		Anade Equipment
1.	Chart 000: Count of Equip by Category (based on tagged equip)	☆	Trend Chart 01Z: Fan Schedule	☆	Trend Chart 01Z: Fan Schedule
,	Trend Chart 01Z: Fan Schedule	☆	Trend Chart 01Zb: All Fan Schedules (Grouped By Equip Type)	☆	Trend Chart 01Zb: All Fan Schedules (Grouped By Equip Type)
	Trend Chart 01Zb: All Fan Schedules (Grouped By Equip Type)	☆	Trend Chart 01Zd: All Fan Schedules (AHU Equip List)	☆	Trend Chart 01Zd: All Fan Schedules (AHU Equip List)
Js	Trend Chart 01Zd: All Fan Schedules (AHU Equip List)	☆	Trend Chart 06Z: Optimized Start	☆	Trend Chart 02Z: Minimum OAD Position Check
	Trend Chart 02Z: Minimum OAD Position Check	☆			Trend Chart 03Z: Simultaneous Heating & Cooling
	Trend Chart 03Z: Simultaneous Heating & Cooling	☆			Trend Chart 04Z: Economizer Operation, Dry bulb
	Trend Chart 04Z: Economizer Operation, Dry bulb	☆			Trend Chart 05Z: Economizer Operation, Enthalpy
	Trend Chart 05Z: Economizer Operation, Enthalpy	☆			Trend Chart 06Z: Optimized Start
	Trend Chart 06Z: Optimized Start	☆			Trend Chart 07Z: RA/Space Temp Control
	Trend Chart 07Z: RA/Space Temp Control	☆			Trend Chart 08Z: DA Temp Control
	Trend Chart 08Z: DA Temp Control	☆			Trend Chart 09AZ: Compressor Cycling & Staging
	Trend Chart 09AZ: Compressor Cycling & Staging	☆			Trend Chart 09BZ: Burner Cycling & Staging
	Trend Chart 09BZ: Burner Cycling & Staging	☆			Trend Chart 10Z: Freeze Protection
	Trend Chart 10Z: Freeze Protection	☆			Trend Chart 11Z: Dehumidification Control
	Chiller Plant		Boiler Plant		Zones
	Trend Chart 18Z: Load Sharing on Cooling Tower Fans	☆	Trend Chart 25Z: Boiler Plant Scheduling	☆	Trend Chart 31Z: VAV Damper Positions & DSP
	Trend Chart 19Z: Chiller Plant Schedule	☆	Trend Chart 26Z: Hot Water Temperature Reset	☆	Trend Chart 32Z: Reheats While Cooling
	Trend Chart 20Z: Chilled Water Loop: Delta-T and LDP	☆	Trend Chart 27Z: Hot Water Loop: Delta-T & LDP	☆	Trend Chart 33Z:Zone Temperature Setpoint

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Airside Equipment

Keeping Track to Pursue to Closure

(Building name) – Tracking Sheet

TREND CHART	EQUIPMENT 🗸	FINDINGS	TO DO 🗸	PRIORITY 🗾 🔻	STATUS 💌
TC 01ZD: Fan Schedule (12/12/22 - 1/9/23)	AHU-1 (w/ heat wheel, serving 1st floor VAVs)	Fan speed command is 40% during unoccupied times and 75% during occupied times, but the DSP remains flat at 1 in WC	Investigate to see if this is the right data of DSP for this unit	Medium	In Progress
TC 01ZD: Fan Schedule (12/12/22 - 1/9/23)	AHU-1 (w/ heat wheel, serving 1st floor VAVs)	Fans are on 24/7, but not needed to be on all the time	Investigate the possibility to have the unit scheduled to follow occupancy	High	In Progress
TC 01ZD: Fan Schedule (12/12/22 - 1/9/23)	HV-1, HV-2, HV-3	In Decemeber, the unit was following schedule with the fan running 30%, but during 12/24-28 the building was on backup power so the units were running harder, now off	N/A	Low	In Progress
TC 01ZD: Fan Schedule (12/12/22 - 1/9/23)	Lab Ventilator	Fans are on at 50% all the time, needs to stay on at low speed to ramp up when hood is used	Investigate the possibility to have the unit scheduled to follow occupancy, or at least lower the minimum fan speed	High	In Progress
TC 02ZD: Min OAD (10/13/22 - 1/10/23)	AHU-1 (w/ heat wheel, serving 1st floor VAVs)	OAD is open 100% when the unit is on, the CO2 levels are low usually ~500PPM which is less than the 750PPM limit for the school	Investigate the possibility of resetting the OAD to 10-20% when CO2 is low to stop over-ventilating	High	In Progress
TC 04Z: Economizer (1/6/23 - 1/10/23)	AHU-1 (w/ heat wheel, serving 1st floor VAVs)	OAD position may be flipped from convention, 0% means fully open and 100% means fully closed	Investigate if this can be fixed to follow convention	Low	In Progress
TC 04Z: Economizer (1/6/23 - 1/10/23)	AHU-1 (w/ heat wheel, serving 1st floor VAVs)	MAT is modulating between 40-55F, and SAT is modulating between 55-75F every 15 min	Investigate with controls tech why these two temps are varying so widely and so frequently	High	In Progress
TC 03Z: Sim. Heat/Cool (12/12/22 - 1/9/23)	AHU-1 (w/ heat wheel, serving 1st floor VAVs)	HW Valve is oscillating 80-100% and OAD is oscillating 20-35% every 15 min	Investigate with the controls tech why the controls are unstable here	High	In Progress
TC 26Z: HW Reset (1/3/23 - 1/10/23)	Hot Water Loop	HW reset is working, HWST resets based on OAT	N/A — Good operation	Low	In Progress
TC 26Z: HW Reset (1/3/23 - 1/10/23)	HCV Positions	Most valves are close to 100%, may be flipped from convention, 0% means fully open and 100% means fully closed	Investigate if these positions are really flipped from convention; and if so, investigate if this can be fixed to follow convention	Medium	In Progress
TC 28Z: Cond. Boilers	Condensing Boilers	NO DATA	BPL team to ask Intellimation about this issue	High	In Progress
TC 27Z: HW LDP (12/12/22 - 1/9/23)	Hot Water Loop	HW pumps are running one at a time close to 90%, with LDP at 15PSI	Investigate the possibility of lowering the LDP to allow the pumps to slow down at time when they are not needed as much	High	In Progress

Current Status – Pilot

The project is in the pilot phase; buildings are being connected, and points are being tagged for this second cohort that will have about 10 buildings and 25 participants.



ROCKEFELLER GROUP



NYC DCAS Citywide Administrative Services

SARATOGA SPRINGS



Brookfield Properties

BINGHAMTON UNIVERSITY STATE UNIVERSITY OF NEW YORK

Department of General Services

Barriers, challenges, risks

- Data acquisition was a long-standing barrier
 - Partner Intellimation has developed more proficiency in recent months.
- Compared to training only, setting up the Building Operator Coaching Solution (BOCS) with coaching is more costly and effortful and is anticipated to be a more difficult sale
 - We anticipate developing an introductory class on tuning HVAC operations that teaches the methods without the technology and acts as a steppingstone to coaching
- Client security concerns regarding data acquisition (via BACnet connectivity)
 - Meetings with IT often addresses concerns
 - The introductory class creates an 'inside champion' that compels IT cooperation



Barriers, challenges, risks



The web platform that includes:

- Learning Management System
- Building document
 repository
- Access to trend charts
- A tracking tool for identified issues
 Rework would enhance the user experience.

Steps to sustainability

- Future sales to pilot partners to expand use across their portfolios.
- Parallel training as a path to sales
- Acceleration of post-pilot uptake through subsidies from grant money.

Validation – future work



Quantify savings with access to building-level energy usage data before and after engagement, with willing participants sharing information regarding any other EE efforts.

Thank You

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