Building Fault Diagnostics

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Acknowledgements: Buildings and Grounds, NYSERDA, Intelligen, Elite Energy, SourceOne

THECOOPERUNION

Background

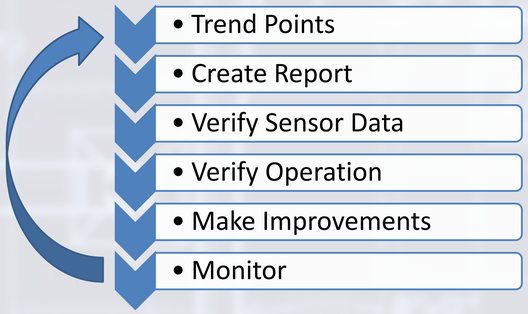
Over the last few years, the Cooper Union campus has not been as energy efficient as in the past. It is expected for a building's efficiency to decrease over time, and at a certain point it should be retuned.

Problem Statement

Develop tools for building retuning which can facilitate the monitoring and verification of building data, increase energy efficiency, and reduce operational cost.

Building Retuning

Retuning is the monitoring and verification of a building's performance. The process tries to solve energy issues by modifying building operation at low or zero cost.



An Iterative Retuning Process

- Trend sensor data from the building management system
- Generate a report which makes the data readable
- Identify abnormal/outlier sensor data and investigate for faulty sensors; e.g., negative humidity data
- Identify abnormal/outlier equipment data and investigate for malfunctioning equipment; e.g., a jammed damper
- Make changes to the system
- Observe effects from changes by trending sensor data from BMS; start the process over

Motivation

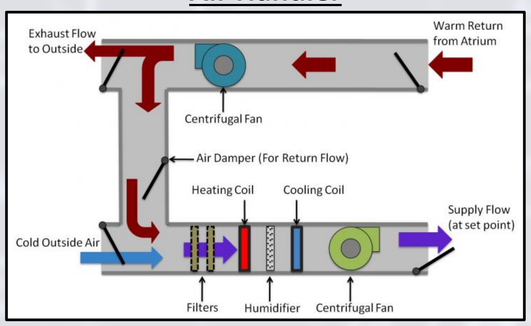
- Potential to reduce utility costs by $300K+ annually, which is approximately 2 full tuition scholarships.
- Reduce annual CO2e emissions by 1000 Mtons, which is equivalent to removing approx. 200 cars from the road[1].
- Support our building staff by helping them troubleshoot building faults.

[1] ww.nyc.gov/html/gbee/downloads/pdf/mayors_carbon_challenge_progress_report.pdf

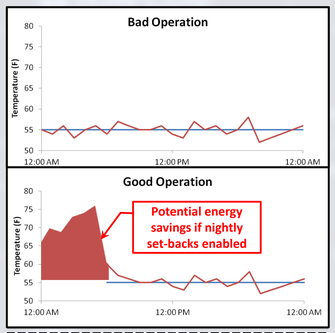
Case Study 1: Air Handler Units (AHUs)

Air handlers are responsible for delivering breathable air of desirable quality to all rooms, and evacuating harmful contaminants from labs. Requires energy for heating/cooling coils and fans. Using a weekly data output from the BMS, a MATLAB script outputs an AHU report.

Air Handler

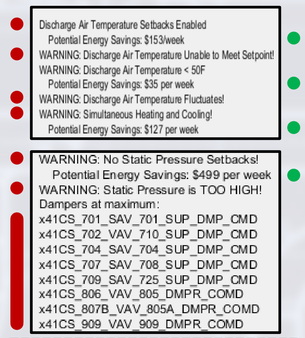


Example – AHU Tuning



Set Point
Room Temp
At night the room temp. should be set-back to reduce required cooling; solid red shows potential energy savings.

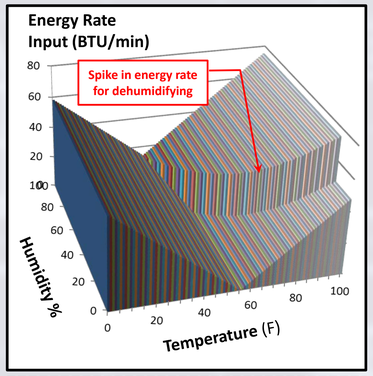
Example - Report



Potential Savings
Potential Faults
Weekly report gives textual fault callouts for operator and quantifies potential savings.

Enthalpy vs Temperature Control (Future Work)

Some modern buildings control air quality using enthalpy based control. Using the AHU analysis tool, enthalpy and temperature control can be compared directly in terms of energy usage. With more building data this can be converted to energy usage.



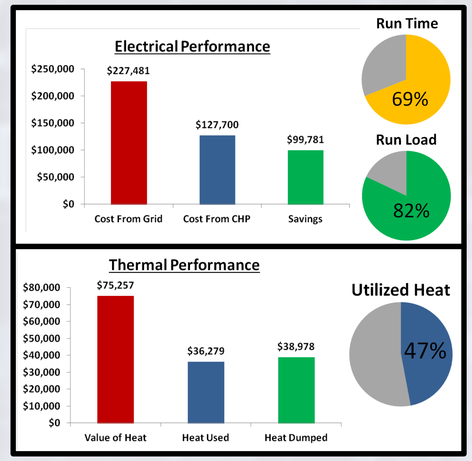
Energy rate to condition air at given temp. and humidity to discharge air set-point of 55°F and 60% RH.

Case Study 2: 41 CS Cogeneration (CHP) Report

Cogeneration, or Combined Heat and Power (CHP), is the process of generating electricity locally and using the 'waste' heat for the building's heating needs. Requires natural gas. Excel templates/reports created from BMS/Elite Energy data.

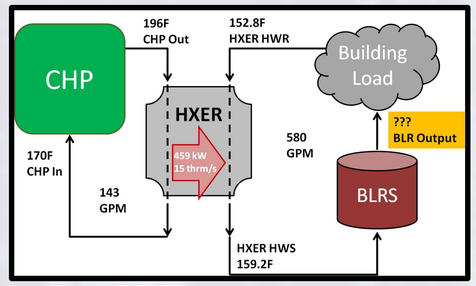
CHP Report – 41 CS 2015

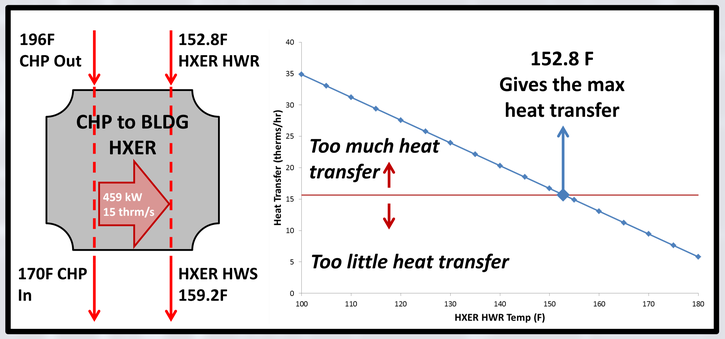
- CHP saves money in electricity production only mode.
- CHP was not running for 31% of 2015.
- 53% of heat produced is dumped.



Heat Utilization Analysis (Future Work)

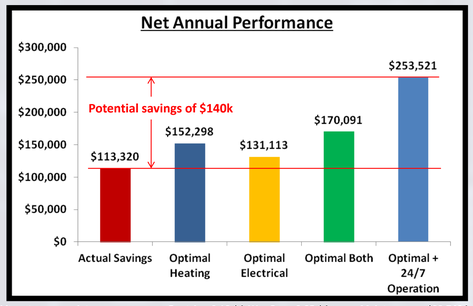
The CHP cannot deliver all of its heat if the building hot water is too hot. The building loop needs to be studied and the boiler load reduced.





Conclusions

- $140k in potential annual savings identified*
- Increase uptime & modify hot water set-points to increase heat recovery



* Utility rates and maintenance assumed: Electric – 0.18 $/kWh, Gas – 0.85 $/therm, Maintenance - $22,740/year