# Case Study: From Promise to High Performance

## Achieving a 30%+ Reduction in Natural Gas Consumption through Existing Building Commissioning

*International Conference for Enhanced Building Operations*
*October 18-20, 2011 / New York City*

# Agenda



**a g e n d a**

1. Introduction
2. Opportunity Identification
3. EB Cx Pre-planning Phase
   - Phase 1 – Planning
   - Phase 2 – Investigation
   - Phase 3 – Implementation
   - Phase 4 – Persistence
4. Lessons Learned
5. Conclusion

# Background



- Energy@Work has been working with what we'll call "Property Management Company" (PMC) for five years.
  - PMC manages over $10 billion in commercial, industrial and multi-residential assets across North America,
  - PMC's Toronto assets include over 10 million $ft^2$ of commercial office space
- PMC has implemented Energy@Work's Energy Master Plan across its Toronto commercial portfolio.
- After three years, EMP properties achieved a 16% reduction, exceeding their target by 60%

# 2 Adjacent & Similar Bld.



**Building A:**

- Built by a commercial developer.
- An active Energy Master Plan (EMP) working for past 3 years
- Property's energy team engaged, active and implementing projects

**Building B:** (Purchased and now operated by A's property manager)

- Built by a residential developer.
- Considered to have higher consumption because of history
- Joined the EMP with an energy audit, BOMA BESt certification, etc.

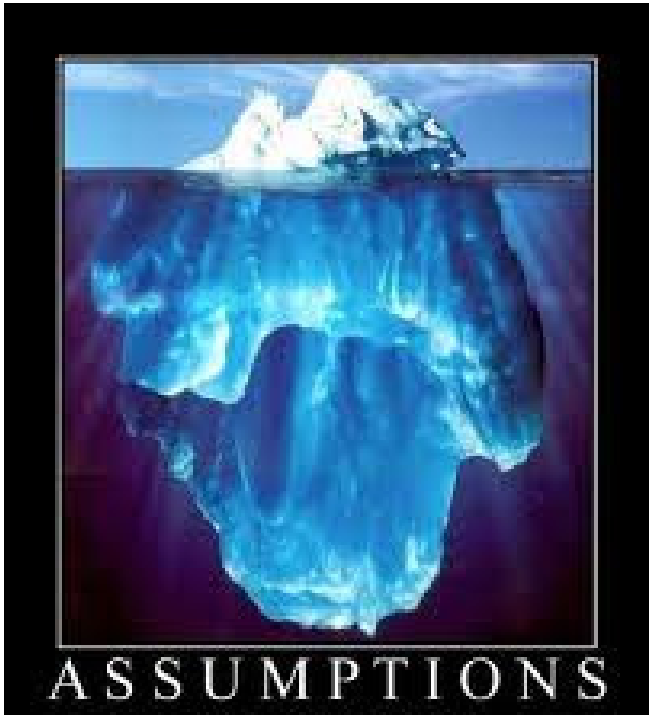
*(Areas, occupancy, and operational requirements are comparable, and weather conditions identical)*

# Assumption



**Building A:**

Thought to be better constructed, commissioned and as a result, naturally have lower consumption.




**Lesson #1:**
**Understand Right**
**"What does the data say?"**

# AN EB-CX OPPORTUNITY

# Discovery! "B" Used Less Gas

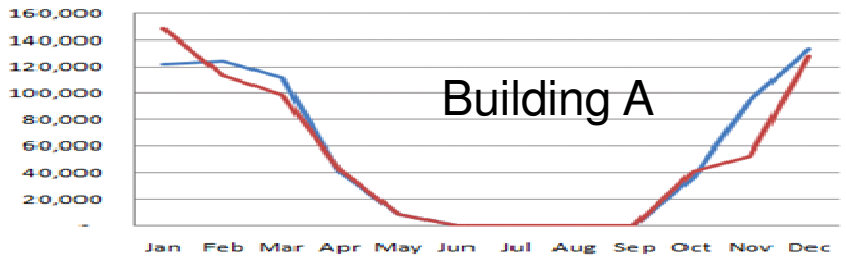


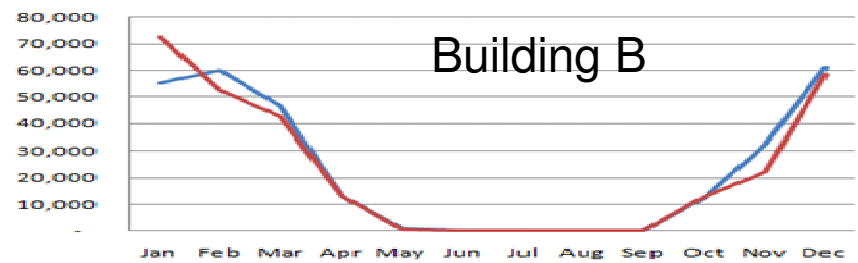
**Mystery:**
Annual profiles for both properties were similar and generated from 2 years of monthly natural gas billing data:
- 2008 (red) &
- 2009 (blue)

**BUT, on closer examination:**
consumption intensities were in different orders of magnitude:

*A: 12.21 ekWh/ft² per year*

*B: 6.98 ekWh/ft² per year.*



# E@W's Tool: ENERCOM

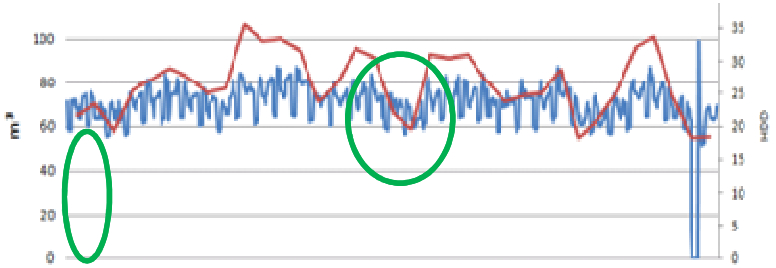


Energy Comparison Tool (EnerCom) allows side by side comparison of interval utility data plus temperature.

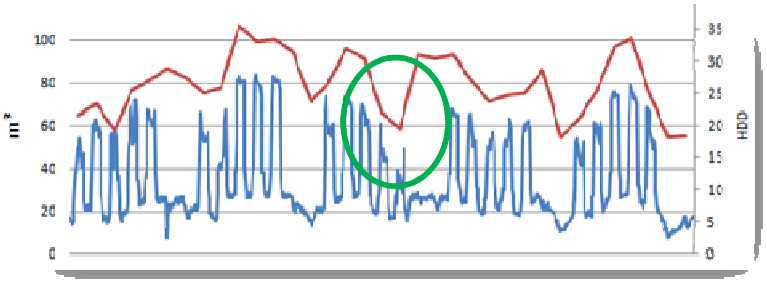
Winter month profile:

- $m^3$ of natural gas in blue
- heating degree days (HDD) in red
- interesting anomalies and comparisons in green

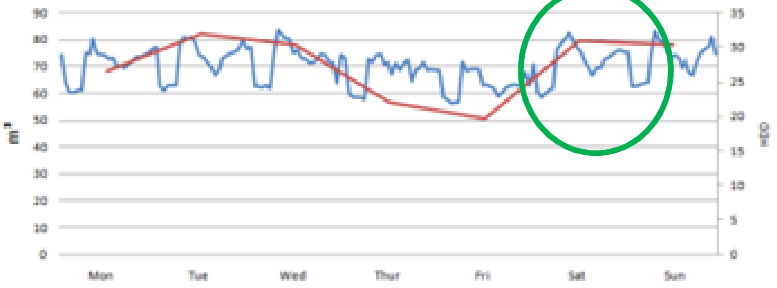
**A**

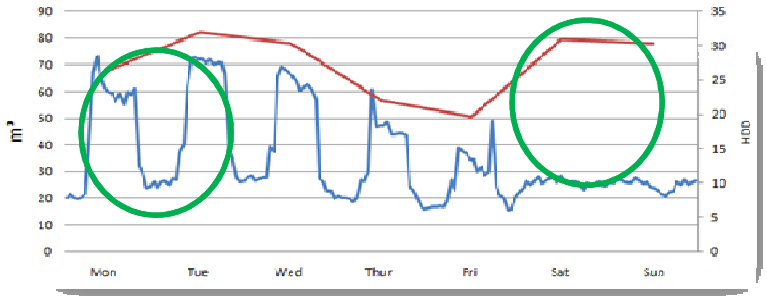


**B**



**Winter week profile:**





# Benchmarking / Opportunity

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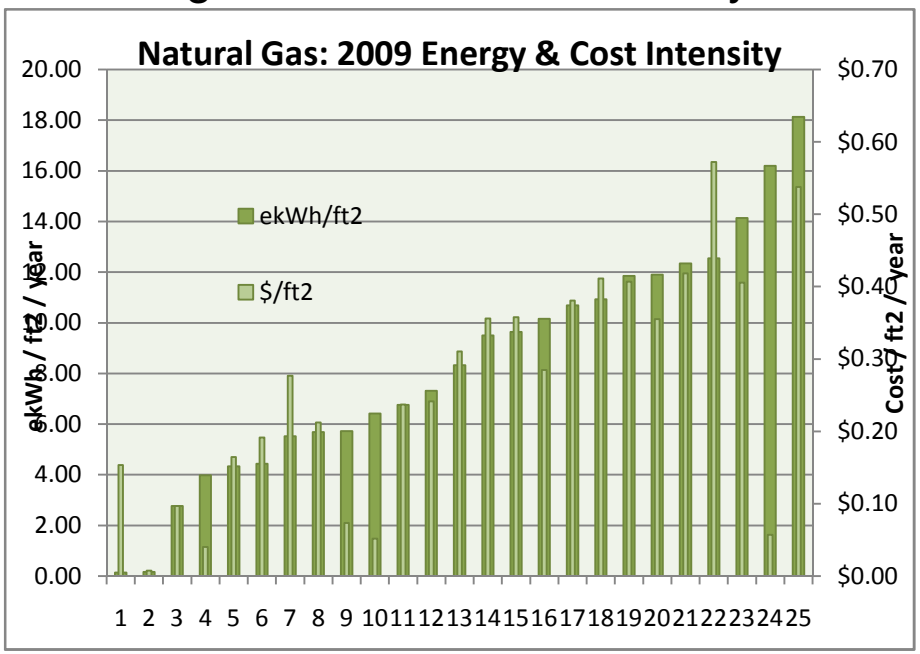
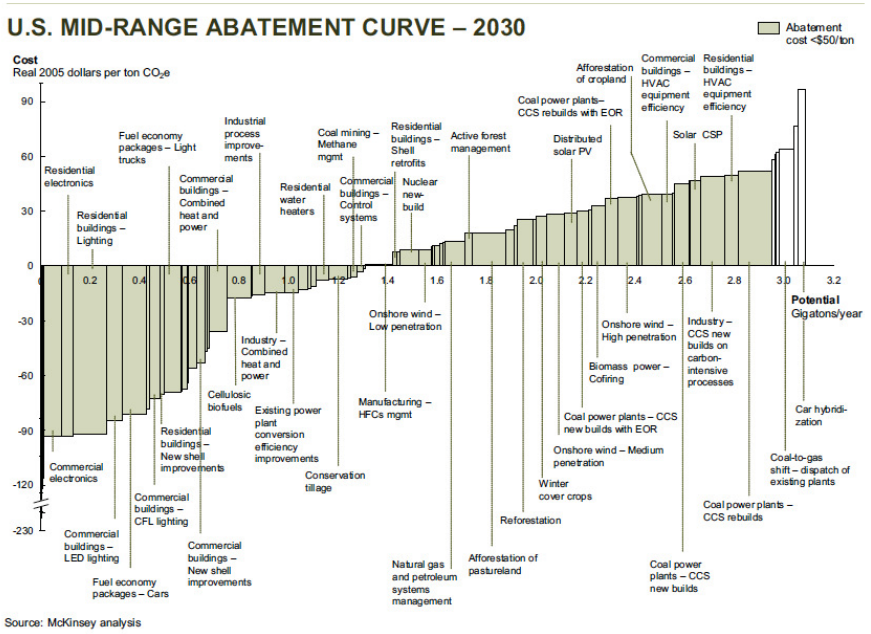
**Benchmarking:**
Wide range in Natural Gas Intensity




**Plus:**
Energy efficiency as least cost solution




Benchmarking highlights potential from the wide range in intensities.
Knowing EE opportunities will provides the confidence to pursue projects

** Ref: "2010 Green Paper Final.pdf" – available at www.energy-efficiency.com*

# EB Cx Natural Choice



- Phase 1: Planning
- Phase 2: Investigation
- Phase 3: Implementation
- Phase 4: Persistence

*Business case based on a 30% reduction target:*

* Simple Payback with no incentives: 0.85 Years
* Payback with Gas Reduction Incentives: 0.50 Years

# EB Cx Business Case



**Business Case was developed and approved, pre-work included:**

1. Natural gas supplier:

   - Replaced the natural gas meter to verify that the gas meter was properly calibrated

   - Provided 2 years of hourly interval data

   - Supported our efforts with their Monitoring and Targeting Program

2. RTM was installed on both properties' main natural gas meters

3. EB Cx Team organized

# Additional Considerations



- Tenant comfort **MUST NOT** be compromised
- Operator engagement and 'buy-in' is essential
- Measurement and Verification (M&V) for customer confidence, incentives and in particular - sustaining savings

# EB Cx Team: Essential



| | |
|---|---|
| Top Level Support: | Portfolio Director & Property Manager<br>Technical Director<br>Operations |
| EB Cx Team: | Jolanta McKay, RoMar Engineering<br>Michel Parent, Technosim Inc.<br>Energy@Work Inc. |
| Utility: | Enbridge Gas Distribution |
| Service providers: | Boiler Maintenance<br>Building Automation |
| Others: | Testing and Air Balancing (TAB) specialist |

# EB CX PHASE 1 – PLANNING

# Phase 1 Highlights



1) Framework / objectives reviewed & established

2) EB-Cx Charter approved

3) Remote access to BAS was established

4) Real Time Monitoring (RTM) installed to provide outside air temperature (OAT)

5) RTM installed on both buildings' A & B gas meters
Ideal for:

* Benchmarking,
* Energy Comparison Tool (EnerCom)
* Energy Comparison Analysis Tool (ECAT)

# EB CX PHASE 2 – INVESTIGATION

# Functional Tests

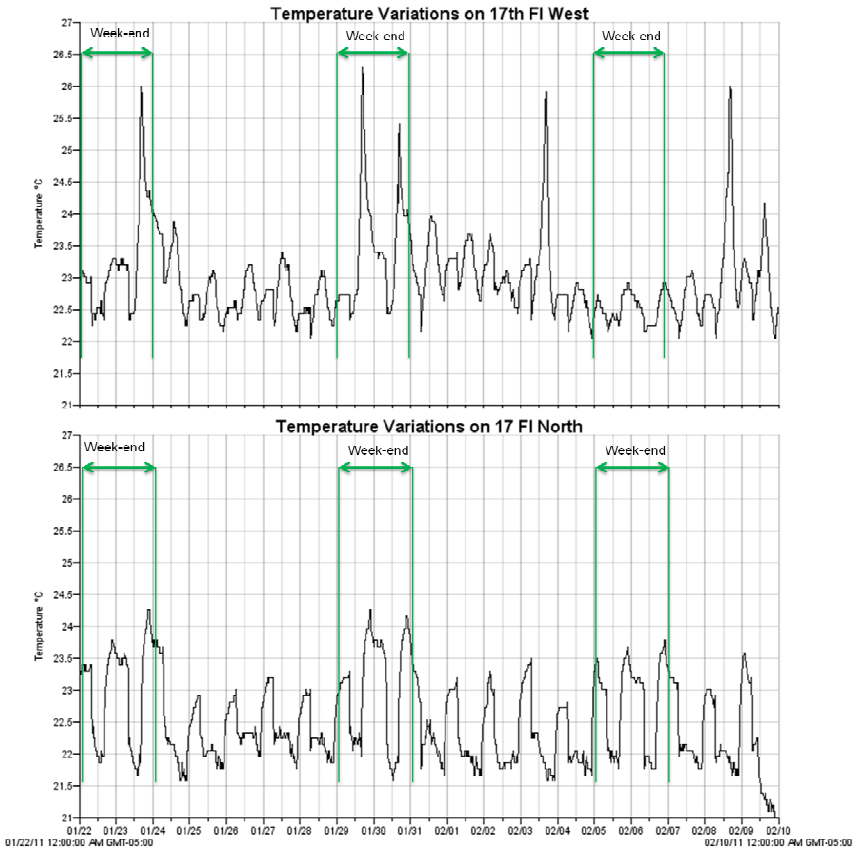


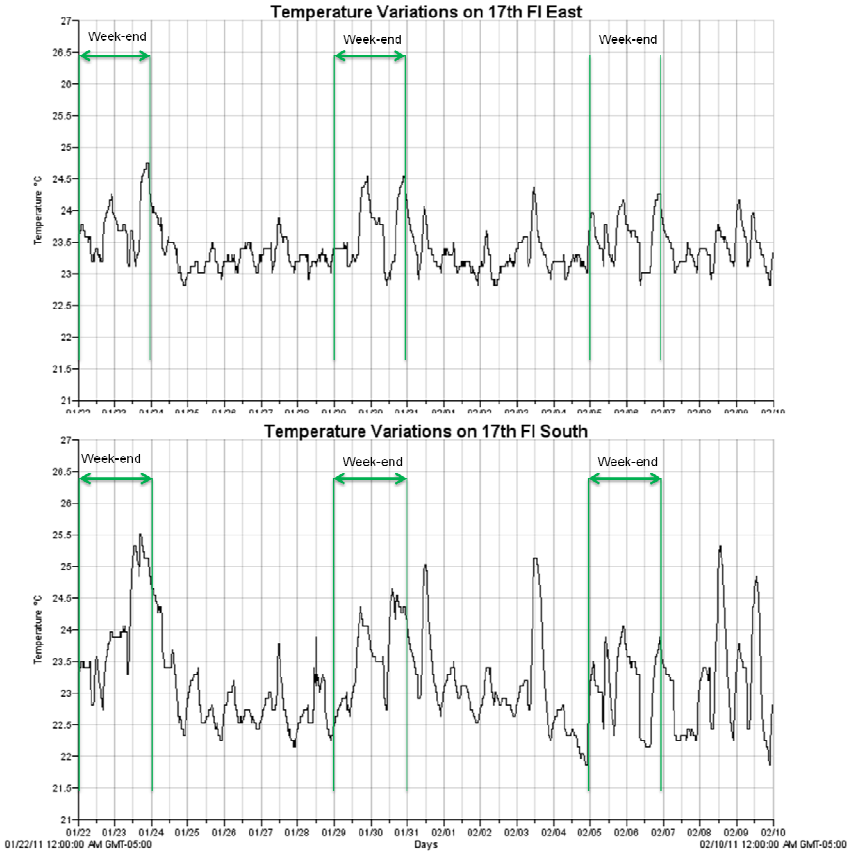
- Temperature data-loggers installed
- Boiler motors data-loggers installed
- Boiler performance checked for proper modulation
- Remote access to the BAS allowed systems comparison to RTM and temperature data
- Temperature and relative humidity set-points assessed against operating conditions, ASHRAE standards, lease requirements
- Etc.

# Example: 17th Floor Temp.



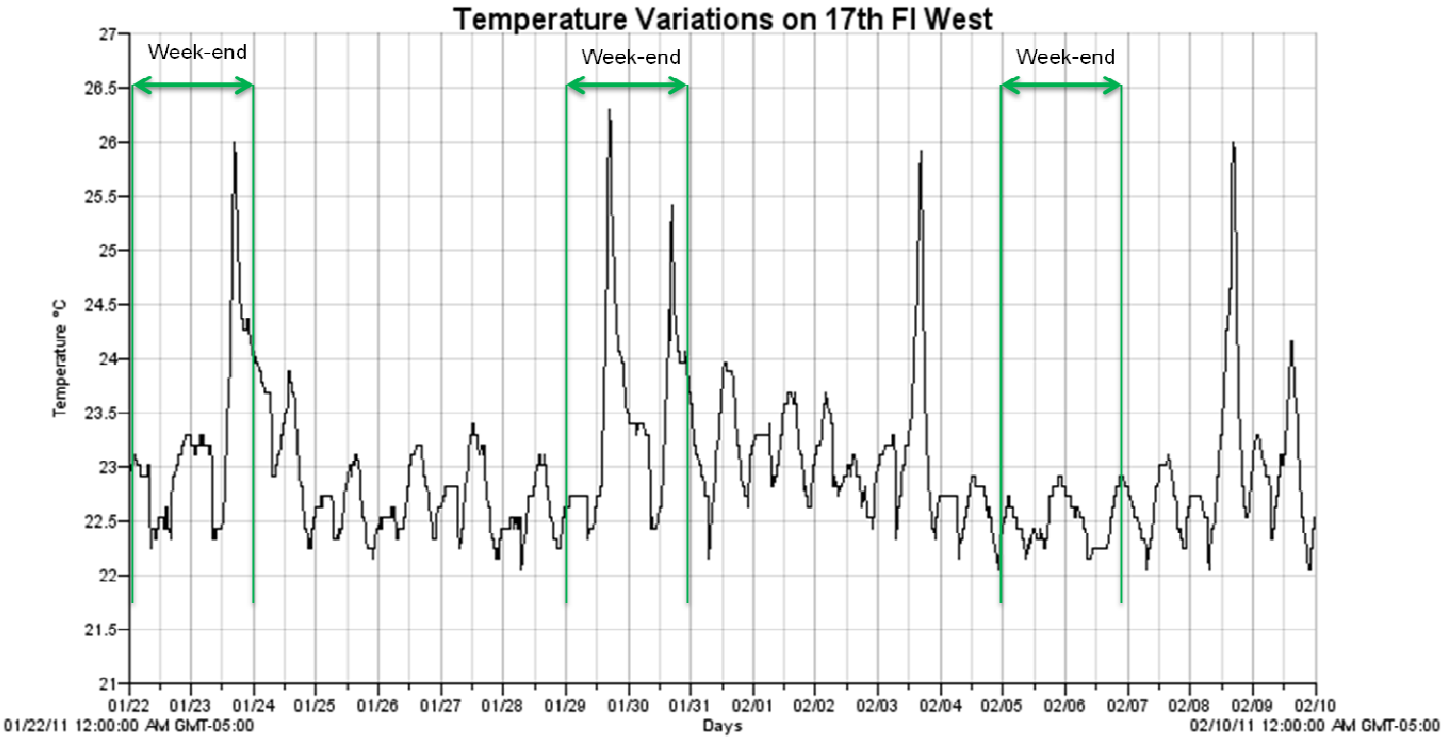
Graphs show temperature variations at the N, S, E and W perimeter locations.



# 17th Floor West






Minimum temperature @ 22 c; Maximum temperature @ 26.3c

Notes: - Temperatures climbed more than 25c - 5 times over the period
- Heating occurring in unoccupied periods
- Inconsistent profiles that were not controlled

# Phase 2 Result: 22 EEM



22 Energy Efficiency Measures (EEM)

EEM Varied:
- Operational
- Behavioural
- Technology
- Capital

## Lesson #2: Use Right

***Using test data to challenge assumptions and make change***

# PHASE 3 – IMPLEMENTATION

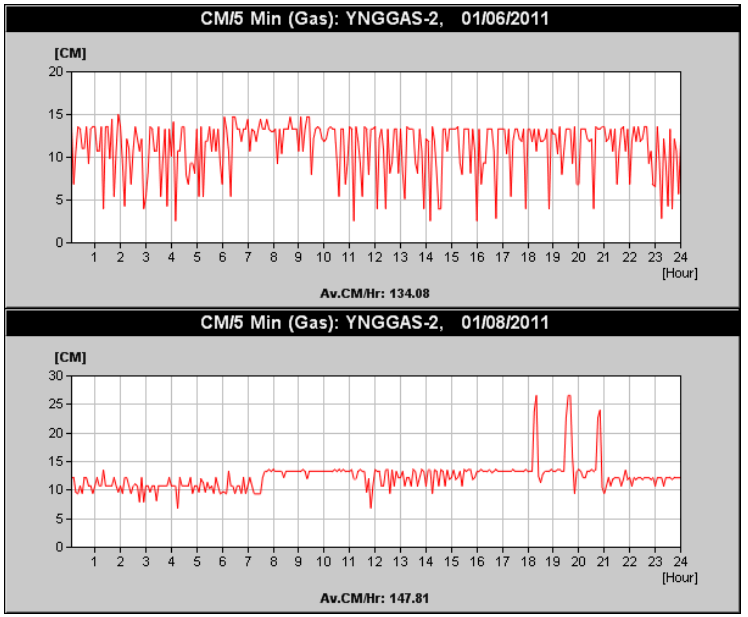
# Example: EEM#4



**Boiler #1 Not Modulating**
**Observation:** Lead boiler short cycling without modulating

*Lead Boiler cycling from high-fire to low or off*

*Lead boiler now modulating, BUT note lag boiler performance*




Re-set BAS so that boilers are modulating as required **& CHECK!**
**Result:** RTM allows operations to view natural gas use and ensure systems are controlled and performing as required.

# Example: EEM#6

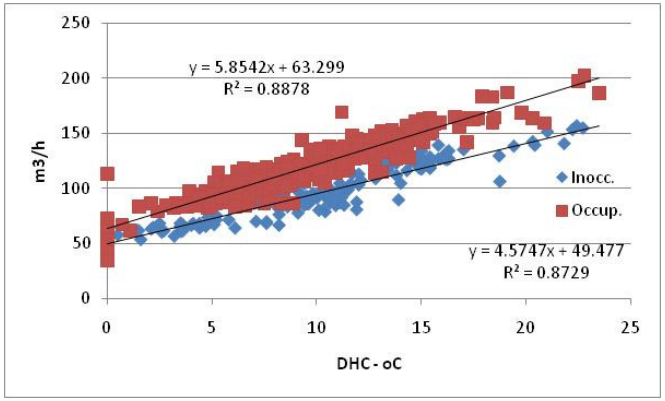


**Sub-optimal Reset on Secondary Heating Loop**

A regression analysis shows difference in stand-by losses and consumption in unoccupied modes

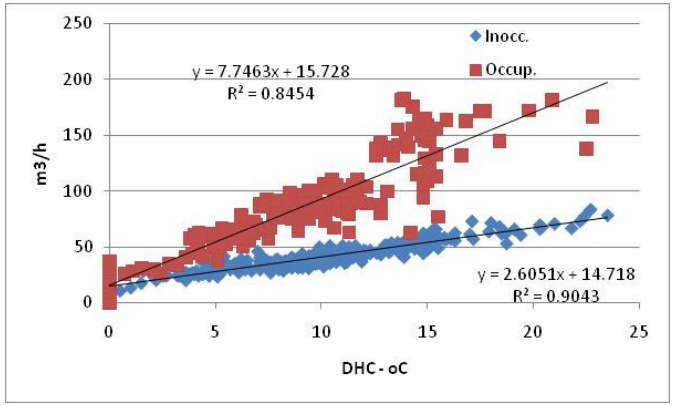
*Bld. A:*

*Note: Nominal day-night differences*
*also, higher stand-by losses*




*Bld. B:*

*Note: Distinct day-night consumption*
*<u>Also</u>, lower stand-by losses*



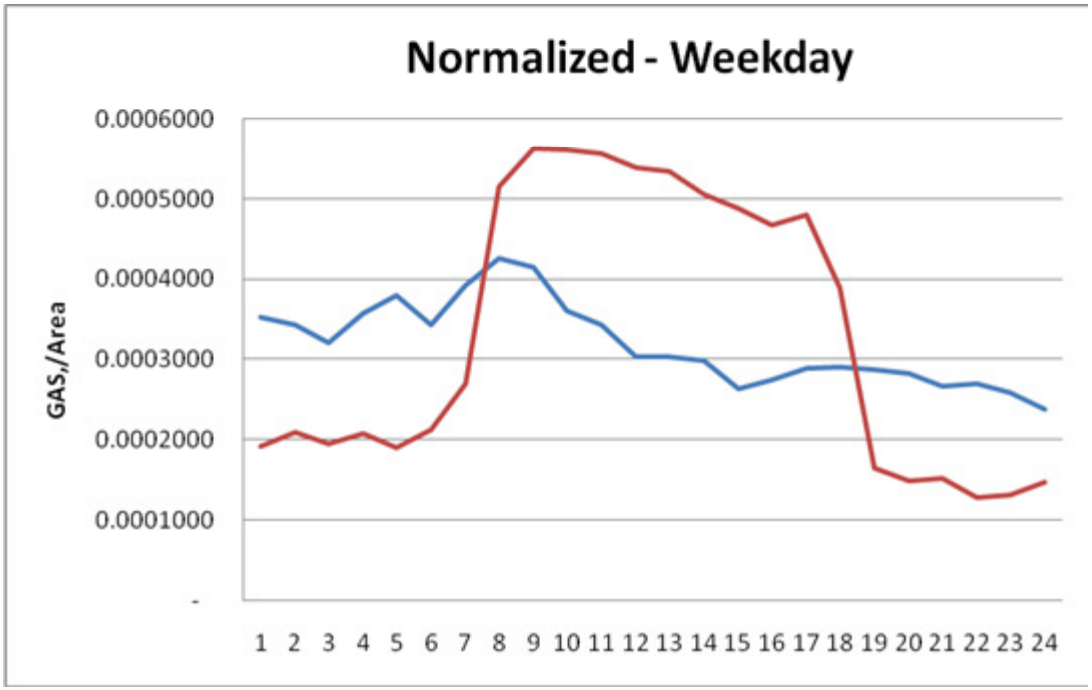
# EEM#6 continued



Real-time data reaffirms observations.
Despite identical weather conditions (data is same-day), and comparable occupancy patterns, the difference between the two buildings' load shapes is stark.

*Bld A, Blue:*
*Day-night difference is negligible.*

*Bld B, Red:*
*Load shape shows sensitivity to occupancy (similar observations to temperature was also noted)*



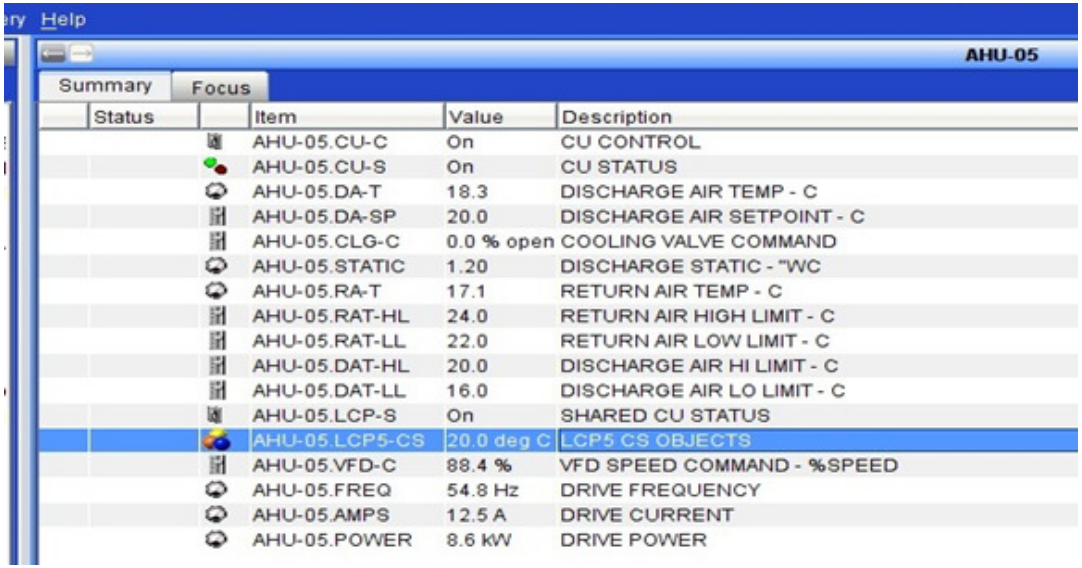
# EEM#8



**EEM #8: Identify and Correct Improperly Operating VFDs for CUs**
**Observation:** 5 CUs were seen running at 100% and failing to modulate.

**Possible causes:** undersized units, heating/cooling combat, faulty boxes, sensor malfunctions, e.g. AHU 5 – setting is 20, however actual is 18.3 (too much OA to reach set point), plus VFD is at 88% (versus 75%)

**Measure:**
Coordinate with BAS Control team to program the "recommended set points"
i.e.: AHU 5 DA SP should be 20.




| Status | Item | Value | Description |
|---|---|---|---|
| | AHU-05.CU-C | On | CU CONTROL |
| | AHU-05.CU-S | On | CU STATUS |
| | AHU-05.DA-T | 18.3 | DISCHARGE AIR TEMP - C |
| | AHU-05.DA-SP | 20.0 | DISCHARGE AIR SETPOINT - C |
| | AHU-05.CLG-C | 0.0 % open | COOLING VALVE COMMAND |
| | AHU-05.STATIC | 1.20 | DISCHARGE STATIC - "WC |
| | AHU-05.RA-T | 17.1 | RETURN AIR TEMP - C |
| | AHU-05.RAT-HL | 24.0 | RETURN AIR HIGH LIMIT - C |
| | AHU-05.RAT-LL | 22.0 | RETURN AIR LOW LIMIT - C |
| | AHU-05.DAT-HL | 20.0 | DISCHARGE AIR HI LIMIT - C |
| | AHU-05.DAT-LL | 16.0 | DISCHARGE AIR LO LIMIT - C |
| | AHU-05.LCP-S | On | SHARED CU STATUS |
| | AHU-05.LCP5-CS | 20.0 deg C | LCP5 CS OBJECTS |
| | AHU-05.VFD-C | 88.4 % | VFD SPEED COMMAND - %SPEED |
| | AHU-05.FREQ | 54.8 Hz | DRIVE FREQUENCY |
| | AHU-05.AMPS | 12.5 A | DRIVE CURRENT |
| | AHU-05.POWER | 8.6 kW | DRIVE POWER |

# EXAMPLE MEASURE: TESTING AND AIR BALANCING (TAB)

# Tenant Issues



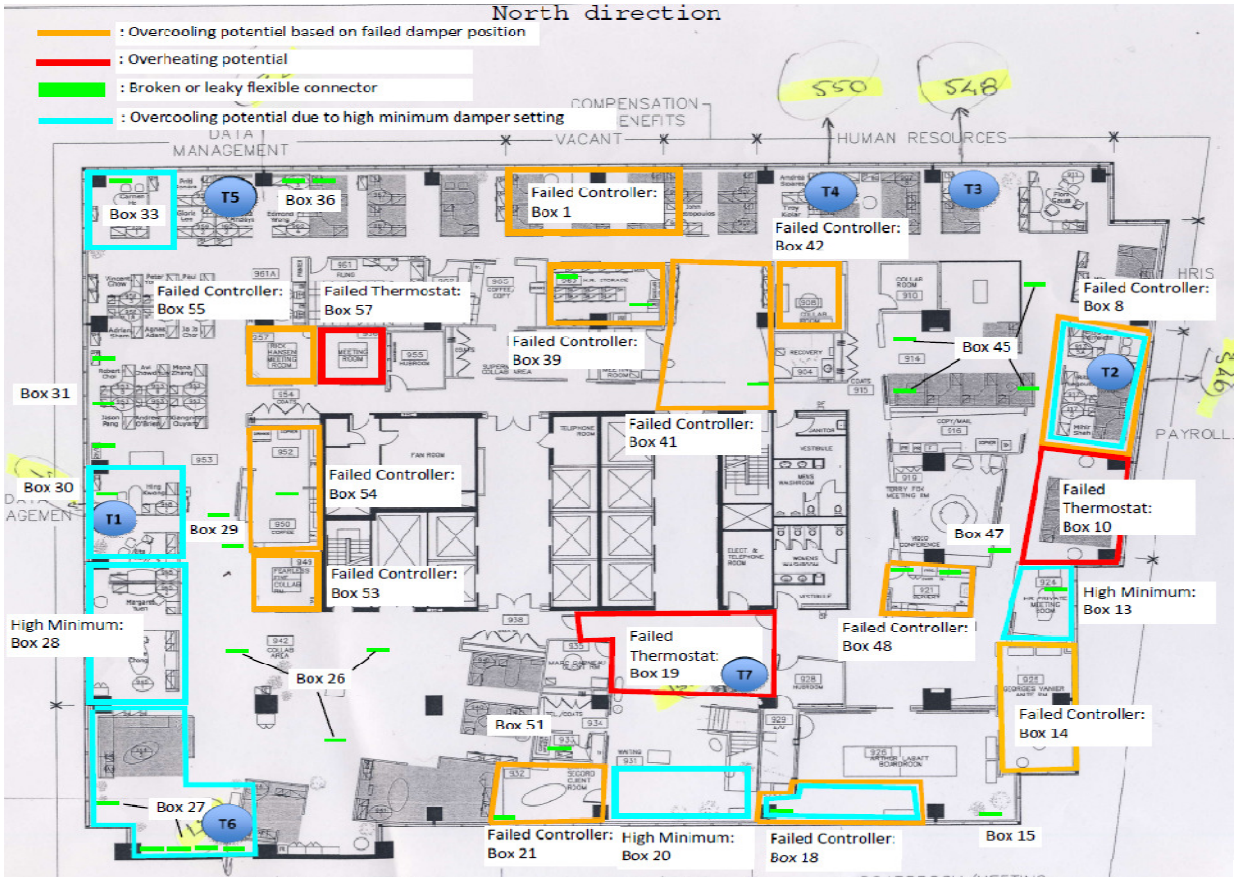
- Tenant experience is subjective, but can be made actionable if verified with good data:
  - What was the temperature? Humidity level? Drafts? etc.
  - How does the data compare to established standards?

- Need to distinguish EB-Cx effects from other factors affecting use and comfort (proper M&V) – understand symptoms versus root causes.

# Facts: Collecting Information



* Temperature and Humidity data loggers installed
  * TAB Contractors hired
    * EEM Project Plan Developed, Supervised and Executed

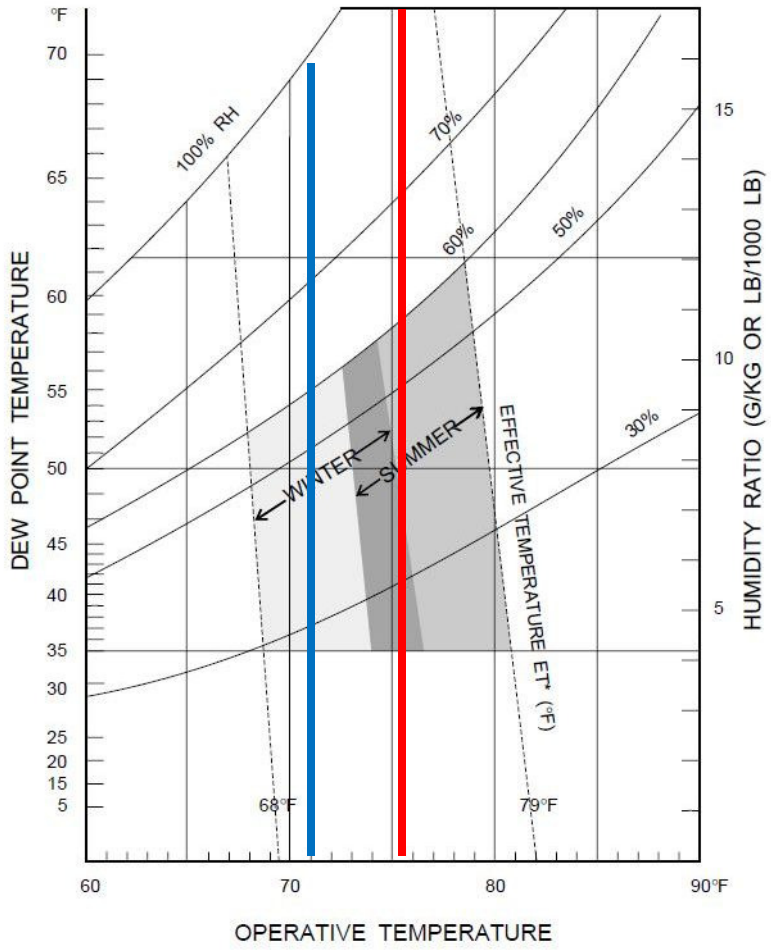


# ASHRAE Standard 55



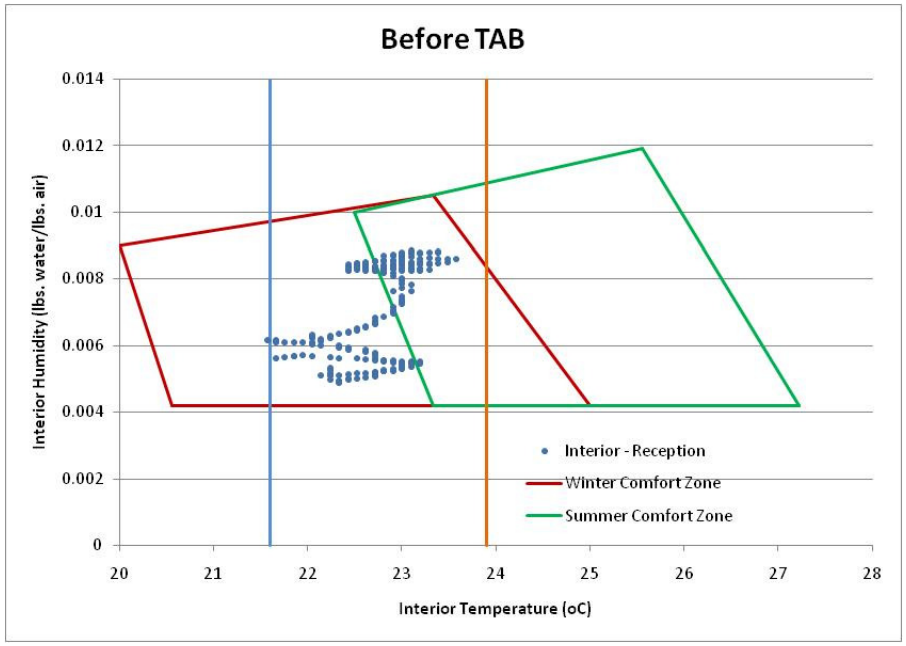
"Thermal Environmental Conditions for Human Occupancy"

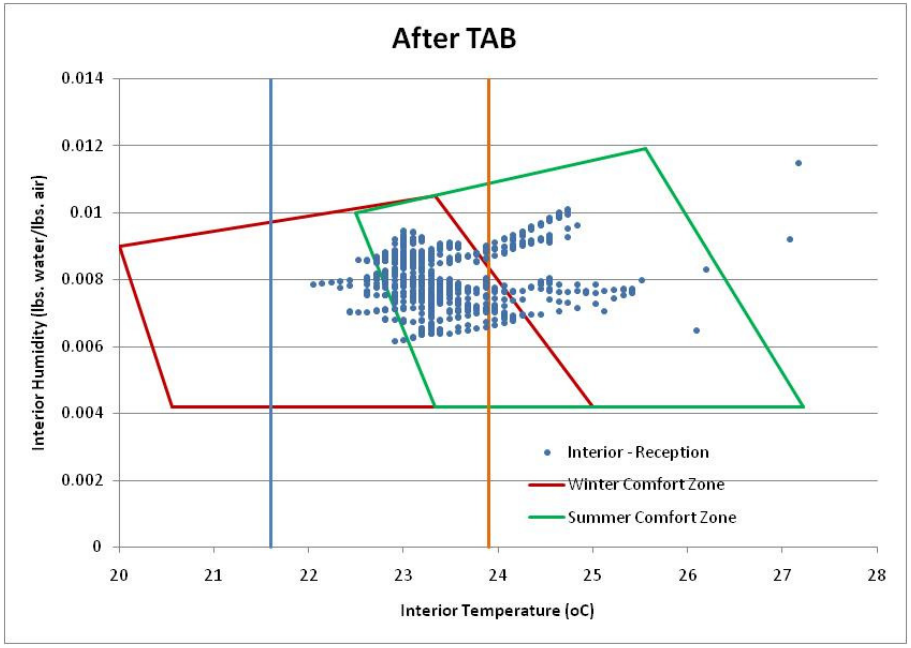
Thermal comfort chart: Industry-recognized indoor comfort reference.



# E.g.: Zone T7





# TAB Findings



1. *"Overall, the temperature measurements show that for all locations the comfort conditions before and after the balancing… were maintained or improved."*
2. *"In most spaces, the comfort conditions regularly drift below the ASHRAE summer comfort zone.*

*BUT*

3. *"This is due to the set point range adopted by the property" which falls below ASHRAE recommendations for summer.*

# TAB Results



The findings also generated a number of suggestions that would improve comfort conditions AND save energy, to the order of…

Re-heat savings: 2,500 $m^3$/yr

and in addition:

Fan electricity savings: 7,000 kWh/yr

## Lesson #3:
## Understand Right → Use Right → Buy Right

# EB CX SAVINGS TO DATE

# Results to date: 30+% Saving



January natural gas use reduced 23% compared to:
January (2008, 2009, 2010) . (Adjusting for HDD using the 18ºC base)

**Results**:

| | |
|---|---|
| 2008: | 196 $m^3$/HDD |
| 2009: | 179 $m^3$/HDD |
| 2010: | 183 $m^3$/HDD |
| 2011 (EB Cx): | 139 $m^3$/HDD |

Additional reductions achieved from EEMs implemented during the EB-Cx Process

Subsequent third-party review: **Revised to a 30+% reduction**

# PHASE 4 – PERSISTENCE

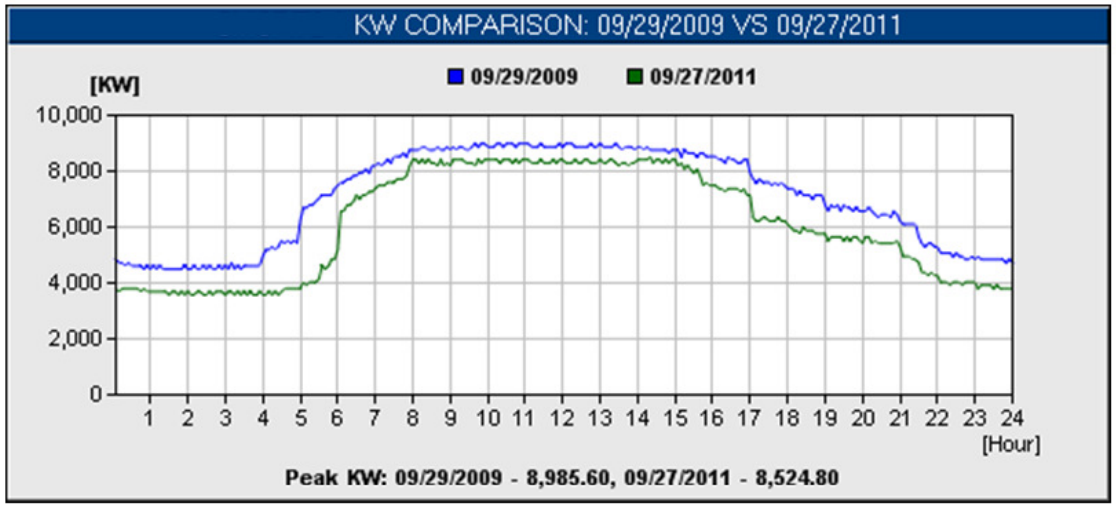
## *Final Phase: Maintain Performance!*

# LESSONS LEARNED

# Lessons Learned



**#1: Understand Right**
**"What does the data say?"**
**I.e.: Install real-time monitoring on natural gas meter**




**#2: Use Right**
**Using test data to challenge assumptions and make change**
**I.e.: Perform functional tests and measure results**

**#3: Buy Right**
**Customize investment in the tools, projects and expertise to optimize building operations/efficiency going forward**
**I.e.: Commission boilers to properly modulate**

# Thanks to Our Customers: We "Understand" Better!



# Thank you!

*Please do not hesitate to contact* **Energy@Work Inc.** *with any additional inquiries…*

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