Existing Building Commissioning (EB Cx)

Top 10 Lessons For Commercial Properties

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Manchester, England
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Agenda

1) Introductions
2) How we define “EB Cx”
3) Case Studies: 2 EB Cx Projects
    a) Heating plant @ mid-sized office tower
    b) Full EB Cx project @ large office complex
4) 10 Lessons Learned
5) Conclusion
6) Questions

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Introduction: Paul Hollins, CEM

Senior Director, Technical Services,
Commerce Court, GWL Realty Advisors Inc.

Responsible for energy management initiatives for 3,000,000 ft2 of Triple A commercial office space in the heart of Toronto's Financial District. Head of operations since 2003 and in operations since 1989.

Participant in design team for LEED GOLD office development in Toronto.

Memberships:

BOMA (Building Owners and Managers Association)
AEE (Association of Energy Engineers)
Certified Building Environmental Systems Operator

Introduction: Paul Hollins, CEM

Commerce Court and South Core Financial Centre are LEED Gold (Core and shell) developments.

Canadian Business Magazine: "Through the successful implementation of sustainable programs and projects, Commerce Court continues to reduce its environment footprint and pass on cost savings to its tenants." Mary Garden, vice-president of real estate at bcIMC. (September 17, 2012: "Great Buildings Reborn" article focused on Commerce Court.)

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Scott Rouse, P. Eng., CEM, MBA

Managing Partner, Energy@Work Inc.

- Professional Engineer (P. Eng),
- Certified Energy Manager (CEM)
- Certified Sustainable Development Professional (CSDP) with the Association of Energy Engineers.
- Advisor for the Industrial Energy Technology Conference held each year in New Orleans.
- Founding chair of the Canadian Energy Manager Network.

In these and other roles, Scott is an active advocate for energy efficiency.

www.Energy-Efficiency.com or Google; "Scott Rouse energy"

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How we define "EB Cx"

EB Cx is a systematic approach aimed at optimizing building operation to achieve specific operating requirements.

10 Specific Objectives

1. Ensure Occupant Safety
2. Improve Tenant Comfort
3. Improve Indoor Air Quality
4. Increase Utility Efficiency
5. Retain Tenants
6. Bring Equipment to Its Proper Operational State
7. Increase Equipment Life
8. Reduce Number of Service and Maintenance Calls
9. Identify and Gather Any Missing Critical System Documentation
10. Upgrade Staff Training

Our EB Cx Approach

Phase 1

Planning (10%)

*Create building description
*Define project objectives
*Define project scope
*Create a project plan
*Name a Cx team and define roles and responsibilities

Typical objectives:

↑ *comfort & safety*
↑ *efficiency/effectiveness of ops, maintenance, & utility use*
↓ *costs*

Deliverables:

1.1 EB Cx Plan
1.2 Project Charter
1.3 Building Operating Plan (BOP)

Phase 2

Investigation (60%)

Creation and implementation of Monitoring Plans (MPs) & Functional Tests (FTs) to establish operating parameters & derive Findings (F).

Findings (F): Observations relevant to the EB Cx objectives, derived from the site assessment, MPs, and/or FTs. Not all findings will result in a measure.

Deliverables:

2.1 Master List of Findings
2.2 "Investigation" Report

Phase 3

Implementation (20%)

Implementation of Measures (M) derived from Findings identified in Phase 2.

Measures (M): Non-capital, low-cost changes to building operation serving the EB Cx objectives. All measures will also result in persistence measures.

Deliverables:

3.1 "Implementation" Report

Phase 4

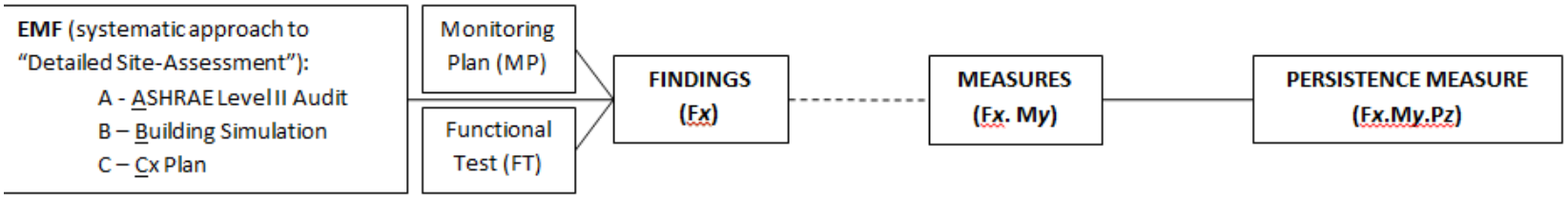
Transfer & Persistence (10%)

Ensuring the achieved savings can be maintained in the future. Identification and implementation of Persistence Measures (P), and any necessary training.

Persistent Measures (P): Prescriptions for ongoing operator action to maintain the improvements achieved through the measures.

Deliverables:

4.1 Phase 4 "Transfer and Persistence" Report



Conservation & Demand Management (CDM) / Demand Side Management (DSM)

Measures identified in Phase 2 that promise to save energy may be eligible for funding support through CDM and/or DSM programs. The property should consider these programs before implementing an energy-efficiency measure (EEM).

EB Cx Preparation and Activities:

Pre-EB Cx:

- ASHRAE Level II Audit
- Building Simulation
- Real-time Monitoring On Utility Meters and 15 Transformers

EB Cx:

- Pre-Functional Checklists
- Monitoring Plans (e.g. Over 500 points tracked at office complex)
- Pre- and Post- Functional Tests

Getting Started…

Prepared Business Case

- one year payback based on savings and incentives

- established EB Cx Plan

- Obtained approval

Contacted Utilities

- checked and calibrated natural gas meter
- obtained interval data
- signed up for incentive programs

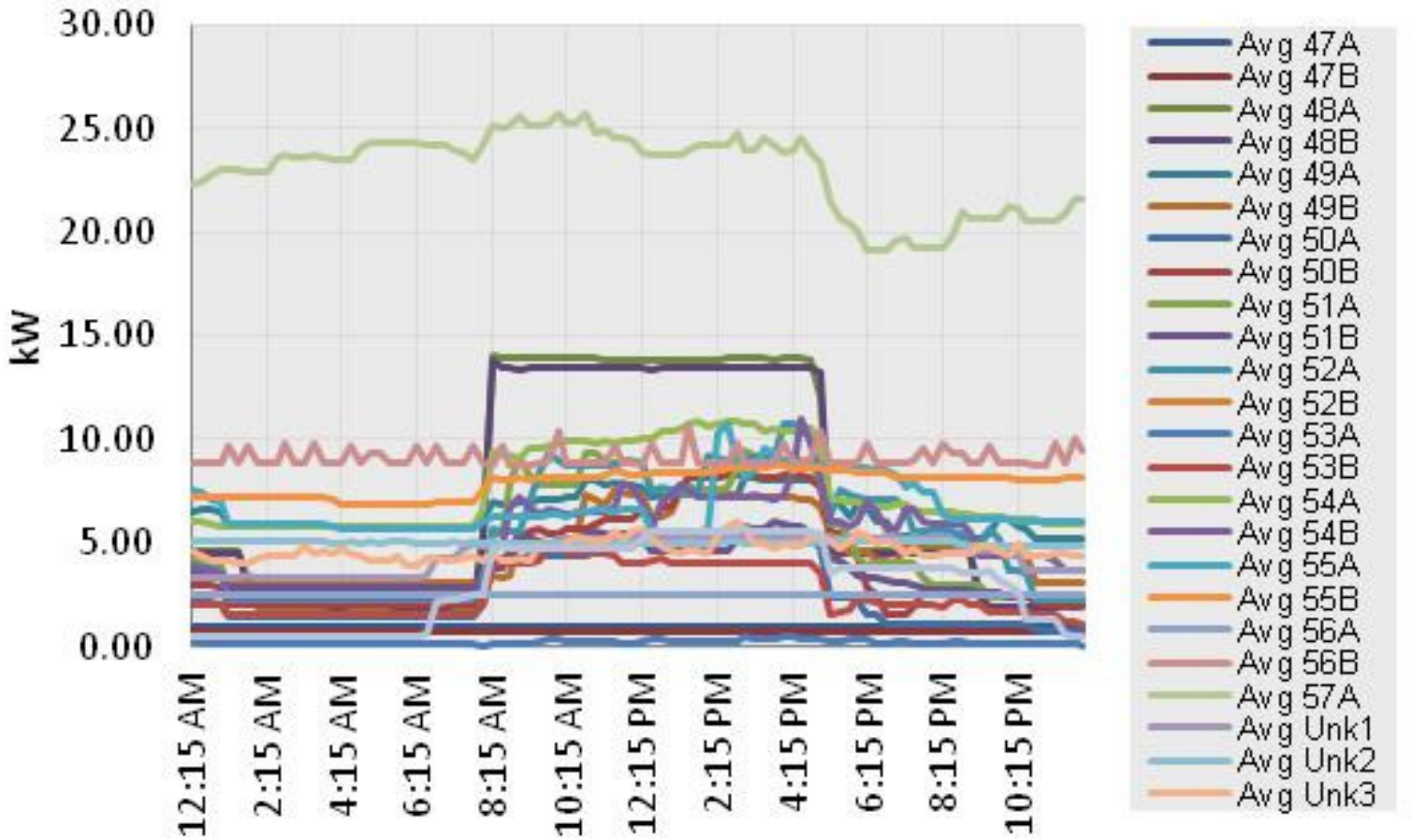
Installed RTM on utility meters:

- Gas, Steam, Chilled Water Electricity

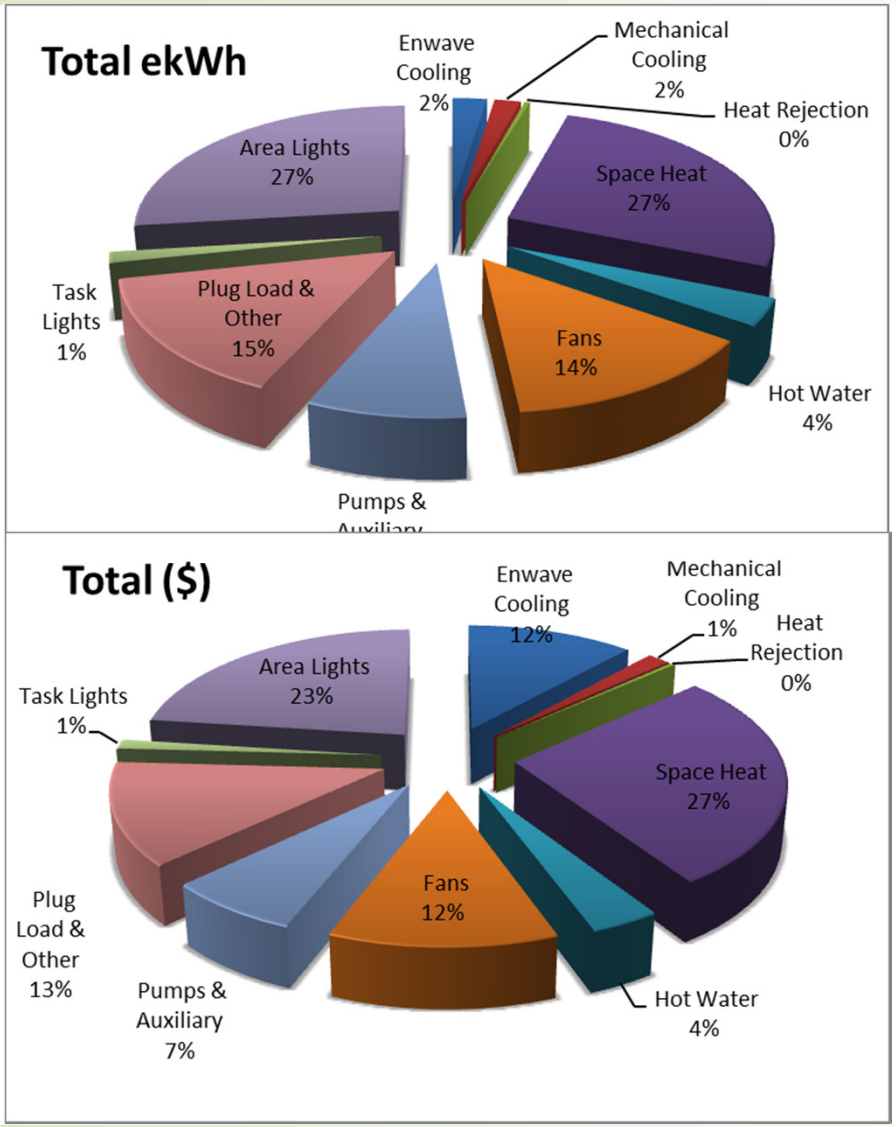
Organized and defined EB Cx Team Roles and Responsibilities

EB Cx Tools: RTM

Real Time Monitoring (RTM) allowed Calibration:



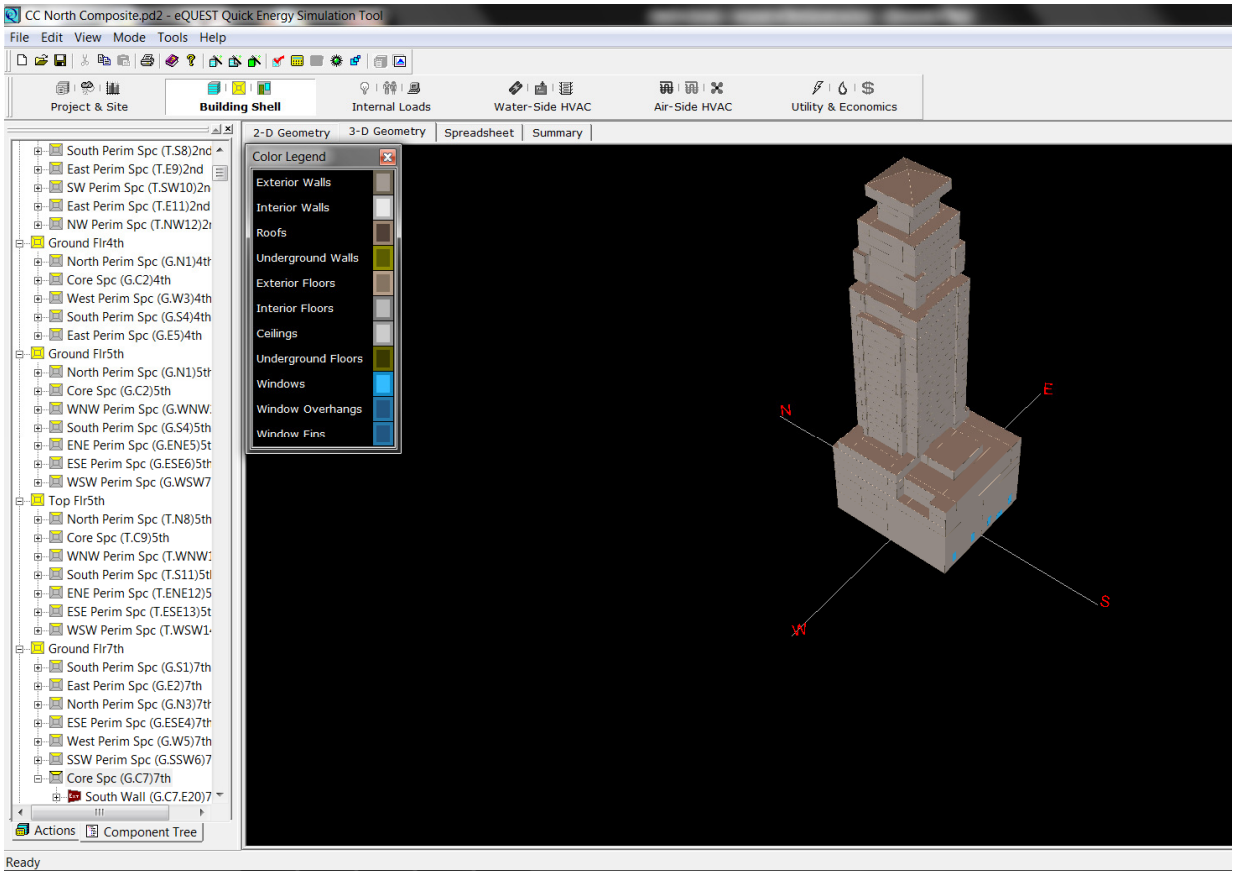
EB Cx Tools: ASHRAE Level II Audits



EB Cx Tools: eQuest Building Model

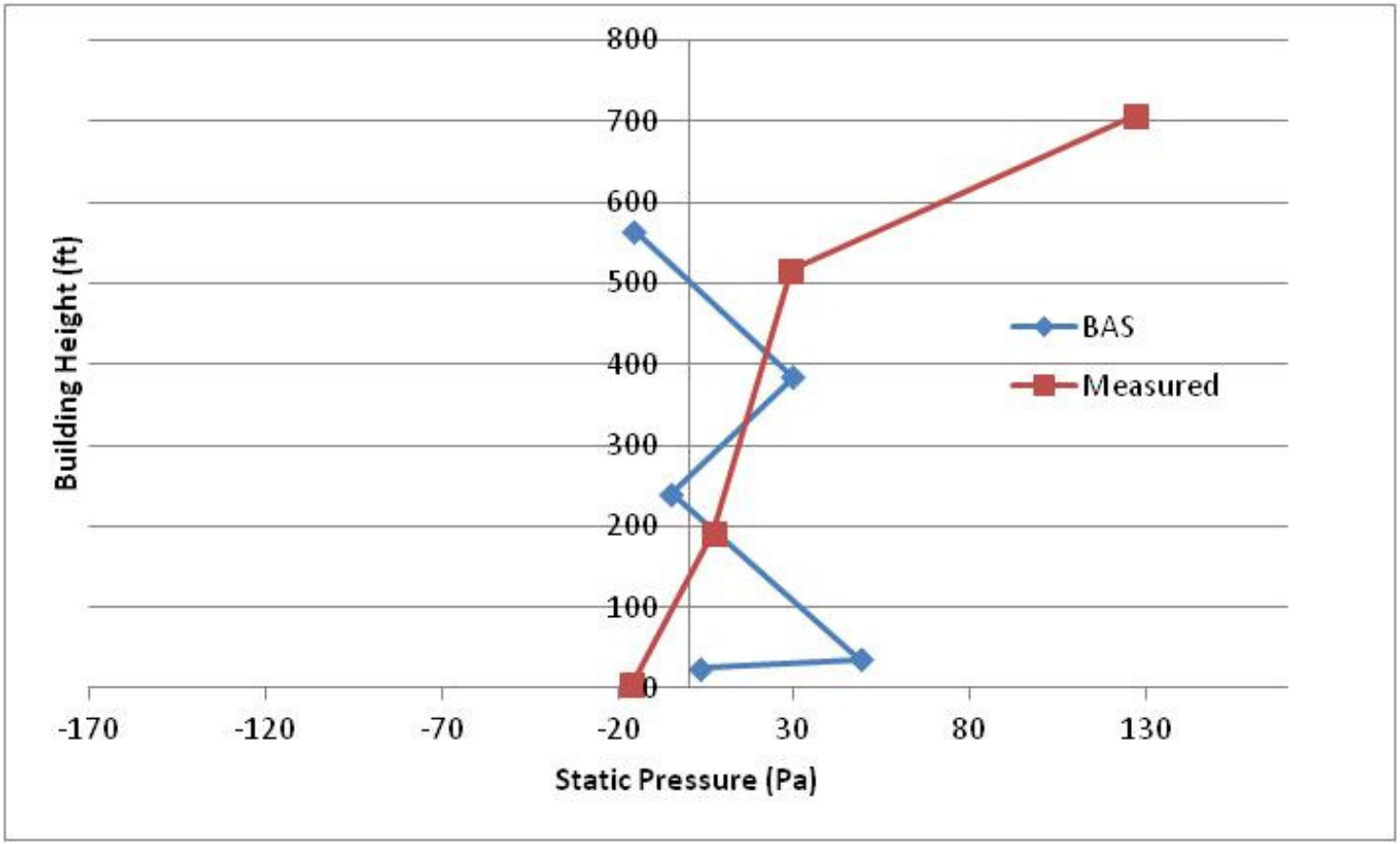
Building Simulation calibrated to ASHRAE 14 standards so that it is compliant with **IPMVP Option D**.

Annual, monthly, and real-time data used to ensure calibration was complient.



EB Cx Tools: Functional Tests

Pressure Sensor Calibration (blue: reported; red: actual):



2 EB Cx Case Studies

1. Class A, 23 storey office tower – heating plant EB Cx.
   - **30% natural gas consumption reduction target for a .5 year payback**

2. Triple A, 3,000,000+ square foot, downtown office complex – complete EB Cx project.
   - 10 Objectives plus:
     15% energy reduction target to achieve a one year payback!

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First Project: Heating Plant EB Cx

23-Storey Commercial Office Tower

EB Cx Case Study

Profiled in Boma's BESt Benchmarking Report as an EB Cx example

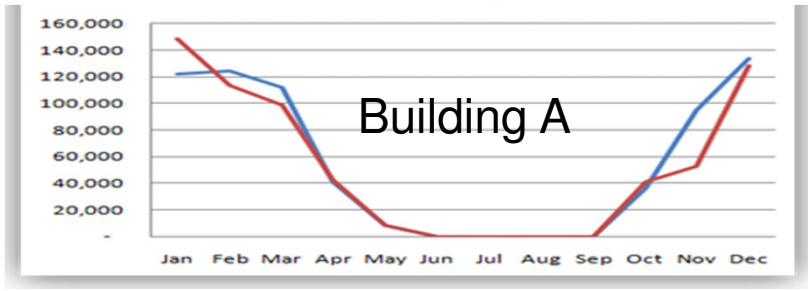
Website: http://www.bomabest.com/publications/2011-boma-best-energy-and-environmental-report-bbeer/

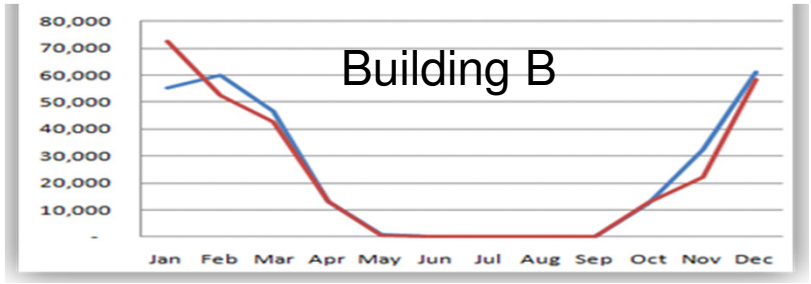
2012-10-23 Manchester ICE'BO Presentation
Scott.Rouse@Energy-Efficiency.com

Discovery! "A" Used Twice "B"

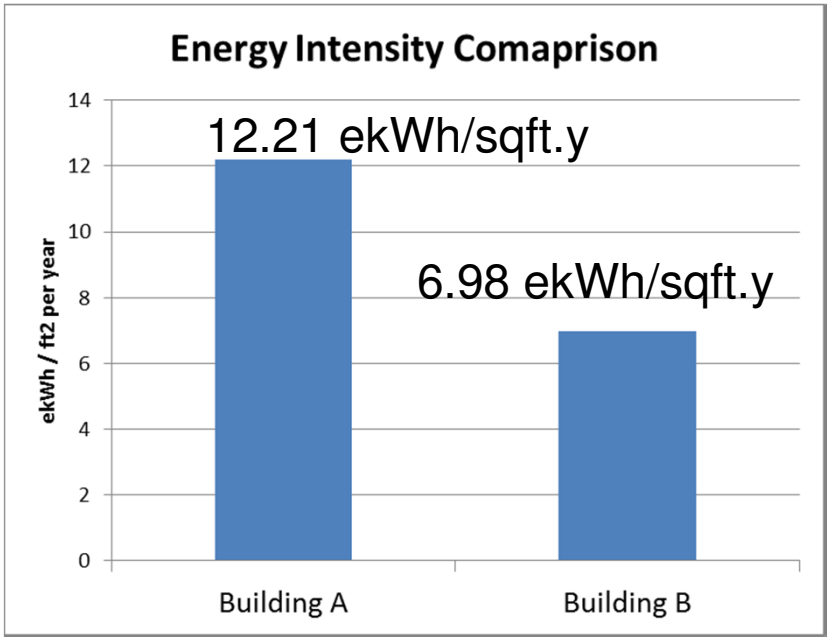
Mystery:

Annual natural gas profiles (2008 & 2009) for both properties were similar using monthly natural gas billing data.





But…



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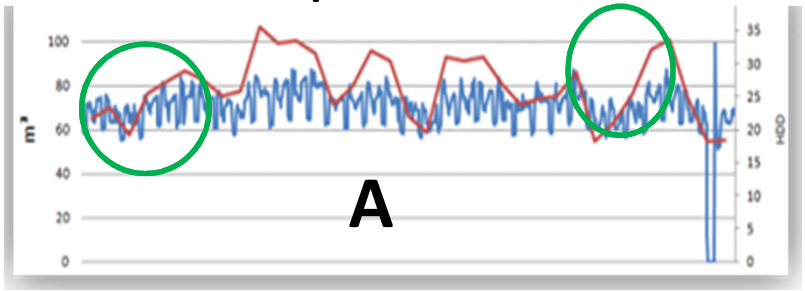
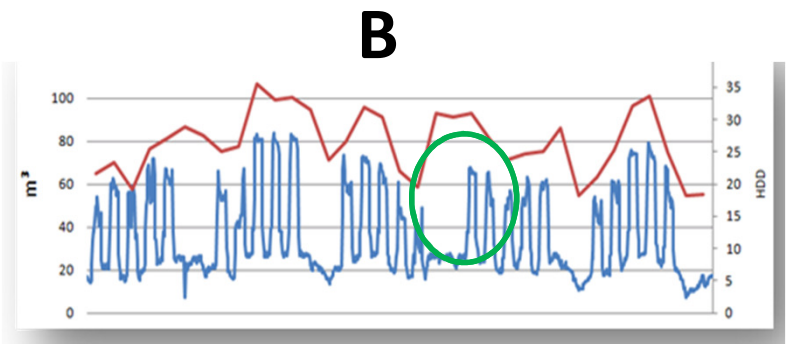
Real Time Monitoring: Visibility

Building "A": No Difference in Weather / Occupancy

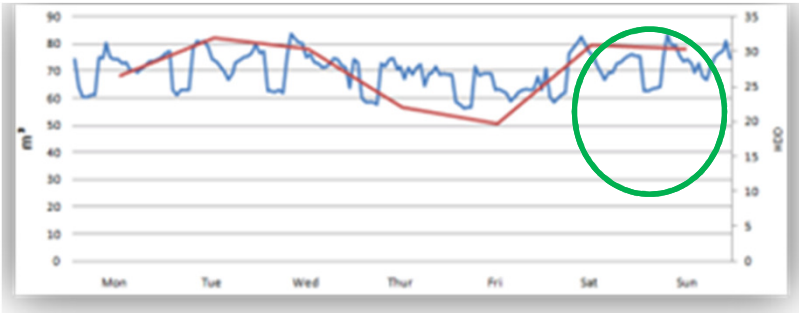
Winter Month profile:

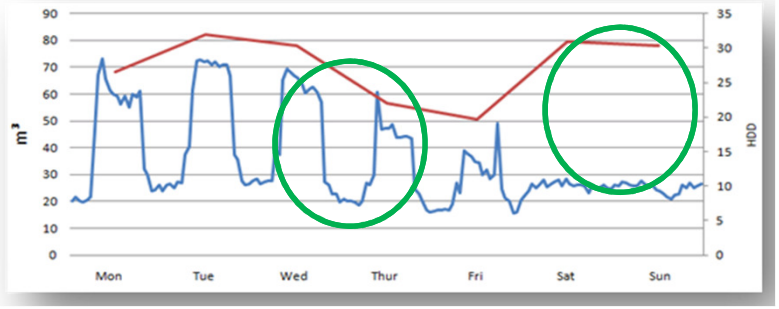


Vs



Winter Week profile:





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

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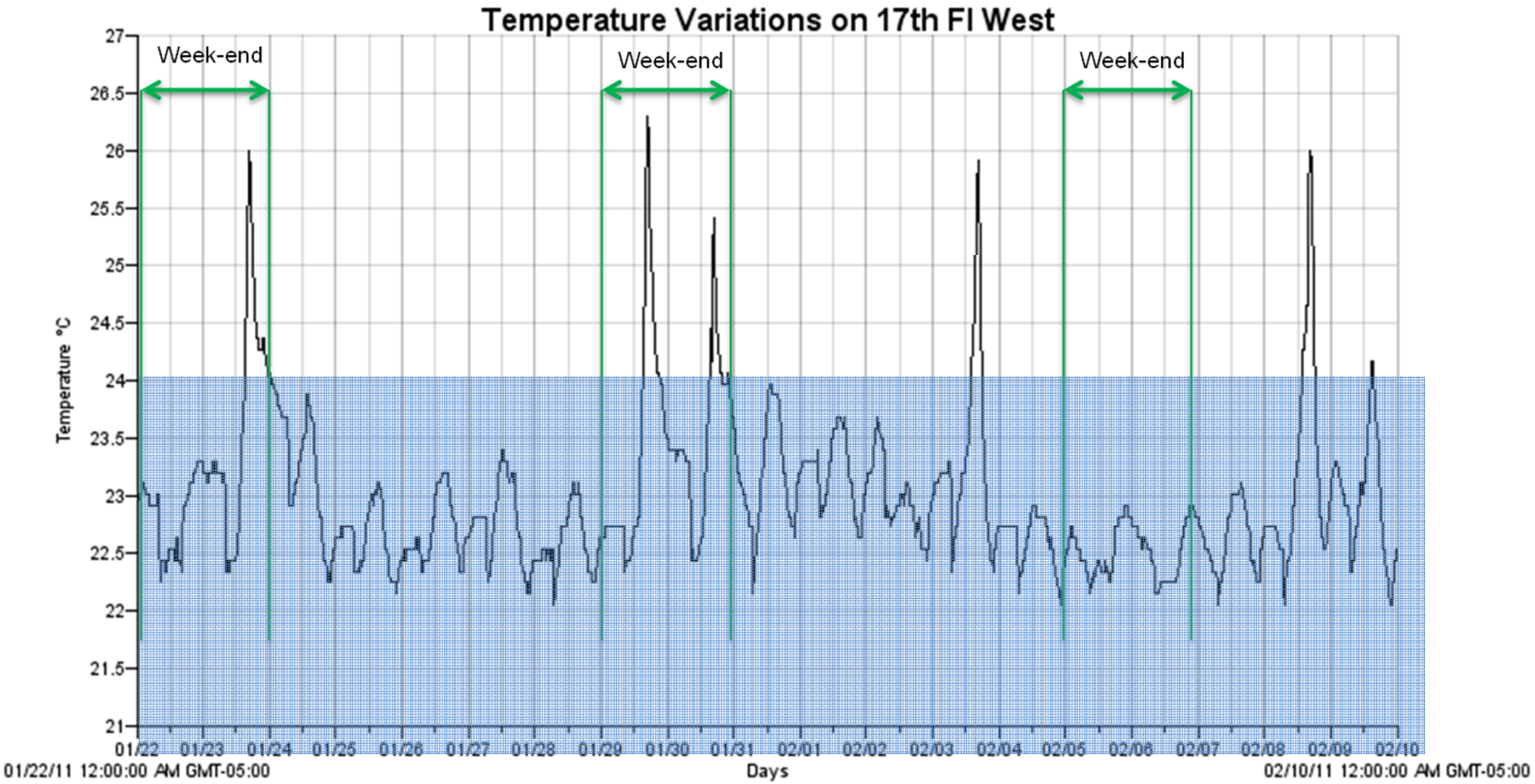
Functional Tests

- Temperature data-loggers installed on several floors
  - 2 weeks typically used
- Boiler motors data-loggers installed
  - not terribly informative and RTM better
- Boiler performance checked for proper modulation
  - very mixed results and not consistent

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

17th Floor West



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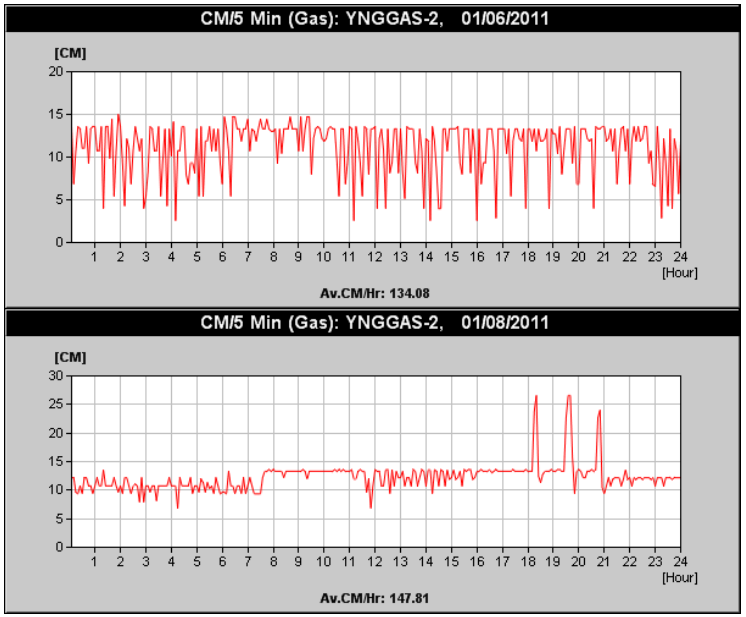
Example: Finding #4

Boilers 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.

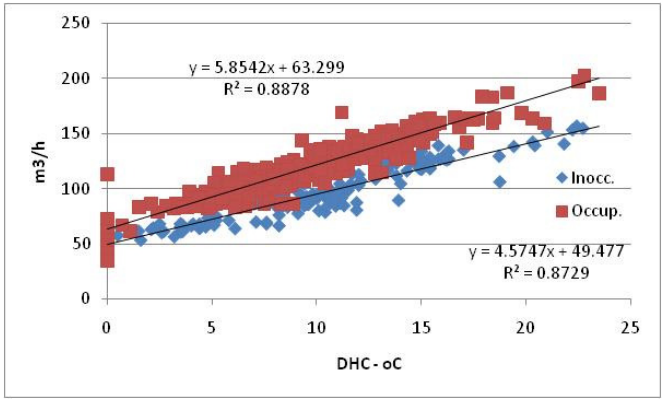
Example: Finding #6

Sub-optimal Reset on Secondary Heating Loop

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

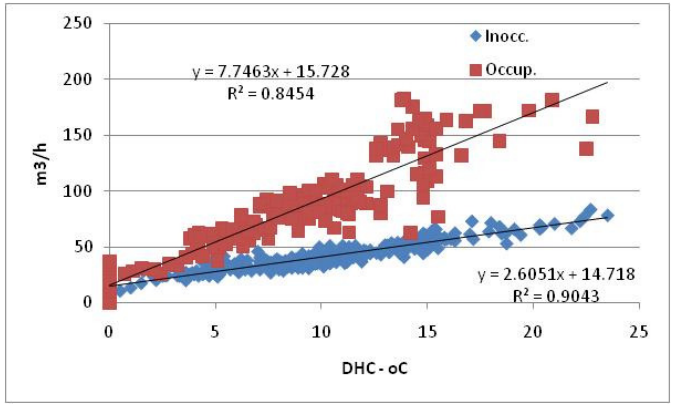
Bld. A:

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



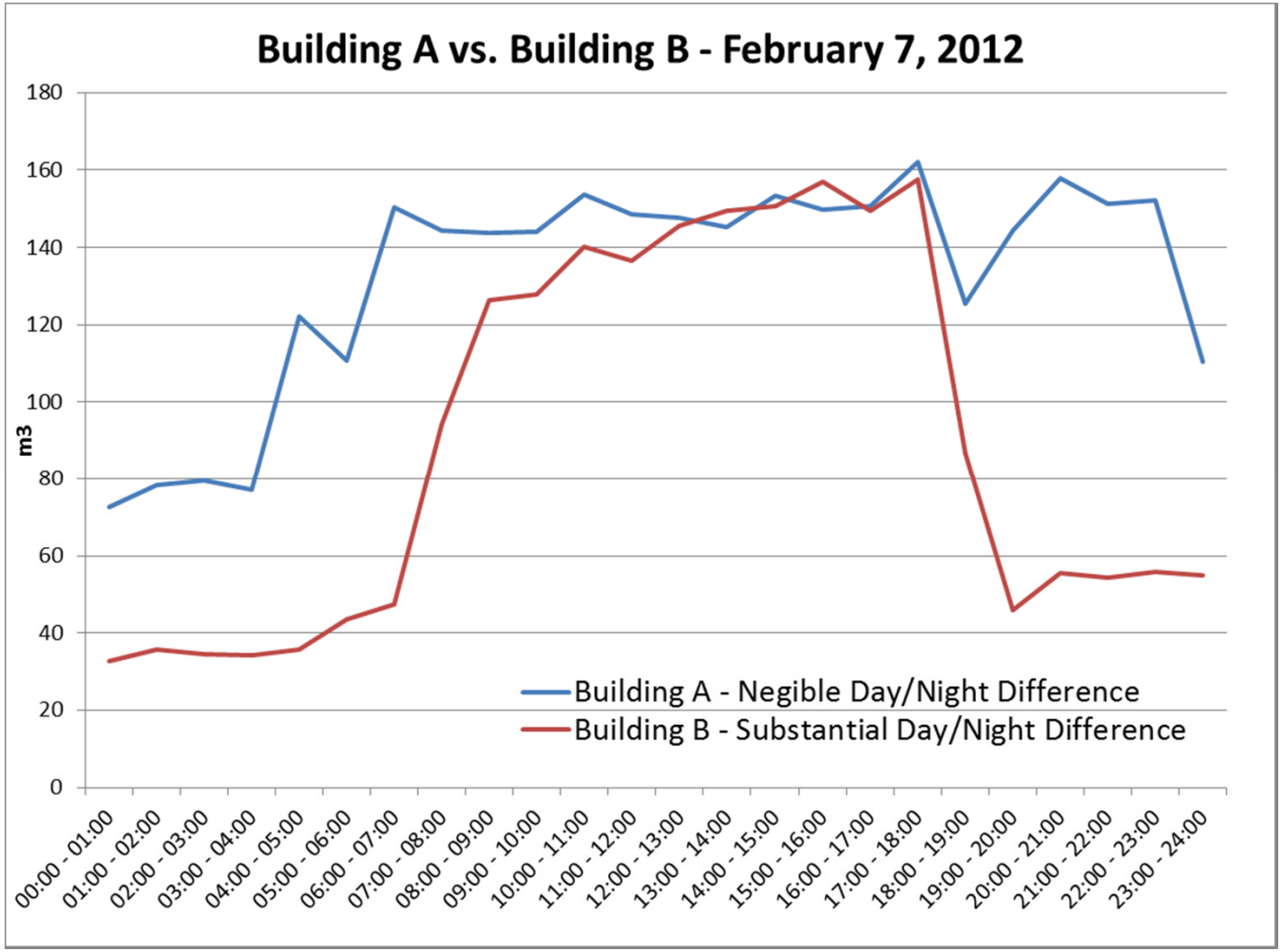
Bld. B:

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



Finding #6, continued

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



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Phase 3: 22 Findings

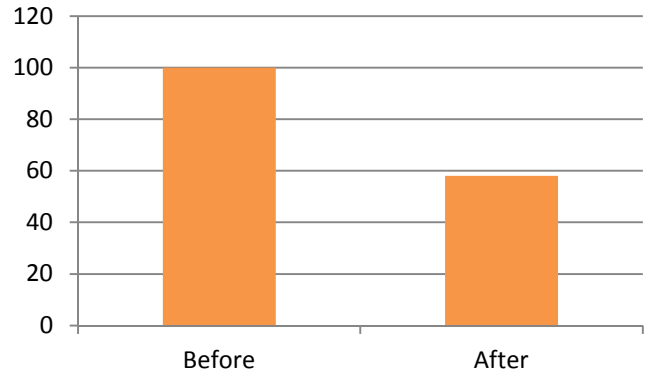
22 Findings

* Included Energy Efficiency Measures (EEMs)
* Identified and Implemented
  - Operational
    - Behavioural
      - Technology
        - Capital not included

Results: 30% Saving Achieved

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: **30% reduction**

Enbridge Provided an Incentive Cheque for Gas Saved

2nd Case Study:
Full Building EB Cx
3 M sqft Triple A Downtown office complex

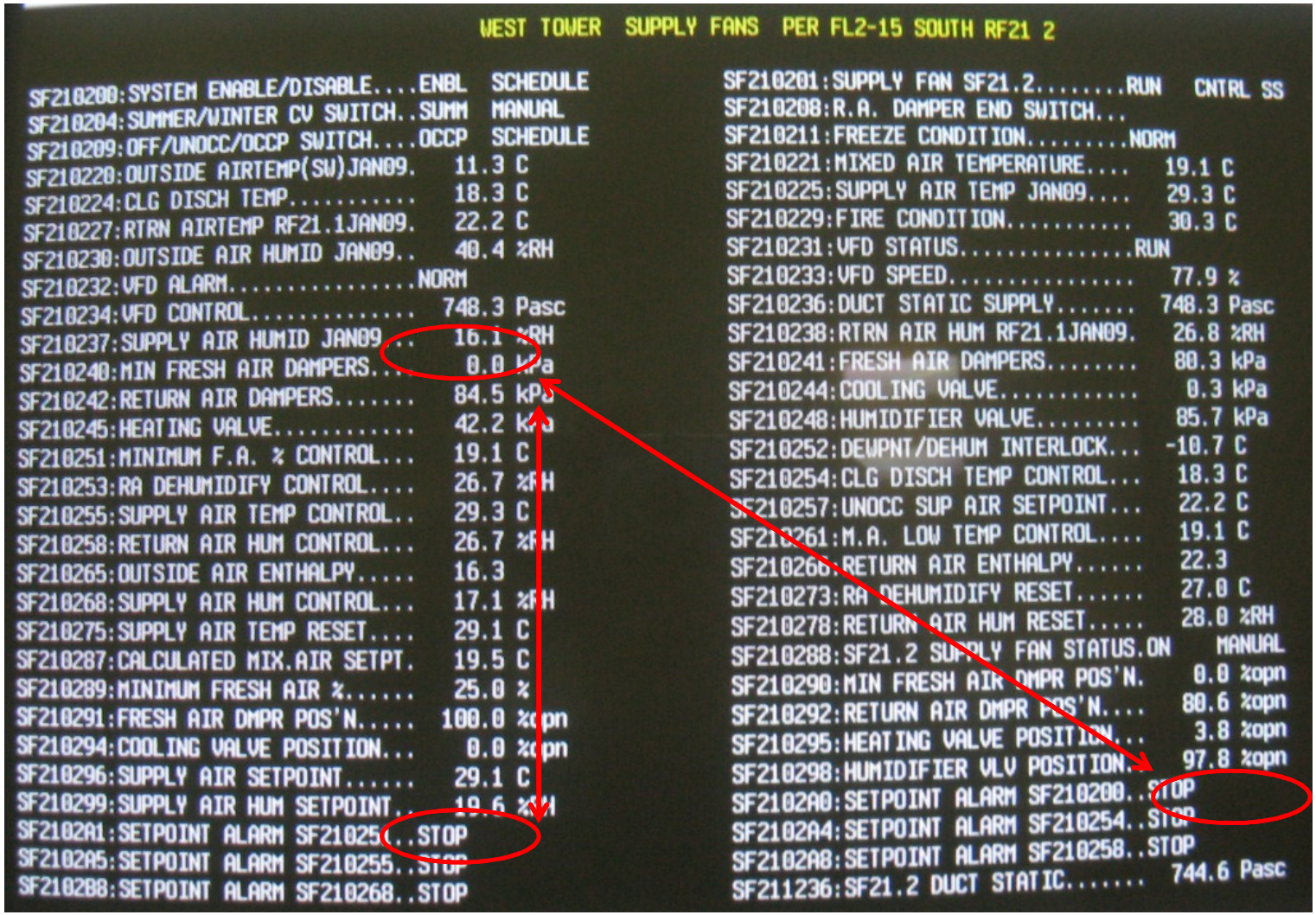
The Case for EB Cx

Identifying EB Cx Potential

EB Cx potential identified in 2010 BOMA BESt audit update when the audit team noted discrepancies between information accessible via the BAS and what was observed in the mechanical rooms, systems, etc.

<2010-03-18 Energy Audit - R17>

Example of sensor problem

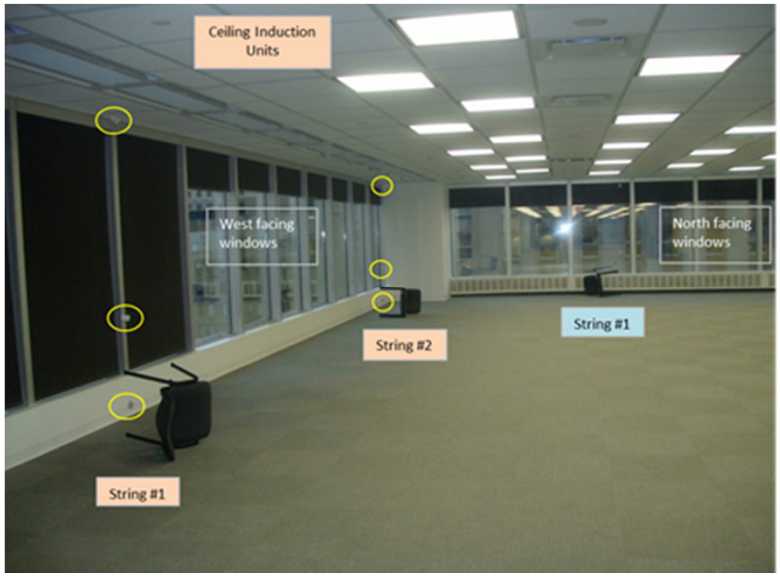


Ceiling Induction Units: Pre-functional Check

Ceiling Induction Units

– Stratification (short term – warmer weather)

- No significant differences, stratification of 0.3°C for floor units and 0.4°C for ceiling units, within instrument uncertainty.
- No difference in floor minimum or maximum temperature.

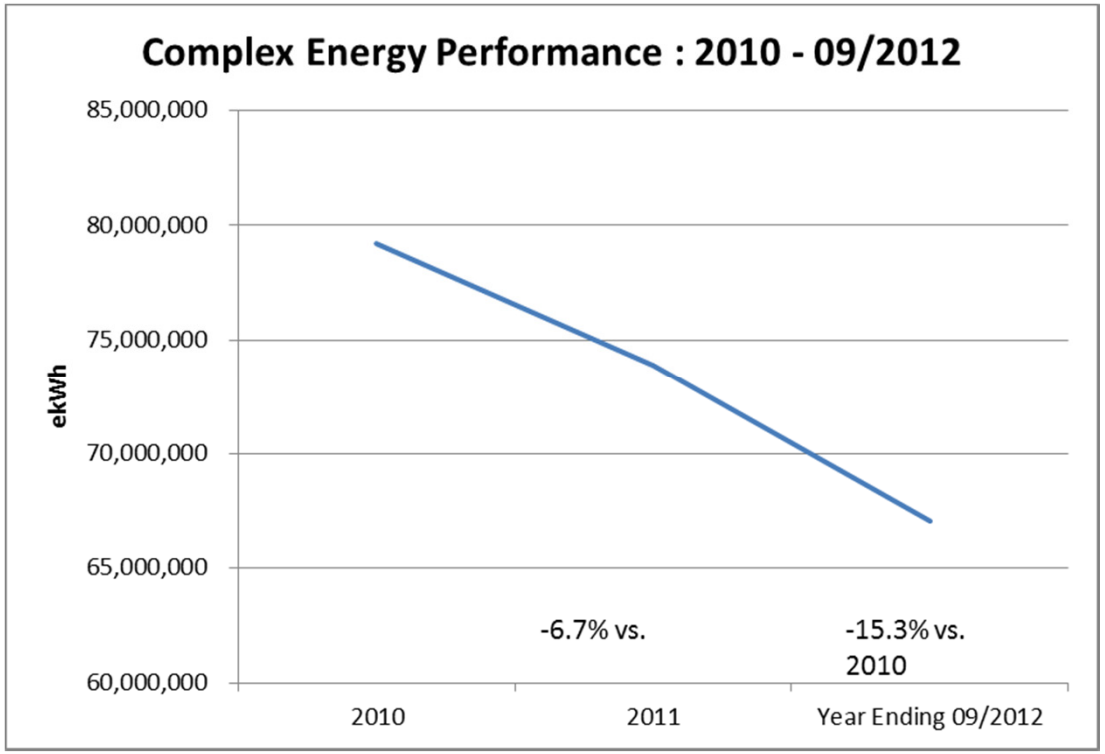


Results

3 million foot^2 downtown office complex

15.3% Savings in less than 2 Years!

Quick Summary



Target:
15% by 2014 vs. 2010 baseline.

Results: For the year ending September 30th 2012, there has been an estimated 15.3% unadjusted reduction versus the 2010 baseline.

86% of savings since 2010 achieved after September 2011

Q3 2012 Financial Results

Summary of utility use reductions versus the 2010 baseline and estimate of costs avoided as a result of those reductions:

Utility	% Difference	Unit Difference	Savings[i]
Electricity (Oct '11-Sept '12)	-14.8%	-8,361,869 ekWh	-$881,464
Chilled Water (Oct '11-Sept '12)	-4.6%	-96,128 ekWh	-$49,506
Steam (Oct '11-Sept '12)	-2.2%	-327,482 ekWh	-$26,843
Natural Gas (July '11-Jun '12)	-61.6%	-3,321,766 ekWh	-$69,995
Water (May '11-Apr '12)	*-28.1%*	*-71,025 m^3*	*- $171,715*
Q3 Total	**-15.3% ekWh**		**-$1,199,523**
		CDM/DSM Incentives Received:	**$915,565**
		CDM/DSM Incentives Pending:	**$343,814**
		GA Costs Avoided:	**-$196,500**

Top 10 Lessons Learned

#1: EB Cx Investment Pays Off

- **Heating Plant project:** 30% natural gas reduction achieved and externally verified: **0.5 year payback.**

- **Complex Full EB Cx:** 15.3% achieved: **1 year payback.**

Note: EB Cx is inexpensive but not 'cheap'.

Requires a minimum full-calendar year to account for seasonal variations in operating conditions. Plus, adequate investment to perform effective functional testing, training, etc.

"Our financial advice is free
... and it's worth every penny of it."

#2: Define "Who" Does "What" and "WHEN"

5.1.1 Property Manager / Owner Representative

5.1.2 Owner-Project Coordinator

5.1.3 EB Cx Project Head

5.1.4 EB Cx Agent

5.1.5 Building Operator

5.1.6 Controls Contractor

5.1.7 HVAC Service Contractor or Vendor

5.1.8 TAB Contractor

5.1.9 Utility Conservation Representatives

5.1.10 Other definitions include

- what is capital / maintenance / operation

#3: Foster Collaboration

EB Cx team member "**Buy in**" from each level is **critical**.

- Team members come from different levels of the organization, background, departments, companies, etc., and have competing priorities, which at times, may lead them to work at cross purposes.

- In our experience, lack of "Buy In" is the leading cause of delays and losses of project momentum.

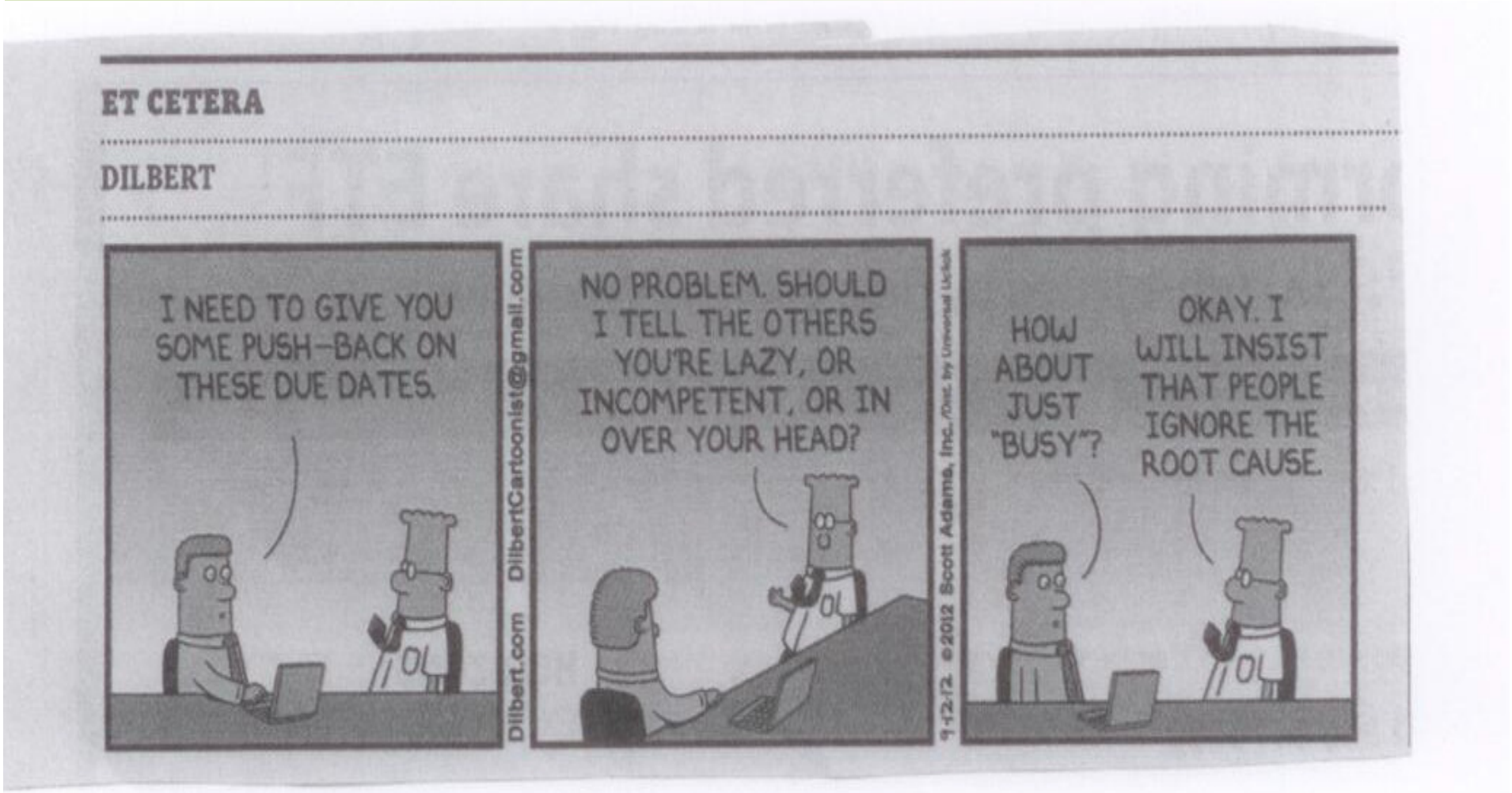
Need to understand and define priorities plus:
Craft EB Cx so that its priorities are understood and become the priorities for everyone.

#4: Question Operating Assumptions

EB Cx process has clearly defined "Functional Tests" to ensure that actions are driven by data, not dogma.

"Listen with your eyes!"

Root Cause Issues: This is the conversation!



#5: Data – Data - **DATA**

EB Cx is a systematic, data-driven process that is designed to achieve specific, pre-defined objectives.

EB Cx is not troubleshooting.

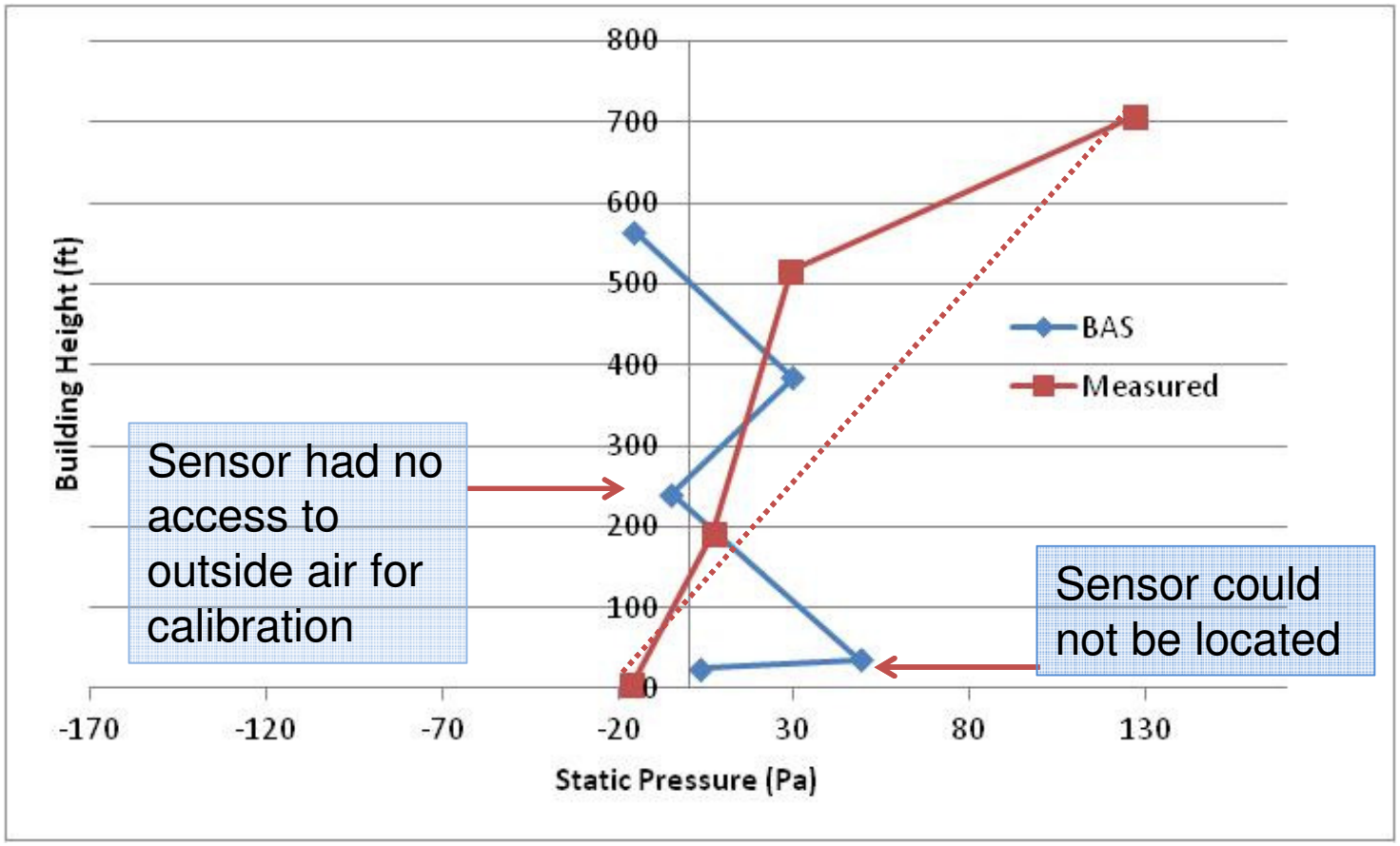
Properly executed EB Cx involves comprehensive functional testing and monitoring oriented towards ascertaining (vs. speculating about) root causes.

Data example: Pressure Sensor Calibration

Building Pressurization Functional Test (FT): **Major Control Points**

Blue is what the Building Automation System (BAS) is reporting <after 'calibration'>

Red is what the FT actually measured



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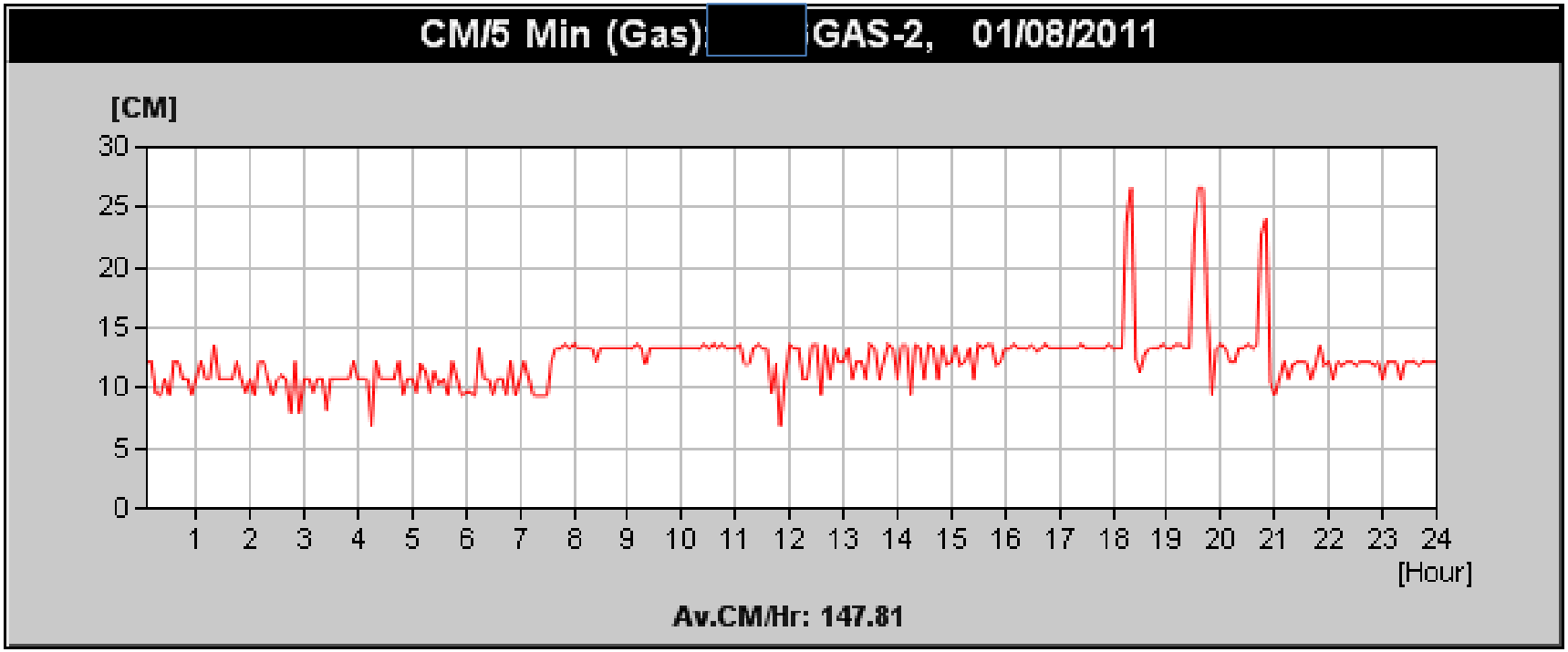
Data Example #2: Boiler Modulation FT

Boiler Not Modulating

Observation: Lead boiler short cycling without modulating



#6: Systematic: Realistic & Prioritize

Systemic improvement requires a systematic process.

It is extremely tempting to subvert the EBCx process and devolve into troubleshooting and / or a 'Trial and Error' **– discipline is required.**

Also,

Opportunities jump out, and the instinct is to resolve individually and immediately, without stopping to consider root causes, why did they occur or think about how the "fix" will affect other systems and be sustained.

There will always be more to do than time/budget will allow.

#7: Maintain Momentum

EB Cx requires a high level of commitment from every member of the EB Cx team. Momentum can easily be lost.

To maintain momentum:

- Positive relationships
- Regular communication (monthly meetings, diligent follow-up, etc.)
- Track and share ongoing results

#8: Include Incentives: DSM / CDM

Case Study 1
(Demand Side Management <DSM>)
- $15,600 incentive provided validation of savings.
- Less than 1 year payback.

Case Study 2
(Conservation Demand Management <CDM>)
- Audit and Building Simulation
- VFD's
Potential CDM:
- Building Automation System Optimization
- Monitoring and Targeting (M&T)

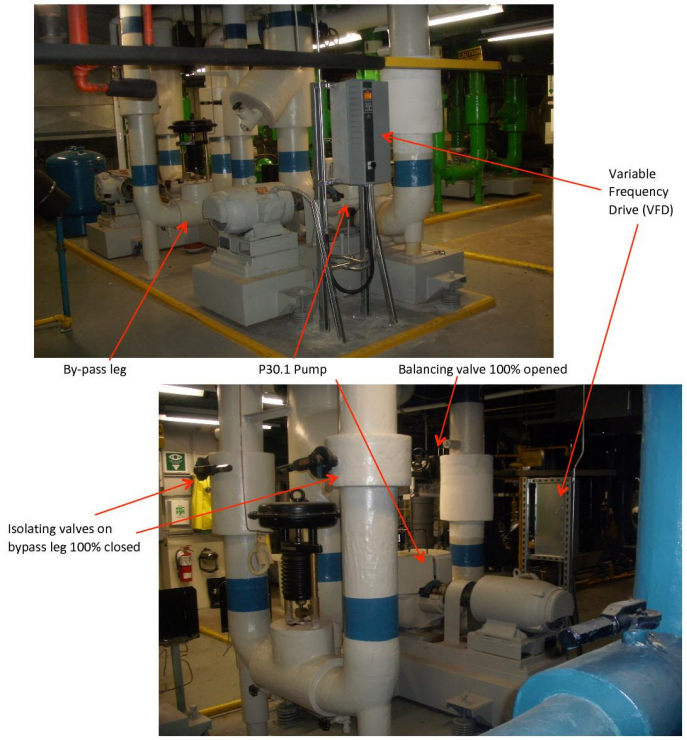
#9: Persistence: The Most Important Phase

Transfer and Persistence ensures improvements implemented through the EB Cx project are sustained.

It is the fourth and last phase of EB Cx.

That doesn't mean it should be left to the end.

Persistence: Documentation is key

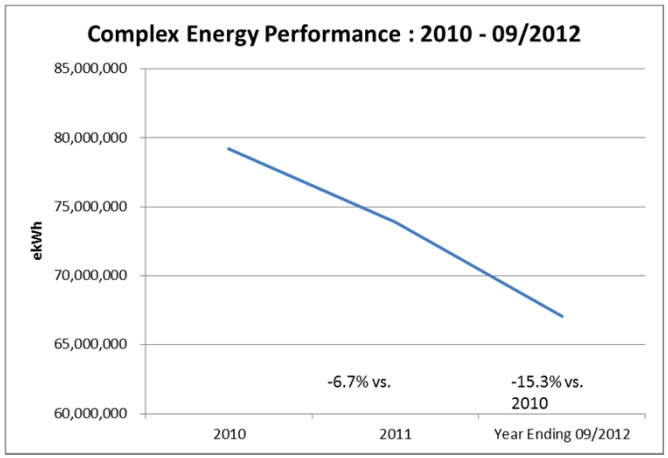


- Gather all relevant information about systems for operators and file so it's easily accessible.
- Highlight persistence actions, and important contacts/resources.
- List all relevant filenames.

#10: Celebrate and Show Success

- ✔ 1. Ensure Occupant Safety
- ✔ 2. Improve Tenant Comfort
- ✔ 3. Improve Indoor Air Quality
- ✔ 4. Increase Utility Efficiency
- ✔ 5. Retain Tenants
- ✔ 6. Bring Equipment to Its Proper Operational State
- ✔ 7. Increase Equipment Life
- ✔ 8. Reduce Number of Service and Maintenance Calls
- ✔ 9. Identify and Gather Any Missing Critical System Documentation
- ✔ 10. Upgrade Staff Training

Showing Success: Both Projects



Target:

15% by 2014 vs. 2010 baseline.

Results:

1) 15.3% unadjusted reduction already!

2) $ 1.2 Million in utility savings

3) Correcting persistent problems

ENBRIDGE

Target:

30% Natural Gas Reduction

Results:

Achieved and received an additional $15,000

CONCLUSION: EB Cx Works!

Even in well-managed, elite buildings that have better than average energy intensities, based on Canada's and Ontario's averages
- achieved 30% and 15% savings via EB Cx.

We believe most commercial buildings have the potential to save at least that much through quality EB Cx projects.

Questions?

Clients and Associations

Commercial Office	Cadillac Fairview; Brookfield Properties; Simcoe Place; pizza pizza; Allied Properties; GWL Realty Advisors; TD Bank Financial Group; Northam Realty Advisors Limited; Markham; Toronto-Dominion Centre
Industrial	Confederation Freezers Refrigerated Warehousing & Distribution; TF; Purolator Where business is going.; Cadbury; GDX Automotive; John Os Family Tradition; LANXESS Energizing Chemistry; LCBO; WAL★MART
Government/ Education	Woodstock Hydro An ISO 9001:2000 Registered Company; Lighting Guide 2005 Reference Document; ieso Power to Ontario. On Demand.; Ontario Power Generation; Ontario; OPA Ontario Power Authority; Upper Canada College; SHS 20th Anniversary 1987-2007

Professional Engineers of Ontario; BOMA Toronto; Canada Green Building Council; ASHRAE; Sustainable Buildings Canada; BCA Building Commissioning Association; IEEE; CIET Canadian Institute for Energy Training

Thank you!

Please don't hesitate to contact **Energy@Work** Inc. *with any additional inquiries…*

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