

# Continuous Optimization for Commercial Buildings

# Organization Overview and Context



- BC encompasses 366,000 square miles (>Ca+Or+Wa)
  - 75% of people live in SW corner of province
- Population of 4.5 million
  - BC Hydro services 95% of population (1.8 million accounts)
- BC Hydro is a regulated electric utility
  - >90% hydro power
  - Net importer of electricity
  - Population and demand growing
  - Commercial marginal rate
    - 3.93¢/kWh
    - \$8.02/kW

## Power Smart - Overview

- Three basic types of energy conservation measures:
  - Retrofit, e.g. lighting upgrade
  - **Operational**, e.g. lighting control schedule programmed to sweep off lights
  - Behavioural, e.g. occupant awareness program to turn off lights after leaving a room.
- Focus of Continuous Optimization is **operational** conservation measures:
  - low / no-cost operational savings
  - Primary impact is on HVAC systems, through the DDC system:
    - Sequences
    - Schedules
    - Setpoints

# Continuous Optimization - Overview

- Two basic components to C.Op program:
  - Recommissioning (RCx)
  - Energy Management Information System (EMIS)

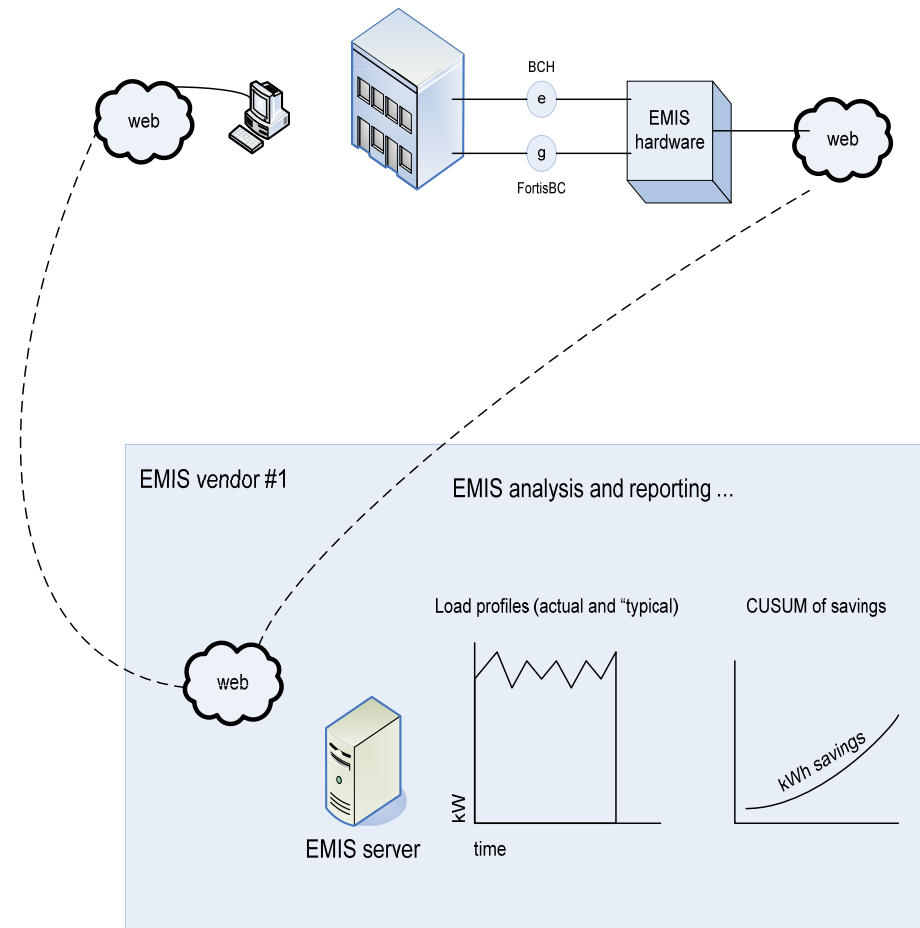
## C.Op – RCx scope of work

- Planning Phase
  - Project preparation
- Investigation Phase (similar to Energy Study)
  - Review facility documentation
  - Perform diagnostic monitoring
  - Perform functional tests
  - Perform simple repairs
  - Develop business case
  - Prioritize and select operational improvements
- Implementation Phase
  - Implement selected operational improvements
- Hand-Off Phase
  - Documentation & training
- **Coaching**
  - **Quarterly visits from consultant**
    - **Viability of implemented measures**
    - **Best practice for DDC operators**

# Energy Management Information System

- **Energy Management Information System**

- Load profiles
- Benchmarking
- Utility Bill Analysis
- Exception Reporting
- Measurement & Verification



# Sample EMIS Report: Load Profile

Energy Expert

9/17/2009

Details

5949

ScoreCard Calendar **Chart** Reports Admin

Load Profile CUSUM Energy CUSUM Emissions

## Energy Expert: Onset 2012362 Expert

### Date

9/16/2009 Wednesday

### Prior Year Weekday

- Day with highest
- Average
- Day with lowest

- Monday Average
- Tuesday Average
- Wednesday Average
- Thursday Average
- Friday Average

### Prior Year Weekend

- Day with highest
- Average
- Day with lowest
- Saturday Average
- Sunday Average

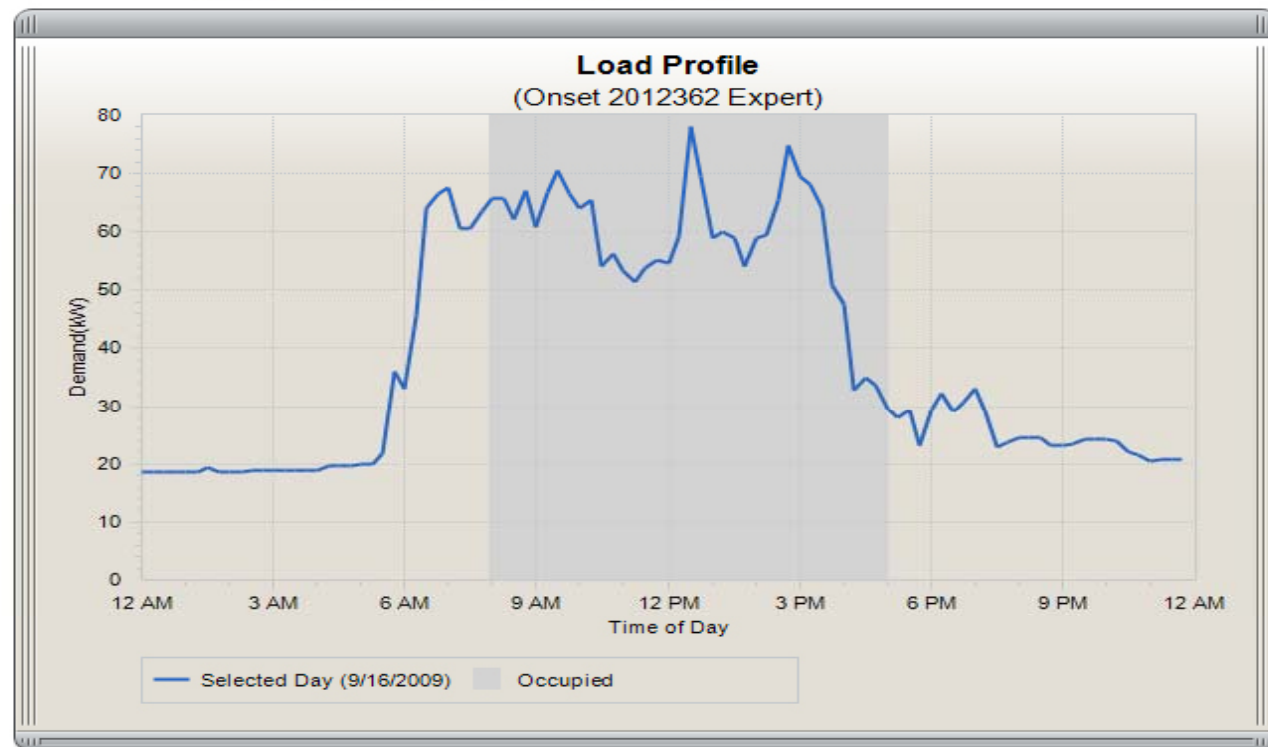
### Prior Week(s)

- Days for 1 Week
- Days for 2 Weeks
- Days for 3 Weeks
- Days for 4 Weeks

### Miscellaneous

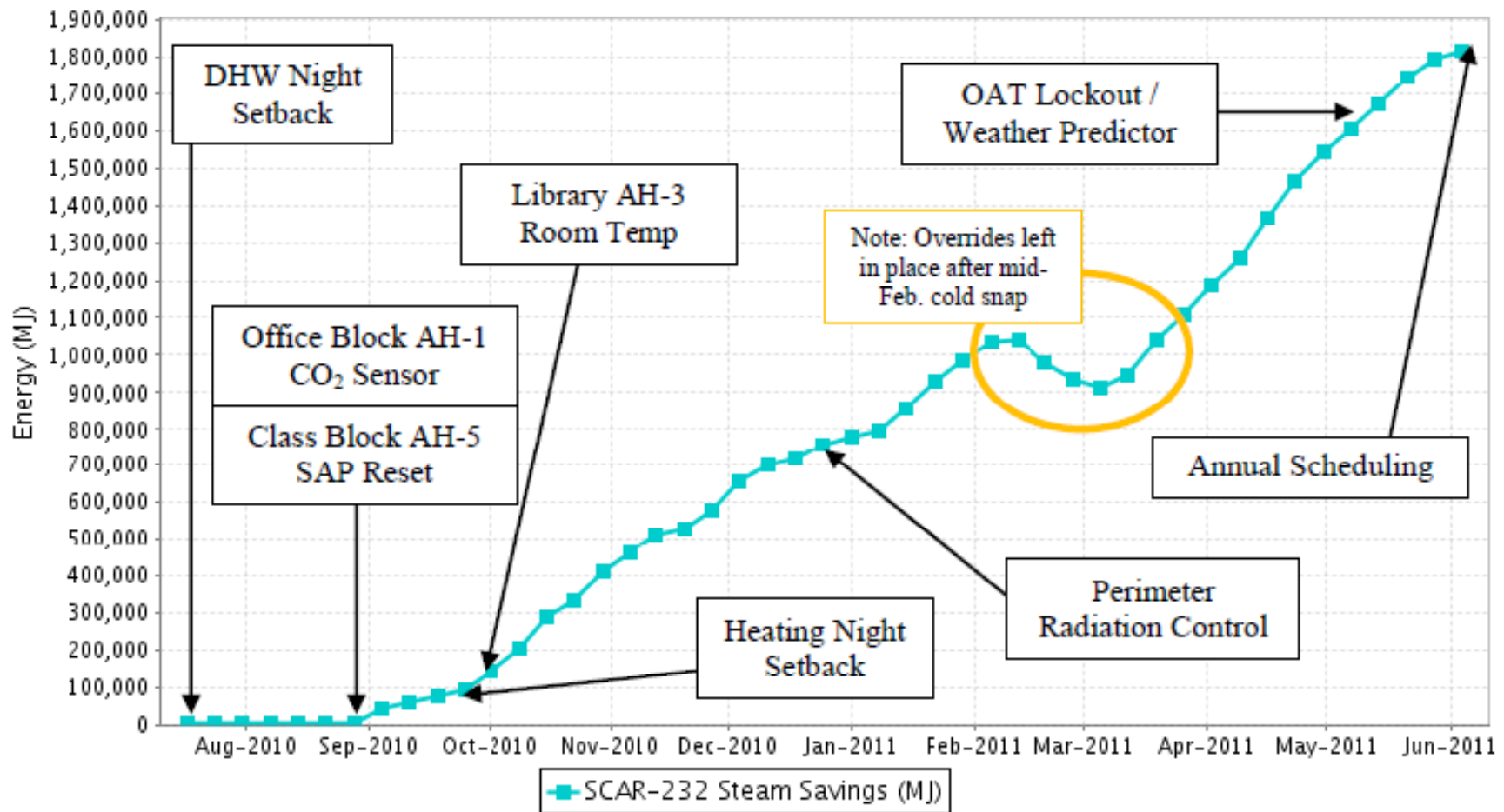
- Show Temperature

Draw Chart



Comments

# Sample EMIS Report: CuSum / Storyline



## Ten Most Common C.Op Measures

Rank	Measure
1	Reduce equipment runtime
2	Optimize economizer operation
3	Eliminate simultaneous heating and cooling
4	Optimize Supply Air Temperature
5	Optimize zone /setback temperature setpoints
6	Eliminate unnecessary lighting hours
7	Optimize ventilation rates
8	Volume control for pumps and fans
9	Add / Optimize Chilled Water Temperature reset
10	Eliminate Passing (leaky) Valves

# Industry Feedback

## **Brian Sikorski**

- Thanks to C Op they now have:
  - New and awesome DDC Graphics;
  - Found that 65% of radiation and heating control valves were broken;
  - Got a great new chiller control sequence;
  - Got rid of lots of bad programming;
  - Got a new boiler and DHW control scheme with variable flow.
  - Uncovered lots of potential capital measures.

## Note:

1. BAS re-programming (correcting or improving) is common measure.
2. C.Op facilitates other program activity.

# Industry Feedback

## **Bob Landell**

- The Pulse meters facilitated an awareness initiative at Queen Alexandra Hospital (**VIHA South**) on May 3rd whereby housekeepers made an effort on one night to turn off all unnecessary lights, copiers, coffee pots, radios, etc. The results were an 18% kWh reduction for the Main Building, and a 23% kWh reduction in the Pearkes Centre, as compared to a normal Tuesday night. Also, savings due to DDC work should be high at the QAH (still waiting for TAB tests).
- **Camosun Interurban:** A 2009 PSECA project reduced the trades buildings' gas use by 67% (down to 33% of baseline) while reducing electrical usage (whole Campus 20%). The Pulse meters were extremely valuable in responding to equipment failures (such as air source heat pumps tripping out and going back onto boilers) and unexpected operator adjustments (such as putting speed drives to 100% and manually setting supply water temperatures very high). Those savings definitely would not have persisted this year if the C.Op. project had not been in place.

## Note:

1. Customers use the EMIS to facilitate behavioural initiatives.
2. The EMIS is useful at detecting maintenance and operational issues affecting persistence.

# Industry Feedback

## **Scott Sinclair**

- In response to your desire to profile a couple of C. Op. clients, I believe that SFU is an amazing candidate to look at for the following reasons.
  - Implementation complete on 4 projects to date.
  - Total Annual Savings: 2.2 million kWh elec, and 7800 GJ heat.
  - Creation of an online educational video on fume hood use.
  - 1st project to complete coaching entirely, with measured electrical savings increasing from 11% to roughly 14% during the coaching phase.
  - Institutional Change with SFU adopting Green Labs campaign, and training staff to use energy monitoring and respond to exceptional energy use.

### Note:

1. C.Op can support more comprehensive programs.
2. Coaching can increase savings, which the EMIS will “lock in”.

# Program Results

Building Type	Size	Annual Utility Cost			Implement.	Energy Savings			Simple Payback
	ft2	electricity \$/ft2	gas \$/ft2	total \$/ft2	\$/ft2	electricity	gas	total	years
	restaurant	50,000	\$ 5.43	\$ 1.21	\$ 6.64	\$ 0.34	13.8%	1.0%	7.4%
large hotel	450,000	\$ 1.65	\$ 0.69	\$ 2.34	\$ 0.28	2.4%	17.8%	8.1%	1.3
hospital	292,414	\$ 1.10	\$ 1.17	\$ 2.27	\$ 0.28	6.8%	14.0%	9.1%	1.6
recreation	120,822	\$ 1.23	\$ 0.97	\$ 2.20	\$ 0.65	11.7%	8.8%	14.8%	2.0
large office	297,443	\$ 1.18	\$ 0.61	\$ 1.79	\$ 0.32	8.4%	15.7%	9.7%	2.1
shopping mall	375,333	\$ 1.60	\$ 0.18	\$ 1.77	\$ 0.09	3.5%	17.7%	4.5%	1.5
univ. / college	132,837	\$ 0.82	\$ 0.73	\$ 1.55	\$ 0.42	9.5%	18.0%	15.6%	2.0
medium office	66,305	\$ 1.07	\$ 0.23	\$ 1.30	\$ 0.35	9.0%	9.7%	10.5%	2.3
large school	99,340	\$ 0.44	\$ 0.61	\$ 1.05	\$ 0.25	9.3%	15.9%	12.4%	2.0
<b>Overall</b>	<b>196,551</b>	<b>\$ 1.07</b>	<b>\$ 0.64</b>	<b>\$ 1.71</b>	<b>\$ 0.34</b>	<b>8.6%</b>	<b>15.1%</b>	<b>11.5%</b>	<b>2.0</b>

Note: 75 projects completed Investigation phase, including

## Ongoing Involvement

- Recommissioning + EMIS = C.Op
- Benefits of continued engagement
  - Is my building energy consumption on target?
  - How much energy did my conservation project save?

## Program Offer

	BC Hydro	Customer
Utility meter upgrades (BC Hydro and FortisBC)*	100%	
EMIS hardware & software license**	~100%	
Consultant fees (investigation, hand-off, coaching)	100%	
Implementation		100%

\* Customer to provide building level meters if there are no utility meters.

## Customer Responsibilities

- Agreement to implement bundle of measures with 2 year simple payback:
  - Within subsequent budget year
  - Up to an agreed cap (\$0.25/ft<sup>2</sup> - \$0.30/ft<sup>2</sup>)
  - Can withdraw by paying cost of Investigation Phase
- Pay incremental cost of additional meters and infrastructure if required (e.g. 120 V duplex)
- Respond to exception reporting

## Program Eligibility

The Continuous Optimization Program is for commercial buildings that:

- Are greater than 50,000 square feet
- Have a Building Energy Management system in good working order (remote access a plus)
- Can provide documentation including mechanical and electrical schematics; control drawings; testing, adjusting and balancing reports; and operation and maintenance reports
- Equipment and systems not at end of life
- Have no imminent plans for major retrofits or tenant improvements (save for later)

## Program Activity

- **Customers enrolled: 117, representing 468 sites and 69.0 million ft<sup>2</sup>**
  - All BC Health Care Authorities
  - The 3 large universities (UBC, UVic, SFU)
  - Most of the large office buildings in downtown Vancouver
  - Several of the leading municipalities (Vancouver, Victoria, Richmond)
  - 15 of 57 school districts
- **Total estimated energy savings: 93 GWh**
- **Number of signed agreements – 414**
- **Number of Eligible EMIS Vendors – 3**
- **Number of Eligible RCx Consultants – 28**
- **Completed projects - 15**

# Business Case

- Business Case
  - Levelized (utility) cost of program 6.9¢/kWh
    - 1<sup>st</sup> business case
  - Changes:
    - SMI, FortisBC
    - 2<sup>nd</sup> business case, range of 3 - 4¢/kWh
    - 100 projects / year

## C.Op Program Design Issues

- Focus on reducing customer risk
  - Pay for consultants, and EMIS (high value)
  - Implementation commitment is “no brainer”
- Use of EMIS for M&V
- Approach to Effective Measure Life
- No incentives for implementation (disconnect kWh from \$)
- Opportunities for synergy with other programs
  - Energy Managers
  - Commercial New Construction
  - Leads for retrofit programs
  - Rates
  - Facilitate behavioural programs