Energy Management and Information System

McGill University – Utilities & Energy Management

International Conference for Enhanced Building Operation

Montréal, QC

October 8-10, 2013

Presenter: Jerome Conraud, Eng., MASc, Energy Manager

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- **Who we are**
- **Our challenges**
- **Our approach**
- **The EMIS project**
- **Lessons learned**

Photo : Owen Egan/McGill University | Radio-Canada

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who we are

- **One of the oldest universities in Canada**
  Established 1821

- **Top 1 university in Canada, among top 20 universities in the world**

- **21 faculties**
  Medicine, Law, Music, Chemistry, Engineering, Physics, Biochemistry, etc.

- **Old stock of buildings**
  Average age: 50+ years

- **Research intensive**
  12 Nobel Prize winners,
  $1.1 billion endowment in 2012

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who we are

Photo: Flicker User trepellu

- **36,000 students**
  11,000 faculty and staff

- **Total gross area: 800,000 m²**
  (8.5 million sq. ft.)

- **Annual energy use: 1.4 million GJ**
  (1.3 million MMBTU | 385 GWh-e)

- **Annual energy cost: CAD $18M**
  (€ 14 million)

- **2 steam distribution networks**
  500+ million lb steam / year

- **2 power distribution networks**
  30MW peak demand

- **3 main chilled water distribution networks**
  12,000-ton capacity

- **±1,000 HVAC systems**

our challenges

- **Highly energy intensive university**

- **Utilities not metered at building level**

- **Numerous HVAC systems**

- **Systems controlled by other unit**

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Hardware

- **$3.0 million investment**

- **400+ meters installed**
  electricity, steam, condensate, natural gas, hot water, chilled water

- **70+ buildings monitored**
  50% of campus gross area

- **80% of energy use monitored**

- **18 months**
  to install, set up, and integrate meters to existing metering platform

- **Procedures and tools**
  developed to verify and validate installations, set-ups, and equipment

- **Credibility**
  Consistent process, standard set-ups, constant validation

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Software

- **Collect and organize data**

- **Plot energy demand in real time** against external factors T_{out}, RH_{out}, wind speed and direction, net solar radiation

- **Generate reports** to follow trends in long-term energy use

- **Train "typical curves"** to benchmark buildings against themselves and detect anomalies

- **Engage building occupants**

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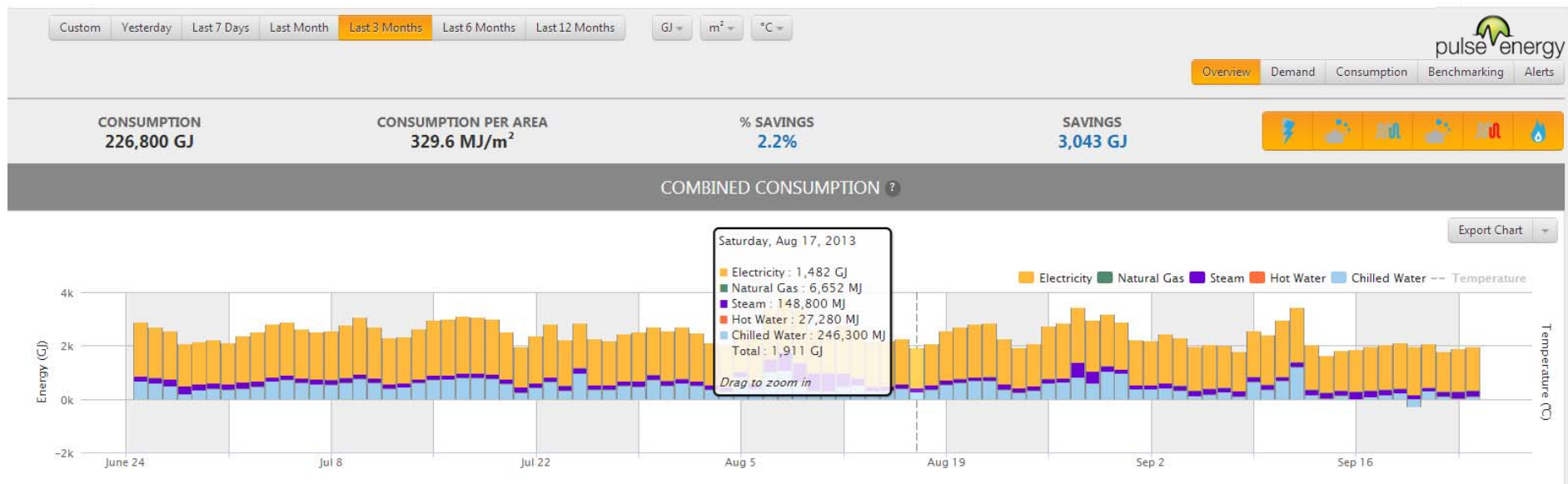
"Humanware"

- **Multidisciplinary team** comprising energy managers, HVAC managers, control technicians, and ad-hoc guests

- **Analyse anomalies and implement measures**
  - Corrective (short term solutions)
  - Preventive (long term solutions)

- **Coordinate operations** energy generation and distribution vs energy demand on campus

- **Review processes, inform decision makers**

- **Examples of anomalies:** abnormal trend in energy use, random spike in demand, unnecessary energy use during unoccupied hours, etc.
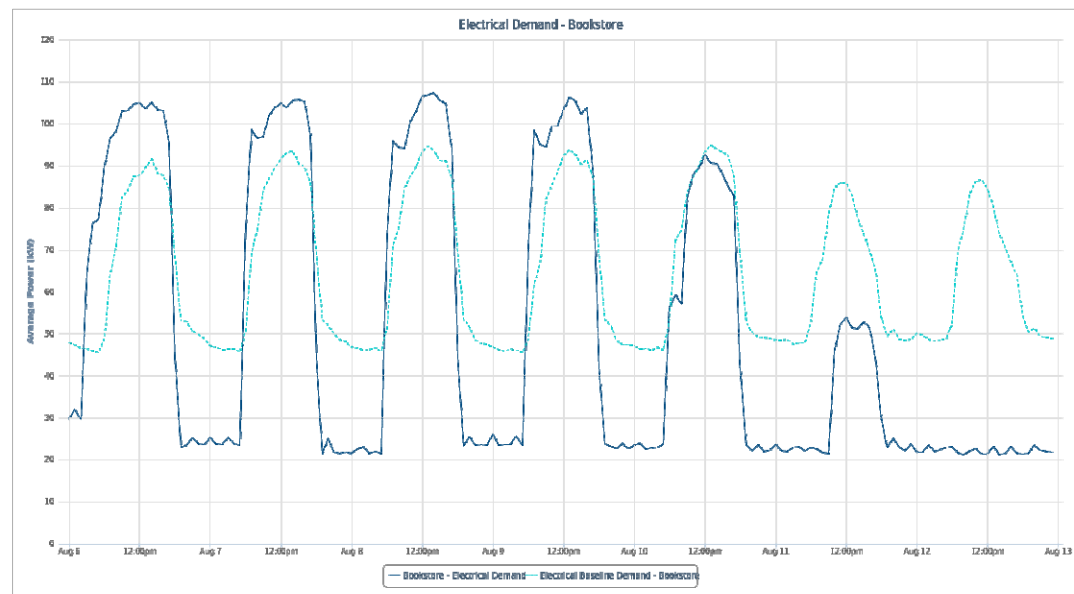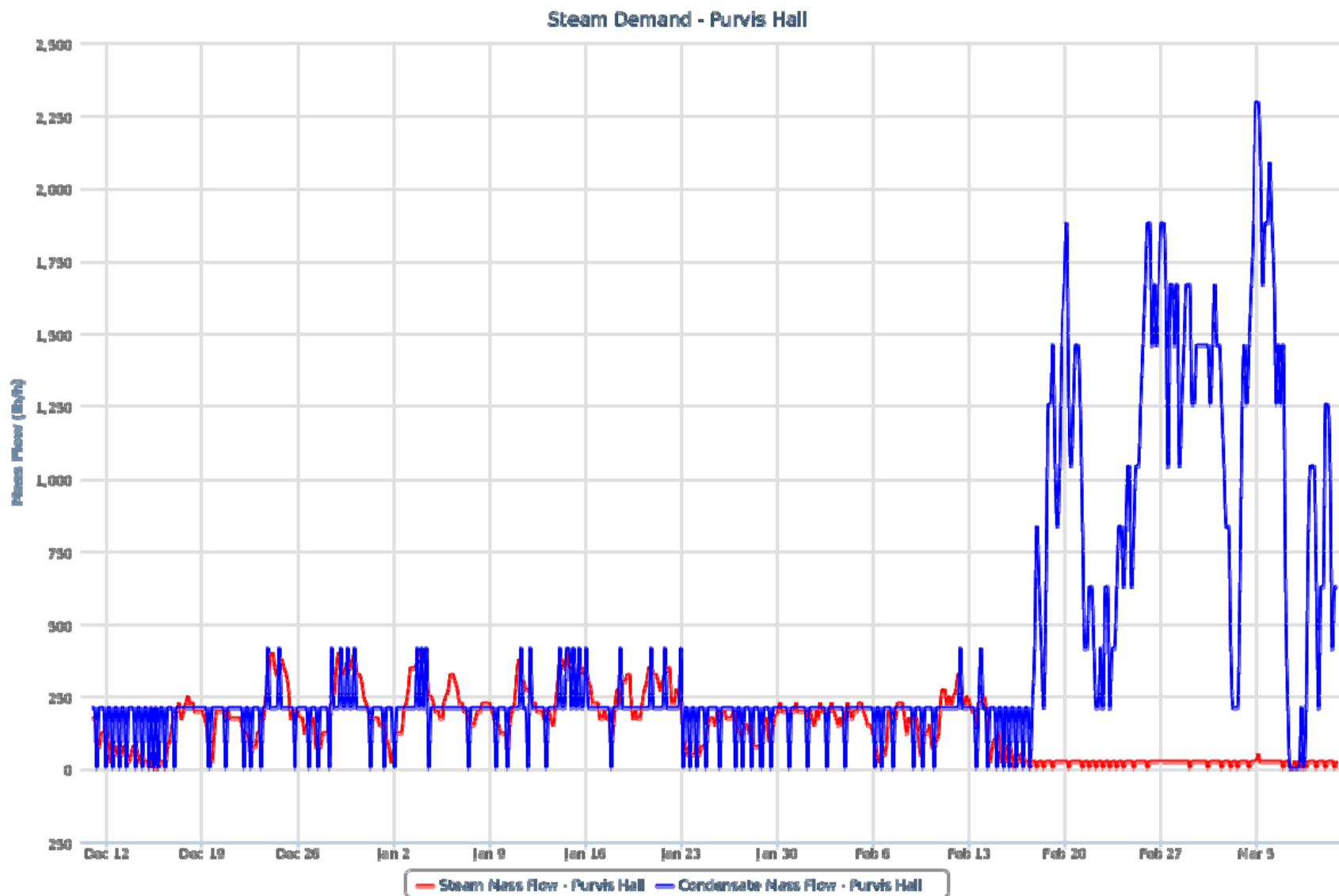
the project

Examples of Measures

- **Review HVAC schedules** to realign occupants' needs and optimal operations

- **Optimize ventilation and temperature set points**

- **Enthalpy control of fresh air**

- **Peak shaving** steam generation and peak power

Building Hours		Other Hours	
Mon-Fri:	09:00-19:00	Mon-Fri:	-
Saturday:	Closed	Saturday:	-
Sunday:	Closed	Sunday:	-

MAASS CHEMISTRY BLDG

	Siemens	SYSTEM				Office	Laboratory	Classrooms	Other	TEMPERATURE CONTROLS						CURRENT HOURS		
		Type	Floor/Room	Heat	Cool					MON-FRI		SAT.		SUN.		MON-FRI	SATURDAY	SUNDAY
										Occ. / Unoc.		Occ. / Unoc.		Occ. / Unoc.		Start - End	Start - End	Start - End
		Supply	All Building	X	-					A	B C	B C	B C	B C	B C	0:00 - 24:00	0:00 - 24:00	0:00 - 24:00
		Supply	All Building	X	-					A	B C	B C	B C	B C	B C	0:00 - 24:00	0:00 - 24:00	0:00 - 24:00
		Exhaust	All	-	-					A	B C	B C	B C	B C	B C	0:00 - 24:00	0:00 - 24:00	0:00 - 24:00
		Exhaust	ALL	-	-	X				A	B C	B C	B C	B C	B C	0:00 - 24:00	0:00 - 24:00	0:00 - 24:00
		Ventilation	Mechanical Room	X	X				X	A	B C	B C	B C	B C	B C	TC	TC	TC
		Ventilation	Mechanical Room	-	-				X	A	B C	B C	B C	B C	B C	TC	TC	TC
		Supply	34, 35, 36, 37	X	X					A	B C	B C	B C	B C	B C	TC	TC	TC
		Ventilation	25B, 26	X	X					A	B C	B C	B C	B C	B C	TC	TC	TC

Steam Demand - Purvis Hall

Electrical Demand - Brown Student Services

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Electrical Demand - Education

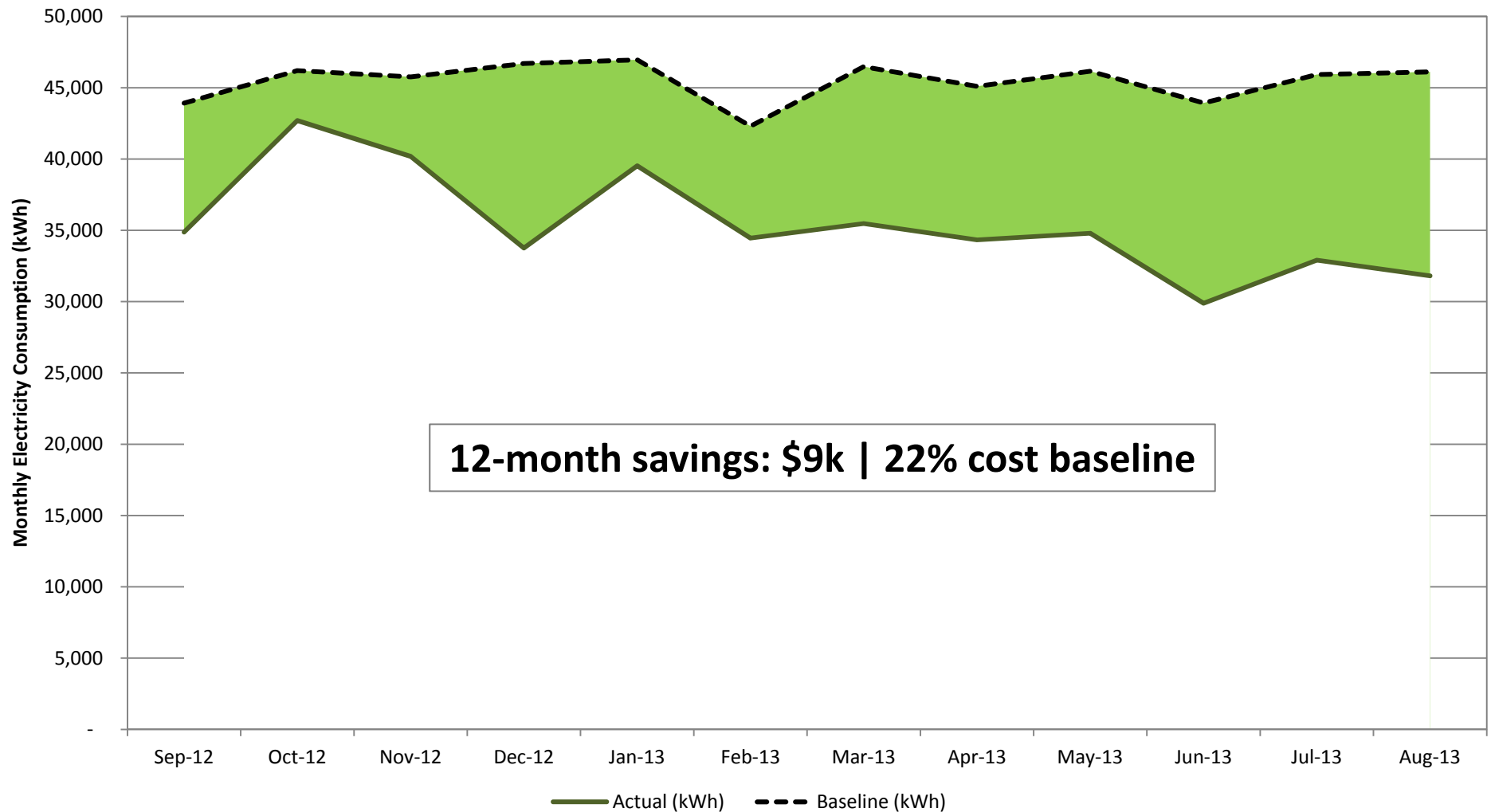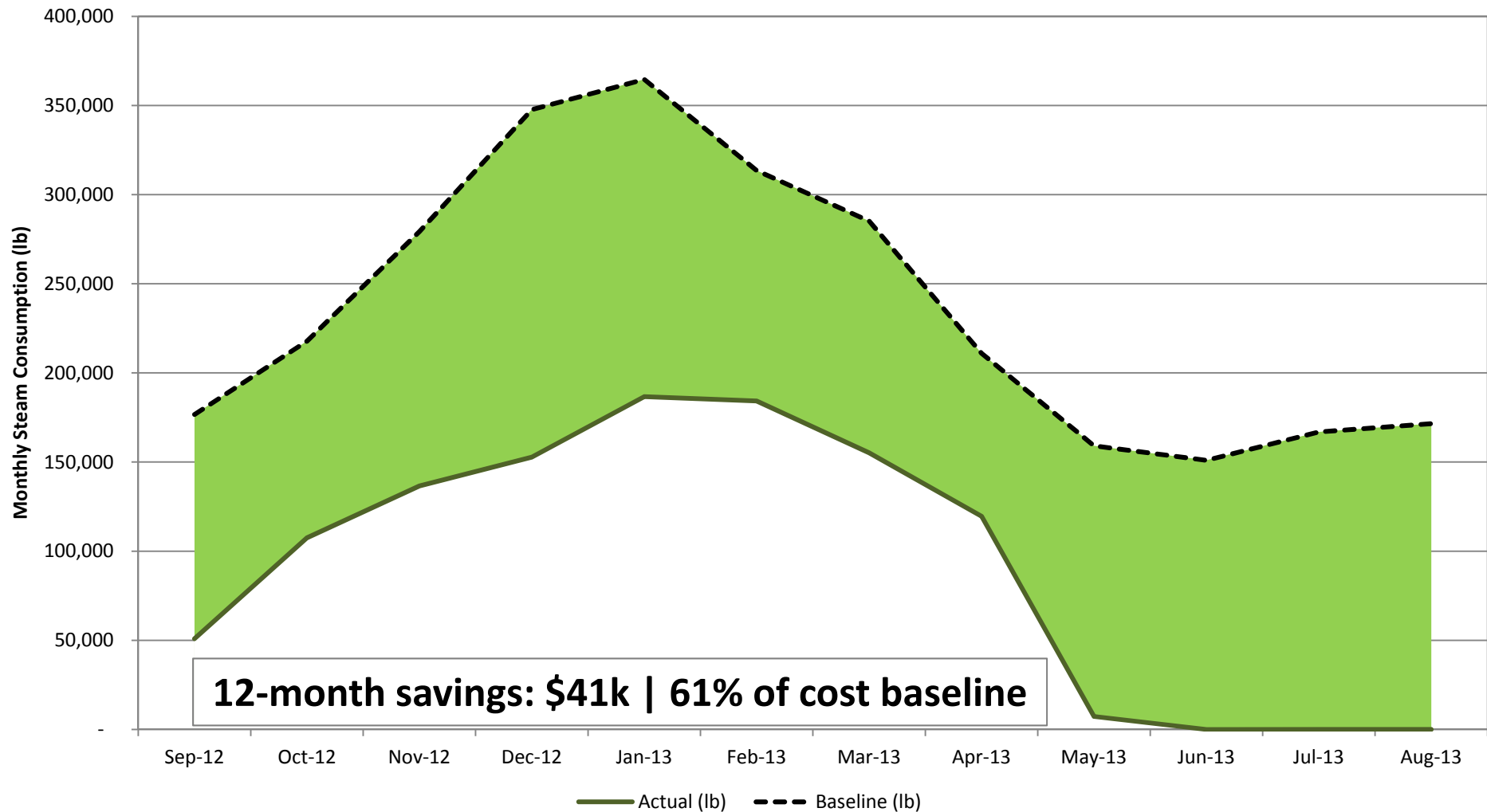Legend: Electrical Demand — Electrical Baseline Demand - Education — Outside Temperature - Montreal
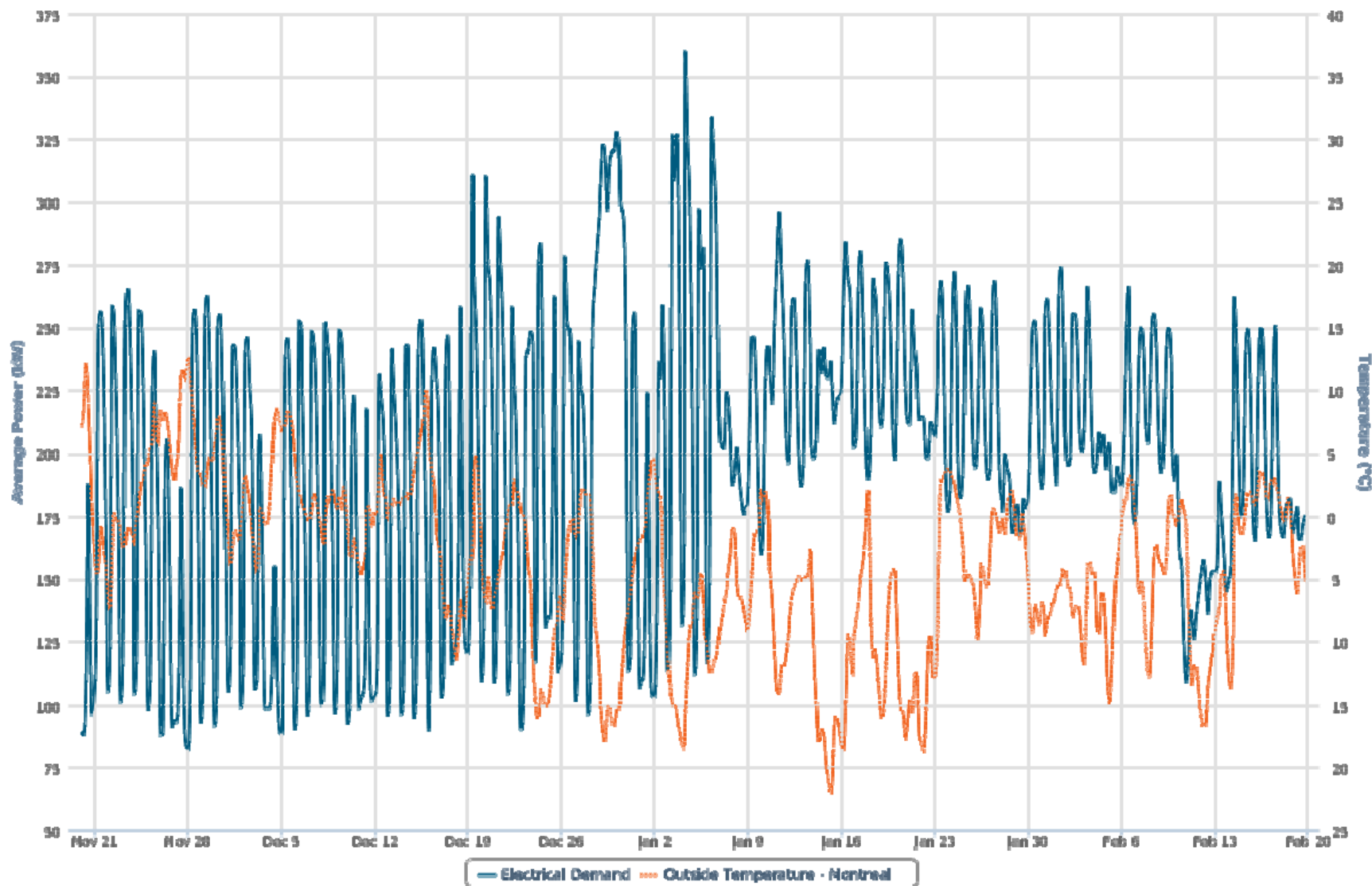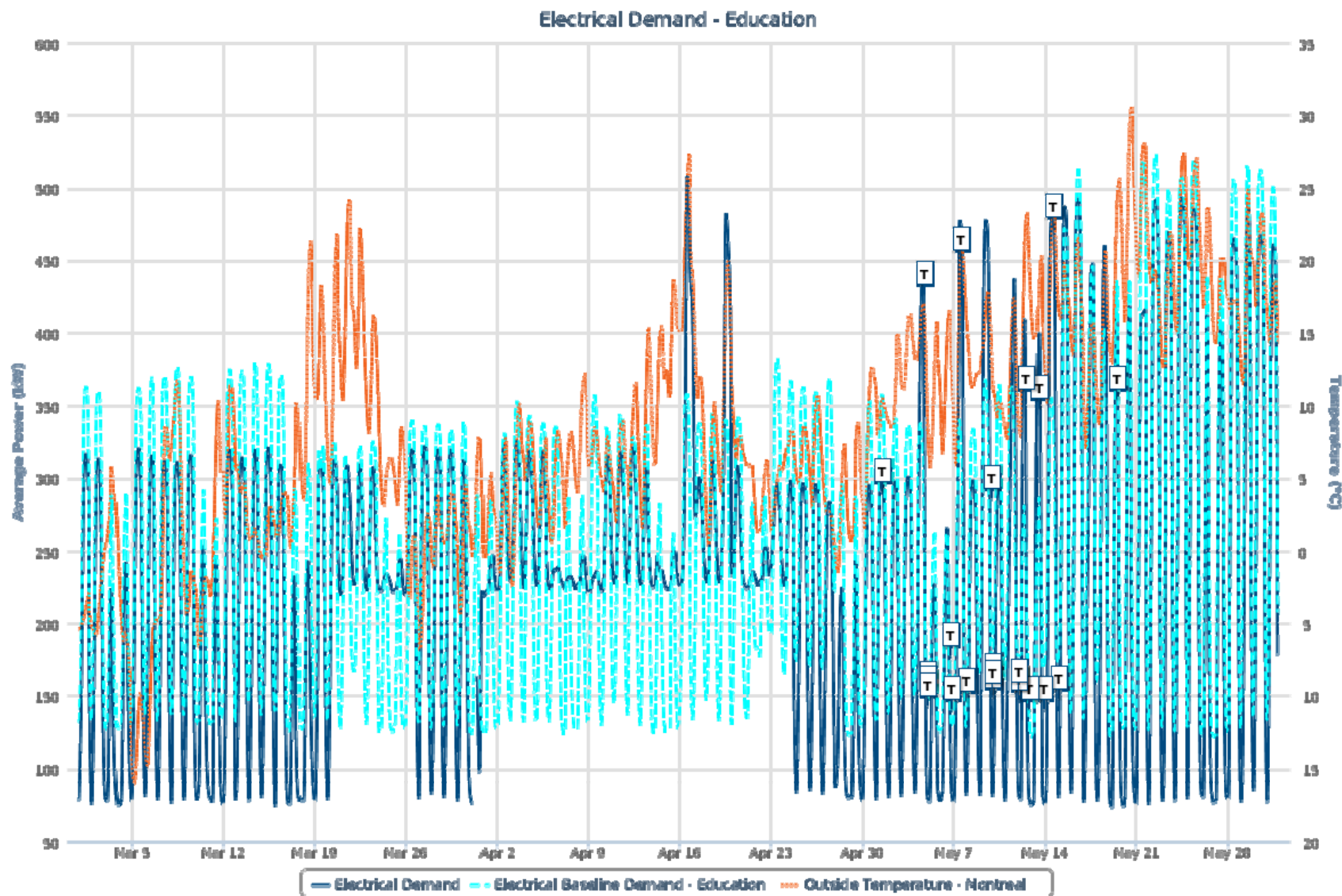
Optimization of the Ventilation Schedule
Electricity Savings – McGill Bookstore

HVAC Schedule Optimization + Enthalpy Control + Steam Shutdown
Steam Savings – McGill Bookstore

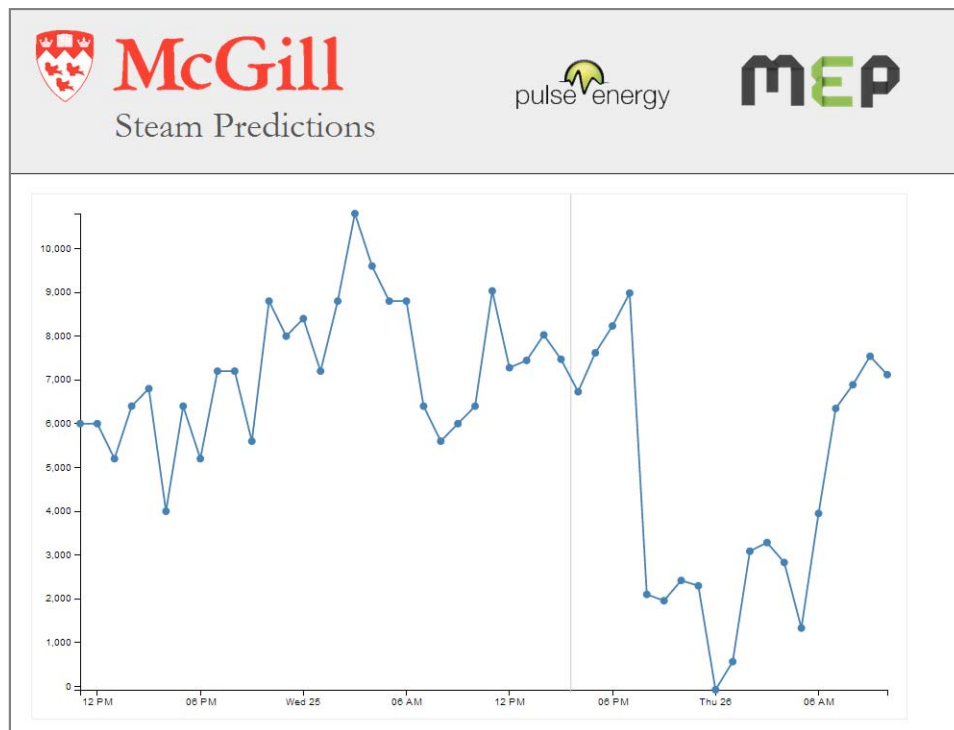12-month savings: $41k | 61% of cost baseline

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HVAC Schedule Optimization + Occupancy Detection
Total Energy Savings - Bronfman Management Building

12-month savings: $131k | 31% of cost baseline

Legend: —— Actual (GJ)   - - - Baseline (GJ)

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Quantifiable Results

- **Review of HVAC schedules**
$180k | 18,000 GJ for 18 buildings reviewed (of 40)

Other Benefits

- **Enhanced cooperation and better understanding of each party's priorities**

- **Pro-active solution seeking and sharing of information**

- **Positive impact on other energy projects (e.g., ReCx)**

- **Increased awareness of Building Operations team**

Fodder for Projects

- **Student projects co-supervised / supported by Energy Management team**
  - Behaviour change project in dorms and labs
  - Steam demand forecast model
  - Steam generation optimization algorithm

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Limitations

- **Level of granularity of metering**
  More granularity would allow us to pinpoint problems more easily but digesting ±400 meters has proved very tedious

- **Extensive monitoring means a lot of extra activities that aren't core business**
  e.g., meter maintenance, annual verification of equipment, etc.

- **Recurring cost**
  to maintain new assets, pay for software fees, coordinating activities, etc.

- **Hardware and software doesn't forgo the need for brain power**

http://www.greenbookblog.org/wp-content/uploads/2013/07/lessons-learned.jpg

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On the Roadmap

- Finish implementing revised HVAC schedules

- Address occupancy detection, ventilation and temperature set points through retro-commissioning

- Better predict steam and power demand

- Peak shaving and load shedding

- Continuous building optimization?

thank you

Jerome Conraud

Eng., MASc., CEM

**Energy Manager
Utilities & Energy Mgmt
McGill University**

jerome.conraud@mcgill.ca
514-398-5870

Take a peek at our energy dashboard!

mcgill.pulseenergy.ca

http://sheaf1.wpengine.netdna-cdn.com/wp-content/uploads/2012/03/Mcgill_ArtsBuilding_original.jpeg