Energy Monitoring and Management: A Case Study of Brentwood Towers, Toronto

Executive Summary

Through good management, and new technologies, O'Shanter Development has achieved extraordinary savings in this five building complex on Lascelles Boulevard called Brentwood Towers. Savings have, in large part stemmed from hourly performance monitoring. The hourly collection of utility data has provided the basis for each upgrade, including new BAS, boiler room improvements, better control of corridor ventilation and exhaust, and water retrofits.

Altogether, O'Shanter has achieved a measured 30% gas saving, equivalent to 600,000 m3 or $180,000 per year, with additional savings in water and electricity. Using a capitalization rate (CAP rate), this translates into an added capital value of $3.6 million, a very worthwhile investment.

Building Specifications

Construction Year: 1958-1961	Heating Fuel Source: Natural Gas
Number of Units: 956	DHW Fuel Source: Natural Gas
Gross Floor Area: 64,000 m^2	Cooling: 25% of suites have window A/C units
Number of Floors: 19	Tenancy: Mix of Family and Single

Introduction

Located on Lascelles Boulevard, Brentwood Towers is a series of five multi-residential buildings in the popular Yonge-Davisville neighborhood. The 956 unit complex was built between 1958 and 1961 and was one of Toronto's first high-rise residential communities. O'Shanter has undertaken a series of upgrades and retrofits at Brentwood Towers over the last 25 years, resulting in significant decreases in energy and water consumption.

Believing in the potential for reduced maintenance and utility costs at Brentwood Towers, O'Shanter realized the value of greater centralized control of individual building systems. While utility bills can provide a coarse overview of water and energy consumption on an annual basis, better utility management requires more detailed monitoring.

The challenge was to develop cost-effective monitoring and control systems which could be used to direct day to day maintenance as well as guide and inform future retrofit work, resulting in the more efficient allocation of resources. The systems also needed to be able to protect investments in conservation and reduce maintenance costs by verifying performance and indentifying issues early.

Evolution of Monitoring and Control

Early Systems

O'Shanter began monitoring and tracking energy consumption at Brentwood Towers before the advent of the internet and automated meter reading technologies. Rather than relying on utility bills, gas consumption was tracked daily by having site staff read the meters manually. Results were then sent to the head office via telephone, and compared to weather data. This system provided day-to-day insight into building performance, and is still utilized at smaller sites.

Originally heating system control was achieved with numatic (air pressure) systems and capillary tubes. Later, basic electronic building controls were installed. These systems utilized thermistors with limited precision and only provided coarse on/off control of mechanical equipment. Furthermore, they could not be accessed remotely or easily modified. This limited the system's responsiveness and its capacity to support further building system innovation.

Enhanced Utility Monitoring

Today O'Shanter gathers hourly natural gas, electricity and water data throughout their building portfolio using the EnergyBrain monitoring system. The system connects the utility meters to the internet, providing continuous feedback about building performance.

Originally all five buildings at Brentwood Towers were served by a single natural gas meter. To better monitor the site, O'Shanter installed submeters to measure consumption at each individual building. The meters are also integrated into the system, providing hourly consumption data online.

Advanced Building Automation

To achieve improved heating system control, O'Shanter has moved towards a more advanced building automation system (BAS), using Unitronics programmable logic controllers (PLCs). O'Shanter uses the BAS in conjunction with monitoring to fine tune building systems. As control adjustments are made, the impact on energy use can be seen immediately. Similarly, trending analysis provided by the BAS can be used to diagnose equipment issues and adjust control algorithms.

Unlike earlier control systems, the Unitronics system has a touch screen graphical interface that can also be accessed remotely over the internet via a VPN connection. This allows technicians to access the system while working on site, and for management to monitor the building and make adjustments remotely. Access and operation is by trained staff or a 3rd party energy management company only.
The result is a shift of building operation away from building staff, and towards experienced building operators who understand the energy impacts.

Utility data sent to EnergyBrain database every hour

Continuous feedback on building performance available through web browser

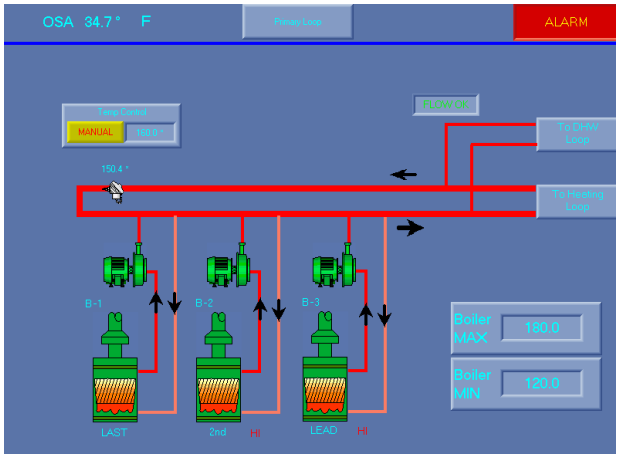

Figure 1. Unitronics BAS display

O'Shanter keeps the cost of installing a new BAS to about $10,000 by using in-house staff to do much of the installation, making it cost effective at all but the smallest multi-residential buildings. Because the Unitronics-based system is also flexible, O'Shanter frequently updates and adds to existing installations, expanding functionality.

Putting Technology to Work

As many property managers have discovered, simply having technology and data does not guarantee results. O'Shanter has been successful at utilizing hourly utility monitoring and building automation to improve performance in a variety of ways.

Continuous Performance Assessment

Central to O'Shanter's utility management strategy is the concept of continuous performance assessment. EnergyBrain projects the building's typical consumption from historical trends and current weather data, and then compares it to the actual consumption. This type of weather-corrected model makes it possible to evaluate the performance of temperature-dependent systems such as heating or cooling even under changing outdoor conditions.

Email alerts help mitigate the cost of unforeseen events by flagging variations in building performance. For example, a single leaking toilet or faucet can easily cost a thousand dollars a year if not reported. The cost of undetected equipment failure and setpoint changes can also add up quickly. By sending alerts of increased consumption, the system helps identify these costly issues so that they can be addressed within days, rather than months later when the utility bill arrives.

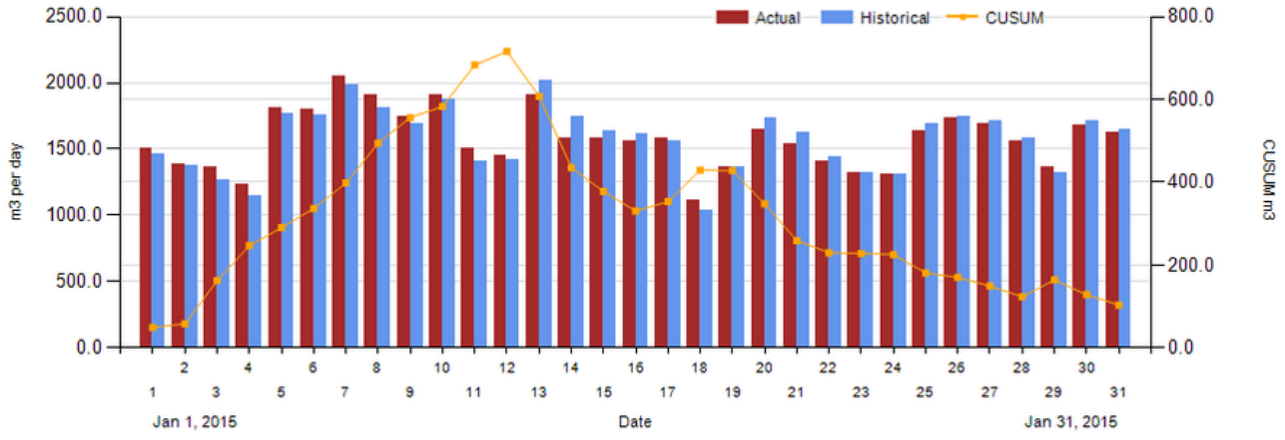

Figure 2. Weather-corrected model compares historical to actual consumption

Guiding Energy Retrofits

O'Shanter has also been able to effectively track retrofit programs using the system. Variable speed drives were recently installed on the domestic water booster pumps at Brentwood Towers, providing electricity savings of 4 kW.

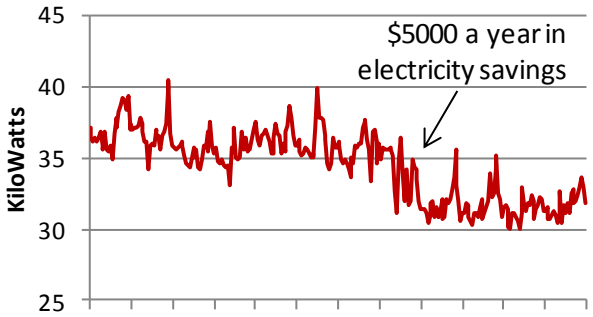

Figure 3. Booster pump retrofit savings

Hourly monitoring allows O'Shanter to verify retrofit results immediately and make decisions accordingly. Monitoring has been used to guide replacement of windows, boilers and toilets, as well as other conservation measures such as T8 lighting and weatherization.

Improved Comfort and Performance

Monitoring and automation technology has also allowed O'Shanter to improve comfort and reduce maintenance costs. In one case, they identified an opportunity for conservation by reducing heating loop temperatures. By installing mixing valves and using the BAS to regulate boiler inlet temperatures, the loop temperature could be reduced while protecting against condensation and extending the lifespan of the heat exchangers. The changes also improved comfort by reducing suite overheating during the spring and fall.

Similarly, the BAS has made it possible to provide better control of ventilation systems. Previously, ventilation air was unheated and the primitive control system meant that it would have to be shut off during cold periods, allowing odours to spread between suites. The BAS is now used to regulate the airflow rate and temperature to meet demand at different points throughout the day, improving comfort and indoor air quality.

Chronology of Events

Here is a summary of the energy conservation measures enacted at these buildings, together with dates.

The benefits and fine tuning of these measures has all been regulated by the hourly monitoring system.

Dates	Measures
2000 - 2001	Installation of hourly monitoring system
2000	Change to 6 litre toilets
2000 - 2002	New windows
2002	Interval monitoring system installed
2003	New boilers
1999 - 2007	DHW re-circ lines, with HX to upper floors
2006	Garage ceiling insulation
2006	Roof insulation
2006 - 2007	Installation of Unitronics PLCs BAS
2007	VFDs on corridor air, and exhaust air
2013	Change to 3 litre toilets
2014	VFD on domestic water booster pumps

Challenges and Solutions

Smaller buildings, particularly those with fewer than 100 suites, often don't have the scale necessary to justify the cost of advanced monitoring and building automation systems. Instead O'Shanter uses their traditional process of manual meter readings. As the cost of installing more advanced systems decreases, they are being extended to smaller sites.

Project Costs

O'Shanter has invested about $10,000 in building automation systems at each of the five buildings, excluding the cost of in-house labour to assist with installation. At each site, the monitoring equipment costs about $2000 to install, with a monthly fee of $60 per meter for third-party data management and review.

Outcomes

The energy required for space heating has been reduced by 30% over the last 25 years, saving over half a million cubic meters of natural gas a year. Energy for DHW heating has been reduced by 27%, saving an additional 180 thousand cubic meters of natural gas a year.

In financial terms, the reductions in natural gas consumption represent a $180,000 per year decrease in operating costs at current rates. Significant cost savings have also been achieved from reductions in electricity and water consumption. Furthermore, utility monitoring has allowed O'Shanter to be more proactive with maintenance, catching issues earlier and minimizing repair work.

O'Shanter recognizes that sustained decreases in operating costs also mean an increase in asset value. Applying a capitalization rate of 5%, each $1 in reduced operating costs translates into $20 in new equity. By focusing on conservation, O'Shanter has been able to finance new acquisitions and grow their portfolio.

Further Retrofit Opportunities

O'Shanter continues to expand the monitoring and control systems, adding additional equipment and data points. Rainwater harvesting is also being explored as a strategy for offsetting irrigation and future water usage. The existing utility monitoring system has been a valuable tool for estimating the water requirements for these outdoor systems.

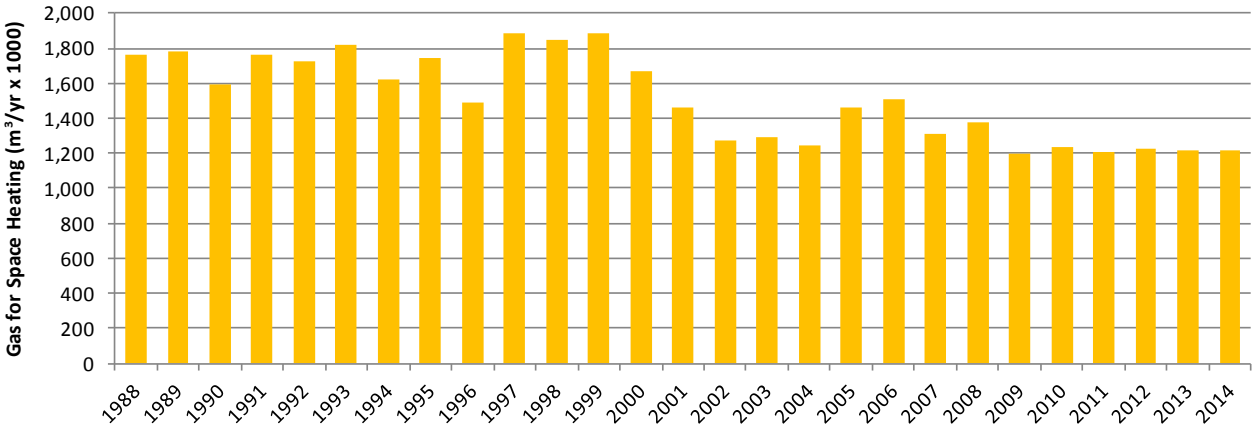

Figure 4. Weather-normalized space heating gas consumption at Brentwood Towers