Mechanical System Upgrade: A Case Study of 45 Dunfield Avenue, Toronto

Executive Summary

The Torontonian at 45 Dunfield underwent a complete heating and hot water retrofit between May and September 2013 to replace inefficient systems that were well beyond their expected lifespan. An adapted 'campus style' distribution system was used to maximize efficiency and control. The goals were, to maximize energy efficiency, increase reliability and reduce maintenance costs, improve resident comfort and service, increase the asset value and free up space for a district heating system.

In its first year of operation, gas consumption was reduced by 8% with improved comfort for residents and enough space made available in the boiler room to build an energy centre for future buildings currently in the planning stage on site.

Shiplake Properties, the owners of 45 Dunfield, had previously installed energy monitoring software and a Building Automation System (BAS) and as a result were well positioned to make a business case for the project. By participating in the City of Toronto Tower Renewal Program they were able to further substantiate results through the Tower Benchmark which showed their level of efficiency as compared to 200 similar residential buildings.

Building Specifications

Construction Year: 1967	Heating Fuel Source: Natural Gas
Number of Units: 575	DHW Fuel Source: Natural Gas
Gross Floor Area: 55,896m2	Cooling: 25% of suites have window A/C units
Number of Floors: 28	Tenancy: Mix of Family and Single

Introduction

Located at 45 Dunfield Avenue, the Torontonian is a large multi-residential building located in the city's popular Yonge-Eglinton neighbourhood. The 575 unit concrete slab structure was built in 1967 and, like many of Toronto's apartment towers of that era, was built with oversized, inefficient energy systems. Towers of this period were also typically over-engineered from a structural standpoint and built to last. As a result, significant upgrades to the building are bolstered by the reassurance that the long term investment will be supported by structural stability.

The challenge facing Shiplake Properties was to replace a 60% efficiency heat and hot water system build with 100% redundancy (twice the capacity required) while reducing utilty consumption by a minimum of 15%. The new system also had to address poor zone control and distibution, excessive stack effect leading to high negative stack pressure.

Retrofit Summary

Original System

- 4 fire-tube boilers (60% efficiency)
- 56 million btuh capacity
- In-suite finned convectors
- KMC BAS
- 4 Gas fired MUA with VFD

New System

- 3 Camus fan assisted Dyna Flame 3000 Boilers
- 18 million btuh capacity
- Updated KMC BAS
- Fulton Direct Digital Control (DDC)
- 1 Heat exchanger
- 9 Grundfos Zone pumps with VFD
- 1 Grundfos booster pump station with VFD
- Enervex computerized draft control

Zone Control

The upper and lower zones were combined, enabling a greater diversity in the system and a reduction of the number of boilers required. Redundancy was maintained while btuh requirements were cut in half.
Boilers were piped in a 'primary-secondary-tertiary' or 'injection' campus style system. The system can send out low temperature water in mild weather while having higher temperature water return. This prevents overheating and can deliver different temperatures to each zone. It also cuts out short-cycling. The system improves efficiency, reduces overheating of apartments, extends the life of the boilers and reduces the maintenance costs associated with replacing heat exchangers.

Variable Drives

Variable speed drives were deployed throughout the system to trim pumps and produce exactly the flows and heads required without wasting energy. In many cases, Enbridge gas offers incentives through different programs which can help offset costs, and further enhance payback.

Domestic Hot Water

Domestic hot water is now supplied via a heat exchanger using heat from the main boiler plant. In larger buildings this design does not require additional boilers for heating domestic hot water.

Risers

The original domestic water pipes delivering hot and cold water were galvanized iron, used an inefficient circulation system and had a significant number of pin-hole leaks at the take offs in the lower levels. The decision was made to replace the pipes with copper. The new risers were insulated to reduce condensation for cold water and heat loss for hot. Anti-scalding mixing valves were also added. The new risers were balanced using unpowered flow control valves allowing measured flow, independent pressure, reduced pump capacity and energy consumption, reduced maintenance costs and faster hot water supply to the residents.

Resident Engagement

Because the replacement of risers required work inside resident's suites, the replacement program began with a meeting where a work schedule was discussed and residents were familiarized with the plan. The disruption of water service during riser replacement was minimized by the installation of shut-off valves that allow water to be shut off to suites individually. And by having a large crew work on the project, the job could be completed quickly.
Residents were kept informed throughout the process through a series of communications.

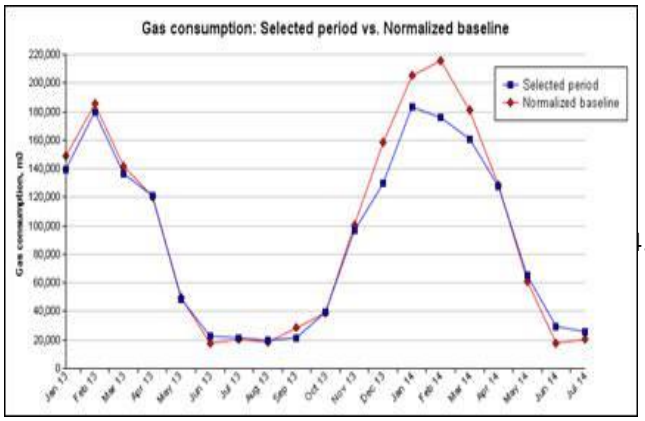
Challenges and Solutions

Older, oversized boiler systems are able to overcome draft caused by a high chimney; with newer systems this can deform the flame. To overcome this problem, an Enervex computerized draft control system was installed.

An excess of Magnetite was discovered in the heating system during the retrofit process. This buildup can damage pump seals and build up in the heat boilers. As a result some pump seals had to be replaced and boiler water aggressively filtered.

Outcomes

Natural gas consumption was visibly lower than the year prior to the retrofit with a savings of over 90,000 cubic meters per month (see Figure 1). This resulted in savings of approximately $27,000 in the first year of operation. It is expected that this performance will improve as the system is adjusted through monitoring and BAS systems.



A reduction to the wear and tear of the boiler system, the repair of pin-hole leaks and the improvement of water distribution will reduce maintenance costs.
Resident service and comfort has been improved as a result of more efficient delivery of hot water and better zone control for heat. A more balanced heating system can help to reduce the practice by residents of opening windows for moderating temperatures in winter. This will be further supported by the goodwill shown during the retrofit process through resident engagement by Shiplake.
Because of the much smaller system installed, approximately 50% of the boiler room was made available for the installation of a district heating system, helping to bring down the construction and operating cost of a planned infill project.

Economics

The performance improvement particularly shows up when we compare the performance of this building with other buildings in the Greater Toronto Area.

When compared against other buildings sampled, 45 Dunfield uses close to half the energy of the median building the same size in the GTA. The median value for energy consumption is 343 ekWh/m2 per year for buildings in the GTA. In comparison, 45 Dunfield uses only 212 ekWh/m2 per year, which is a reduction of 131 ekWh/m2 per year and a comparative annual saving of over $212,000.

Using a CAP rate of 5%, typical for central Toronto, this means a $1 saving on utility costs translates into a $20 increase in building capital value.

Looking at the value of 45 Dunfield, the $212,000 utility saving would result in an increase in property value of over $4 million. On many levels, investment in conservation just makes good sense.

Further Retrofit Opportunities
With the success of this retrofit program Shiplake is now undertaking further upgrades to the Domestic Hot Water distribution system.

Consideration is also being given to an over-cladding system to further improve energy efficiency, resident comfort and adding a 'face-lift' to the building as the company moves forward with an upcoming infill project.