BETTER BUILDINGS

CASE STUDY NUMBER 45

REDUCING MAINTENANCE, OPERATING AND ELECTRICAL COSTS IN A HIGH RISE CONDOMINIUM

INTRODUCTION

The Board of Directors of a ten-year old 22-storey condominium in Toronto undertook a number of improvements to the mechanical and electrical systems with the goal of reducing maintenance and operating costs and improving the building's overall energy efficiency.

The building, constructed around 1986, has a floor area of 25,284 m^2 (272,000 sq.ft.) and contains 336 suites. There are also three levels of parking below grade.

THE PROBLEM

Most of the equipment in the ten-year old building was still performing well with only routine maintenance, and had many years of remaining service life. However, the hot tub heaters had been requiring more servicing than anticipated. It was decided to replace the whirlpool heaters and, at the same time, to look for other measures that could reduce energy costs.

Building Element Description

Building Envelope: Typical exterior wall construction is 76mm brick veneer, with 25mm air space and RSI 2.55 (R14.5) rigid insulation and trowel on air/vapour retarder; 90mm concrete block; and 13mm drywall.

Roof construction: paving stones, with RSI 2.55 rigid insulation, 3 ply membrane, and concrete slab.

Windows: thermally broken aluminum frames; lower windows are horizontal sliders; upper windows are double glazed fixed units.

Mechanical System: Heating or cooling is provided to the suites by in-suite fan coil units. Heated or chilled water is provided via a two-pipe system to the fan coils from central boilers and chillers. Fresh air is provided to the corridors by central fans. Fresh air is heated or cooled by coils in the air stream.

Figure 1.

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Kitchen and bathroom exhaust fans extract stale air from the suites.

Lighting: In the parking garage the original lighting consisted of 143 fixtures with two F-96 T-12 lamps and 86 fixtures with two F48 T-12HO lamps.

THE WORK

Proposals were invited from qualified Energy Management companies, and reviewed by the condominium's Board of Directors. Key considerations for proposed energy conservation measures were: cost-saving potential; durability; and exclusivity (that is, multiple options for equipment and service providers). The Board also wanted a simple payback period of less than four years.

The successful contractor (Provident Energy Management) began with an energy audit of the building. Based on the recommended energy conservation measures flowing from this audit, the following work was performed.

1. Garage Lighting Retrofit: The original fluorescent lighting in the garage was removed and replaced with high pressure sodium lighting (100 fixtures of 150W and 7 fixtures of 100W units).

2. Building Automation System: A new Landis and Gyr System 600 was installed. This system provides direct digital control of most loads over 2 horse power; equipment rotation; time of day control; proportional, integral, and derivative (PID) loop (valve) control; demand limit and chiller water reset; fresh air supply free heating/free cooling; and temperature set-back on domestic hot water; one year of remote monitoring was included in the cost of $62,000 for this measure.

Figure 2. New garage lighting

Figure 3. New building automation system

3. Fresh Air Supply Fans: The original fan motors were replaced with Teco Westinghouse Optim HE motors, with added variable speed control.

4. Hot Tub Conversion: A Phalen gas-fired water heater was installed at the hot tub to replace the existing electric water heater. The original in-line immersion electric heaters were left in place as a back-up to the new system.

5. In-suite fan coils: Fan motors were replaced in 70 of the fan coils. New PSC type motors replaced the existing shaded pole motors. The inside of the units were cleaned, including the back of the coil, and the filter media was changed.

Water conservation measures such as toilet replacement and shower and sink aerators were also considered. However, the estimated cost ($160,000) was viewed as too high, although the payback period of 5.5 years was reasonable.

Figure 4. New fresh air supply fans

SCHEDULING

The work was performed between March and September, 1997 and was tailored to minimize disruption to the owners, and to balance out the payments to the contractor.

SUCCESS FACTORS

Three Energy Management companies were invited to submit bids, allowing the Board to select the company best suited to their needs. The Board budgeted its Capital Replacement Reserve Fund to ensure financing of the energy retrofit work. An important provision was that a portion of the energy savings realized by the project would be directed back into the Reserve Fund to make up any shortfall in the Fund.

The Energy Management company provides remote monitoring of other condominium complexes with similar equipment. This means that empirical data from similar buildings is available for monitoring and comparing the performance of the retrofits. In addition, remote monitoring of the mechanical systems was initiated following the completion of the work, which allowed for early detection of any malfunctioning components.

The fresh air supply system was re-balanced floor-by-floor following the retrofits.

DIFFICULTIES

Central Building Automation System (BAS) panels were located in the mechanical penthouse, with contacts and controls as far away as the ground floor. As a result, the routing of control wiring through the existing building was challenging.

After one owner, who lived directly above a mechanical room housing one of the new direct drive fan motors, complained about the noise, an acoustic engineer evaluated the problem. Isolation hangers were installed at fans, and non-rigid couplings installed in piping. This reduced the noise enough to satisfy the complainant.

The overlap of routine maintenance work with the energy retrofit work created some difficulties, mostly related to access and coordination of scheduling. For example, painting of the garage was carried out simultaneously with the lighting retrofit, so access to areas of the garage had to be coordinated with the painters.

High pressure sodium lighting results in sharper shading as compared to the original fluorescent lights. Residents reported some discomfort with the new system, but became accustomed to the change.

THE COSTS

Total cost for the project, including the development of proposal documents and the energy audit, was $160,000 plus GST. The breakdown of costs is:

Garage Lighting Retrofit: $45,000

Building Automation System: $62,000

Fan Motor Replacement: $24,500

Hot Tub Conversion: $14,5000

Fan Coil Units: $14,000

THE RESULTS

The primary measure of performance for this project is the annual savings in operating costs. The projected savings vary depending on the basis for the calculation (see table 1, below). The contractor projected annual savings of $38,423 resulting in a 4.4 year simple payback.

Energy Savings Projections

Provident Energy Management calculated projected annual energy savings by separately considering each of the individual elements being altered. The synergistic effect of the elements taken together was not considered, assuming that this would allow for a more conservative estimate. Siemens SimoSave software was used to model the motor replacement. Empirical data from similar buildings was used to model energy savings from work proposed at the hot tubs. Provident projected a total annual energy saving of $38,100 using 1995/96 as the base year.

Table 1

CONSUMPTION DATA (Combined Cost of Natural Gas and Electricity)			
	1998 Consumption	Comparison	Savings
Actual Utility Data	$292,609	$345,767 (1996 Actual)	$53,158
Provident's Projections	$307,344	$345,767 (1996 Actual)	$38,423
PowerDoe Projections	$307,438	$335,044 (Simulated Pre-Retrofit 1998)	$27,606

PowerDoe is an energy analysis program developed by the U.S. Department of Energy. The PowerDoe energy simulation provides weather normalized data, as well as data on the impact of individual measures. As it is good management practice to provide an independent source for confirmation of energy savings, PowerDoe was also used on this project. The following table summarizes the actual utility data, Provident's projections, and energy consumption projected by PowerDoe.

Table 1 shows actual utility consumption data and projected consumption for 1998. The savings vary dramatically depending on the method used to calculate them. However, the order of magnitude is the same. The results differ for a number of reasons including the fact that each individual suite will have a different temperature and lighting regime. When modeling the building, assumptions must be made regarding this information. These assumptions will not perfectly simulate actual conditions.

The choice of baseline data affects the calculation of savings. Provident has chosen the year 1995/96 as their baseline with no consideration for weather effects on the data. The savings could be affected as much by variations in the weather as by the conservation measures.

In fact, 1998 was considerably warmer than the baseline year, increasing apparent savings. Although the monetary savings to the Corporation are real, it is difficult to measure the proportion of the savings due to the energy conservation measures, and the corresponding success of the retrofit work.

The PowerDoe savings calculations compare the actual utility data for 1998 to a simulation of how the building would have behaved in 1998 if the retrofit had not taken place. This allows for a more accurate evaluation of the success of the retrofit work, but it reduces the value of the total savings that will be realized during a warmer year.

CONCLUSION

The retrofit measures undertaken by the condominium corporation met the key objectives of the project, that is, energy conservation and reduced maintenance and energy consumption costs. A simple pay back of 4.4 years was realized.

PROJECT TEAM

Property Manager:

Del Property Management

bbaskovic@deltera.com

Energy Service Company:

Provident Energy Management

info@pemi.com

Consulting Engineer:

Halsall Associates Ltd

mvandusen@halsall.com

If you have any comments, or would like to submit your project for publication, please contact:

Idemigue@cmhc.ca

For more information about building envelopes solutions and best practices, visit the Canada Mortgage and Housing Corporation (CMHC) Web site at

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