TowerWise

Case Study:

15 Kensington Road

1. Executive Summary

When new property managers arrived at 15 Kensington in 2005, they saw an opportunity to significantly reduce operating costs in the building by improving its energy efficiency. They identified replacement of all heating and domestic hot water boilers, toilets and the chiller, along with integration of the air handling unit with the boiler and chiller systems to pre-heat and pre-cool incoming air, as actions that could save the condominium significant operating costs.

However, because of the scope of the project, it was important to stage it in a way such that utility savings from initial retrofit items would help to offset the cost of later items and with an eye to integrating all system components to maximize efficiency. This allowed 15 Kensington to undertake a deep retrofit that maximized cost savings while relying only on reserve funds and operating surpluses to finance the work. The end result is that natural gas use has been reduced by 28% while water use is down 29% and the electricity demand of the chiller has been reduced by more than half. All of these measures have resulted in a decrease in the building's greenhouse gas emissions by an average of over 300 Tonnes of CO_2e per annum.

Conservation measures	Annual utility bill savings	Annual GHG reduction	Blended payback	Net Present Value in 2010 (10 yr.)
Boiler replacement Toilet Replacement Chiller Replacement	$65,000	300 tonnes	4.4 years	$183,000

2. Project Description and Rationale

Constructed in 1974, 15 Kensington Road is a 210-unit condominium building located in Brampton, Ontario, that had not undergone any previous energy-related retrofits. Though over three decades old, the building had no maintenance backlog and a reasonable building envelope, including double glazed low-emissivity windows. However, high energy bills prompted the new building manager to consider retrofit strategies for the building.

Priorities for the retrofit work included minimal disruption to residents and use of reserve funds to finance the project in order to avoid borrowing costs. Condo fees for this building were the lowest in the area and the board wanted to ensure these low fees were maintained. To determine the types of energy saving projects undertaken and in what order, the available reserve funds were used as a budget and actions with the shortest payback period were selected first to generate savings to help finance longer payback items. Although consultants were hired to help with the selection of the chillers, the on-site property manager, Ehsan Haghi, managed the remainder of the project directly.

Effective communication between the building manager, condominium board and suite owners was critical to the success of the project. To ensure success, Mr. Haghi used tools such as:

- a detailed operational budget to prove the case for change to the condominium board;
- long and short-term updates to tenants through newsletters and notice boards;
- before and after pictures, savings on a per unit basis and project next steps presented at the AGM;
- and implementation of a tenant education program including “do’s and don’ts” to maximize the effectiveness of the retrofits.

Stage 1 – Boiler Replacement

In March 2008, the domestic hot water (DHW) boilers were replaced. Two 45% efficient DHW boilers (1.05M BTU and 770K BTU) were replaced with two 88% efficient boilers (1.5M BTU each). It was a seamless installation, with almost no disruption to the hot water supply, achieved by replacing one boiler at a time. These boilers were purposely oversized so that when a new Air Handling Unit (AHU) was eventually installed, the DHW boilers could be used to pre-heat the incoming air though a heat exchanger, thus eliminating the need for a separate inefficient AHU burner. Additionally the water moving through the DHW boiler is now closed-loop to improve water quality.

After this, five 55% efficient atmospheric space heating boilers were replaced with just two 85% efficient condensing boilers. According to the building manager, on a cold day in mid-winter, one of these boilers will operate at 85% capacity while the other operates at just 10%. This means that one could fail without heat to the building being interrupted. These two boilers are used alternately to extend their service lives.

Stage 2 – Air Handling Unit Adjustments

The AHU was connected to the heating boiler through a heat exchanger in late 2008 and, once the chiller was replaced in 2010, it was also connected to the AHU to provide common area cooling. The motors were also replaced with variable frequency drives to reduce electricity costs. The contractor hired for the boiler installation also retrofitted the AHU and deferred the cost for this work to the next fiscal year.

Stage 3 – Toilet Replacement

For the toilet replacement, an "all-inclusive" contract was issued to a contractor experienced in these types of retrofits and who was used to dealing with tenants. To prevent costly repairs to the surrounding bathroom tiles in some suites, the contractor reserved the right to not install the toilet, but to give the toilet to the tenant along with a rebate of the installation fee in order to allow the tenant to complete their own installation (or arrange for another installer). The building manager then inspected the suite to ensure the work done was satisfactory.

Stage 4 – Chiller replacement

With a provincial requirement to replace chillers using banned CFC gases by the end of 2010, Mr. Haghi started planning an early replacement to avoid the spike in costs he anticipated would develop as the deadline approached. The pre-retrofit capacity of the chiller was 206 tonnes while the new chiller has a capacity of 260 tonnes. This increased capacity allowed the common areas to be cooled in addition to the suites.

3. Project Performance

3.1 Gas savings

From the baseline year of 2007 to the end of 2009, the retrofit measures at 15 Kensington Road have reduced natural gas consumption by 28%.

Figure 1 below shows the actual natural gas usage for 2008 and 2009 alongside a projected usage[1] based on how much gas the building would have used without the retrofit. Also noted in Figure 1, are the months in which gas-saving projects were completed. As the boilers were replaced when the weather started to get warmer (March 2008), the savings associated with this retrofit do not become evident until October 2008. Comparing October 2008 (when the boiler replacement had been completed) to October 2009 (when the AHU retrofit had been completed), the natural gas use was $56m^3$/HDD (Heating Degree Day) and $54m^3$/HDD respectively which represents a slight gain (3.5%) in natural gas use efficiency. This efficiency gain can be attributed to the fact that a burner was no longer required in the AHU because the new boilers, through use of a heat exchanger, could pre-heat the incoming air.

Using this comparison of usage per heating degree day, we can calculate that overall gas usage was reduced by 28% thanks to the retrofit (see Figure 5). However, if we look at gas use for space heating only, we can estimate that this usage was reduced by about 40%.[2]

3.2 Water savings

Replacement of toilets in the building reduced overall water consumption by 29% with toilet-specific water use reduced by 68%. Because 15 Kensington has an automated sprinkler system for its grounds, water use rises over the summer months, so the impact of the toilet use be can seen more clearly in the winter months in Figure 3.

Figure 1: Projected and Actual Natural Gas Usage

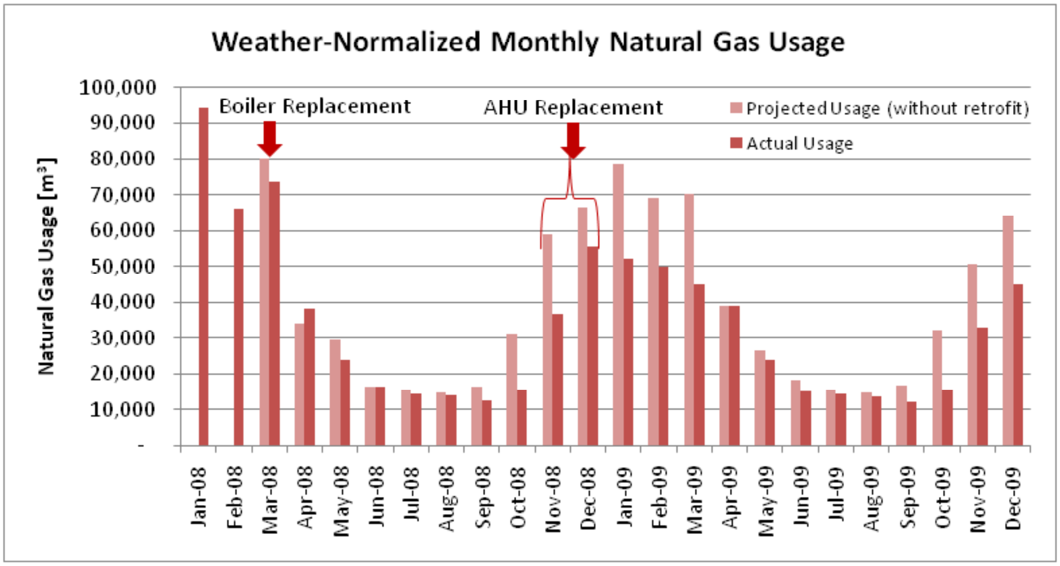


Figure 2: Natural Gas Usage per HDD

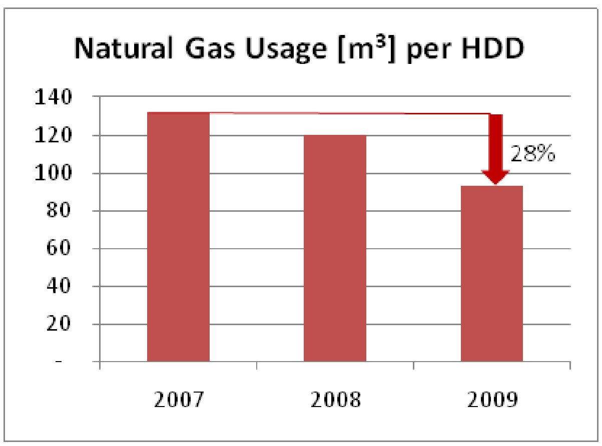
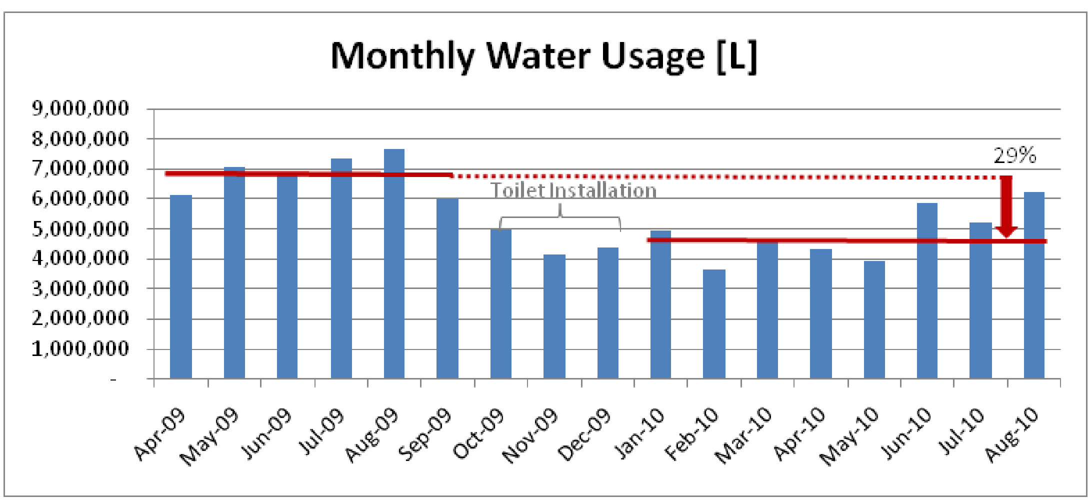


Figure 3: Monthly Water Usage

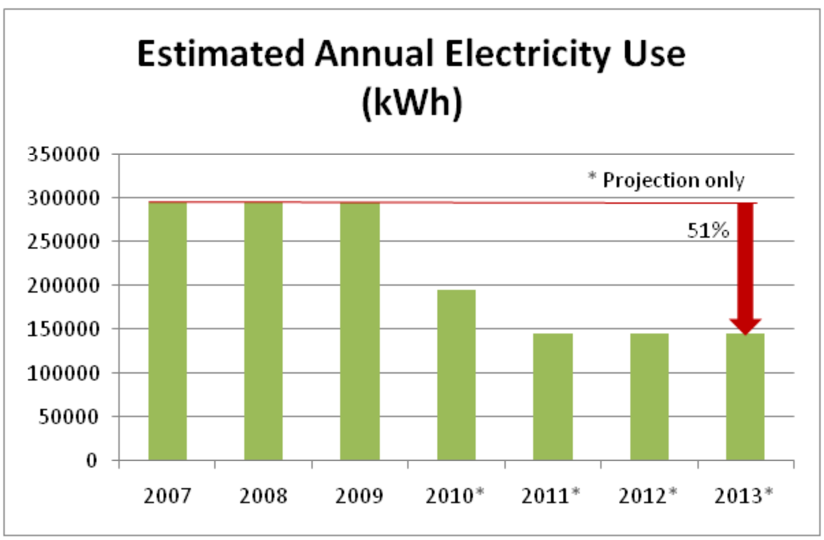


3.3 Electricity Savings

Both the AHU retrofit and the chiller replacement have contributed to building electricity savings, but as there is only one electricity bill for the entire building it is somewhat difficult to isolate the specific savings generated by these measures. For those considering similar retrofits, it could be useful to individually meter loads like chillers before and after the retrofit to allow for accurate tracking of energy savings.

The consultants that assisted with the selection of the chiller equipment were, however, able to provide chiller efficiencies for the pre and post-retrofit equipment. Based on the size of the equipment size at 15 Kensington and an estimated annual usage derived from the number of operating hours for a similar sized building, this allowed an estimation of the results shown in Figure 7 (for 2010, the new chiller was in place for only part of the cooling season). Overall, chiller-related electricity savings are estimated at just over 50%.

Figure 4: Estimated Annual Electricity Use associated with the Chiller



3.4 Greenhouse gas savings

In addition to reducing utility costs, the retrofit avoided emissions of about 254 Tonnes of CO_2e as a result of annual natural gas savings, while water and electricity reductions resulted in savings of about 7 and 41 Tonnes of CO_2e annually. When combined, all of the retrofit measures resulted in a total of over 300 Tonnes of CO_2e saved annually.

4. Project Costs and Returns

To make the retrofit as financially painless as possible, the building managers created a plan that would allow the use of reserves and operating savings to pay for the retrofit costs. Table 1 outlines the work completed, schedule, budgeted and actual costs as well as the source of capital funding.

Table 1: Details of Retrofit Project Costs

Retrofit Measure	Month Completed	Budgeted Cost	Actual Cost	Source of Funds
Heating and DHW Boiler Replacement	March 2008	$200,000	$210,000	Reserve Fund
AHU Retrofit	Nov.-Dec. 2008	$98,000	$98,000	Reserve Fund
Toilet Replacement	Oct.-Dec. 2009	$37,000	$25,720	Operating Surplus from Boiler Savings
Chiller Replacement	April 2010	$351,000	$344,000	Reserve Fund
Total Project		**$686,000**	**$677,720**	

Note: All prices are before tax and are net of all incentives and rebates

Incentives of $15,000 from Enbridge Gas were received to offset the cost of the boiler replacement. The incentive application was completed by the manufacturer and was subject to an inspection by Enbridge of the actual installation. Project costs were also reduced by installing multiple boilers simultaneously, which reduced installation costs by half. There were, however, some unanticipated costs associated with expansion tanks that led to the boiler replacement coming in slightly over budget.

To reduce costs for the remaining project phases, the chiller was installed before July 1, 2010 to avoid the harmonized sales tax (HST), which resulted in a savings of $16,000. Also by using the same installer for the boiler and the AHU, the building manager negotiated a payment deferral for the AHU to May 2009 so the costs appeared in the fiscal year after it was actually installed.

Incentives were also used to offset the costs of the toilet retrofit. A rebate of $60 per toilet was received from the Region of Peel, totalling $11,280, which allowed the toilet retrofit to come in under budget.

A contingency of 15% was allowed for all projects, but was not needed.

4.1 Financial Analysis

Figure 5 charts the cash flow associated with the project for the period 2008-2019.[3] Expenditures result in negative cash flows, while savings result in positive cash flows. Net cash flow became positive almost immediately, in 2009. These calculations are based on current utility costs (electricity, gas, water) and do not factor in potential increases in future utility rates.

Figure 5: Project Cash Flows

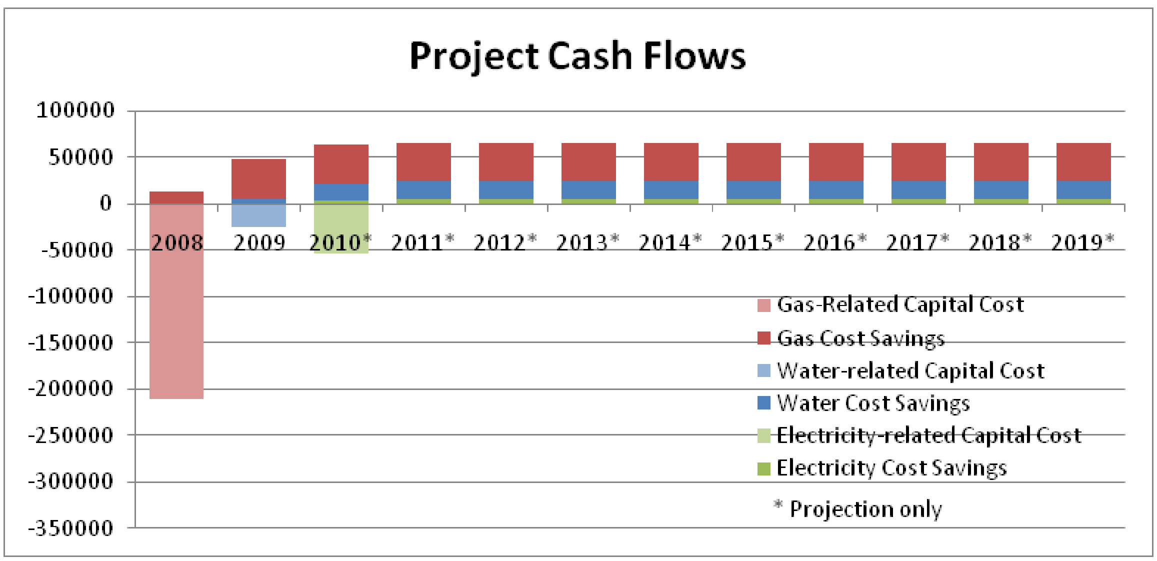


Table 2 shows the simple payback, return on investment (ROI) and internal rate of return (IRR) for the first ten years following each retrofit measure.[4] The table also includes the net present value (NPV) of each investment using 2010 as the present year and assuming ten years of cost savings following completion of the retrofit. For the chiller replacement, we have only included the incremental cost of opting for a high-efficiency chiller as the basic unit replacement was mandatory and not purely an energy efficiency measure.

Both the gas and water-saving measures appear to be investments with a reasonable payback and positive NPV. Though the chiller replacement is not as attractive in terms of simple payback, the work had to be done in order to eliminate R11 gas in compliance with the provincial directive and associated spending on a efficient equipment resulted in a reasonable return on investment over 10 years. It is also important to note that this equipment will likely last much longer than 10 years, which will, in turn, generate a positive NPV and improve the IRR. Due to the major investments in equipment in 2008 and 2010, the overall project financial performance has only been demonstrated with NPV as at 2010, considering a time period from 2008 to 2019.

Table 2: Financial Analysis Measures

Utility Affected (Project duration)	Project	Simple Payback	10 year ROI (Est.)	IRR over 10 years (Est.)	Net Present Value in 2010
Gas (2008) (See Note 1)	Boiler Replacement	4.6 years	116%	17%	$116,000
Water (2009) (See Note 2)	Toilet Replacement	1.2 years	747%	84%	$110,000
Electricity (2010)	Chiller Replacement	9 years	4%	1%	-$12,500
Total Project (See Note 3)		4.4 years	n/a	n/a	$183,000

NOTE 1: Given the minimal contribution to increased natural gas use efficiency associated with the AHU replacement (3.5%) compared with the overall efficiency gain of 28%, for the purposes of the financial analysis, the gas-savings measures considered will only include the boiler replacement. Utility cost reduction associated with the AHU will appear in the analysis of electricity consumption.

NOTE 2: As there was no complete year of water data, the average monthly consumption April to September 2009 (before the toilet replacement began) was used to determine annual pre-retrofit consumption used for 2008 data. This pre-retrofit monthly average was combined with known data for October to December 2009 (during the toilet replacement) to generate 2009 annual consumption and the average monthly consumption between January and August 2010 was used to determine the annual post-retrofit consumption. 2009 rates were determined from the Region of Peel [5]

NOTE 3: Financial indicators for the Total Project were determine by shifting all expenses (gas, water and electricity-related) to 2009 and including savings generated over the following 10 year period (2010-2019)

According to the building manager, the financial savings achieved were better than anticipated and a condo fee increase of 3-4% due to HST was reduced to a 2% increase because of the operating surplus. This operating surplus was also used to fund other more visual improvements to the building, such as fences and garden improvements.

5. Challenges

Though the individual projects ran relatively smoothly, there were a number of challenges facing the building manager as he tried to implement these utility cost-saving measures. The largest of these was reassuring the board and unit owners that the retrofits would not result in major disruptions or cost increases. In particular, getting the board to approve the first key step of boiler replacement was a time-consuming process. By presenting clear financial information on costs and benefits, Mr. Haghi eventually secured board approval.

The building manager also had to prepare tenants for the work and minimize disruption to lessen the resulting complaints. To achieve this he outlined long-term plans at the condominium annual general meetings so that nothing came as a surprise to the suite owners. Short-term updates and worst-case scenarios were outlined in newsletters and notice boards so that residents could be prepared. Finally the building manager shared news of the success, including cost savings, with suite owners so they could feel that the inconveniences were worthwhile.

6. Testimonial from Building Manager

"We wanted to make sure that this project was sustainable which meant ensuring a sustainable source of funding. This goal was achieved by scheduling the work such that it could be paid for out of the reserve fund and the operating surplus from the new boilers. Some suite owners feared that condo fees would increase to fund these projects. One owner actually placed his unit on the market as a result. When presenting information about the project I tried to ensure that budgets were transparent and suite owners understood how projects are being funded. Once the suite owner found out the initial project funding was coming from reserve funds, he removed his property from the market. In terms of equipment, suppliers and contractors, go for the best not the cheapest and be fair with the contractor to ensure they are not losing money as this will result in sub-par work."

7. Conclusions

The project ran fairly smoothly with retrofits achieving greater savings than anticipated, though jobs like the boiler and chiller were far easier to manage than jobs that required access to units, such as the toilet replacement.

Communication played an essential role in the success of this project because the condominium board controlled the available funds. Mr. Haghi's proactive approach to communication ensured that owners understood the need for change and then, after the project, saw the operational cost benefits. These "invisible" changes were also made more visible by using the operating surplus on aesthetic improvements in the common areas.

When planning the projects, Mr. Haghi also looked ahead to other anticipated projects in order to make provisions for incorporating future benefits. For example, over-sizing the boilers to eliminate the need for a burner in the AHU and using the chillers to pre-cool incoming air in the summer providing common area cooling.

This case study illustrates a number of best practices which can be implemented in other energy efficiency upgrades, such as:

- Taking a holistic approach allows building owners to take full advantage of the synergies between various measures and maximize the energy savings.
- Careful timing and sequencing of each measure can save money on installation and provide additional cash flow from initial measures to finance later measures
- Reserve funds can be a great source of financing for many condo energy retrofit measures, and can help to minimize borrowing costs.
- Good communication at every stage of the project can help residents and management work together to improve the building.

Acknowledgements

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Endnotes

1 The projected usage is determined based on the volume of gas consumed per heating degree day (HDD) in the baseline year, 2007, and then applying that usage rate according to the number of HDDs for each subsequent year.

2 By examining gas usage in the summer months, when space heating is not required, the DHW gas requirements can be estimated at about 15,000m^3 annually. We then deducted this amount from total gas consumption to calculate usage for space heating.

3 Natural gas cost savings are generated from the difference between actual consumption and projected consumption, while costs were derived from historical natural gas prices adjusted by a common factor to more closely match the sample cost data provided by building manager [3]. Projected consumption was derived using a pre-retrofit baseline year, 2007, and adjusting that baseline usage according to the HDDs of the subsequent years to determine how much energy would have been used had there been no retrofit. The HDDs as well as water and electricity consumption for 2010 and beyond are assumed to be the same as 2009. Likewise utility rates beyond 2010 are assumed to be equal to 2010 rates.

As the chiller replacement was necessary to comply with the new R11 gas guidelines, only the incremental cost between a standard constant speed drive and the higher efficiency variable speed drive that was installed are considered. The negative electricity-related cash flows in Figure 8 represent the incremental cost between the standard-efficiency and high-efficiency chiller while the positive electricity-related cash flows are the electricity cost savings from the added efficiency gain.

4 The 10-year periods for both the water and electricity measures is 2010-2019, while the gas-saving measure period is 2009-2018 due to the time of completion of each of these projects.

Glossary

Equivalent Carbon Dioxide (CO_2e) – A measure used to compare the emissions from various greenhouse gases based upon their global warming potential. For example, the global warming potential for methane over 100 years is 21. This means that emissions of one metric ton of methane are equivalent to emissions of 21 metric tons of carbon dioxide. (Source: Organisation for Economic Co-operation and Development)

Heat Exchanger – A device used to transfer heat from one fluid to another across a barrier which does not allow the two fluids to come into direct contact. (Source: The Renewable Energy Resource Centre)

Heating Degree Day (HDD) – Represents the amount of heating energy required during the heating season. It is measured by the difference between the base temperature of 18°C and the mean temperature for a particular day. (Source: Natural Resources Canada)

Internal Rate of Return (IRR) – The discount rate at which the net present value of all cash flows from a particular project is equal to zero. The IRR can be used to compare several projects under consideration. If all other factors are equal among the various projects, the project with the highest IRR would likely be selected first. (Source: Investopedia)

Low-emissivity (Low-E) Windows – Low-E coatings are microscopically thin, virtually invisible, metal or metallic oxide layers deposited on a window surface primarily to reduce the thermal conductance by suppressing radiative heat flow. (Source: Efficient Windows Collaborative)

Net Present Value (NPV) – The difference between the present value of the cash inflows and the present value of the cash outflows which can be used to analyze the profitability of a project. (Source: Investopedia)

Return on Investment (ROI) – The benefit of an investment, or gain from investment minus cost of investment, is divided by the cost of the investment. This ratio or percentage is used to show the efficiency of the investment. (Source: Investopedia)

Simple Payback – The length of time in years required to cover the cost of a project. It is calculated by dividing the cost of the project by the annual cash inflows. (Source: Investopedia)

Sub-metering – The individual metering of utilities at the unit level in a multi-unit residential building. Each household can then be responsible for their own energy costs as opposed to splitting the energy bill for the entire building equally among all occupants. (Source: New York City Department of Housing Preservation and Development)

Weather Normalization – A mathematical process that adjusts actual energy usage so that it represents energy typically used in an average year for the same location. This accounts for weather differences from year to year that may result in abnormally high or low energy consumption. (Source: ENERGY STAR)

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