# 10 (PLUS 1) WAYS TO SAVE MONEY ON ENERGY

A seminar prepared for Enbridge Consumers Gas and the Ontario Non-profit Housing Association by Weinstein Taylor and Associates Inc.

## 1. SAVING THROUGH PROPER MAINTENANCE

The best way to save money is through proper maintenance. The capital cost is low and the savings in energy consumption is high. All that is required is knowledge and vigilance.

- Make sure seasonal equipment if turned on and off at the appropriate times. For example, we have found uncontrolled electric ramp heaters that were left on permanently.
- Not changing filters regularly can decrease the efficiency of make-up air units and other air handlers. Consider 'dirty filter' switches.
- Ensure belts have correct tension and are aligned.
- Install carbon monoxide detectors to control exhaust fans in parking garage.
- Make sure corridor make-up air grilles are clean and the air is properly balanced between floors.
- Turn off heating system pumps in the summer.
- Make sure the outdoor temperature sensor is not in a location where the sun will hit it and it will not be subject to high winds.
- Have the boiler efficiency tested with a gas analyser every year when the boiler is cleaned.
- Clean the boiler yearly. Clean the tubes or the fire side of the heat exhangers where accessible.
- Avoid excessive boiler room dust that will contaminate the boiler.
- Repair leaks immediately, e.g. pumps in boiler rooms, leaking pressure relief valves, etc. This saves water. It also saves the energy required to heat fresh water.
- Make sure the air vents in boiler rooms are not blocked or dirty. Insufficient air, as well as being dangerous, will lower the efficiency of the boiler plant.
- Lower temperature of local fan heaters (like in the garbage room) to 60°F.
- Replace inoperative back draft dampers on ventilation fans to limit air infiltration.
- Repair damaged weather seals on exterior doors.
- Limit indoor air temperatures in the suites, if possible.
- Lower corridor air temperatures by controlling the make-up air unit.
- Replace old refrigerators before they fail. A new refrigerator will use about half the electricity of a 15 year-old one. The average life span of a refrigerator is 19 years.
- Turn down the water temperature in washing machines.
- Clean dryer vents and grilles. This will save energy and help avoid dryer fires.
- Make sure window type air conditioners are removed or have insulating covers over them during the winter.
- Make sure the seals around the sleeves of incremental (PTAC) units are in good condition.

- Ensure that the right voltage is being supplied to your building. Over voltage and under voltage can be inefficient and damage equipment.
- Many larger buildings are penalized for poor power factor. This can be caused by large motors, chillers, and even flourescent lights with magnetic ballasts. Poor power factor can be corrected with capacitors.
- Newer, high efficiency motors are as much as 20% more efficient that older motors. Since motors consume a great deal of power, $600 per HP or more per year, this can add up to substantial savings. Always specify high efficiency motors when ordering new equipment.
- Consider longevity and energy efficiency when replacing equipment.

## 2. SAVING MONEY ON SPACE HEATING

***Determining economic lifespan of equipment***

Equipment that is old and inefficient will cost more to operate than newer, energy efficient equipment. Often though, the capital cost, when compared to the savings, does not appear to justify replacement. However, when you consider that the equipment will have to be replaced anyway within a certain period of time, an economic case can often be made for replacing the equipment early, before it fails.

All equipment has a certain lifespan, at which point, on average, the equipment is prone to imminent failure. They also have an 'economic' lifespan. This is the point at which replacing the unit makes economic sense, even though it may still be functional. It's like running a car. At some point, even though the car is still running, replacement becomes economic because of escalating repair costs, decreased fuel economy and unreliability.

One of the challenges of the property manager is to know when to replace heating equipment. You can simply leave until it fails. This is what happens in many cases, though this tends to be expensive. Replacing equipment on an emergency basis costs more than a planned replacement. Often there is no time to consider energy-efficient alternatives or energy efficient equipment that might not be immediately available. Replacing a heating plant, for example, can take 4 months or more from the time the engineer puts pencil to paper, the job is tendered and the contractor installs the new equipment. Make-up air units could require about the same amount of time, since delivery of the unit can take 2 months or more. So a planned replacement requires ample lead time.

Determining the correct time to replace equipment must take into account energy costs, feedback from your service contractor and perhaps a small engineering study by a qualified firm to determine the condition of the equipment, the capital cost of replacing it and annual savings attributable to new equipment.

***Install more efficient boiler plants***

Many heating systems in buildings were poorly designed. This could have been done to keep the capital costs down, or it could be because the mechanical systems of older buildings were not designed for energy efficiency. The result is poor quality, inefficient equipment and poor control. Many hot water heating plants installed in the ‘80s are now ready for replacement.

New boilers can reach 85 or 90% seasonal efficiency compared with about 60% for older boilers with atmospheric burners. However the piping in the boiler room, the controls and the method of pumping may also have to be changed to accept the newer, smaller boilers. These new higher efficiency boilers must have the correct amount of water flowing through them and that water must be at a certain minimum temperature . . .usually about 130°F. The older boilers contained a lot more water and were not quite so sensitive.

***Design for primary-secondary pumping***

An energy-efficient design for a building involves primary-secondary pumping. With this design, the temperature of the distribution system does not have to be the same temperature as the water in the boiler loop. This provides better temperature control in mild weather. This can save money by eliminating the over-heating of apartments during the shoulder seasons. Savings can be as high as 25% in some buildings over and above the increased efficiency of the new boilers.

***Install more efficient make-up air units***

The purpose of make-up air units is to pump air into the corridors to help maintain positive pressure in the building, particularly in the winter. Maintaining positive pressure helps prevent cold drafts in the winter. It also prevents cooking odours from entering the corridor and migrating to other suites. Without make-up air, exhaust fans in the kitchens and bathrooms will tend to depressurize the buildings. This can lead to moisture problems and even mould in apartments.

Make-up air units consume a lot of energy and, because the furnace sections tend to be crude, they have a limited lifespan. They tend to last about 12 to 15 years, although many fail prematurely. At present, a conventional make-up air unit will cost about $1.25 per cfm per year to run. A typical 8000 cfm make-up air unit will cost about $10,000 per year to operate. Most often there are 2 of them per building.

One common energy saving measure is to put the make-up air units on timers, to shut the make-up units off at night. This, however, violates the property standards of most municipalities. Another

alternative is to have 2-speed blowers and multiple furnace sections or modulating gas valves on the units. This can be tricky though. Low air flow over the heat exchanger can lead to differential temperatures over the heat exchanger that can lead to premature failure.

There are some models of MAU that are more efficient than others. Conventional furnace sections have 'clam shell' heat exchangers with atmospheric burners underneath. Newer 'drum and tube' burners use more efficient power burners firing into a stainless steel drum. The hot air then goes through a series of heat exchanger tubes. As well as being as much as 20% more efficient, these units have a much longer lifespan and are not prone to premature failure.

***Control water temperature to heat pumps***

Heat pumps are small refrigeration units, usually in each suite. They 'pump' heat from water that is piped throughout the building into the air, for space heating. In summer, the process is reversed and heat is pumped from the air into the water. The water temperature is controlled by boilers when it needs to be heated and cooling towers when it needs to be cooled. The temperature of the water flowing to the heat pumps needs to be controlled. Many people dealing with heat pumps think that the cooler the water the better in the summer and the warmer the better in the winter. This is not true, however. The water temperature needs to be kept to within strict limits for maximum efficiency.

## 3. SAVING BY INSTALLING BETTER CONTROLS

***Install better boiler controls***

Many boiler plants have simple outdoor reset controls. More sophisticated digital and/or electronic controls give much finer control and can save significant amounts of money. Conventional controls essentially tell the system that the boiler water is either too hot or too cold. Better controls have logic to anticipate what the water temperature of the supply water should be according to various inputs and computation of trends. This makes for a more accurate and more constant supply water temperature, without large temperature swings that waste energy. Controls are also part of the strategy of preventing the boilers from rapid cycling. Like starting and stopping your car repeatedly, this wastes money. (The other part of this strategy is ensuring sufficient thermal mass.) Upgraded boiler controls can have a payback of between 1 and 3 years.

***Install better distribution system controls***

Many buildings have radiators that are not controlled. This is wasteful, because under some conditions, a room may not require the energy being sent to it because of solar gain or internal sources of heat.

Thermostatic rad valves are one solution, although they have been found not to work well with baseboard convectors. There are other alternatives, however. You should discuss these with your engineer.

***Install better cooling system controls***

A common retrofit for cooling towers is to install variable speed fans controlled by temperature sensors on the condenser water lines to more accurately control the temperature drop through the cooling tower to match demand. This can have a very attractive payback, often less that 3 years.

***Install load shedding controls***

As the rate structure for hydro changes, controls for load shedding will become more attractive economically. It is anticipated that during peak times, electricity will become very expensive. Load shedding can shut down non-essential electrical loads during those peaks.

## 4. SAVING THROUGH LIGHTING UPGRADES

***Replace incandescent lights with flourescent, compact flourescent, HPS or LED lamps.***

Most property managers know about replacing incandescent lights. It costs about $37 per year to power a 60 watt light bulb for a year, but only $8 for a 13 watt compact fluorescent bulb. Newer compact flourescent light can even function in low temperatures. Compact fluorescents are also good choices to replace bathroom lights in suites. There are also LED replacement lamps for exit lights. These replace 20 watt lamps and consume less than 5 watts. They also last virtually forever. Incandescent lighting in garages should be changed to high pressure sodium. Older style fluorescent lights can also be replaced with HPS lighting. Some cold temperature double tube 8'0 fluorescent lights consume as much as 400 watts, at a cost of about $250 per year each.

***Replace T-12 fluorescent lights with T-8 fluorescent lights***

A 4'0 double lamp fixture fitted with T-8 lamps with electronic ballasts consume about 70 watts rather than more than 100 watts for conventional T-12s. Most regular fluorescent lights can be retrofitted by changing the ballasts and the lamps.

**De-lamp where possible**

Many areas are over lit, particularly corridors and stairwells. In many cases we have been able to replace double 4'0 fluorescent lights with single 4'0 T-8 light at a savings of over 65 watts per fixture, or $40 per year.

***Add controls to lights***

There may be cases where lights can be controlled by photo-cells to come on only when needed. Corridors with windows are an example. They can also be controlled with motion sensors, such as in meeting rooms and laundramats.

## 5. SAVING MONEY THROUGH COGENERATION

Cogeneration is the use of a natural gas or diesel engine driven generator to generate electricity. This is usually used to save the peaks off energy consumption. This will become increasing viable as the rate structure for electricity changes. It is predicted that the electricity rates for hours of peak use will cost much more that off-peak energy use.

Cogeneration is only economic at this time if there is a good use for the considerable heat generated as a byproduct of the engine. About 25% of the energy of natural gas is converted to electricity. About 40% is converted to heat that can be recovered. The rest of the energy is lost as unrecoverable heat. We recently re-engineered a cogeneration plant that had never worked. The plant consumed about 2 million btu's per hour, producing 150 kW of electricity and 800,000 btu/hr of recovered heat. The heat was used for heating domestic hot water, preheating corridor make-up air, and contributing to space heating. The uses for the heat, however, are limited in the winter. If there had been an absorption chiller (which uses heat to provide chilled water for air conditioning) the heat recovery would make the cogeneration plant much more economic in the warm weather. The end cost of the electricity produced was about .05 per kW/hr.

Although this seems attractive, the capital cost is high. This particular installation cost over $500,000. The maintenance cost is also very high. The engine has to be rebuilt few years at a cost of about $3,000 each time. The system is also quite complicated and requires a DDC control system and a skilled person to operate it.

These systems will become increasing attractive in the future for limiting the electricity that has to be purchased from the utility during peak periods of the day when the electricity might be very expensive.

## 6. SAVING MONEY ON PATIO AND RAMP HEATING

Ramp heaters can be electric or hydronic (hot water). Most are electric. These fall into two categories; ordinary heating cable and self-regulating cable that increases its output as the ramp temperature decreases.

***Add controls to the ramp heating.***

The best kind of control for any type of heater is a diligent super who will turn the control on and off. In the real world, however, where supers take sick days or insist on sleeping at night, we have to make do with better automatic controls. Some ramp heating systems are controlled by temperature sensors. Adding snow sensors to these systems will limit the operation of the ramp heaters to conditions where there is snow and cold. More sophisticated systems will turn the ramp heating off when it is very cold. This is because the ramp heating system won't melt snow at very low temperatures. Fortunately, it rarely snows at such low temperatures.

## 7. SAVING MONEY ON HUMIDIFICATION

Few residential buildings humidify the air. One reason is that there is no economical way to do it. Commercial humidifiers usually operate by injecting steam into the ventilation air. This can be done with electric boilers or gas boilers. Gas boilers are cheaper to operate, of course. There is another way that is cheap to operate. That is with ultrasonic vaporizing nozzles. However, this requires pure water (to avoid spraying minerals into the air), which is generally make with a reverse osmosis water purification plant. Although cheap to operate, this equipment is very expensive to buy and install.

## 8. DOMESTIC WATER HEATING

***Heat the water with an energy efficient boiler***

It pays to heat domestic water with a very efficient boilers or tank heater. In general, tank heaters have a shorter life expectancy than separate boilers and storage tanks. This is because fresh cold water is being heated. In that process, the minerals tends to settle out and coat the heat exchanger. This leads to decreased efficiency and hot spots on the heat exchanger that can eventually lead to the failure of the heat exchanger.

When replacing the domestic water boiler or tank, replace it with the most efficient unit possible.

***Consider using the main boilers to heat domestic hot water***

If you have an efficient boiler system for space heating, you can use it to heat domestic hot water also.

This involves the use of a double wall heat exchanger to transfer the heat energy from the boiler water to the domestic water. This system does not accumulate scale and has no hot spots. So it has a very long life expectancy. The heat in the storage tanks is controlled by turning the pumps from the heat exchanger on and off.

***Turn the boiler pumps on and off with the boiler***

The boiler pumps should be wired to come on and off when the boilers fire. If the pumps are working continuously, not only is electrical energy wasted by powering the pumps, but the water is cooled by circulating it through a non-firing boiler.

***Set back the tank temperature at night***

During times of light load (at night), the domestic water temperature can be lowered on central systems from 130°F to120°F with a simple timer control.

## 9. SAVING THOUGH WATER CONSERVATION

**Repair Leaks**

Now that water has become so expensive, it is even more important to periodically check all faucets and toilets for leaks.

**Use flow control devices and low flow toilets**

Use flow control devices on faucets. People have varying experiences with retrofitting water savers on toilets. At a minimum, toilets being replaced should be the water conserving 6 gallons per flush. Some low flow toilets can be adjusted to use more than 6 gallons. These toilets should be adjusted to use no more than 6 gallons per flush.

**Make sure pipes are insulated to the extent possible**

All exposed plumbing pipes, especially hot water pipes, should be insulated on the boiler room, in the ceiling plenums and in common areas.

**Make sure the hot water re-circulation lines are working and the design is adequate**

If the hot water re-circulation line is not well designed, or if the recirc pump has died, people will have

to run their taps for a long time before getting hot water. This is very wasteful of water.

***Control Water Pressure***

Many buildings have booster pump stations to increase the water pressure to reach the upper floors. In a surprising number of buildings we have looked at, the booster pumps were not required at all. They were just wasting money. A 10 HP pumping station will consume about $6000 per year in electricity if it runs continuously.

Taps and shower heads work well at about 25 psig. If the water pressure is higher, the amount of water coming our of the tap will be greater. A low flow faucet, which is rated at 8.35 gal per minute at 25 psig, will have a flow of 13.9 psig at 70 psi (The flow is proportional to the square root of the head pressure.) Similarly a low flow shower head with a supposed flow of 9 psi will have an actual flow rate of 15 psi at 70 psi.

Reducing the water pressure will reduce water consumption. A pressure regulating valve with a by-pass can be installed near the water meter. The pressure regulator should be set to give a pressure of about 25 psi at the top floor. It might have to be set higher to account for pressure losses in the pipe during high use periods. It will be a matter of trial and error until the right pressure is achieved. This reduction of water pressure should reduce the water consumption quite significantly.

***Install a variable speed drive on large booster pumps***

Some buildings can benefit from installing variable speed drives on their booster pumps. Controlled by a pressure sensor on the most remote plumbing riser, the variable speed drive can control the water pressure accurately and use only the pumping power required to meet demand. These devices often have a 1 to 4 year payback on investment.

***Water Conserving Landscaping***

There are many cases in which proper landscaping and lawn watering practices can greatly reduce your overall water bill. Follow these simple tips to save lawn watering.

- Water only when necessary. When grass turns a dull grey-green, and when footprints remain when one walks across the lawn, it's time to water. If most of the lawn looks green and only spots or areas near concrete are grey, root-water or hand-water just the dry spots.
- Adjust lawn watering to the weather and soil conditions. Following a heavy rain, skip the regular watering schedule until the grass needs it. Sunny, south sides of buildings,

or slopes, or areas near sidewalks and driveways usually require watering more often. Planting shading trees or drought resistant grass seed in sunny areas can reduce watering. Shady or north locations need watering less frequently. Therefore it is important to know how to turn off and control automatic sprinkling systems.

- Avoid frequent watering. Watering too often causes your turf to develop shallow roots. This will leave th lawn vulnerable ot dry conditions. Reduce watering in the spring and your lawn will establish a deeper root system to better withstand hot weather.
- Water slowly. Run-off and puddling are wasteful.
- Water early in the morning, or later at night, NOT in the midday heat.
- Avoid using a lawn sprinkler. A single lawn sprinkler spraying 19 litres per minute uses 50% more water in just one hour that a combination of ten toilet flushes, two 5 minute shower, two dishwater loads and a full load of cloths.
- A drip or trickle irrigation system is the best watering method, using 25-75% less water than conventional methods. Drip irrigation is porous tubing with baffles openings which allows water to drip on the root areas.
- If you must use a sprinkler, use a low rise sprinkler head. Ensure that you are not watering sidewalks and driveways.
- Use a broom to clean the driveway or a sidewalk. NOT a hose.
- Use the principles of Xeriscaping- Use plants that are native to your area and survive under low water conditions.

**10. SAVING BY SEALING THE BUILDING ENVELOPE**

Sealing the building envelop is inexpensive and effective. Some areas that are often overlooked are:

- Sealing the top of the garbage chute
- Seal the elevator penthouse, install electric dampers on ventilation fans and relief air. The elevator shaft is a huge chimney that heat flows up.
- Seal the stairwells and other vertical shafts. Make sure the dampers on the smoke control fans seal properly.
- Renew window and patio door seals. Seal kits are available for most common doors and windows.

**11. SAVING BY CONVERTING FROM ELECTRICITY TO NATURAL GAS**

There are still buildings with electric heating, electric domestic hot water heaters and electric make-up

air units. Despite the rise in gas costs recently, it is still costs twice as much to generate heat with electricity than with gas. Whether conversion is economical or not depends largely on conditions specific to the particular building. It costs, very roughly, $5,000 to $8,000 per suite to convert a large building from electric heat to heating with gas fired hot water. If the electrical consumption exceeds about $1500 per suite, it is worth doing a feasibility study to establish the cost effectiveness of converting to gas.

There are gas-fired baseboard heaters that can be installed to replace electric baseboard heaters. They have limited application, and must be vented to the outdoors. They can be appropriate for lobbies, vestibules, stairwells and other common areas and utility areas where there is an outside wall and gas available.

**CONCLUSION**

- Know when to replace equipment. There is no point in keeping mechanical equipment running past its economic lifespan. It may still be running, but it will have to be replaced anyway and in the meantime it could be consuming far too much energy.
- Know what your energy and water consumption should be for a building of your size and type. If your building uses too much energy, then hire someone to find out why.
- Every building is unique. There are no standard measures that apply to all buildings. Some of the greatest savings result in correcting conditions that are unique to a particular building.

**Weinstein Taylor and Associates** are consulting engineers specializing in mechanical and electrical systems. They have worked extensively in the not for profit sector, particularly in the design and troubleshooting of heating and air conditioning systems. They have been in the forefront of technological advances including the application of primary-secondary pumping for heating and air conditioning systems, DDC controls, applying variable speed pumping to domestic water booster pumps, and using air to air heat exchangers in recreation centres. Phone (416) 463-6662. Fax (416) 461-8296. Or visit our website at *wtaeng.com.*