Multi-Unit Residential Buildings
Energy and Water Efficiency

HEATING AND VENTILATION SYSTEMS

This document has been designed to provide a general understanding of the principles and practical considerations involved in implementing cost-effective energy and water efficiency measures in existing MURBs.

The measures have been organized from the easiest to implement to the more complex.

The simple payback for each measure is fairly broad, given the wide variations in factors affecting costs and savings. Users should complete their own assessment based on actual capital costs and estimated annual energy savings for an individual measure. Where appropriate, other factors specific to individual measures have been identified in their description.

This document is intended as a guideline only and is not intended to replace professional advice. Prior to incorporating any energy or water efficiency measures into existing MURBs, it is recommended that they be reviewed by qualified energy management professionals. All work must be performed in accordance with applicable codes and standards.

Introduction

Properly maintained mechanical systems help maintain occupant comfort, as well as ensure an acceptable level of indoor air quality throughout the building. There are a number of service and maintenance repair and retrofit opportunities that can optimize the efficiency of heating and ventilation systems, as well as improve tenant comfort and reduce energy consumption.

Importance of maintenance

A sound maintenance program is the cornerstone of any energy or water efficiency plan. Existing equipment and systems must be in good working order so that the maximum benefit of any efficiency measure can be realized.

For more information on maintaining your building equipment and systems, refer to cmhc.ca.

Most mechanical system deficiencies can be prevented by:

- conducting regular inspections and implementing needed repairs;
- recording operation conditions and looking for anomalies (temperatures, pressures, current and voltage);
- ensuring maintenance contracts are in place for more complex equipment and systems;
- ensuring regular component replacement as recommended by the manufacturer.

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Preventive maintenance is necessary to maintain system safety, reliability and efficiency. Regular maintenance for heating and ventilation systems may include:

- bleeding air from hydronic systems;
- checking, adjusting, or replacing belt drives;
- cleaning ducts, fans, coils and grilles;
- checking and adjusting dampers and linkages to ensure proper positioning;
- lubricating equipment on a regular basis;
- maintaining water treatment of hydronic systems;
- checking and adjusting temperature and pressure controls.

Maintenance request forms are useful, as building occupants can report small problems before they develop into big problems.

Small repairs should be done immediately using quality parts approved by the equipment manufacturer to ensure equipment warranties remain valid. When required, use a qualified trades person to perform repairs.

Check with your municipality or social authorities having jurisdiction over MURBs to ensure that the energy and water efficiency measures you have planned are in accordance with governing codes and standards.

Codes and standards

Compliance with building codes and standards is often required; these include:

- the provincial building code;
- the provincial plumbing code;
- CAN/CGA B149.1, Natural Gas Installation Code;
- CAN/CGA B149.2, Propane Installation Code;
- CAN/CSA B139, Installation Code for Oil Burning Equipment;
- C22.1, The Canadian Electrical Code (or the provincial equivalent).

Installation of equipment may require the services of qualified trades, including gas fitters, oil burner mechanics, electricians, plumbers, sheet metal workers, refrigeration and air conditioning mechanics, or insulators.

Factors affecting energy savings

Actual energy and/or cost savings for each heating/ventilation energy efficiency measure may be affected by these factors:

- Cost of energy.
- Type of utility energy rate structure.
- Overall capacity of the system.
- Initial and final overall operating efficiency of heating plant.
- Initial and final efficiency of distribution system.
- Capability and accuracy of controls.
- Number of occupied hours and use of setback controls.
- Local climate.
- Insulation levels on pipes and ducts.
- Air leakage rates through ducting in unheated spaces.
- Temperature setpoints.

Maintenance, repair and retrofit opportunities

This section describes a number of heating and ventilation retrofit measures that have been organized from the easiest to implement to the more complex.

LESS

MORE

1 Install heat reflector panels behind hot water baseboard convectors and radiators on outside walls

Measure

Install heat reflector panels behind hot water baseboard convectors and radiators located on outside walls.

Payback

Simple payback: 6 months to 3 years.

Application

MURBs with hot water or steam heating using radiators and/or hot water baseboard convectors.

Benefits

- Reflection of over 90 per cent of radiant heat otherwise lost through the exterior wall.
- Reduced boiler supply water temperature and run time.
- Improved occupant comfort.
- Energy savings.

Considerations

- This measure can be implemented by the property manager or building superintendent, or by a qualified installer.

Implementation

- Purchase reflector panels that are designed for the purpose, and sized to individual radiators or baseboard radiation.

2 Calibrate hot water temperature reset controller

Measure

Calibrate the hot water reset temperature controller for space heating boilers to ensure the system temperature is just hot enough to meet the space heating needs of the building.

Payback

Simple payback: Immediate.

Application

MURBs with hot water space heating systems having a controller that adjusts or "resets" the system water temperature as the outdoor temperature changes.

Benefits

- Lower space heating costs for the building.
- Improved comfort and reduced occupant complaints concerning apartment temperature.
- Minimized use of windows by occupants as a means to control temperatures, thus further saving energy.

Considerations

- This measure should be performed annually as a part of regular maintenance activities.
- This measure can be implemented by the property manager or knowledgeable maintenance staff or could be included in a maintenance contract with an outside contractor.
- This measure is not intended to control indoor space temperatures. These should be controlled by space thermostats.
- Setting the controller too low will result in insufficient heat being available to the building during times of cooler outdoor conditions.
- Ensure the heating system maintains the manufacturer's recommended minimum temperature to prevent condensation or other damaging effects.
- Mount the outdoor temperature sensor in the shade, preferably on the north side of the building.
- Infrequent, individual tenant complaints about lack of heat may indicate specific local causes, such as malfunctioning thermostats, zone valves, isolating valves, or obstructions of radiators or convectors. Do not attempt to resolve this type of problem with an indoor/outdoor temperature controller.

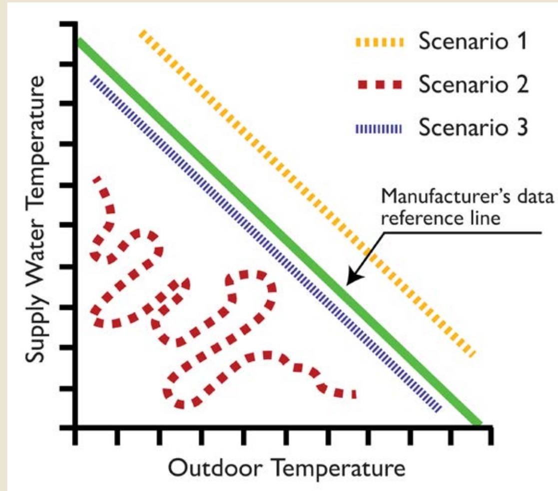
Implementation

- To determine control performance, the manufacturer's data is used to plot the performance of the indoor/outdoor controller on a graph. Supply water temperature is recorded on the Y-axis, and the outdoor temperature is recorded on the X-axis. This is the control line.
- Use reliable thermometers to measure and record the outdoor temperature and the supply water temperature two times a day (morning and afternoon) over a two-week period.
- Plot the points on the same graph as the manufacturer's data.

Scenario 1: Measured data forms a line that is offset from manufacturer's data.
Cause: Controller is out of calibration.

Scenario 2: Measured data is scattered and does not form a line.
Cause: Controller is malfunctioning.

Scenario 3: Measured data is within 5°C of the manufacturer's reference line.
Cause: Controller is operating properly.



- Once the control is operating properly, adjust the settings down in small increments to reduce the supply water temperature in mild weather.
- For each change in setpoint, redraw the new control line based on the manufacturer's data and increase it in cold weather. Plot the new system water temperatures against your measured outdoor temperature.

3 Reduce garage temperature to 5°C (40°F)

Measure

Lower the minimum air temperature in parking garages that are temperature-controlled in winter.

Payback

Simple payback: Immediate.

Application

MURBs with heated parking garages.

Benefits

- Reduced energy use for garage heating.
- Lower operating costs.

Considerations

- This measure can be performed by the property manager or maintenance staff.
- There may be a concern that reduced garage temperatures will cause pipes to freeze close to doors or ventilation openings. If pipes are vulnerable, install a self-regulating heating cable and insulation on the pipes to prevent freezing.
- Cold floors may be experienced in apartments located above the garage. Insulating the garage ceiling can alleviate the problem.

Implementation

- Turn thermostats down to 5°C (40°F) in heated garages.
- If thermostats do not go down as far as 5°C (40°F), replace them with units that have a suitable range.
- If necessary, install ventilated metal covers over the thermostats to prevent tampering.
- If the garage heating is independent of the heating for the building, it should be shut down in mild weather.
- For garages that use hot water for space heating, use the thermostat to shut down the circulating pump as well.
- If the circuit does not have its own pump, it will be necessary to install an automatic valve to close the hot water circuit to the garage heaters to prevent unintentional heating of the garage from the system piping.

4 Insulate boiler and heating piping

Measure

Repair or add insulation to heating system piping and boilers.

Payback

Simple payback: 5 to 10 years.

Final payback will depend on these factors:

- Surrounding air temperatures.
- Temperature of water in the pipes.
- Value and condition of existing insulation.
- Contribution of pipe heat loss to space heating.

Application

MURBs with central hot water heating systems for space heating and/or domestic water heating.

Benefits

- Reduced heat loss from pipes to the surrounding air.
- Reduced energy costs.
- Reduced risk of pipes freezing.
- Improved delivery of hot water for space heating or domestic hot water use.
- Improved occupant comfort.
- Reduced complaints regarding a lack of domestic hot water.

Considerations

- Small pipe insulation jobs can be done by building staff with readily available products.
- All insulation should be applied according to manufacturer's specifications and in compliance with applicable codes and regulations.
- Large pipe insulation jobs should be done by an experienced insulation contractor.
- Piping that is not readily accessible may require demolition and repair of parts of walls, etc. (The cost of this will extend payback estimates.)
- Ensure any insulation that may contain asbestos is not disturbed.
- Ensure all work complies with local regulations.

Implementation

- Boilers can be packaged (large boilers, usually only two or three in number) or modular (smaller units, usually three or more in number). Both include factory-applied insulation covered by a finished steel jacket.
- Insulation inside the boiler, damaged by improper boiler operation, should be repaired by a boiler specialist.
- Follow manufacturer's guidelines on products and installation procedures for different applications.
- Insulation should be added to hot water piping on a priority basis as follows:
  1. New piping used in replacements or additions.
  2. Large existing pipes.
  3. Pipes in unheated spaces.
  4. Uninsulated horizontal distribution mains in the basement or top floor ceiling.
  5. Other accessible uninsulated pipes.
- Close vertical shafts at the top and bottom of risers to minimize heat loss from insulated pipe in vertical risers.
- Insulation thickness of 2.5 cm (1 in.) is recommended on piping, and 5 cm (2 in.) on boilers. Minimum pipe insulation requirements should be confirmed with local building code authorities.
- Exposed insulation should have a durable jacket.
- Insulation in ceilings must have a fire-retarding jacket.

5 Seal and insulate warm air ducts in unheated spaces

Measure

Seal and insulate warm air supply ducts located outside the conditioned space.

Payback

Simple payback: 6 months to 2 years for straightforward jobs; 5 to 10 years for more complex work.

Final payback will depend on these factors:

- Existing condition of the ducts and amount of duct insulation, if any.
- Volume and temperature of air being moved in the ducts.
- Temperature of area surrounding the ducts.

Application

Ducting in unheated spaces, including warm air supply ducts on the roof, in rooftop penthouses or in unheated garages.

Benefits

- Improved performance of the space heating system.
- Reduced heating and cooling energy costs.
- Minimization of potential condensation problems in unheated spaces.
- Improved occupant comfort.

Considerations

- Ducts must be sealed before they are insulated.
- All insulation and duct sealant and/or tape should be installed according to manufacturer's specifications.
- Sealants and coverings of ductwork must meet building code regulation flame-spread and fire-resistance requirements.

Implementation

- Ductwork should be inspected to identify uninsulated ducts, ducts with torn or damaged insulation, or signs of air leakage from duct seams or other duct areas.
- Check duct conditions when the fan is in operation to locate leaks.
- Existing insulation may have to be removed to find the source of air leakage in the duct.
- Duct tape is a poor way to permanently seal ducts. Greater air leakage reduction can be achieved using a mastic-type duct sealer.
- Check for leakage around access panels in the ducting. New gaskets may be required.
- An insulation contractor should be retained to install insulation on uninsulated ducts in unheated areas, or to replace damaged or missing insulation on ducts exposed to the outdoors. If the source of leakage is due to poorly fitting sections of duct or duct fittings, hire a sheet metal contractor to correct it.
- Minimum insulation thickness should be 2.5 cm (1 in.) in interior unheated spaces, and 5 cm (2 in.) in exterior locations. Confirm with local building code authorities.
- Ducts in unheated spaces may require a fire-retardant covering.
- Outdoor ducts require a weatherproof covering.
- Ducts carrying air-conditioned air through an unconditioned space require a vapour barrier wrap on the outside.

6 Reduce short cycling of space heating boilers

Measure

Add an indoor/outdoor (also known as an outdoor reset) control to a boiler installation so that the supply water temperature adjusts upward as the outdoor temperature falls.

Payback

Simple payback: 6 months to 2 years.

Final payback will depend on these factors:

- Proper setup of the control to match the heating system water temperature rise to the outdoor temperature drop over the heating season.
- Ensuring that each boiler in a multiple boiler arrangement only comes on when the operating boiler(s) approach the point when they cannot meet the heating load.

Application

MURBs with one or more hot water space heating boilers.

Benefits

- Improved system efficiency.
- The heating system will only be able to supply a limited amount of heat to compensate for a window or door that is left open. When the room cools off, the occupants will close the opening to the outdoors.
- This will prevent the rest of the building from becoming overheated.
- Lower energy costs.
- Reduced boiler wear.

Considerations

- This measure should be implemented by a qualified heating contractor who is familiar with indoor/outdoor controllers.
- The heating system should have a minimum temperature setpoint, based on the type of boiler.
- Check boiler operating cycles periodically after changes are made.

Implementation

- The contractor can supply an electronic control that will reset the system supply water temperature and schedule multiple boilers as required to meet the heating load.
- After installation, check that the boiler sequencing is occurring correctly and that there is no short cycling of any boiler.

7 Reduce operating period of central corridor air supply fans and/or central exhaust fans

Measure

Install a time clock control to shut down the operation of the central makeup air supply fan during periods where ventilation requirements are minimal. This can also be applied to major exhaust fans.

Payback

Simple payback: 6 months to 2 years.

Final payback will depend on these factors:

- Limiting fan operation only to periods when it is necessary for occupant comfort and satisfaction.
- Setting the outdoor thermostat to the highest setting that will still limit occupant complaints.

Application

MURBs where heated air is supplied by a makeup air unit to corridors. This is also applicable where bathrooms and kitchens are exhausted by a central exhaust fan.

Benefits

- Reduced energy consumption required for heating incoming makeup air or heat lost through exhaust air.
- Reduced electrical consumption due to reduced fan operation.
- Lower utility bills and operating costs.

Considerations

- This measure requires the services of a qualified consultant and a mechanical or electrical contractor.
- ON and OFF intervals should not be less than one hour to minimize fan wear.
- Where tenants complain of odours or a buildup of condensation on windows, adjust schedules to allow for longer ON periods.
- Operation and control of the corridor makeup air system and bathroom/kitchen central exhaust system may be subject to local fire and building regulations. Ensure that this measure does not contravene any local regulations.

Implementation

- Before installing automated controls, ensure all corridor air and exhaust system equipment is in good working order. It is desirable to balance corridor ventilation system air flows and exhaust system air flows to original design specifications.
- Each makeup corridor system air unit should have a motorized tightly closing air inlet damper that will prevent air leakage when the system is off.
- Each exhaust fan system must have either a motorized or gravity-actuated discharge damper.
- Examine existing dampers and replace edge seals as required to minimize air leakage when closed. New dampers should be tight-sealing.
- Motorized dampers must be interlocked with fan motor starters so that the dampers close when the fans are stopped.
- Install a 24-hour timer to control system operation of the supply and exhaust air systems and an outdoor thermostat to override it. Continuous corridor air system operation is often required when outside air temperature exceeds 20°C (68°F).
- Continuous operation may be necessary at lower temperatures depending on the building.
- A basic corridor air and exhaust fan schedule could be:
  ON – 6:00 a.m. to 11:00 p.m.
  OFF – 11:00 p.m. to 6:00 a.m.
- Schedules tailored to daily cooking and bathing routines will generate greater savings while meeting the needs of the occupants and minimizing complaints.

8 Install time switches on local exhaust fans

Measure

Control local exhaust fans by turning them OFF with automatic timer switches when operation is unnecessary.

Payback

Simple payback: 1 to 3 years for exhaust systems previously operated continuously.

Final payback will depend on these factors:

- Limiting fan operation to periods only when it is necessary for occupant comfort and satisfaction.
- The number and size of local exhaust fans controlled.

Application

MURBs with local exhaust fans in areas such as laundry, recreation and storage rooms.

Benefits

- Reduced heat loss due to the exhausting of heated air.
- Reduced electrical consumption due to shorter fan operating periods.
- Lower utility bills and operating costs.

Considerations

- This measure requires the services of a qualified mechanical or electrical contractor.
- Reducing exhaust fan operating periods can sometimes lead to odour and/or humidity buildup. This can be overcome by increasing the timer-scheduled fan ON time.
- Exhaust fans serving clothes dryer exhaust systems must be in operation whenever a clothes dryer is in operation. Lint can otherwise build up in the ducts and become a fire hazard.
- Humidistats that override the timer should be used where fans are required to control humidity levels.
- Parking garage vestibule ventilation systems must run continuously.

Implementation

- Identify areas of your building where exhaust fans serve a single room and exhaust directly outside.
- Establish the schedule of operation for each exhaust fan (will depend on usage patterns for the space and may need to be adjusted to match occupant needs). At a minimum, it should be possible to keep fans serving unoccupied spaces off overnight.
- Prior to installing timer controls, ensure that fans are in good working order.
- Make certain each exhaust fan is equipped with a well-sealed backdraft damper to prevent air infiltration when the fan is off.
- Where fans are to be replaced, select quieter, energy-efficient fans.
- For rooms with a set schedule of use (such as laundry rooms), use a 24-hour timer and apply the same schedule to the timer.
- If a fan schedule changes for different days of the week, install a seven-day timer with the capability to have a different schedule for each day, or each group of days, for example, Monday to Friday and Saturday and Sunday.
- For schedules requiring fans to turn on and off several times a day, ensure the timer has the proper capability.
- Fans should not be cycled on and off more frequently than once per hour.

9 Balance airflows

Measure

Rebalance or adjust corridor air supply systems and/or central exhaust systems to ensure air is evenly supplied and/or exhausted from each area of the building at the rate required to maintain good indoor air quality.

Payback

Simple payback: Variable – savings will result if corridor air supply or exhaust air systems are excessive.

Application

Corridor air supply systems and/or central exhaust systems.

Benefits

- Reduced energy costs.
- Improved tenant comfort.
- Improved indoor air quality.

Considerations

- Corridors pressurized with supply air ensure odours are contained within suites, while exhaust systems remove odours and humidity from kitchens and bathrooms.
- Airflow balancing should be accompanied by grille and diffuser cleaning and repair.
- A mechanical engineer should be retained to review the airflow rates for each system. It may be possible to reduce system airflows while maintaining good indoor air quality.

Implementation

- Airflow balancing requires the services of a qualified air-balancing contractor.
- Exhaust system corridor air and supply flows must be measured and adjusted to ensure that they are even from floor to floor or that they meet the flows specified in the design drawings or those recommended by a consulting engineer.
- Building codes generally require exhaust flow rates of 25 L/s (50 cfm) per bathroom and 50 L/s (100 cfm) per kitchen; check with your local building code official.
- Recommended corridor supply airflow rates are 2 air changes per hour.
- The contractor will measure supply airflow to each floor and exhaust airflow from each suite, adjust dampers to provide correct airflow rates and adjust fans to provide necessary total airflows.

10 Install intelligent thermostats in individual suites

Measure

Replace in-suite thermostats with thermostats having both "learning" capability using an occupancy sensor and occupant temperature setpoint adjustments and an energy conservation capability through temperature setback (heating) and temperature setup (cooling).

Payback

Simple payback: 2.5 to 7 years.

Final payback will depend on these factors:

- Length of occupied and unoccupied periods in each unit.
- Optimized setback and setup periods.

Application

In-suite heating systems or heating-cooling systems with existing wall-mounted thermostats.

Benefits

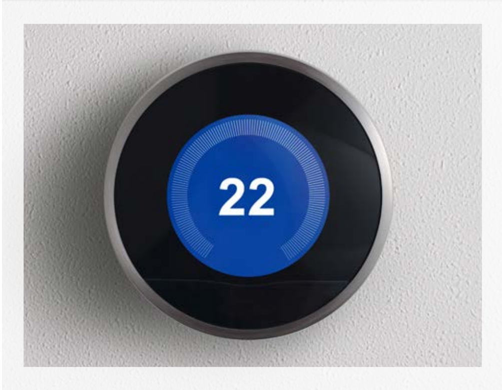
- Added convenience and comfort for occupants by automatic temperature control, as the thermostat "learns" the occupant schedules and temperature preferences.
- Intelligent recovery ensures that the space temperature is restored to comfortable conditions by the time the occupant returns.
- The thermostat can be remotely controlled from a smartphone using local Wi-Fi.
- Better control of indoor comfort.

Considerations

- This measure can be implemented by the property manager or maintenance staff if the controls to be replaced operate at low voltage (24 volts A/C).
- Intelligent thermostats for electric resistance heating applications, such as baseboard or wall-mounted heaters, will require a transformer/relay for each individually controlled heater and should be installed by a qualified electrician.
- Intelligent thermostats have the capability to control both heating and cooling, and may also control relative humidity where a humidifier is installed.
- Occupants usually don't require assistance in programming thermostats as the intelligent controls "learn" occupant preferences.
- Savings will accrue directly to occupants in those MURBs with individual in-suite energy metering.
- Be aware of electricity billing structures based on time of use to minimize the use of electric space heating equipment during peak billing periods.

Implementation

- Examine existing thermostats to determine voltage, mounting, and function to ensure that the replacement thermostats can be easily retrofitted.
- Select only intelligent thermostats having a "learning" capability.
- Install the new control in the same location (unless the original thermostat is inappropriately located in direct sun or adjacent to a heat source such as a refrigerator).
- Provide preliminary instructions to the occupants to ensure the "learning" operation is initiated.
- Remind occupants that it takes approximately one week for the intelligent thermostat to learn their habits.



11 Install variable frequency drives (VFDs) on electric motors with extended operating hours

Measure

Install VFDs on electric motors driving centrifugal fans and pumps.

Payback

Simple payback: 2 to 5 years.

Final payback will depend on these factors:

- Annual operating hours of the motor.
- Efficiency of the existing motor.
- Variability of the load on the driven fan or pump.
- Type and value of incentives.

Application

Three-phase induction motors (1 hp and greater) that operate for long periods of time each year.

Benefits

- Energy savings of 10 to 25 per cent.
- Variable speed that can match the load on the driven equipment.

Considerations

- Implementation of this measure requires the services of a mechanical or electrical contractor who is familiar with the application of VFDs for fans and pumps in buildings.
- Ensure that the motor is suitable for the addition of a VFD.
- A sensor must be installed that can measure a variable that is indicative of the load on the driven device and supply a signal to the VFD to adjust the motor speed appropriately.
- Reasons to replace the motor at the same time include the following:
  - The existing motor is not a three-phase induction motor or is not suitable for a VFD.
  - The existing motor is approaching the end of its useful life.
  - The load on the driven equipment has increased for other reasons, and the motor is now at its capacity limit or is undersized.
  - The motor efficiency is very low compared to a new motor.

Implementation

- Contact a knowledgeable, experienced contractor to ask for a recommendation and a proposal.

12 Replace residential single-phase motors with higher-efficiency types

Measure

Replace failed conventional motors with more efficient models.

Payback

Simple payback: 6 to 8 years for continuously operating fans.

Simple payback for non-continuous operation will vary widely.

Final payback will depend on these factors:

- Annual operating hours of the motor.
- Efficiency of the existing motor.

When replacing a motor that has reached the end of its useful life with a new one, the simple payback evaluation should be based only on the incremental cost difference between the new high-efficiency motor and the standard-efficiency motor, not the total cost of the high-efficiency option.

Application

Fractional horsepower, single-phase motors on residential furnaces, air conditioners and other air handling devices.

Benefits

- Energy savings of 25 to 30 per cent.
- Improved operation.
- Improved reliability.

Considerations

- This measure requires the services of a qualified mechanical contractor.
- Ensure that the proper type of residential blower motor is being used for the replacement.
- Typical efficiency of belt-drive furnace blower motors is 50 to 55 per cent. High-efficiency motors have an efficiency level of 70 to 77 per cent.
- Belt-drive blowers can also be replaced with direct-drive multi-speed blowers of the same physical dimensions and air handling capacity. Eliminating the belt drive improves the efficiency by 20 to 30 per cent, and improves the reliability.
- High-efficiency motors can be easily specified when replacing fan coils or furnaces.

Implementation

- If electronic air cleaning or ventilation is provided by a continuously operating fan, replacement is highly recommended.
- Equipment that runs during both heating and cooling seasons will benefit most from high-efficiency motors.
- Original equipment direct-drive motors may be shaded-pole (small fractional horsepower) or permanent split capacitor (PSC) type. PSC motors are much more efficient and should be used to replace shaded-pole motors. A capacitor of the correct rating must be supplied and mounted.
- Where a new furnace, air-handling unit or air conditioner is being purchased, choose one with an electronically commutated motor (ECM™). The ECM™ is the most efficient single-phase fractional horsepower motor. These are very efficient at speeds below their full rated speed and can reduce electricity consumption by 60 per cent at 50-per-cent capacity, over a PSC motor.

13 Replace gas- or oil-fired boilers with higher-efficiency models

Measure

Replace existing space heating or domestic hot water supply boiler(s) with higher-efficiency models. This measure is most often applied at the end of the useful life of the existing equipment.

Application

MURBs with gas- or oil-fired boilers for space heating or domestic water heating.

Benefits

- Reduced energy consumption and costs.
- Additional space in mechanical rooms (newer equipment is often smaller in size).
- Cleaner combustion.
- Reduced maintenance and repairs.
- Improved reliability.

Considerations

- A number of replacement gas- or oil-fired boilers operate at thermal efficiencies of 85 to 95 per cent, compared to 75 per cent for older atmospherically vented units.
- Implementation requires the services of a consulting engineer and/or a qualified heating or mechanical contractor.
- Venting requirements for higher-efficiency equipment may be different. Carefully examine chimneys and vents shared by several combustion appliances to ensure they are suitable for the new equipment, or install new, separate venting. Higher-efficiency boilers can often be side wall-vented, eliminating the need for a vertical chimney or vent.
- The range of water system temperatures required by the building should be evaluated against the performance specifications of the new boiler to ensure a match.
- In some cases, heating system changes can be made that will optimize the efficiency of the new boiler.

Payback

Simple payback: 3 to 9 years.

Final payback will depend on these factors:

- Matching operation of the new boiler to the distribution system through changes to the piping connections.
- The addition of newer controls that can optimize the operation of the heating system.
- The effect of access to the boiler room and other site issues on the total capital cost.

When replacing a boiler that has reached the end of its useful life, the simple payback evaluation of a new higher-efficiency boiler over a standard-efficiency type should be based only on the incremental cost of the higher-efficiency unit over the standard model, not the total cost of the replacement.

Implementation

- Building heat loss calculation should be done to match new space heating boilers to the actual building load. Many existing heating plants are often oversized. Basing the capacity of the replacement equipment on the original boiler specifications is not recommended. Similarly, the required capacity for domestic hot water supply boilers should be reviewed.
- Since most higher-efficiency boilers are fully enclosed and have reduced clearance limits, space may be gained by making piping changes to move the new boiler closer to the wall.
- Where replacing only one boiler in a two-boiler plant, operate the new boiler as the base load unit to take advantage of its higher efficiency.

14 Convert from a higher- to a lower-cost fuel for heating

Measure

Convert from a higher to a lower cost fuel for heating equipment. The conversion is often performed as part of a replacement or upgrading of the heating equipment. The usual conversion is from electricity or oil to natural gas. Some cities can provide steam or hot water from a district heating system.

Payback

Simple payback: 3 to 9 years.

When replacing a heating system that has reached the end of its useful life with a new system that uses a lower-cost fuel source, the simple payback evaluation of the new system should be based only on the capital cost difference between that new system and the cost of replacing the old system with one using the same energy source, not the total cost of the replacement with fuel substitution.

Application

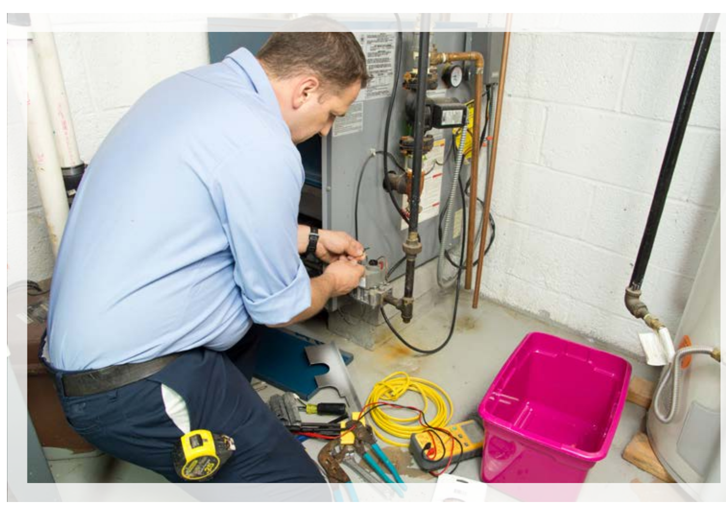
MURBs heated using an energy source that is significantly higher in cost per unit of delivered heat.

Benefits

- Energy cost savings.
- Very rapid payback when measure is undertaken as part of a required boiler or furnace replacement.

Considerations

- Changing from oil to gas may require modifications or replacement of the existing venting system, such as the installation of a vent liner.
- Oil storage tanks for oil-fired equipment must be properly removed and then disposed of.
- Changing from electricity to a fuel-fired system will require the installation of a flue gas venting system. This can pose a challenge in cases where boilers are located in the basement or on the ground floor.
- The existing distribution system may need to be modified, or replaced entirely.
- For domestic hot water heating system fuel conversion, the following should be considered:
  - In-suite or central system.
  - Hot water supply boiler/water heater efficiency level.
  - Boiler/furnace efficiency level for fuel-fired system.
  - Venting/chimney for fuel-fired system.
  - Availability, routing and cost of fuel supply.
  - Utility incentive contributions.



Implementation

There are several conversion options for space heating systems. When deciding, consideration should be given to the following issues:

- Fuel conversions often require the services of a consultant to determine the costs, benefits, and implementation considerations.
- The need for individual versus central metering and cost allocation capabilities.
- Individual suite and/or room control, ventilation requirements, noise level, durability, maintainability, in-suite space requirements and maintenance requirements.
- Type and cost of required heat distribution system.
- Location and cost of new equipment room, if required.
- Boiler/furnace efficiency level for fuel-fired system.
- Venting/chimney requirements for fuel-fired system.
- Availability, routing and cost of fuel supply.
- Future adaptability to other low cost fuels.
- Availability of utility incentive contribution to cost of high-efficiency fuel supply system.

Comparing energy/fuel costs

The cost of two different fuels can be compared on the basis of heat delivered to the space as follows:

Cost per kWh delivered to space =

$$\frac{\text{Unit Cost of Fuel} \times \text{Conversion Factor to kWh}}{\text{Boiler or Furnace SE* } \times \text{ System Distribution Efficiency}}$$

* SE = seasonal efficiency

Conversion factor to kWh

The following are some of the more common conversion factors to kWh:

- BTU / kWh = 3142
- cu. ft. gas / kWh = 3.33
- m^3 gas / kWh = 0.094
- L no. 2 fuel oil / kWh = 0.0934
- U.S. gallons no. 2 fuel oil / kWh = 0.0246
- L propane / kWh = 0.143
- Lb propane / kWh = 0.182

Seasonal efficiency (SE)

- Electricity use 1.0
- Gas-fired systems = 0.65 - 0.90
- Oil-fired systems = 0.65 - 0.80

System distribution efficiency (SDE)

- Electricity = 1.0
- Hot water = 0.95
- Forced air = 0.95

Example

Conversion of a building heated by electric baseboard heaters to one that is heated by a new gas-fired hot water system.

New boiler will operate at a seasonal efficiency of 84%.

Average winter rate for electricity is $0.10/kWh.

Average natural gas rate is $0.25/m³.

Relative cost of energy delivered to the conditioned space (using equation from above):

Heating fuel 1: Electricity (with baseboard heating)

$$\text{Cost/kWh delivered} = \frac{\$0.10/\text{kWh} \times 1.0}{1.0 \times 1.0} = \mathbf{\$0.10/kWh}$$

(100% heating plant and system efficiency)

Heating fuel 2: Natural gas (with hot water heating, medium efficiency boiler)

$$\text{Cost/kWh delivered} = \frac{\$0.25/\text{m}^3 \times 0.094\ \text{m}^3/\text{kWh}}{0.70\ \text{Boiler SE} \times 0.95\ \text{SDE}} = \mathbf{\$0.035/kWh}$$

On this basis, natural gas heating can be provided at approximately one third the cost of electricity.

Notes

- The same analysis can be used for domestic hot water by excluding the system distribution efficiency.
- Where load shifting for electricity is being used, or special rates charged, a more complex analysis is required.
- Where possible, consideration should be given to the future cost of the two fuel sources. In some cases, contracts defining a maximum allowable price adjustment over an extended period can be negotiated.
- The total cost of the conversion can be estimated by the consultant or contractor.

15 Indoor swimming pool dehumidification

Measure

Replace existing heating and ventilation system in an indoor pool area with a swimming pool dehumidification system.

Payback

Simple payback: 4 to 8 years for cases where pools were previously ventilated by 100-per-cent fresh air, 100-per-cent exhaust air systems.

Application

For indoor swimming pools, considerable energy is lost in the warm, humid air that is exhausted from the indoor pool enclosure to prevent moisture damage. This heat is provided by the pool water heater, the pool enclosure heater and the makeup air system.

Benefits

- An indoor pool dehumidification system can reduce or eliminate the need to exhaust large quantities of indoor air by removing moisture and heat from the air and returning it to the water and the enclosure.
- Significant reduction in energy costs.
- Recovery of water evaporated from the pool surface.
- Reduced operating and maintenance costs.
- Improved control of indoor humidity levels.
- Reduced potential for condensation and damage to pool room, walls, roof, and interior finishes.

Considerations

- This measure requires the services of a consulting engineer and/or a qualified contractor.
- Indoor air temperature should be maintained at 1°C (2°F) above the pool water temperature to minimize evaporation.
- Ensure the dehumidification unit capacity matches the water and air temperatures maintained in the pool area.
- A separate mechanical room may be required to house the equipment.
- New ductwork may be required to supply and return air from the pool area to the dehumidification unit.

Implementation

- The dehumidification unit will be connected to both the air distribution system and the pool water circulation system. Access will be required to both.
- The best location for introducing supply air from the unit to the pool enclosure is under any exterior windows. The dry air supplied will help prevent condensation.
- Moisture condensed by the dehumidification unit should be returned to the pool to minimize the need to add makeup water to replace evaporated water.
- The condensate can drain by gravity from the dehumidification unit. Where the unit is below pool water level, the condensate will have to be pumped.
- Additional heat to maintain indoor air temperature must be provided as part of the system.

16 Install a ground source heat pump system

Measure

Install a ground source heat pump (GSHP) system to provide space heating and space cooling to the building. This system may also be able to supply domestic water heating.

Payback

Simple payback range: 10 to 30 years (without incentives).

Application

MURBs with sufficient ground available to install a vertical or horizontal ground collector loop to act as a heat sink for the GSHP.

Benefits

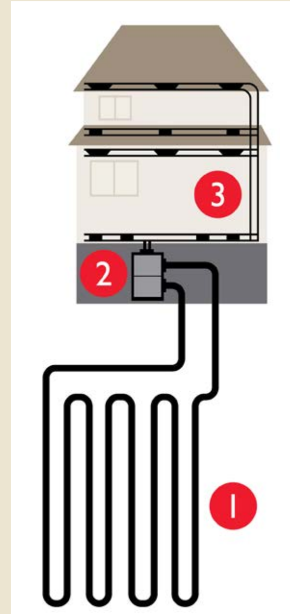
- Reduced purchased energy consumption for space heating and cooling.

Considerations

- GSHP systems (also called geoexchange systems) use electricity to drive a refrigeration compressor and circulating pumps to collect heat from the ground in winter and reject heat to the ground in summer.
- The collector or ground loop can be installed either horizontally, which is less expensive but requires much more land area, or vertically, which requires a series of "wells" to be drilled up to 200 metres deep for the collector pipes. A heat exchange fluid circulates through the loop.
- A GSHP system uses about 30 to 50 per cent of the energy for space heating that would be consumed by a building having electric resistance heating units, such as electric baseboards. Energy consumption for space cooling provided by the GSHP is also reduced.
- Installation costs will vary widely depending upon the type of collector and the site conditions encountered.
- The heating and cooling can be supplied to a water distribution system (typical for larger MURBs) or to an air distribution system (more usual for smaller MURBs).
- GSHP units can be central or distributed, for example, one per suite or one per floor. For distributed systems, the thermal fluid from the ground loop is piped to each GSHP unit.

Implementation

- Implementation requires the services of a knowledgeable and qualified GSHP contactor.
- The contractor should apply for all electrical safety, municipal, utility and other permits required to complete and start up the system.
- GSHP systems are generally very reliable, but in addition to routine lubrication and filters, they should be checked at least annually by a certified GSHP contractor.



1. Ground loop
2. Heat pump unit
3. Distribution system

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