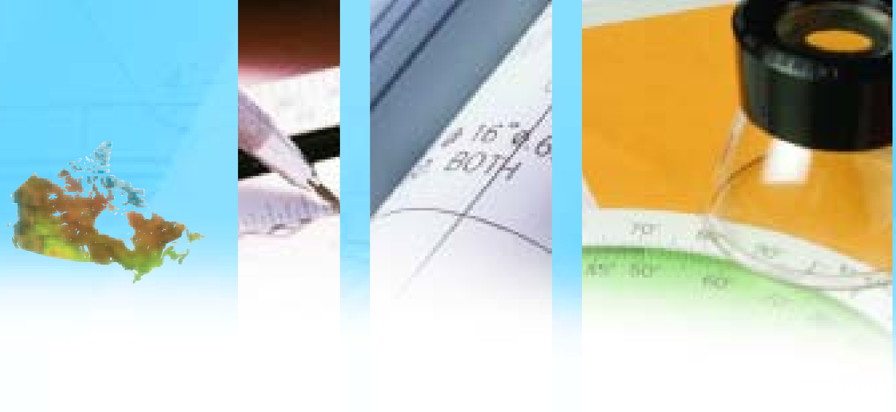

Energy Innovators Initiative

Technical Fact Sheet

Economizers for Packaged Air-Conditioning Units

Description

Individually packaged heating, ventilating and air-conditioning (HVAC) systems, usually placed on the roof and known as rooftop units (RTUs) (see Figure 1), are widely used in small- and medium-sized commercial and institutional buildings.

Although these air-conditioning systems can consume a lot of electricity, you can save energy by using an economizer. Economizer systems take advantage of favourable weather conditions to reduce mechanical cooling by introducing cool outdoor air into a building. The term “free cooling” is used in the HVAC industry to describe savings achieved from a properly working economizer.

Economizers not only save energy, they also decrease wear on the air-conditioning unit and can postpone costly repairs or even the need to replace it.

In mild climates, economizers save energy by using outside air instead of refrigeration equipment to cool the building. In climate zones with hot daytime temperatures and very cold nights, an economizer is not usually worthwhile.

Most packaged RTUs have an optional economizer add-on package, which can be installed when the system is new or may be added to the system as a retrofit at a later date. Retrofitting old economizer control systems to make use of electronic controls is a simple, easy and straight-forward operation that can also improve a building’s energy performance.

Figure 1 – Rooftop Unit

Technical Specifications

An economizer consists of dampers, sensors, actuators, controls and links that work together to determine how much outside air to bring into a building.

Accurate sensing of outdoor air conditions ensures that free cooling is used only when cost-effective.

For most common applications, a sensor monitors the outdoor air “dry bulb” temperature, or enthalpy[1], to determine whether it is below a predetermined set-point. If it is, the actuator opens the outdoor air damper and alters the path of the return air so that it is exhausted from the building. This is called single sensing. Facility operators need to determine which set-points are best for their building’s location, type and internal loads.

[1] Enthalpy is a measure of the total heat content of air based on both the air’s temperature and its humidity.

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Adding a second sensor in the return air is called differential sensing. With this method, instead of determining an optimized outdoor air set-point, the control system simply chooses the source of air (outdoor air or return air) that has the lowest temperature, or enthalpy.

A differential enthalpy control system can let in excessive outside air when heating is required, so the system must be wired to operate only when there is a need for cooling. This is done using an indoor thermostat.

Some economizers are temperature-only-based systems. Although the temperature of the outside air may be sufficient for cooling, the humidity levels may be too high. However, these systems will bring the humid outdoor air into the building because they cannot detect humidity. This excess humidity can make it uncomfortable for building occupants and can cause air-conditioning compressors to run longer to dehumidify the air, adding to the building's overall energy consumption.

Caution: An economizer system needs to be designed with adequate relief air so that when outside air is drawn into the building, the excess air is relieved. Without an adequate relief system, the building can become over-pressurized, causing exterior doors to stand open and air to whistle through exterior doors and elevator doors. There are three common types of relief systems that can be considered when retrofitting an RTU with an economizer: relief dampers, relief fans and return fans.

Energy Savings

Estimating the savings associated with a given economizer depends on many factors, including building location, construction materials, building use, actual occupancy, the nature of the HVAC equipment, HVAC parameter settings and control systems.

When economizers are properly installed and maintained, they can reduce mechanical cooling by up to 75 percent in certain climates.

To achieve the highest level of energy savings, combine economizers and demand-controlled ventilation (DCV). This combination can reduce air-conditioning costs while bringing in outdoor air for ventilation only as required, based on actual occupancy. DCV, when used alone as a control strategy, does not always save energy. For example, in arid climates, using a DCV control strategy reduces the volume of outdoor air intake, thus restricting the free cooling available from the air. Using both an economizer and a DCV will prevent this. The economizer should be given preference so that free cooling is used when required.

The extra cost for an optional economizer when purchasing an RTU is summarized in Table 1. An installation cost of $1,000 should be added when retrofitting an existing system with an economizer.

Table 1 – Extra Costs for Economizers at Time of RTU Purchase

Cooling Capacity (ton)	Cooling Capacity (kW)*	Average Cost ($)
Up to 10	Up to 35	$500
11 to 20	36 to 70	$900
21 to 30	71 to 105	$1,100
31 to 60	106 to 210	$2,500
61 to 100	211 to 350	$4,000

* kW: kilowatt

Caution: Malfunctioning economizers waste more energy than they were intended to save. For example, if a damper is stuck in the wide-open position, cooling or heating systems have to compensate for the excess air load entering the building. Therefore, ensure that your economizer is properly installed and maintained.

Table 2 – Cost-Effectiveness of Economizers

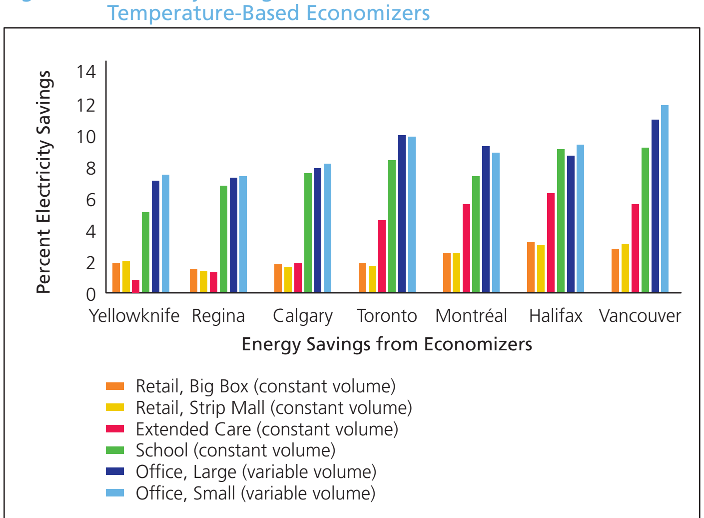
Facility	Area (m^2)	Number and Capacity of RTUs	City	Consumption (kWh)	Payback (years)	
					New RTU	Existing RTU
Extended health care	5000	10 units, 10 ton each	Toronto Montréal	33 500 34 000	3.4 5.3	7.1 11.2
Small office	3000	6 units, 12.5 ton each	Toronto Montréal	42 900 38 700	1.6 2.8	3.3 5.9

Comparison

Figure 2 provides percentage electricity savings achieved for RTUs equipped with temperature-based economizers in seven cities across Canada for different building types and systems.[2] The models all provide for a dry bulb limit of 23°C (74°F), above which the economizer control is disabled and the outside air returns to minimum. All systems are heated with natural gas.

There was only a minor improvement in energy performance when an enthalpy-based economizer was used.

Figure 2 – Electricity Savings for RTUs with Temperature-Based Economizers



Case Study

Based on the findings from the energy simulations, the following scenarios were developed to demonstrate the cost-effectiveness of an economizer (see Table 2). Utility rates were assumed to be $0.08/kWh for Toronto and $0.05/kWh for Montréal. The paybacks are presented in two columns. The first one is for purchasing an economizer option when buying a new RTU. The second one is for retrofitting an existing RTU with an economizer that includes the extra installation cost of $1,000 per unit.

The Energy Innovators Initiative, part of Natural Resources Canada's Office of Energy Efficiency, helps commercial businesses and public institutions improve energy efficiency and reduce greenhouse gas emissions that contribute climate change.

For more information, contact

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[2] The energy performance models are derived from Natural Resources Canada's set of prototype buildings developed in support of the technical guidelines produced for the Commercial Building Incentive Program (CBIP). These models were developed by surveying design professionals across Canada to identify typical new construction practices. The feedback from this process was combined with requirements of the *Model National Energy Code for Buildings* to provide for code-compliant representations of the commercial building stock across Canada. These prototype models have been expanded to represent different HVAC configurations for dozens of weather regions across Canada as the basis for the CBIP Web Screening Tool.

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