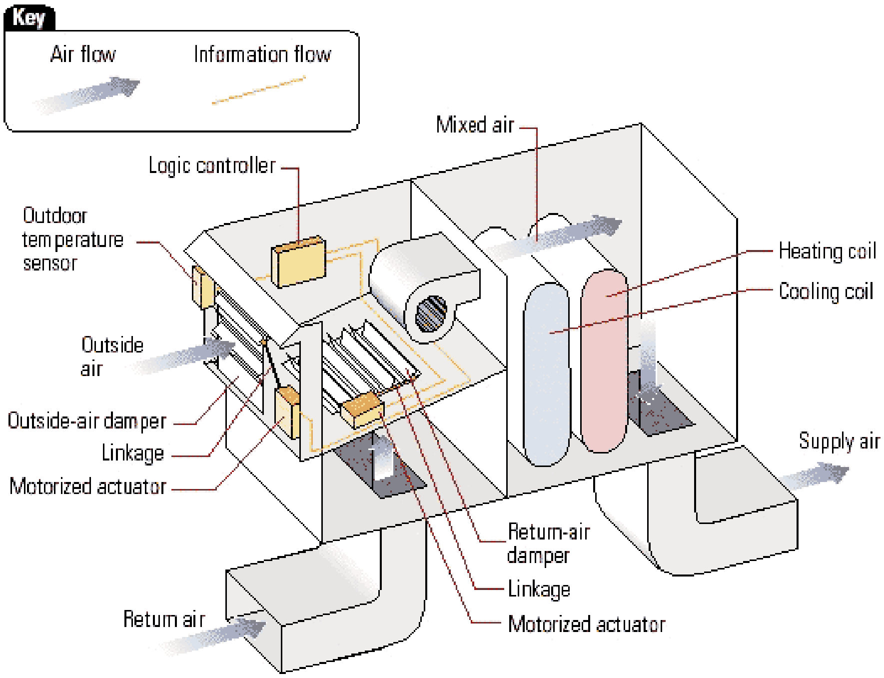
HVAC: Economizers

If you are responsible for a cooling system that has a capacity of 7.5 tons or more, you probably have an air-side economizer—and chances are it could use some attention.

When the outdoor temperature and humidity are mild, economizers save energy by cooling buildings with outside air rather than using refrigeration equipment to cool recirculated air (**Figure 1**). A properly operating economizer can cut energy costs by as much as 10 percent of a building's total energy consumption (up to 20 percent in mild, coastal climates), depending mostly on local climate and internal cooling loads.

Figure 1: The components of an economizer

An economizer is simply a collection of dampers, sensors, actuators, and logic devices that together decide how much outside air to bring into a building.



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So, economizers are designed to save energy, and that's good. The bad news is that probably about half of all newly installed economizers don't work properly, and their problems increase as they age. To make matters worse, there's a good chance that malfunctioning economizers waste much more energy than they were intended to save. If an economizer (which is actually a temperamental collection of parts including dampers, sensors, actuators, controls, and linkages) breaks down when its damper is in a fairly wide-open position, peak loads shoot up as cooling or heating systems try to compensate for the excess air entering the building. A computer simulation of an office building in arid Phoenix, Arizona, shows that a damper permanently stuck in the wideopen position could add as much as 80 percent to that building's summer peak load—that is, assuming the building had enough cooling capacity to meet the much higher load resulting from cooling excessive outside air.

What Are the Options?

To increase the likelihood that an economizer will not turn from an energy saver to an energy waster:

1. Specify upgraded components, such as stainless-steel dampers, direct-drive actuators, and enthalpy control.

- Stainless-steel dampers resist corrosion much better than the galvanized-steel and aluminum dampers typically used in economizers. Though stainless-steel dampers cost about twice as much as galvanized-steel dampers, they are cheaper than the total cost (including labor) of removing and replacing a failed damper. Unless a building is near sources of marine or industrial corrosion, however, this extra cost is probably not justified.

- Direct-drive actuators have fewer moving parts between actuator and damper, and therefore fewer parts that can fail. They are also much easier to install than typical linked actuators. Since their introduction in the 1980s, a company named Belimo has dominated the market, but increased competition is narrowing the price gap between direct-drive actuators and the more failure prone linked actuator. In many cases, direct-drive models now cost the same as or less than their linked counterparts.

- In a relatively dry, mild climate, a drybulb control system that simply measures outdoor air temperature is sufficient. In more humid climates, enthalpy-based controls, which account for both drybulb temperature and humidity, are best. Modern sensors that use solid-state electronics to measure enthalpy are much more reliable than older-technology sensors.

2. Test economizers right from the start and at least twice a year thereafter. Here are three testing techniques:

- Observe the damper position. Stand next to the outside-air damper with a handheld thermometer, and compare the damper position with the lockout and high-limit settings. If the damper's position is inconsistent with the settings on the controller, either the controls are malfunctioning or the damper is stuck. For the same reason that a broken clock tells the right time twice a day, it is impossible to know from a single observation whether a damper is functioning properly or just happens to be frozen in a position that is momentarily consistent with the controls. For this test to be effective, it must be repeated under a range of outside-air conditions.

- Fool the economizer controls. To test drybulb economizers, wait for a cool day when the economizer damper is open, and then warm the outdoor temperature sensor with your hands or an electric hair dryer. When the measured temperature exceeds the lockout setting, the damper should move to its minimum position. If the economizer has enthalpy controls, lightly spraying the enthalpy sensor with water from a spray bottle will temporarily raise the humidity of the air, which should trigger a reaction from the system. If the system does not behave according to its control settings, either the sensors are inaccurate or the economizer controller is malfunctioning.

- Install temperature dataloggers. For a detailed look at how individual economizers operate over time, diagnosticians can install portable devices that measure and log temperature. Typically, these devices are installed in the outside-air, return-air, supply-air, and mixed-air streams for two weeks. The collected temperature data may then be downloaded and diagnosed using simple spreadsheet software.

3. When all else fails, lock the economizer in the minimum-outside-air position.

Some economizers cannot be cost-effectively maintained in working order. They may be:

- Located in an especially corrosive environment;
- Made from seriously inadequate materials;
- Even in top condition, capable of producing only inconsequential energy savings;
- Installed in a building with undersized outside and exhaust air openings; or
- Serviced by unmotivated technicians.

Regardless of the reason, if an economizer repeatedly fails and it is prohibitively expensive to repair it, the best solution is to lock it into its minimum-outside-air position. Although you don't get the benefits of the economizer's potential energy savings, you do guard against its becoming a significant energy waster.

How to Make the Best Choice

The biggest choice faced by economizer owners and operators is whether or not it is worthwhile to invest in upgraded components and testing for a particular economizer. To make this decision, first estimate how much energy an economizer is likely to save. Then, choose upgraded components and testing procedures accordingly. For example, a functioning economizer installed on a 30-ton rooftop unit might save about $1,000 per year, and so it is probably worth maintaining. An economizer in a unit one-tenth that size that saves only $100 a year might be better off locked in minimum position. The biggest challenge you'll face is estimating the savings associated with a given economizer. Because those savings vary widely by location and building type, check with local sources to learn what savings are typically produced by economizers at similar buildings.

What's on the Horizon?

In the future, economizer control systems may be able to diagnose their own difficulties. Pacific Northwest National Laboratory (PNNL) is developing a modular diagnostic software system, named the Whole Building Diagnostician (WBD), that detects and diagnoses common problems associated with the operation of HVAC systems and equipment in buildings. The WBD tracks overall building energy use, monitors the performance of the air-handling units, and detects problems with outside-air control. Its development is part of the commercial buildings research program of the U.S. Department of Energy's Office of Building Technology, State and Community Programs. PNNL intends to eventually work the WBD's intelligence into stand-alone controllers for packaged HVAC equipment.