Commercial Buildings Breathe Right with Demand-Controlled Ventilation

The Problem

Demand controlled ventilation (DCV) systems save energy by using building occupancy indicators that usually measure CO_2 levels to regulate the amount of outside air that is drawn in for ventilation. But DCV systems are not widely used, because their cost-effectiveness has not been clearly defined, their benefits have not been demonstrated or documented in the field, and design guidelines are rarely available.

The Solution

Researchers performed an economic analysis of DCV with the help of a computer simulation known as VSAT (Ventilation Strategy Assessment Tool). The analysis determined the conditions under which DCV is most likely to be cost-effective. In addition, field tests were conducted to verify the savings and identify potential problems in the application of DCV (**Figure 1**). The results also included a set of design recommendations.

Features and Benefits

Analysis of DCV systems coupled with economizers covered a variety of new and existing buildings with a wide range of occupancy schedules. The sites included a small office building, a sit-down restaurant, a retail store, and several school spaces—a class wing, an auditorium, a gymnasium, and a library. In all cases, the DCV-plus-economizer system showed greater savings and quicker payback than an economizer-only system. Payback periods were typically two years or less.

Table 1: Savings vary with location

For a given temperature, measured cooling energy savings at the site in Sacramento were greater than those at Bay Area sites because occupancy rates were lower.

	Savings		
Daily average temperature (Fahrenheit)	Bradshaw Road (Sacramento)	Milpitas (Bay Area)	Castro Valley (Bay Area)
60	Not applicable (fan only)	26%	15%
70	46%	16%	11%
80	28%	12%	9%
90	20%	10%	8%

Figure 1: Field tests show DCV savings

Demand-controlled ventilation proved itself cost-effective in field tests in McDonald's PlayPlace areas and Walgreens drug stores.

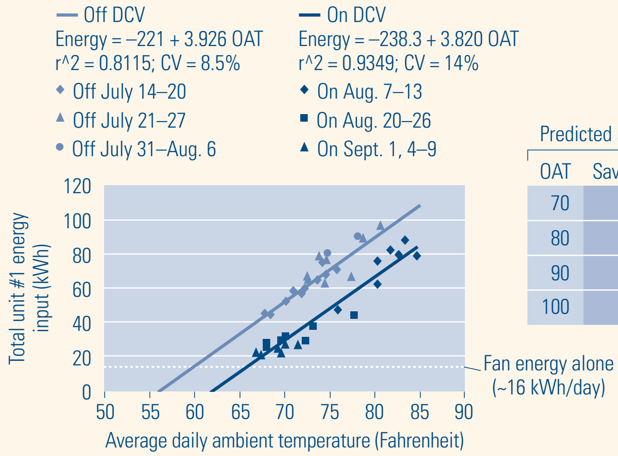
Field tests conducted in coastal and inland climate zones in California included sites such as McDonald's PlayPlace areas, modular school rooms, and Walgreens drug stores. The largest savings occurred in inland buildings with low occupancy rates and high ventilation loads (see **Table 1,** at left, and **Figure 2**, next page). No substantial savings were found in buildings with high occupancy rates that varied only a little, such as modular school rooms. Also, timers or controllable thermostats meant that HVAC units only operated during normal school hours.

Several conclusions from the study can help designers decide where and how to implement DCV:

- The greatest savings and shortest payback periods occur for buildings that have variable and unpredictable occupancy levels, with high occupant densities at peak occupancy.
- Savings vary with climate. In California, greater savings occurred in hot, inland climates than in mild, coastal climates. Potential savings from DCV are greatest in cold climates, where heating dominates.
- A nonzero minimum ventilation rate will keep non-occupant sources of indoor contamination at acceptable levels. It helps to establish minimum ventilation rates based on the expected types and strengths of pollutant sources.

Figure 2: Cooling energy use with and without DCV

A McDonald's in the Sacramento, California, area consumed significantly less energy when DCV was in use. Tests also showed indoor air quality stayed within acceptable limits. For a hot day with an average temperature of 80º Fahrenheit, the estimated savings were about 28 percent.



Predicted savings

OAT	Savings (%)
70	46
80	28
90	20
100	16

Notes: kWh = kilowatt-hour, OAT = outside air temperature, CV = coefficient of variation.

- In buildings with an economizer cycle, allow the economizer to override the DCV system at times when the additional ventilation would provide "free" cooling.
- Select DCV systems that are able to increase outdoor air intake before the building opens in the morning to deal with concentrations of contaminants that may build up overnight.
- Always calibrate and maintain sensors according to manufacturer recommendations.
- Avoid placing CO_2 sensors for ventilation control near doors, windows, air intakes or exhausts, or occupants. Do not use a single sensor located in a common return to control ventilation rates for multiple spaces with different occupancies.
- The VSAT tool is available for evaluating the impact of setpoints, minimum ventilation rates, and operating schedules during the DCV system design phase. The program can be downloaded from the web at www.energy.ca.gov/pier/buildings/tools.html.

Applications

The DCV technology evaluated in this project is used on packaged air-conditioning systems, which are typically found in small commercial buildings. Facilities likely to benefit from DCV include auditoriums, gyms, and retail stores.

California Codes and Standards

The changes to Title 24 that take effect on October 1, 2005, require DCV in all spaces where an HVAC single-zone system includes an economizer and that have an occupant density of greater than or equal to 25 people per 1,000 square feet. Exceptions include classrooms, areas where space exhaust is greater than the design ventilation rate, and spaces with processes or operations that generate dust, fumes, mists, vapors, or gases. The new code will also require acceptance tests to ensure the technology is properly installed.

What's Next

As interest in DCV increases, its impact on comfort and productivity should be studied to provide additional information for designers and building owners.

Collaborators

Organizations involved in this project include Purdue University and the National Institute of Standards and Technology.

For More Information

Reports documenting this project and providing more details may be downloaded from the web at www.energy.ca.gov/reports/2003-11-18_500-03-096-A8.PDF.

To view Technical Briefs on other topics, visit www.esource.com/public/products/cec_form.asp.

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About PIER

This project was conducted by the California Energy Commission's Public Interest Energy Research (PIER) program. PIER supports public-interest energy research and development that helps improve the quality of life in California by bringing environmentally safe, affordable, and reliable energy services and products to the marketplace.

Arnold Schwarzenegger, *Governor*

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Pub # CEC-500-2005-126
Date 07/30/05