



BUILDING AMERICA TOP INNOVATIONS HALL OF FAME PROFILE

INNOVATIONS CATEGORY:

1. Advanced Technologies and Practices
- 1.3 Assured Health, Safety, and Durability

Outside Air Ventilation Controller

Building America partner Davis Energy Group worked with Monley Cronin Construction to build 100 energy-efficient homes in Woodland, CA, with night-cooling ventilation systems.

Building America research showed automated night ventilation can reduce cooling energy costs up to 40% and peak demand up to 50% in California's central valley climates and can eliminate the need for air conditioning altogether in the coastal climate. Variations of these systems are being used in over 20,000 homes.



BUILDING AMERICA TOP INNOVATIONS

Recognizing Top Innovations in Building Science – The U.S. Department of Energy's Building America program was started in 1995 to provide research and development to the residential new construction and remodeling industry. As a national center for world-class research, Building America funds integrated research in market-ready technology solutions through collaborative partnerships between building and remodeling industry leaders, nationally recognized building scientists, and the national laboratories. Building America Top Innovation Awards recognize those projects that have had a profound or transforming impact on the new and retrofit housing industries on the road to high-performance homes.

Building America researchers developed technologies to harness the natural day-night temperature swings in the U.S. Southwest to cut cooling energy peak demand with no compromise in comfort.

Building America research has shown that, in dry climates, the use of ventilation cooling can significantly reduce, delay, or completely eliminate air conditioner operation resulting in both energy savings and reduction of peak demand (Springer et al. 2012).

Opening and closing windows is an age-old practice for cooling homes that still has potential, especially in dry climates with day-night temperature differences of 20°F or more, as is true for much of the Southwest. However, security concerns and occupant work schedules limit the practicality of this option. A 2006 Lawrence Berkeley National Laboratory (LBNL) study found that 20% of California households never open windows and 50% rarely open windows.

Building America research teams investigating alternatives to compressor cooling in the 1990s came up with a simple automated system that uses lower temperature night-time air to cool the inside of the home, without opening windows.

The system was developed by Building America research partner Davis Energy Group and builds on the central fan-integrated ventilation concept developed by Building Science Corporation. Fresh outside air is drawn in through a fresh air intake ducted from an outside vent to the return side of the air handler plenum. Electronically controlled dampers open and close the fresh air intake to prevent over-ventilation. The system is fully automated requiring no actions by occupants once the thermostat is set, provides controlled ventilation with filtered air, and offers security as windows and doors do not need to be left open to take advantage of night-time cooling.

Air conditioning installation and usage have continued to increase in the United States. Currently, 61% of households have a central cooling system (EIA 2011) and nearly all new homes are built with central air conditioning. Although air conditioning only accounts for 7% of California's annual energy use, by 2006 it accounted for 45% of summer peak cooling. Building America research showed that using night ventilation could reduce cooling energy use up to 35% in locations where day-night summer temperatures range 30°F or more.

During the cooling season, the air handler ventilates the house with 100% outside air when outdoor temperatures are at least 5 degrees cooler than indoors. The electronic controller operates the fan and the dampers to prevent under-delivery of fresh air during shoulder season conditions, when the thermostat is not calling for much heating or cooling, and over-delivery of fresh air during periods of more continuous central fan operation, such as mid-winter and mid-summer, when too much outside air can increase heating or cooling costs. If the indoor temperature exceeds the high limit temperature setting, the system operates the split-system air conditioner, if one is provided. The system can also operate a split-system air conditioner and can control the outside damper to operate as an economizer, circulating outside air rather than return air if it is cooler outside than in while the air conditioner is running.

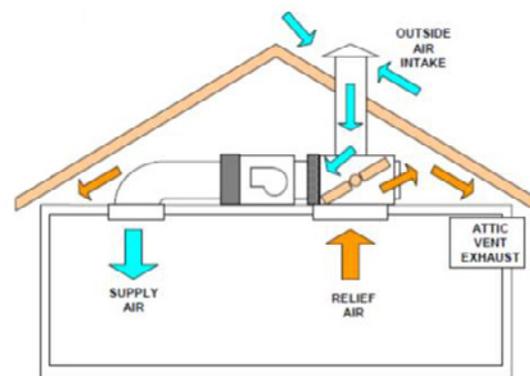
The system can be set up to provide heating as well by circulating hot water from the home's tank water heater through a coil located in the air handler.

The system was commercialized and marketed under the names SmartVent and NightBreeze. The SmartVent system, which works with a fixed speed air handler fan, was developed in the mid 1990s and, as of 2011, more than 20,000 systems had been installed. NightBreeze, which works with a variable speed air handler fan, became available in 2003 and several hundred units have been installed (Hoeschele 2011). In 2007 PG&E monitored six units (3 NightBreeze and 3 SmartVent) near Sacramento. Annual savings were calculated compared to a 17 SEER air conditioner. Savings for days >92°F were sizable at 14% for SmartVent and 30% for NightBreeze. The most significant were savings during the peak cooling load afternoon hours of noon to 6 p.m. where researchers found a 48%-50% reduction in power demand (Hoeschele 2011).

The technologies overcome some of the limitations of whole-house ceiling ventilation fans, which have been used for cooling in hot-dry climates. Whole-house fans pull large quantities of hot air out of the home and into the attic where it is directed to exit through roof vents. First-floor windows are opened to allow in cooler night-time makeup air. The large volume results in a quick cooling of the house air, but noise, manual not automatic operation, and security concerns limit their use (Springer et al. 2012).

Key Lessons Learned

- Building America research proved the outside air ventilation controller systems deliver impressive energy and peak demand savings while addressing lack of occupant use of operable windows for natural ventilation cooling.
- Broader adoption was hindered by market barriers that face many new technologies – finding investors and a manufacturer, marketing and distribution issues.



Grube Homes of Sacramento worked with Building America research partners ConSol and Davis Energy Group to add energy-saving features like night ventilation cooling to its 144-home Carsten Crossings development in Rocklin, CA.

REFERENCES

- Springer, D.** 2004. *NightBreeze Product and Test Information*. Prepared by Davis Energy Group for the California Energy Commission, www.energy.ca.gov/reports/500-04-009/500-04-009_ATTACH1.PDF
- Hoeschele, M.** 2011. "Residential Night Ventilation Cooling," Presentation to California Statewide Utility Codes and Standards Program by Davis Energy Group, May 13, 2011. www.h-m-g.com/T24/Res_Topics/2011.05.13MeetingDocuments/Night_Ventilation_Hoeschele_051311.pdf
- Matrix.** 2007. *Residential Night Ventilation Monitoring and Evaluation*. Prepared by Matrix Energy Services, Inc., for the Pacific Gas and Electric Company (PG&E). www.etcc-ca.com/images/download_project_report.pdf
- Springer, D., B. Dakin, and A. German.** 2012. *Measure Guideline: Ventilation Cooling*. Prepared by Davis Energy Group for the U.S. Department of Energy Building America, www.davisenergy.com/wp-content/uploads/2012/06/BA_measure_guide_vent_cooling_PUBLISHED.pdf