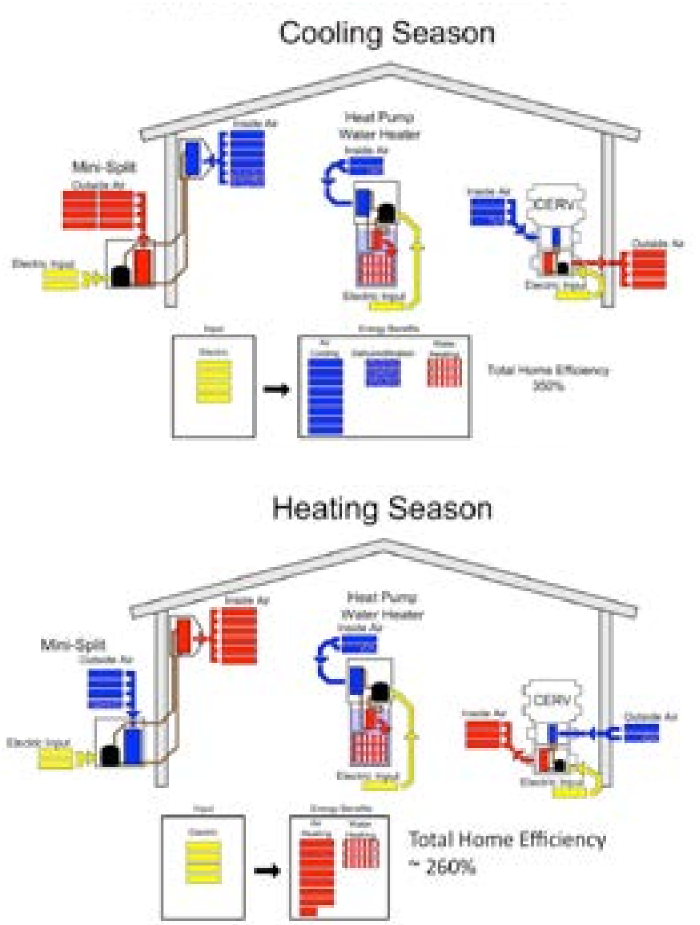
BY TED CUSHMAN

# Conditioning Energy Recovery Ventilators

**High-performance buildings** present a special problem to HVAC designers—not because the numbers are big, but because they're small. In a superinsulated home with very low heat gain or heat loss, it can be a finicky puzzle to match the equipment to the loads. Too much capacity, and systems won't run efficiently; too little capacity, and rooms may be too hot or too cold. Too much or too little dehumidification, and rooms could be over-dry, or damp and clammy, even when the room temperature is on the money. The balancing act is trickiest in the "swing" or "shoulder" seasons of spring and fall, when calls for heating or cooling are small and intermittent, but the house still needs continual fresh air.




A three-way heat-pump tag team lets a small home squeeze more comfort from its electric supply.

Illustration: Build Equinox

Airtight and superinsulated buildings, of course, require mechanical ventilation. In warm climates, the humidity brought in by the code-required in-flows of fresh air can apply a "latent load" that challenges air conditioners—a load that looms relatively larger in the calculations for a building with superinsulated walls and roof, advanced windows, and tight air-sealing—all of which minimize heating and cooling loads associated with heat gains and losses through the building envelope.

Heat recovery ventilator (HRV) systems address the heating and cooling part of the problem by transferring heat from the outgoing airstream to the incoming one during the heating season, and doing the reverse during the cooling season. Energy recovery ventilator (ERV) systems go one better by also addressing latent loads: They transfer moisture as well as heat from one airstream to the other as needed. But both systems can accomplish only so much, because they operate passively: HRVs transfer energy from warm air to cold air, while ERVs also transfer moisture from humid air to dry air, but neither one can pump vapor or heat "uphill." An HRV's limitations are most apparent in humid climates, where incoming fresh air brings an outsize load of moisture with it; but in a humid climate, even an ERV can bring in air that's damp enough to make trouble for the air conditioning system and make the house uncomfortable for occupants. Instead of helping with the space-conditioning problem, in short, ventilation systems are often part of the problem.

Humidity control has always been an issue in hot/humid or mixed climates. *JLC* has looked at solutions to this problem in the past, focusing on variable-speed compressors and air handlers for central air conditioners (see, for example, "Air Conditioning for Humid Climates," 10/04). But those articles dealt with conventional code-compliant houses, not Passive House or net-zero homes. Conventionally-sized furnaces and air conditioners—even the ones with advanced humidity-control features—pack way too much punch for a 21st-century superinsulated home (especially a small one). The new

A Build Equinox Conditioning Energy Recovery Ventilator (CERV) is shown installed in the mechanicals room of a superinsulated 1,000-square-foot modular home in Vermont. The unit preconditions incoming air and delivers cooled or warmed fresh air to remote rooms as needed, controlling humidity and air quality as well as temperature.

Photo: Peter Schneider/Efficiency Vermont

generation of advanced homes needs a mechanical system with less muscle, and more brain.

#### ENTER THE CERV

After several years of research and development, Indiana-based Build Equinox is now manufacturing and marketing a conditioning energy recovery ventilator (CERV)—an ERV augmented with a small heat pump. The heat pump actively precools the outgoing air and prewarms the incoming air (or vice versa), before the incoming air reaches the passive heat-exchange core and after the outgoing air has already passed through the passive core.

Build Equinox systems also come with a “black box” smart control system that senses humidity, carbon dioxide (CO2), and volatile organic compounds (VOCs) in the air, turning the system fans and heat pump on and off as needed to address the building’s actual pollutant load and humidity conditions, rather than using a timer to determine the flow of ventilation air. When fresh air isn’t needed, the black box responds to variations in house temperatures, operating in recirculation, or “recirc,” mode to move air around and maintain an even temperature.

The value proposition? Better air quality, reduced energy consumption, improved comfort, and lower construction costs—in the cold north as well as the humid south. In humid climates, a CERV can wring most of the moisture out of the incoming air before it enters the home, delivering cool, dry air from the fresh-air registers and easing the strain on the home’s air conditioner. And in a cold climate, a CERV can boost the temperature of supply air in the fresh-air ducts, allowing the ventilation system to carry some, or even all, of the heating load for rooms. With its smart controls, the CERV runs only when needed, saving energy. And although it’s an active system, not a passive one, a CERV can allow designers to approach the Passive House ideal of using ventilation ductwork for space conditioning as well as fresh air—a key cost savings that could help offset the increased construction cost associated with envelope upgrades like superinsulation, meticulous air-sealing, and triple-glazed windows.

#### CASE STUDIES

Two cases illustrate the CERV’s usefulness in meeting energy challenges: a small, affordable dwelling in the chilly Vermont climate, and a larger, custom home in warm, humid North Carolina. In each situation, the CERV helps to meet the specific needs of the climate and the design.

**In Vermont,** the state’s energy-efficiency utility, Efficiency Vermont, has been replacing old energy-hog trailer homes with new modular units the same size and shape as the house trailers, but built with superinsulated, airtight double-stud-wall construction. Built in Wilder, Vt., by modular builder VerMod, the new units are net-zero capable, generating as much power as they consume each year with a rooftop-mounted photovoltaic solar array.

But heating and cooling the long, skinny units is a challenge. VerMod meets the need with a three-component HVAC system made up of the Build Equinox CERV, a 9,000-Btu air-source minisplit heat pump, and a heat pump water heater (HPWH).

Efficiency Vermont program manager Peter Schneider explains how it works (see illustration, page 29): “The units have a heating load of 8.4 kBtu per hour at the design temperature. We meet that heat demand with a small cold-climate ductless heat pump (a Mitsubishi FH09 or a Fujitsu 9RLS3h) and the Build Equinox CERV. The CERV can meet the heat demand down to 32°F, and below that temperature, the ductless heat pump provides the additional Btus needed to achieve the desired set point."

Schneider continues: "We meet the hot-water demand with a GE GeoSpring heat pump hot-water heater, which has a coefficient of performance (COP) of 3.1 and is quiet. The CERV and HPWH are located in a sound-dampened mechanical room, and the CERV draws air into the mechanical room from the hallway at about 30 cubic feet per minute (CFM) to mix the air for the HPWH."


A close-up of the remote-control display for the Build Equinox shows readouts for temperature, humidity, carbon dioxide, and volatile organic compounds.

Photo: Ted Cushman

Most of the dwelling's cooling demand can be met with the CERV's cooling capacity, in combination with the HPWH, says Schneider. "The CERV captures the cool, dehumidified exhaust air from the HPWH, combines that with its own cooling and dehumidification capacity, and delivers that air to all the living spaces via the ventilation air," he explains. Only during extended bouts of hot, humid weather is the ductless minisplit called on to help with cooling.

The CERV also manages indoor air quality in the small dwellings, "continually evaluating the indoor air quality with $CO_2$ and VOC sensors in the return airstream," says Schneider. "The occupant sets the desired ppm for the air quality (we recommend 1,000 ppm) and the CERV recirculates the air unless the ppm is exceeded, and then it brings in outside air. The CERV exhausts air from the kitchen and bathrooms and supplies air to the living areas and bedrooms."

So far, the Vermont program has set more than 20 net-zero dwellings in the field, and the builder, VerMod, is producing another unit every month. Efficiency Vermont has instruments in place to monitor air quality and energy consumption in all the houses, and on average, the units are living up to their zero-energy billing, Schneider says. The design is also working comfort-wise. "I know of energy-efficient houses where there are 5-degree or 10-degree temperature differences between rooms," says Vermod executive Chet Pasho. "In our houses, the temperature in the bedroom stays within a degree or two of the temperature in the living room, where the minisplit is located."

While a CERV can offset space-conditioning demand in a low-load home, Build Equinox isn't pushing the system as a space-conditioning solution. The primary focus is air quality. Build Equinox president Ben Newell says the smart controls—in particular, the sensing instruments that detect excessive $CO_2$ and VOCs—are a key advantage. The two types of sensor are independently valuable, he says: Excessive $CO_2$ can affect comfort and is an indicator of occupancy, but the VOC sensor has its own purpose. Build Equinox offers an optional module that reports on air quality over the Internet. "In a few of the homes," says Newell, "the VOC sensor has detected gas leaks that needed to be fixed. And in one of the VerMod homes, all the furnishings are supposed to be low-VOC finishes, but one of the countertops was mixed up in delivery from a supplier. We were seeing higher VOCs, and that's how they found out that they had the wrong countertop."

**North Carolina CERV.** Humidity is not a pollutant, exactly. But in the hot and humid South, it can certainly be an air-quality problem. That's the reason Kevin Murphy, a Passive House builder in Chapel Hill, N.C., turned to the Build Equinox CERV. "I used conventional ERVs in my first couple of houses," Murphy says. "And the one complaint I got from my clients—particularly in the first year when all that water was drying out from the slab, the lumber, drywall mud, and so forth—was that they were uncomfortable in the house. So I was excited when the CERV became available." Murphy got his first CERV in time to install it in a home that had been designed for a conventional ERV.

Murphy builds custom homes on big lots, and he can orient his houses to optimize seasonal solar exposure. With triple-glazed windows and careful siting, he says, "heating the homes is not a problem"—solar gain takes care of it. "Cooling the homes is more the problem," he says. "And conventional ERVs are great, but you're pumping humidity into the house in summer. They're not capable of dehumidifying." By capturing and eliminating outdoor moisture before it comes into the house, the CERV keeps the indoors dry. And like the Vermont modulars, Murphy's newer homes follow the strategy of cooling a central area with a small minisplit and using the CERV to draw stale air from central rooms, the kitchen, and the baths and supply conditioned air to bedrooms. "I'm a fan," says Murphy. "I've only installed one, but I have three more on order. I'm pretty much including it as a standard feature now."

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