Using Heat Recovery Ventilation to Meet Title 24 Requirements

Already familiar with HRVs? Skip to the good parts about HRV modeling using HRVs

When designing new homes or multi-family projects in California this year, architects may find themselves feeling challenged in creating beautiful, functional designs that also meet Title 24 requirements. One requirement, the use of a mechanical ventilation systems or Heat Recovery Ventilators (HRVs), can help increase design flexibility and potentially decrease construction costs. HRVs go hand-in-hand with the improved airtightness requirements in meeting the Energy Design Rating. If you're familiar with HRV and the code and just want to get to the data (good stuff), you can skip background information by clicking here.

Energy Design Rating Recap

Energy Design Rating, or EDR, is the index California building code uses to express the energy usage of a home. To meet code compliance to the new 2019 code, a California home will need to score between a 50 and 60 on the EDR index, with a 2006 IECC code compliant home representing 100 EDR. This means a home will need to use 40-50% less energy (before solar panel production) than a 2006 home. The new code further requires bringing the home into the 20 – 30 EDR range by adding an appropriate amount of solar panel, or photovoltaic (PV) capacity. With smart building design and proper use of energy efficient items like an industry-leading Zehnder

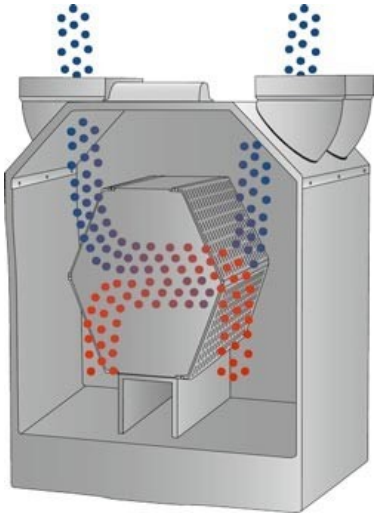
HRV, homes can be produced that meet energy code requirements and retain the design features called for by homeowners and architects.

Heat Recovery Ventilators

Zehnder 350

Heat recovery ventilators circulate fresh air in a home and used, stale air exhausts to the outdoors, while recovering the heat contained in the exhaust air. A typical HRV, a Zehnder Q350 for example, has 4 ports for handling air. Fresh outside air will come in through one port, pass through a dust filter, and then pass through a heat exchanger where it recovers the heat from air leaving the house. The fresh air continues out the other side through the distribution port where it is then ducted to the living spaces such as bedrooms and common areas. As occupants live and breathe in their houses, oxygen from the fresh supply air is used up and CO2 and water vapor are produced. Cooking creates more vapor and other chemical compounds and bathrooms contain yet more vapor, odors and chemicals from cleaning and use. Exhaust registers are placed in these areas to pull the air and all the unwanted items from the rooms, promoting circulation of the fresh supply air. This exhaust air is pulled through another dust filter on the opposing side to the intake filter, it then passes through the same heat exchanger, but through a different channel, passing on the heat energy of the inside conditioned air without ever touching and contaminating the fresh air supply. The air is then exhausted through the last port on the unit to the outside.

The Core Is Where HRV Efficiency Happens



The heat exchanger core is where most of the efficiency of the system is happening. The example Zehnder Q350 boasts a 93%[1] recovery effectiveness, which outclasses any typical recovery ventilator, usually in the 60%-80%[2] range. What this means is a loss of only 7% of the heat from the conditioned air as it leaves and transfers heat to the intake air. This allows the heating system in the home to not have to work as hard to maintain a steady comfortable temperature. The reverse is true in the cooling season; warm outside air is cooled to the temperature of the indoor air as it exits through the core. These cores are made up of many hundreds of individual channels that direct air through one side to the other, in two distinct paths that never touch. The heat energy is exchanged through the membrane

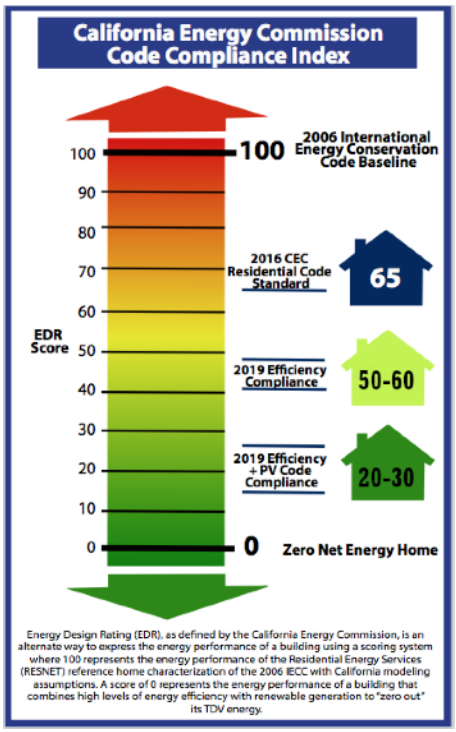
that separates the channels, keeping used, stale air from passing any contaminants to the fresh supply air.

Proper distribution and balancing of the air exchange further improves the efficiency of an HRV in the home's total energy use and health of the occupants. Accurate air volume measurements are calculated based on room sizes, and the supply and return registers are adjusted to provide the right amount of air exchange, measured in cubic feet per minute (CFM), for each space, allowing the building to achieve the targeted air changes per hour. Because the exhaust registers are typically placed in bathrooms and laundry areas, there is no need for a traditional exhaust fan in these spaces, as most systems have a "boost" function that allows the system to run at a higher CFM for a predefined amount of time to adequately remove moisture and odors. Since the systems don't recirculate the air, and the supply and return never touch, there is no worry of spreading odors, contaminants or unwanted humidity throughout the building.

Compared to the old standby of exhaust-only ventilation, such as leaving a bathroom fan on, this brings in a more controlled supply of fresh air. Rather than the home's fresh air coming in through gaps and cracks in the assembly, which is hard enough to do in today's airtight homes, fresh air is managed and properly filtered. This results in much cleaner air, as it is brought in through a now code-required minimum MERV-13 rated filter, opposed to through the wall assembly where it can bring in unwanted contaminants as it passes through insulation.

California's New Building Code and Energy Efficiency Standards

California's new 2019 building code offers two paths for achieving compliance, a prescriptive approach and a performance approach. The prescriptive approach requires compliance on each individual standard - windows, insulation levels, HVAC, etc. must all comply. The prescriptive approach offers little room for deviation from the standard building, while the performance approach offers flexibility so long as energy efficiency meets or exceeds the levels of the prescriptive approach home's total. The performance approach is heavily focused on the energy design rating (EDR) of the building, the 0-100 index of energy use, 100 being a 2006 code compliant home, and 0 representing a building that has a zero energy impact.



This focus on improved energy efficiency standards aims to ensure that builders use the most energy

efficient and energy conserving products and practices available, in turn producing a home that is cost effective over the building's lifespan. Nearly every decision made on a new building is going to affect the EDR score, be it positively or negatively; therefore it is important to have a good understanding of how different elements can affect this score.

Using Energy Modeling to Demonstrate HRV's Contribution to Home Performance

These EDR numbers are generated through use of energy modeling software simulating a proposed building's energy use over a full year compared to a prescriptive building's standard energy features. These tests and simulations provide the data necessary for energy consultants to calculate the efficiency delta between the proposed design and the standard model. Build Smart Group, an energy consultation group in California, has provided an excellent case study that demonstrates the level of compliance value heat recovery ventilators contribute to new single and multi-family buildings. Their testing methodology was comprised of representative buildings for single family and multi family prescriptive and performance designs. These were all modeled in each of California's 16 climate zones and EDR impact data was recorded for selected ventilation strategies. Build Smart Group used Zehnder recovery ventilators for these simulations to maximize the EDR return. Zehnder recovery ventilators have the highest recovery efficiency in North America.

The findings were then compared to determine the impact of recovery ventilators on the overall performance compared to that of other energy measures. The single family residential home is represented by California Energy Commission's new 2,700 square foot 2-story home using typical energy features, and a larger 4,000 square foot 2-story home is modeled to represent the custom home segment. An 8 unit 2-story CEC prototype building is also used to represent the impact for multifamily development.

Their findings demonstrate how significant the impact is that recovery ventilators have on compliance. The most common climate zone for each building type shows that a single family production home (2700 sq.ft. 2-story) using an HRV, when compared to exhaust only ventilation, displays a change of 11%/4.9 EDR in climate zone 12, a single family custom home (4000 sq.ft. 2-story) has a 9.9%/4.5 EDR change in climate zone 2, and a multifamily building using an HRV gains

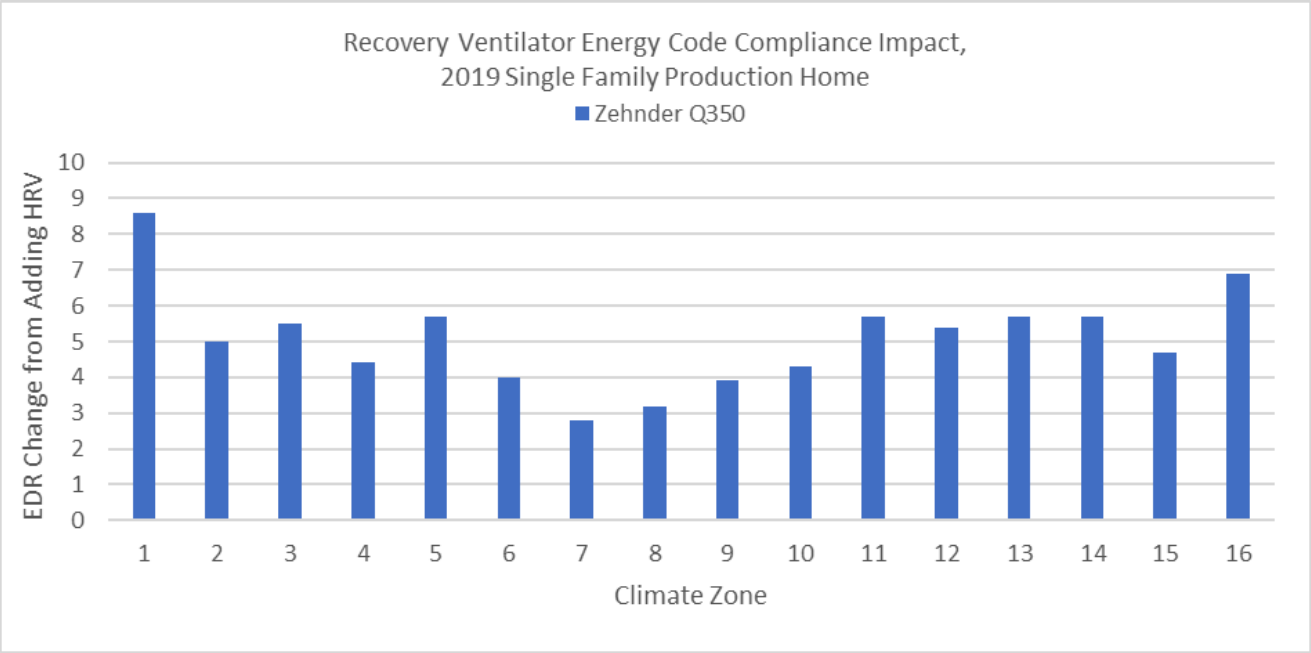
27.8%/16.8 EDR over not using one. This substantial effect on the EDR score can substitute for other energy features and even PV production levels, which can save on the cost of construction, or offset design features that have a negative impact on energy efficiency.

Comparing High Efficiency HRVs to Other Energy Saving Strategies

Compared to the impact of other features in a single family home, using a properly sized, highly efficient HRV like Zehnder gives the biggest EDR change (on average ~5 EDR@ 147cfm) other than changing from inefficient aluminum windows (5.2 EDR) or removing 1 kW of PV panels (8.1 EDR). All other measures Build Smart Group tested had an impact between 0.7 – 2.1 EDR. This means an HRV can help offset the change for example from 2x6 R-21 walls to 2x4 R-13 walls (-2.10 EDR) in Climate Zone 5, saving on building costs, while still maintaining compliance. In fact, this same example home could further go down to R-30 in the attic (-0.7 EDR) and use a standard gas tankless water heater (-0.7 EDR) and still comply with 1.5 EDR to spare.

Other Options CZ5	EDR Change
2x4 R-13	2.10
R-30 attic	0.70
Al windows U=0.5	5.20
QII	1.70
Std tankless .82	0.70
PV - 1 kW	8.10

This table shows the EDR value of other options for meeting code requirements.



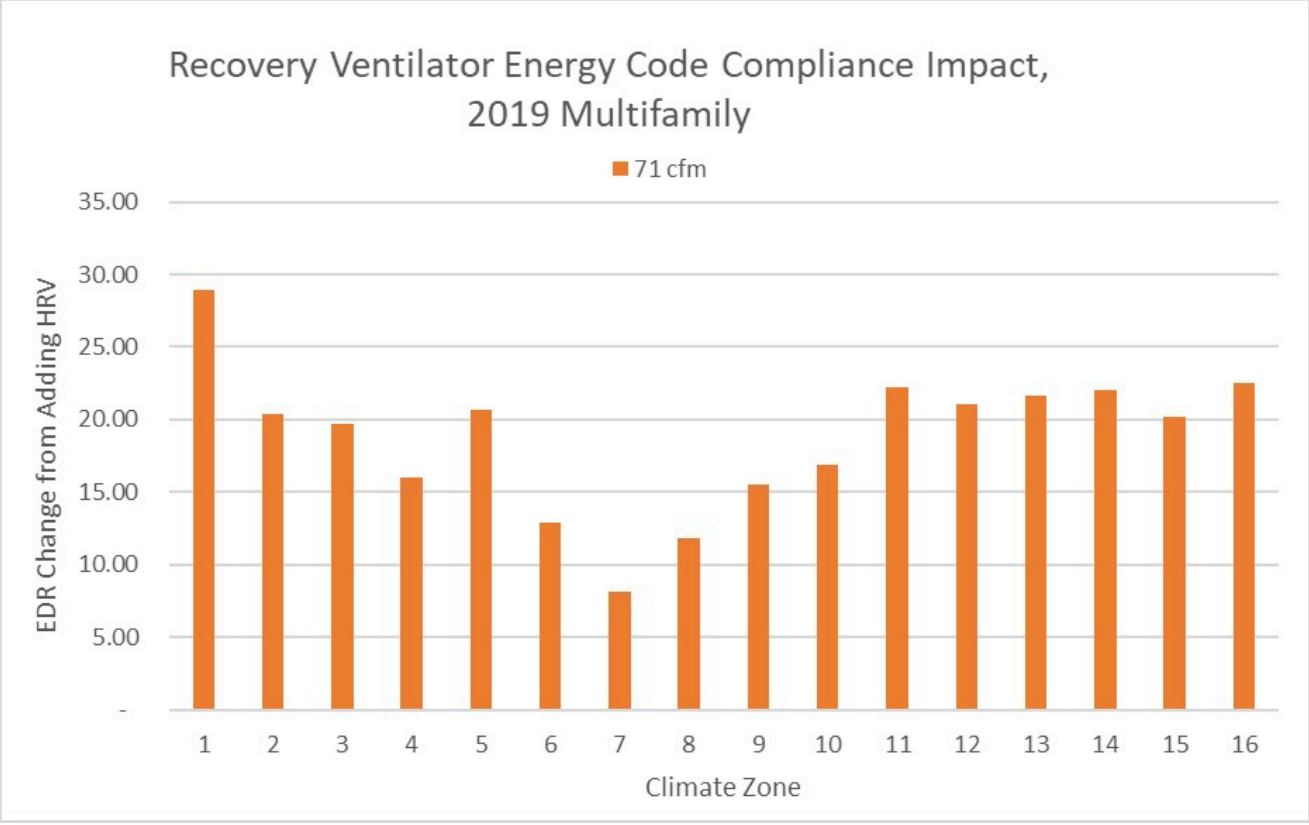
This table shows the EDR change that can be achieved by adding a high-efficiency (Zehnder) HRv in each of California's sixteen climate zones. Image credit: Build Smart Group, 2019

HRV in Multi-Family Projects

Looking into the effect on a multifamily project only further shows that recovery ventilators can achieve an impressive EDR delta. The new code further requires balanced ventilation in all multifamily units, a requirement HRVs are well suited to meeting. The average EDR score impact for the 2 tested airflow rates was 15.3 EDR (53 cfm) and 18.8 EDR (71 cfm). None of the other tested variables came even close to these EDR score impacts.

Baseline Design Exhaust Ventilation min cfm	**With Recovery Ventilator 53 cfm**
Walls 2x6 wood R-21	Walls 2x4 wood R-13
Roof R-38	Roof R-19
Windows 14%, U=0.30; SHGC=0.23	Windows 28%, U=0.50; SHGC=0.23
Quality Insulation Installation QII HERS inspection	No QII
PV 22.37 kW	PV 16.00 kW
2.2 EDR short of compliance with Title 24	Complies with Title 24

To demonstrate the immense value of the recovery ventilator, Build Smart Group built side-by-side energy designs to simulate multifamily buildings, one with, and one without a recovery ventilator. Without the recovery ventilator, they were 2.2 EDR short of compliance, but upon adding ventilators to each unit, 5 energy upgrades and 6 kW of PV panels were able to be removed and remain compliant with Title 24.



This table shows the effect adding an HRV in a multi-family can have on your EDR by climate zone.
Table Credit: Build Smart Group 2019

Using a Highly Efficient HRV Provides Design Flexibility

Looking at these results, it becomes very clear that an HRV plays a vital role in the energy design of a home. Furthermore, an energy efficiency trade off strategy can be employed to compensate for the negative impact for design features of a home while following the performance approach. While the previous examples showcased using an HRV for cost saving efforts, it is also possible to build to the higher efficiency standards, and instead offset the impact of inefficient features like a large window that takes advantage of a scenic view. By achieving higher overall efficiency with a Zehnder HRV, capacity is increased to nullify inefficient features. Maybe the client finds solar panels unsightly and wants to use as few as possible, or any number of cases that may come up in the design and planning process. The impact of using an HRV is substantial enough to offset the increased energy costs associated with these possibilities.

High Efficiency HRVs Provide Fresh Air & Lowers Energy Costs

The future of energy efficient homes is one that is looking towards a net-zero strategy. With such an impact on the overall efficiency of a building, it is easy to see how high efficiency Zehnder HRVs will play a critical role in achieving that goal. The fine tuning of a building will only benefit from using a recovery ventilator, and with air tightness measures ever increasing, the need for fresh air will be met perfectly by its use. Taking these factors into consideration, lower cost and more energy efficient designs are achievable to the savvy designer.

[1] www.zehnderamerica.com

[2] http://www.mnshi.umn.edu/kb/scale/hrverv.html

Source: "Recovery Ventilators for Residential California Energy Code Compliance". Nick Brown, Build Smart Group, 2019

Want to learn more about how Zehnder HRVs can help you meet Title 24 requirements?

Contact us, we can help!

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