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Heat Recovery Ventilation:
Why Efficiency Matters

Heat Recovery Ventilation: Why Efficiency Matters

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The American Institute of Architects
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Purpose and Learning Objectives

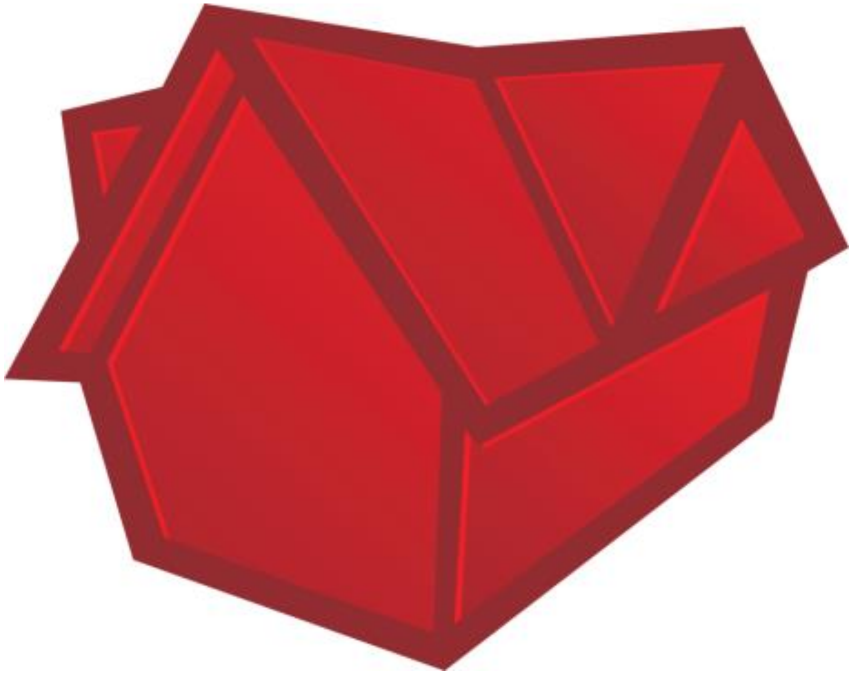
Purpose: In the last couple of decades, houses have become progressively more airtight due to energy efficiency and cost concerns. While air infiltration and exfiltration rates have been significantly reduced, the need for an efficient ventilation system has become extremely important. This course evaluates different types of mechanical ventilation systems and discusses why heat recovery ventilation (HRV) and energy recovery ventilation (ERV) systems are characterized by a high level of energy efficiency and as an effective means for improving indoor air quality.

Learning Objectives: At the end of this program, participants will be able to:

- identify the advantages and weaknesses of supply, exhaust, and balanced ventilation systems to show how mechanical ventilation systems impact our energy consumption and the air we breathe
- examine HRV/ERV system configurations to determine the role of an HRV/ERV system in creating an energy-efficient home
- cite case studies and discuss how HRV/ERV systems maintain healthy indoor air conditions in different climatic conditions and geographic locations with variations in occupancy, and
- discuss the importance of planning an HRV/ERV system installation, and review balancing, commissioning, and maintenance considerations to ensure efficient system operation.

Contents

Click on title to view



Mechanical Ventilation & Energy Efficiency

Mechanical Ventilation: Why Is It Important?

Why has mechanical ventilation become increasingly important?

In the last couple of decades, houses have become progressively airtight due to energy efficiency and cost concerns. While air infiltration and exfiltration rates have been significantly reduced, the need for an efficient ventilation system has become extremely important.

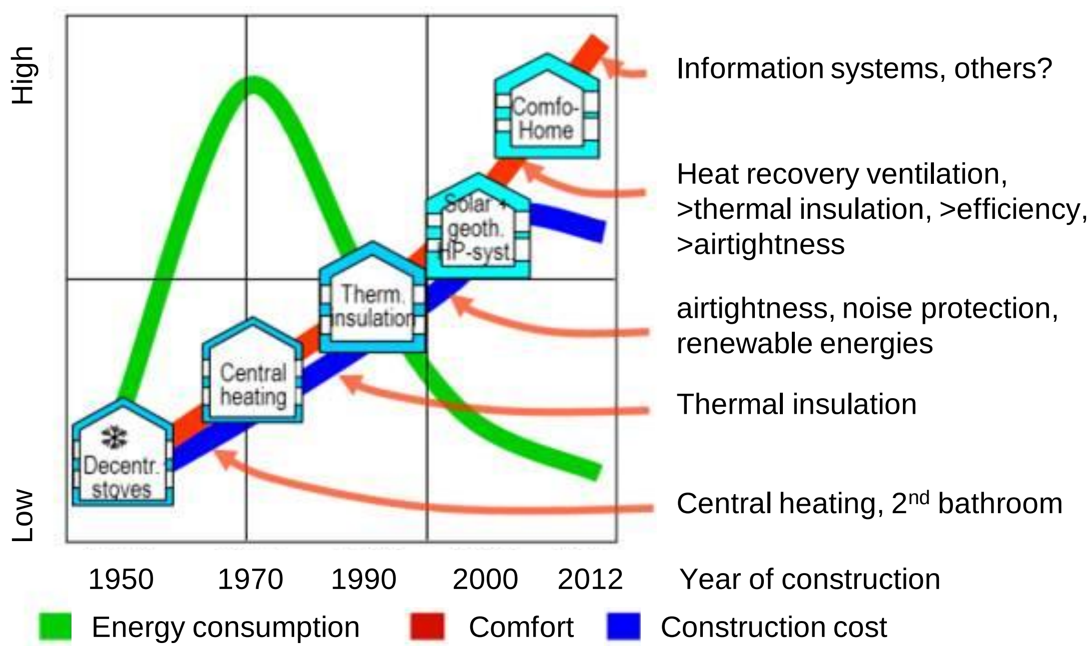
An inadequate ventilation system impacts our energy consumption and the air we breathe. Some homes are experiencing issues with moisture and mold control and with air pollution from allergens and chemicals that enter the indoor environment from building materials, cleaners, furniture, carpets, and other products. Poor ventilation impacts the health and comfort of the occupants.

The U.S. Environmental Protection Agency (EPA) estimates that the average person spends as much as 90% of their time indoors and that indoor air contains two to five times more pollutants than outdoor air. A constant supply of fresh air in these indoor spaces is vital to the occupants' health.

Technologies for System Components

Over time, as HVAC system designs changed and improved, energy consumption increased. This trend is reversing as more efficient systems and better building envelopes are installed. Comfort levels have steadily increased, and system costs are starting to level off with the acceptance of better techniques and technologies for system components.

This graphic shows the changes to a residential building envelope since the 1950s. By the mid-twentieth century, most homes had central heating. At that time, the role a high R-value and airtight wall assembly played in both human comfort and energy costs was not well understood. As insulation levels and airtightness of the envelope increased, comfort level went up and energy consumption went down.



Current Building Codes & Standards

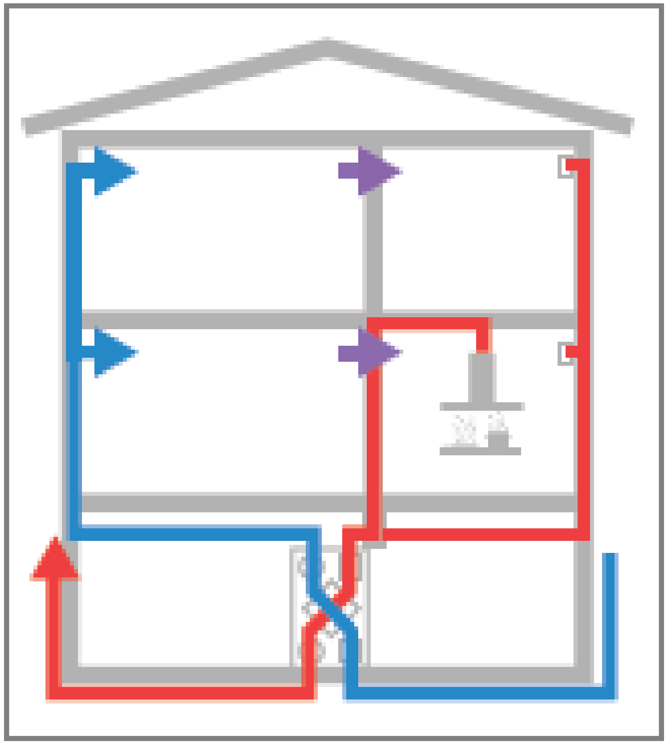
Beginning with the 2012 round and all subsequent rounds of residential building codes, dwellings are required to be significantly tighter. Most North American climate zones require three air changes per hour (ACH) at 50 pascals pressure (ACH50).

2012 ICC (International Code Council) Residential Building Code

- N1102.4.1.2 (R402.4.1.2) Testing: The building or dwelling unit shall be tested and verified as having an air leakage rate of not exceeding 5 air changes per hour in climate zones 1 and 2, and 3 air changes per hour in zones 3 to 8. Testing shall be conducted with a blower door at a pressure of 0.2 inches w.g. (50 pascals)

ENERGY STAR® Qualified Homes: Version 3 (2012)

- 6 ACH50 in climate zones 1, 2
- 5 ACH50 in climate zones 3, 4
- 4 ACH50 in climate zones 5, 6, 7
- 3 ACH50 in climate zone 8



Types of Ventilation Systems

Ventilation Options

Many typical American homes use bath fans and range hoods to meet the ventilation requirements established by the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE, www.ashrae.org).

ASHRAE 62.2-2016 requires 3 cfm (cubic feet per minute) of mechanical ventilation for every 100 sf (square feet) of occupied space and an additional 7.5 cfm per bedroom, plus 1.

ASHRAE 62.2-2016 is presently the most prescribed standard in building codes; the International Code Council (ICC) uses ASHRAE 62.2 as its standard for residential ventilation, as does the ENERGY STAR v.3 residential standard.

In a residential home, three types of mechanical ventilation are possible.

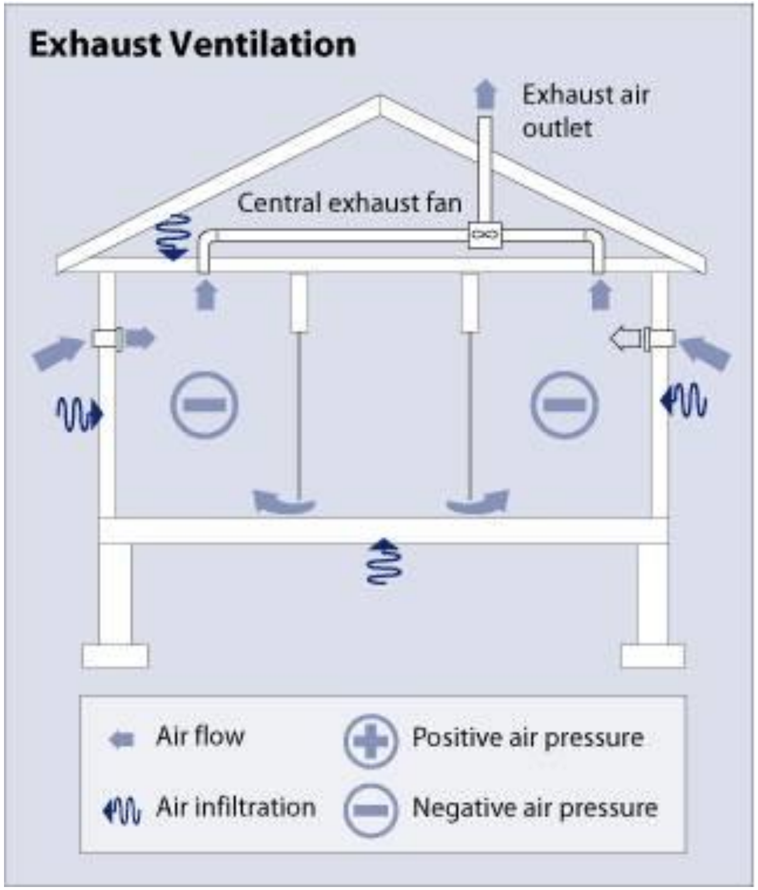
1. Exhaust ventilation systems
2. Supply ventilation systems
3. Balanced ventilation systems

Exhaust Ventilation

A typical exhaust ventilation system uses bath fans and range hoods to expel air from wet or polluted spaces. In more deliberate installations, makeup air may occur through passive trickle vents (somewhat controlled). But much more typically, makeup air occurs through leaks in the building envelope (uncontrolled and unpredictable).

Additionally, makeup air may enter the interior space through cracks and leaks from crawl spaces or basements at the sill, or from unconditioned attics. This makeup air may contribute to poor indoor air quality since radon, dust, and mold may be located at each source.

Energy spent to heat or cool the interior air is forfeited in the exhaust air, and more energy is spent to heat or cool the makeup air.



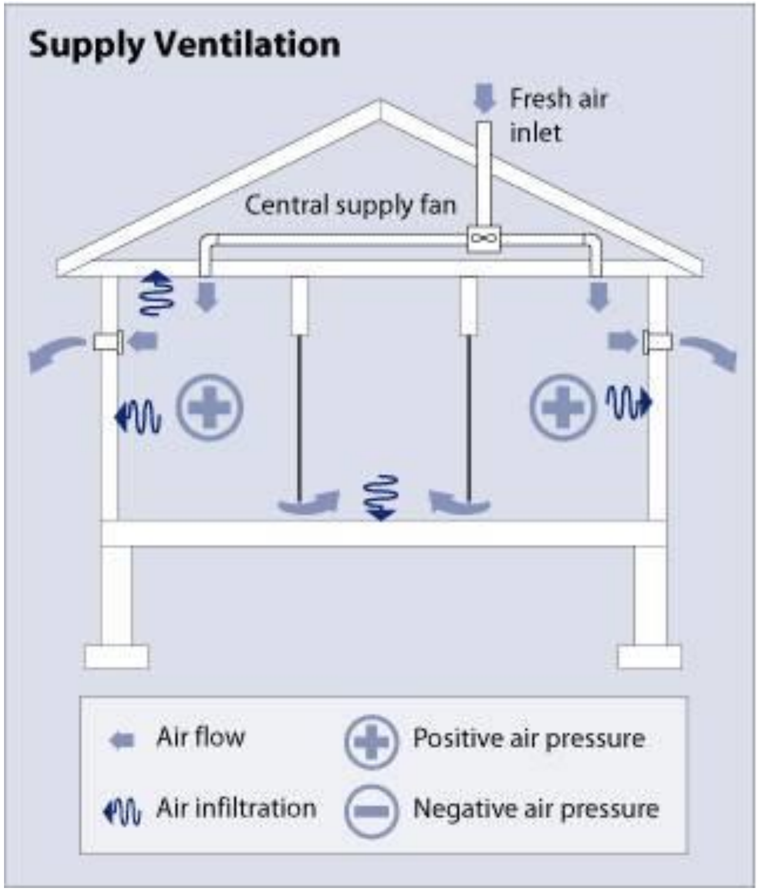
Source: U.S. Department of Energy (DOE), http://energy.gov/energysaver/articles/whole-house-ventilation

Supply Ventilation

Supply ventilation is commonly achieved with a supply duct from the outside that is tied directly to the return plenum of an air handler. Outside air is pulled into the system and distributed throughout the home. Stale air exits the space through random leaks in the building envelope.

In some cases, a makeup air duct is controlled with a damper, which opens and closes on a timed schedule.

Although the makeup air can be heated or cooled in a furnace/air handler, this requires additional energy. Also, the stale air that exits the home through random leaks carries heating/cooling energy with it.



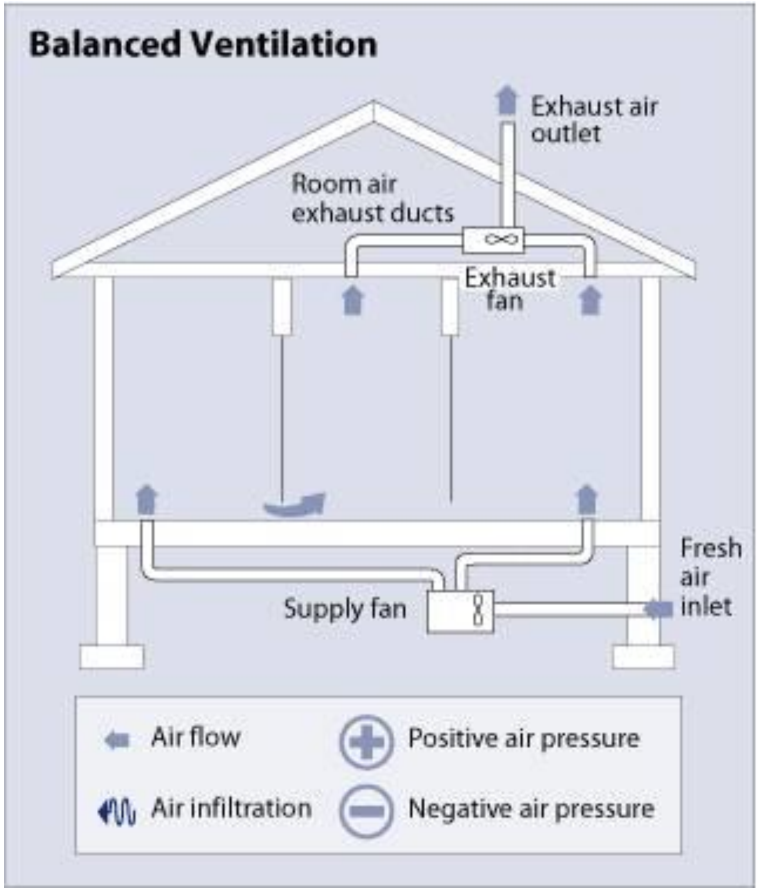
Source: U.S. Department of Energy (DOE), http://energy.gov/energysaver/articles/whole-house-ventilation

Balanced Ventilation

A balanced ventilation system typically uses two fans and two duct systems with exhaust and supply vents in suitable places throughout the home.

A balanced ventilation system that uses a heat recovery ventilator (HRV) or an energy recovery ventilator (ERV) is a cost-effective, energy-efficient system that improves the interior comfort levels of a home.

HRV and ERV systems are the focus of the remainder of this presentation.



Source: U.S. Department of Energy (DOE), http://energy.gov/energysaver/articles/whole-house-ventilation

Review Question

How much mechanical ventilation does ASHRAE 62.2-2016 require in an American home?

Answer

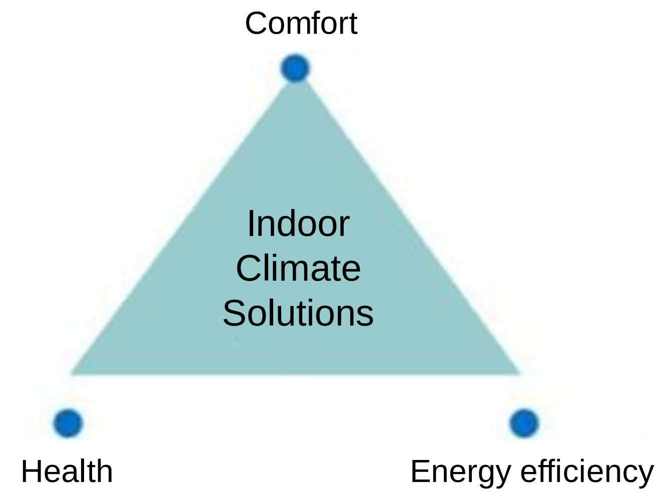
ASHRAE 62.2-2016 requires
3 cfm (cubic feet per minute)
of mechanical ventilation for every
100 sf (square feet)
of occupied space and an additional
7.5 cfm per bedroom, plus **1**.

Heat Recovery Ventilation Systems

Introduction: HRV Terminology

HRV systems are balanced ventilation systems that provide for comfort, health, and energy efficiency.

Balanced ventilation means that pollutants from the kitchen, the bathroom, the toilet(s), and possibly the storage room are extracted, while the same amount of fresh air is blown into the living room and bedrooms. Gaps under or near the doors ensure a good through-flow of air in the dwelling. The air circulation is in balance.



Besides ensuring a healthy balance between incoming and outgoing air, the system also provides the benefit of heat recovery.

Heat recovery means that energy is transferred between stale, exhaust air and fresh, intake air with the result of the incoming air temperature being close to the same temperature as the exhaust air.

HRV Systems: Where Are They Used?

HRV systems can be used for single-unit as well as multifamily homes.

In addition, the systems can be used for small commercial applications, classrooms, nursery school facilities, and retirement communities.

The systems are used in both retrofit and new construction projects.

Solution with HRV/ERV Ventilation

Fresh air is fed into the HRV/ERV system via an external wall vent and is distributed primarily to bedrooms and to living spaces. Stale, exhaust air is removed from the bathrooms and kitchen.

Depending on the quality of the device and the design parameters of the system, up to 96% of the energy difference from the warmer airstream can be transferred to the cooler airstream. Supply air can be further conditioned using optional components.

The fresh air distribution system channels optimally tempered fresh air to individual rooms as needed and vents extracted air to the outside. The air volume can be adjusted individually for each room.

Occupant Health

HRV and ERV systems remove unwanted pollution and smells and can help manage healthy humidity levels.

In cold climates, indoor humidity and condensation can be reduced, minimizing the chance for mold to grow. In hot, humid climates, ERVs help reject outdoor moisture that other ventilation devices would otherwise allow into the home.

Indoor Air Quality

In 2017, a case study was performed on a single-family home in Massachusetts where a second-floor addition had previously been built and insulated with spray foam, achieving a high degree of airtightness.

The family's bedrooms were located within the addition. After they began getting sick and noticing odors, they suspected air quality problems and hired a local company to perform air quality testing. Results from the worst pollutant categories are in the left-hand column in the table below.

A balanced ERV system was installed with dedicated supply air ducting to the three bedrooms and exhaust air ducting from the two bathrooms. Further air testing was conducted seven months later. Results are included in the right-hand column in the table below.

Pollutants	**Before ERV installation**	**After ERV installation**
VOCs	**220-230 ppb**	**32-48 ppb**
Formaldehyde	**30 ppb**	**11 ppb**
Particulates (PM5)	**340-620**	**20-150**
Carbon Dioxide (CO_2)	**800-900 ppm**	**450 ppm**

Key

- Moderately elevated
- Extremely elevated
- Normal

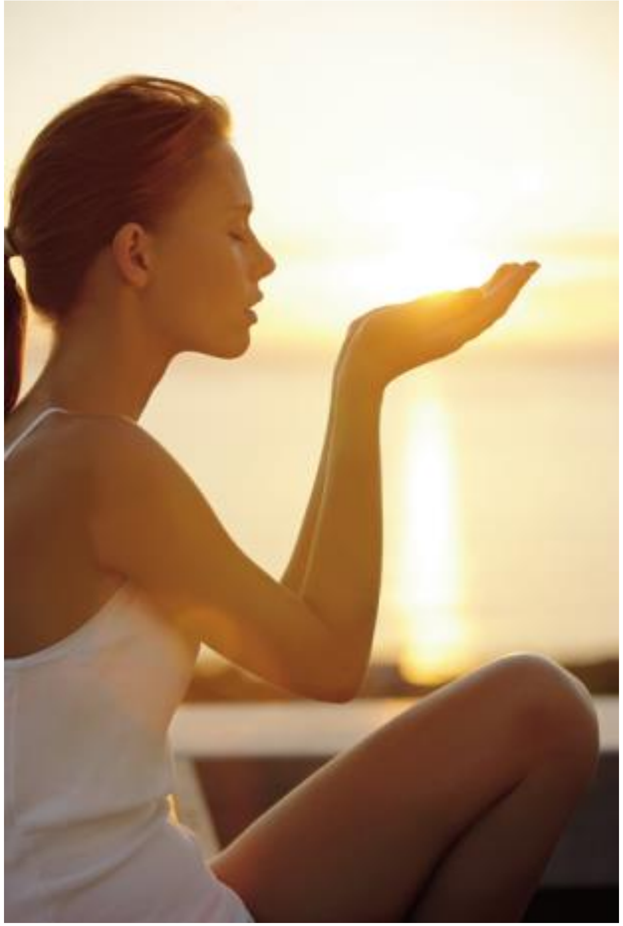
Occupant Comfort

Since an HRV system controls the flow of outside air into and out of a building, windows can remain closed. With closed windows, the risk of air pollutants, insects, and outside noise in the home is reduced, and security is improved.

Summary: Benefits of HRV Systems

Heat recovery ventilators:

- provide a continuous supply of fresh air
- provide a uniform distribution of fresh air
- filter outside air and prevent pollen and insects from entering the interior environment
- remove air pollutants such as odors, smoke, and volatile organic compounds (VOCs)
- prevent the growth of mold and mildew
- protect the building against damage that is often caused by excessive moisture and humidity
- protect the health of the building occupants, and
- meet the requirements of future energy performance building standards.

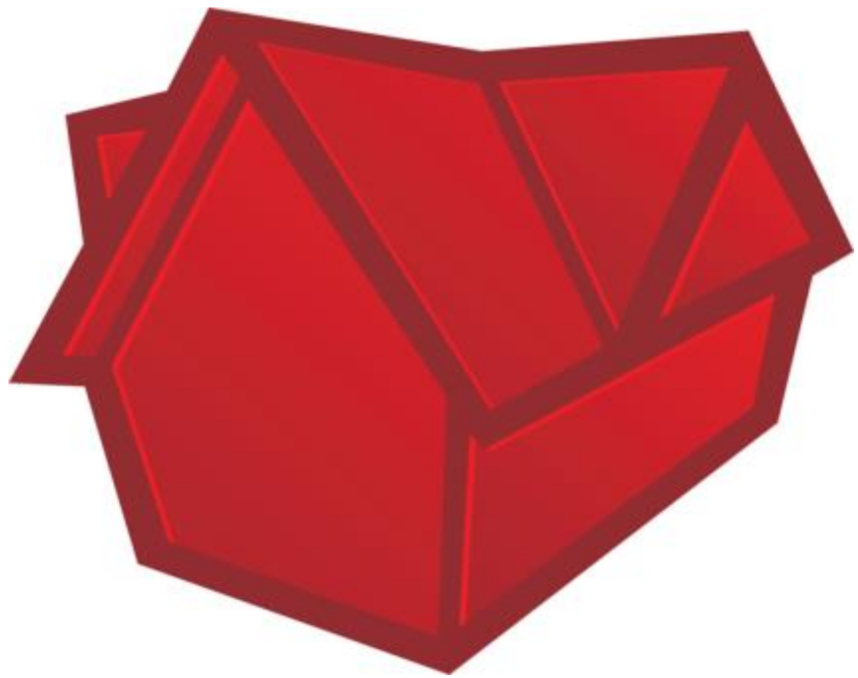


Review Question

In an HRV/ERV system, how much energy does the ventilation device transfer between the two airstreams?

Answer

In an HRV/ERV system, the ventilation device recovers up to **96%** of the energy difference from the warmer airstream and transfers it to the cooler airstream. The supply air can be further conditioned using optional components.



Building Energy-Efficient Homes

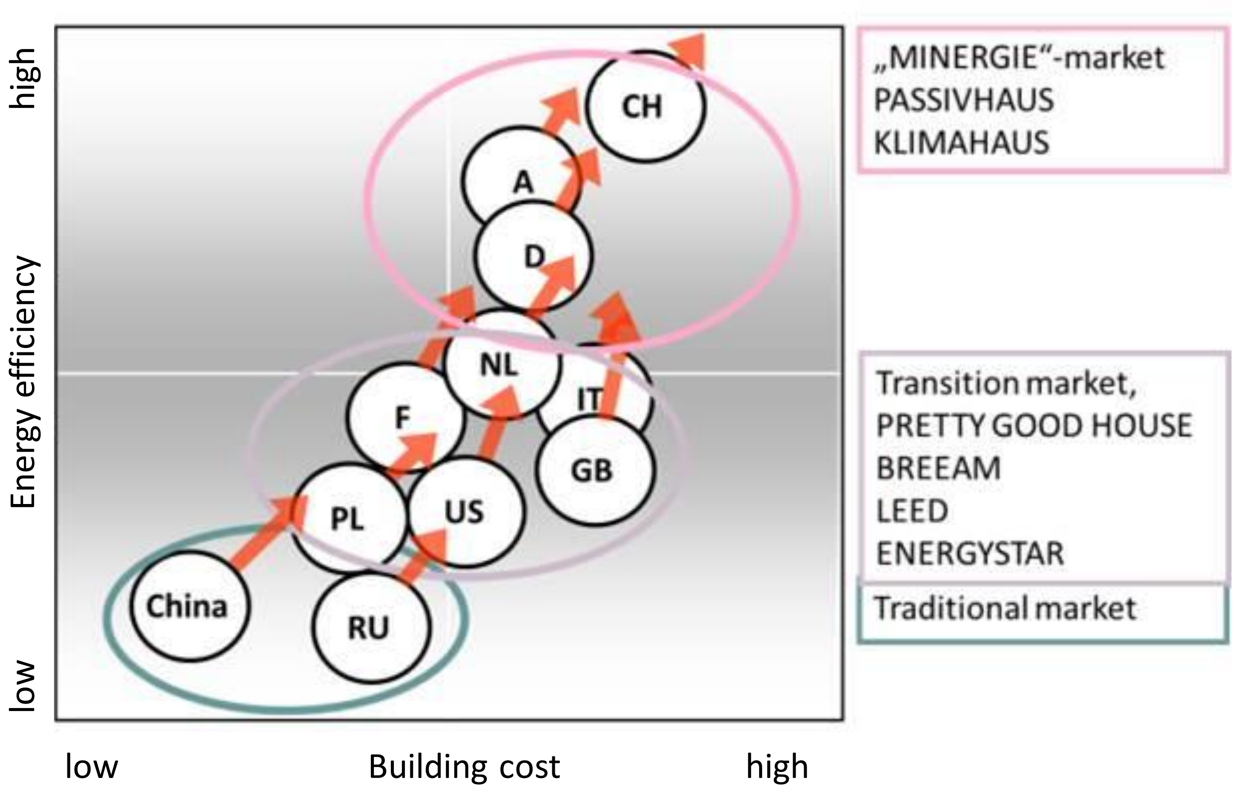
Leading Energy Efficiency Standards

Europe, specifically Switzerland, Germany, and Austria, has led the world when it comes to remodeling and building energy-efficient dwellings. The USA and Canada are improving their building practices quickly.

- Switzerland established the Minergie® building standard, which requires buildings to lower energy consumption and provide a higher level of comfort.
- The German Passivhaus Institut (Passive House Institute, PHI) established a design process with performance-based energy standards for building components and construction systems. The Passivhaus standard is used around the world.
- KlimaHaus, established in Italy, encourages energy-saving strategies and protection of the environment.
- BREEAM®, established in England, is a design and assessment rating system for sustainable buildings.
- American and Canadian standards include the U.S. Green Building Council's (USGBC's) LEED® (Leadership in Energy and Environmental Design) green building certification program, ENERGY STAR (a joint program of the U.S. Environmental Protection Agency and the U.S. Department of Energy), PHIUS (Passive House Institute US), and the NAHB (National Association of Home Builders) Green Standard.

Leading Energy Efficiency Standards

This graphic is a comparison of a number of voluntary building standards from both North America and Europe for building cost and energy efficiency.



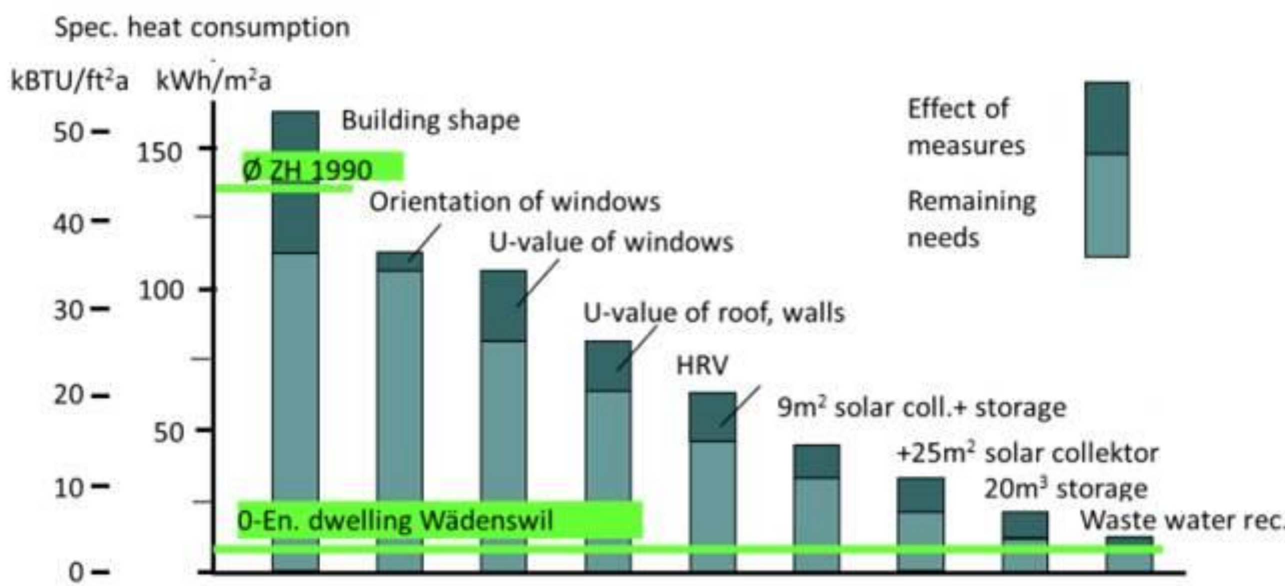
Zero-Heating-Energy Dwellings

Pictured here is a “laboratory on a hill” in Wädenswil, overlooking Lake Zurich in Switzerland. In 1990, these five duplex homes were built to use solar heat and test components of energy-efficient home construction—notice the different sizes of radiant solar panels located on the end of each home. These zero-heating-energy dwellings showed that an airtight and well-insulated building envelope combined with heat recovery ventilation can reduce the energy demand for space heating to a very low level at reasonable cost.

Source: Kriesi, Ruedi, Dr.sc.Tech. “Comfort Ventilation—A Key Factor of the Comfortable, Energy-Efficient Building.” *REHVA Journal,* May 2011, https://www.rehva.eu/fileadmin/hvac-dictio/03-2011/Comfort_ventilation_-_a_key_factor_of_the_comfortable__energy-efficient_building.pdf

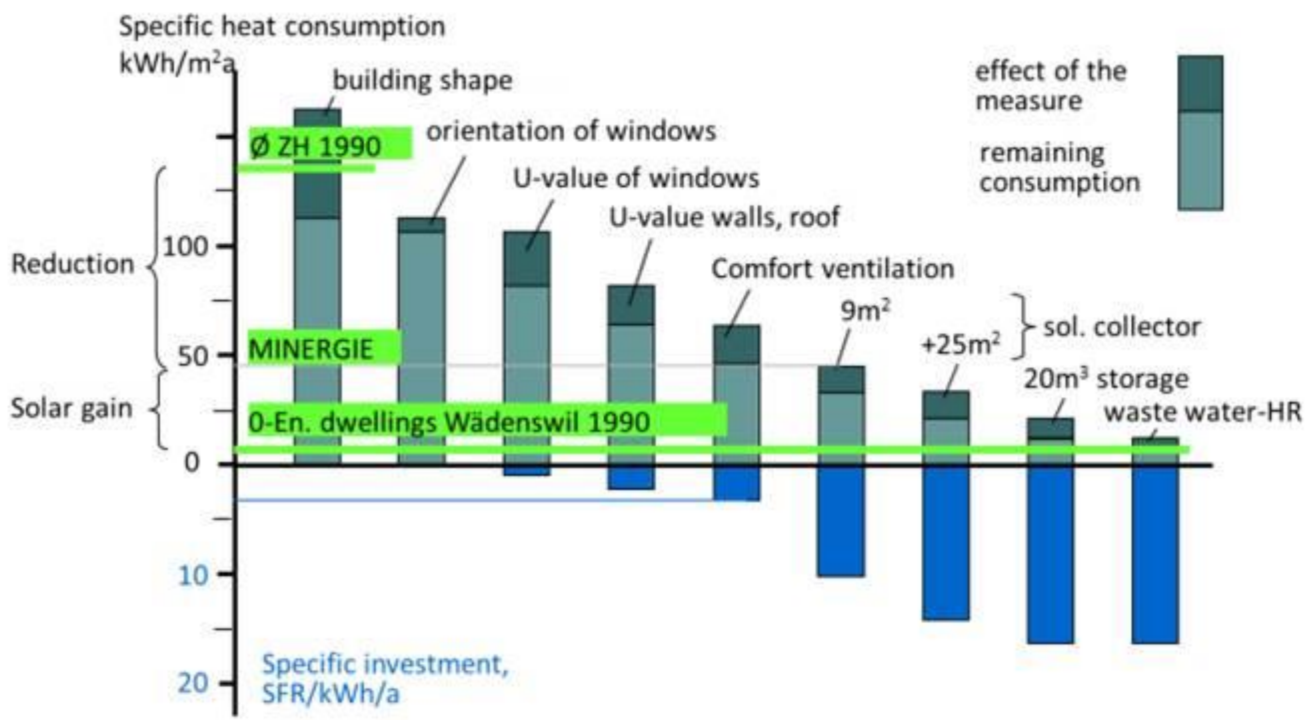
Determining Factors: Energy Use in Zero-Energy Homes

This graph identifies the components of construction that contribute to the reduction of energy use in the zero-energy homes. Notice the significant reduction in energy use provided by high-performance heat recovery ventilation. The “0 ZH” line (highlighted in green) represents the energy use of a typical Swiss home, and each “Effect of measures” represents the reduction in energy use that measure provides. The “Remaining needs” indicates how much reduction each cumulative step accounts for in the total reduction in energy use.



Specific Investment: Low for Reduction, High for Solar System

This graphic includes the amortized cost of each component. Note that the cost of the first five components is almost zero, including HRV use. The diminishing returns are in the solar radiant system and wastewater recovery system. In the next few slides, we'll look at the costs of HRV use in different climate zones.



Example of Energy Savings in a Cold Climate: Finland with Energy Recovery

In a cold climate, the energy savings are nominal but still important. Keep in mind that energy is still being saved while clean, fresh air is being provided. Additionally, damage issues associated with mold growth are prevented and occupant comfort is increased.

- Average heat consumption for space heating in dwellings in Finland: 29,000 kWh
- Consumption with energy recovery: 24,500 kWh
- Net savings: 4,500 kWh per year or 15%

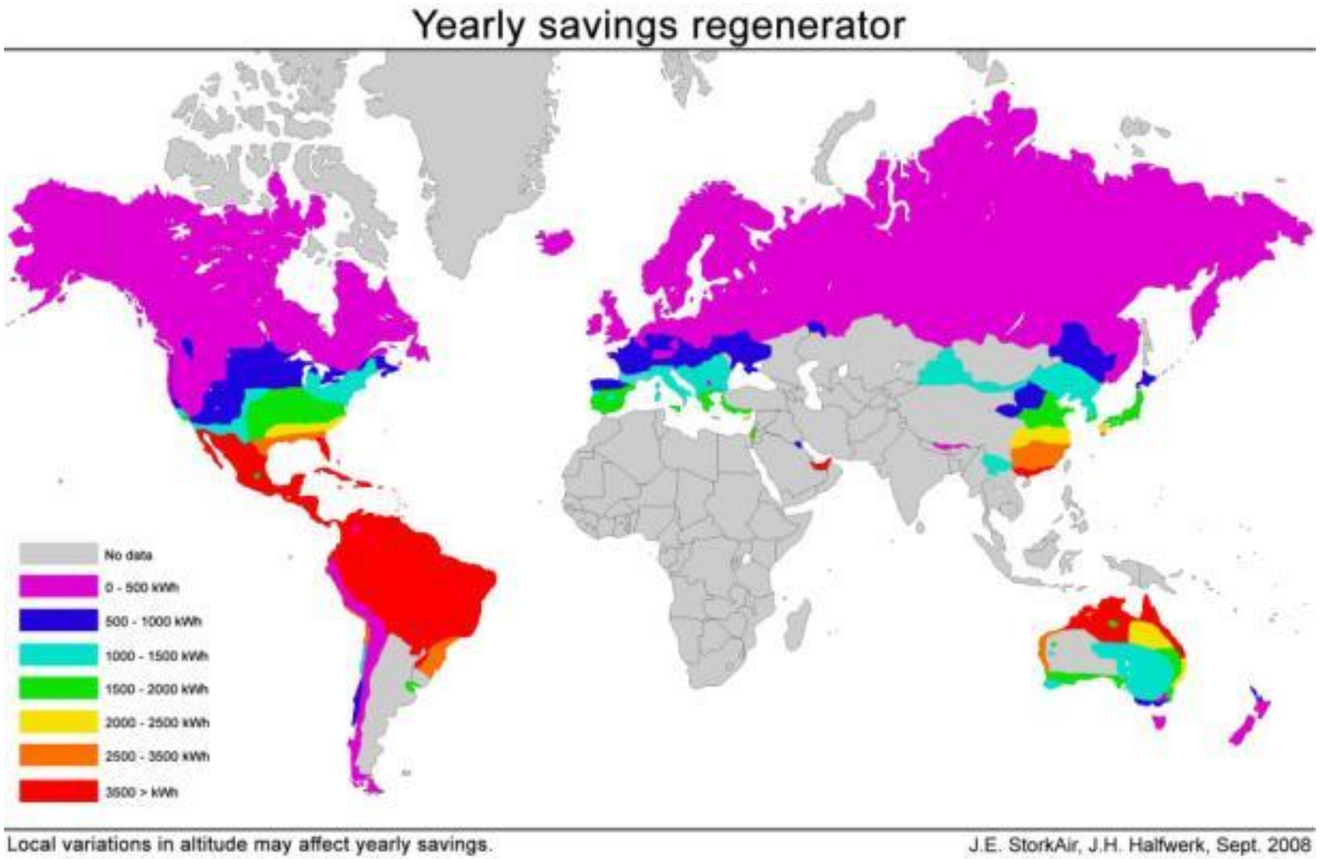
Example of Energy Savings in a Hot Climate: Abu Dhabi with Humidity Recovery

Meanwhile, in a hot, humid climate, the savings can be very significant. This is due to the benefit of providing enthalpy recovery. By reducing the relative humidity of the incoming air, the costs of cooling and dehumidification are reduced accordingly.

- Average electricity consumption for cooling in dwellings in Abu Dhabi: 3,800 kWh
- Consumption with energy recovery: 2,080 kWh
- Net savings: 1,677 kWh per year or 45%

Yearly Savings

This map illustrates the projected savings of using an HRV system by climate zones.



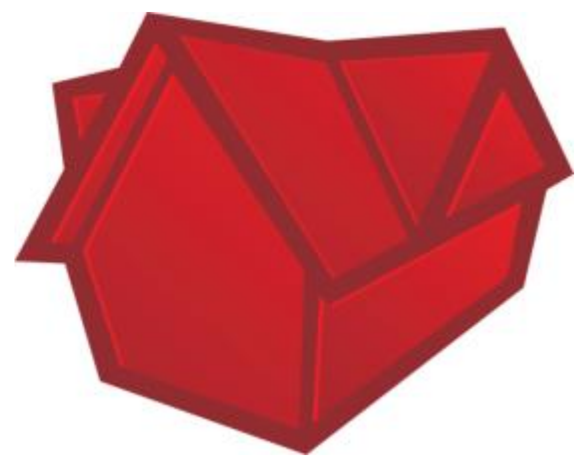
Case Study: HRV Energy Use

The next few slides demonstrate how efficiency really does matter with regards to heat recovery ventilation.

Assuming a modest-sized home in a northern climate, we can see the savings realized with various ventilation schemes.

Assumptions:

- Home: 3 bedrooms, 1 bath, 1,500 sf (square feet), 8 ft (foot) ceilings
- Passive house ventilation: 0.3 ACH = 60 cfm
- Outside air temperature: 30°F
- Inside air temperature: 70°F



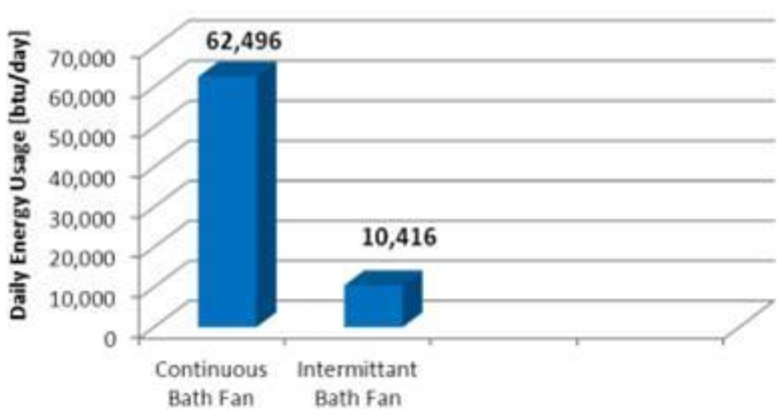
Case Study: HRV Energy Use

Stated below is the energy usage for two bath fan options—an intermittent bath fan and a continuous running bath fan. The continuous bath fan reflects the new ASHRAE 62.2-2013 requirement for residential ventilation.

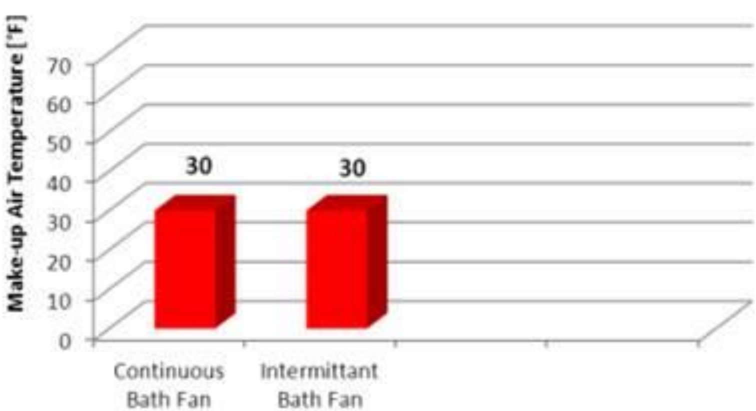
- **Bath Fan Case**, **60 cfm continuous**
  Energy Usage = (1.085)(60 cfm)(70°F - 30°F)(24 hours) = 62,496 Btu/Day

- **Bath Fan Case**, **120 cfm intermittent** (2 hours per day)
  Energy Usage = (1.085)(120 cfm)(70°F - 30°F)(2 hours) = 10,416 Btu/Day

Ventilation Thermal Energy Usage



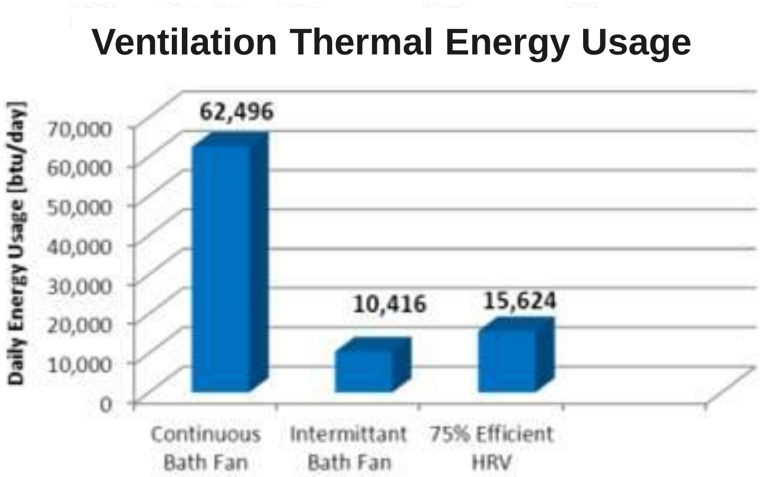
Makeup Air Temperature

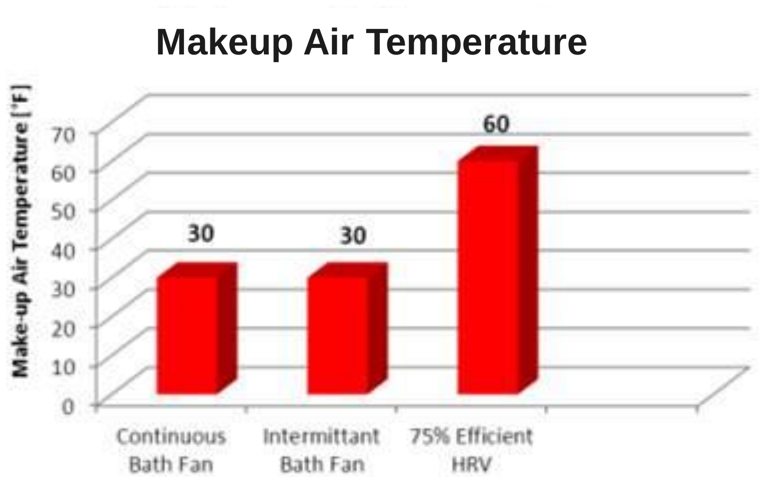


Case Study: HRV Energy Use

When a 75% efficient HRV is used, the amount of energy lost from the home is lower than the amount when the continuous bath fan is used, but higher than that of the intermittent bath fan use. Notice the temperature of the makeup air for all three options. On a cold night of 30°F, the 75% efficient HRV provides 60°F air to the home.

- **75% Efficient HRV Case**, **60 cfm continuous**
  Energy Usage = (1.085)(60 cfm)(70°F - 30°F)(24 hours)(1 - 0.75) = 15,624 Btu/Day
  Makeup air temperature = 30°F + (70°F - 30°F)*(0.75) = 60°F



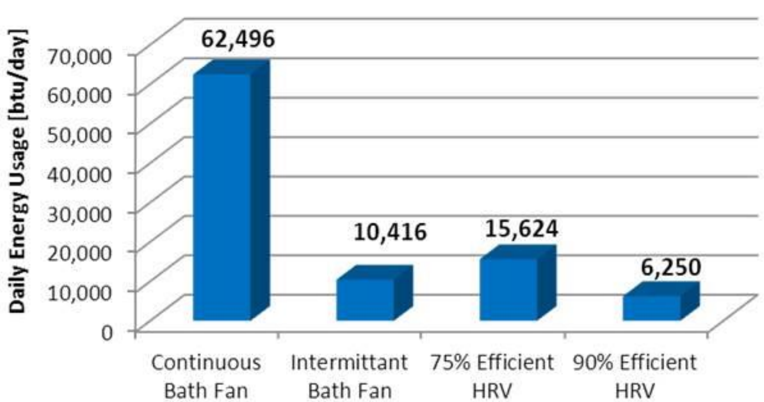


Case Study: HRV Energy Use

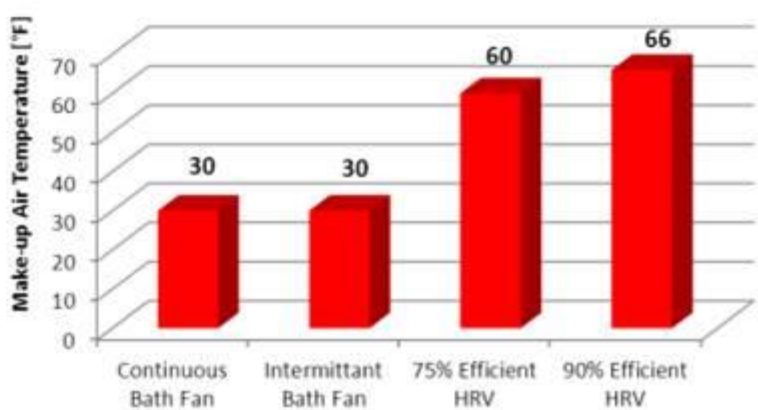
When a 90% efficient HRV is used, the energy loss is much less, and the incoming air is a full 6°F warmer (very close to the interior air temperature of the home).

- **90% Efficient HRV Case**, **60 cfm continuous**
  Energy Usage = (1.085)(60 cfm)(70°F - 30°F)(24 hours)(1 - 0.90) = 6,250 Btu/Day
  Makeup air temperature = 30°F + (70°F - 30°F)*(0.90) = 66°F

Ventilation Thermal Energy Usage



Makeup Air Temperature



HRV Energy Use

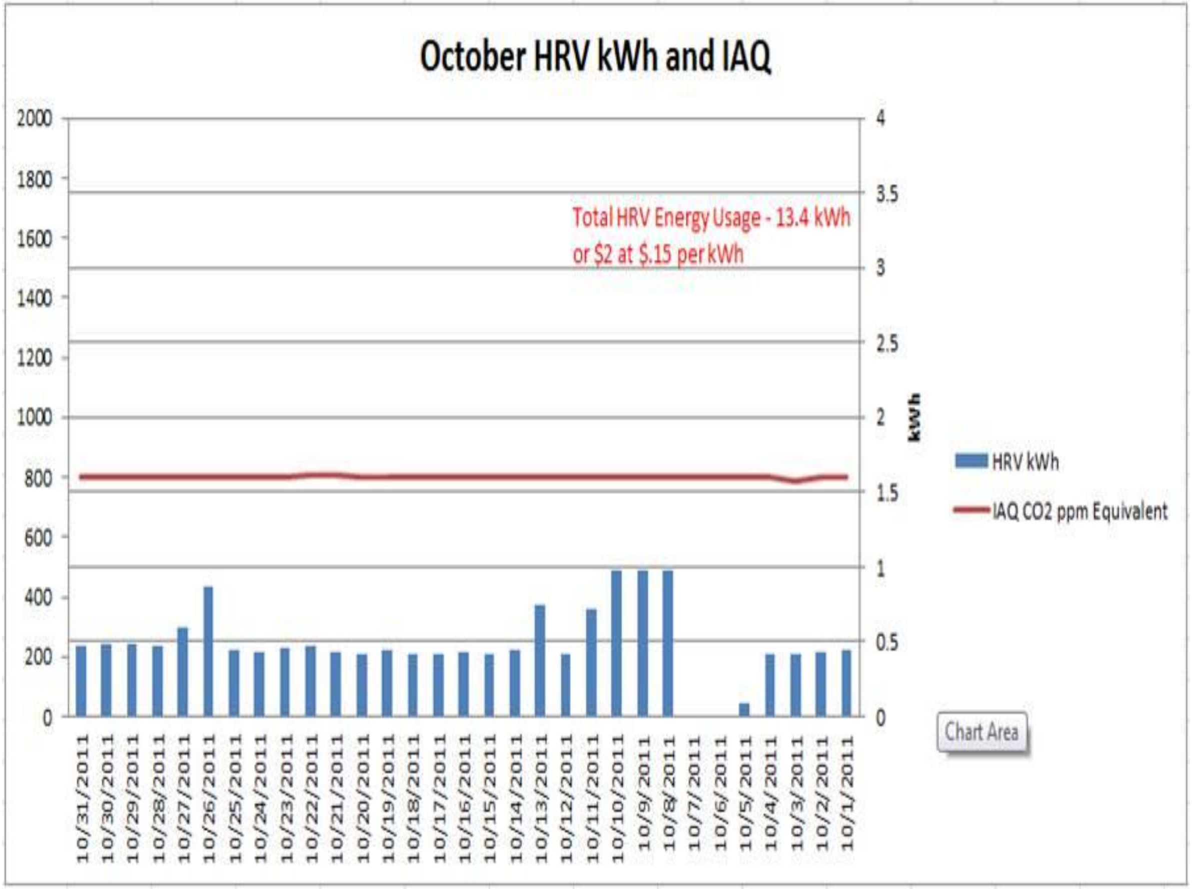
This affordable housing project in Charlotte, Vermont, incorporates high-efficiency heat recovery ventilation to achieve outstanding energy efficiency and comfort. Monitoring of the homes and systems has helped to fine-tune efficient operation of the HVAC systems.

HRV Energy Use

As shown here, this HRV system is using very little energy to operate and providing very good indoor air quality (IAQ).

A reading below 1,000 for the IAQ is considered good.

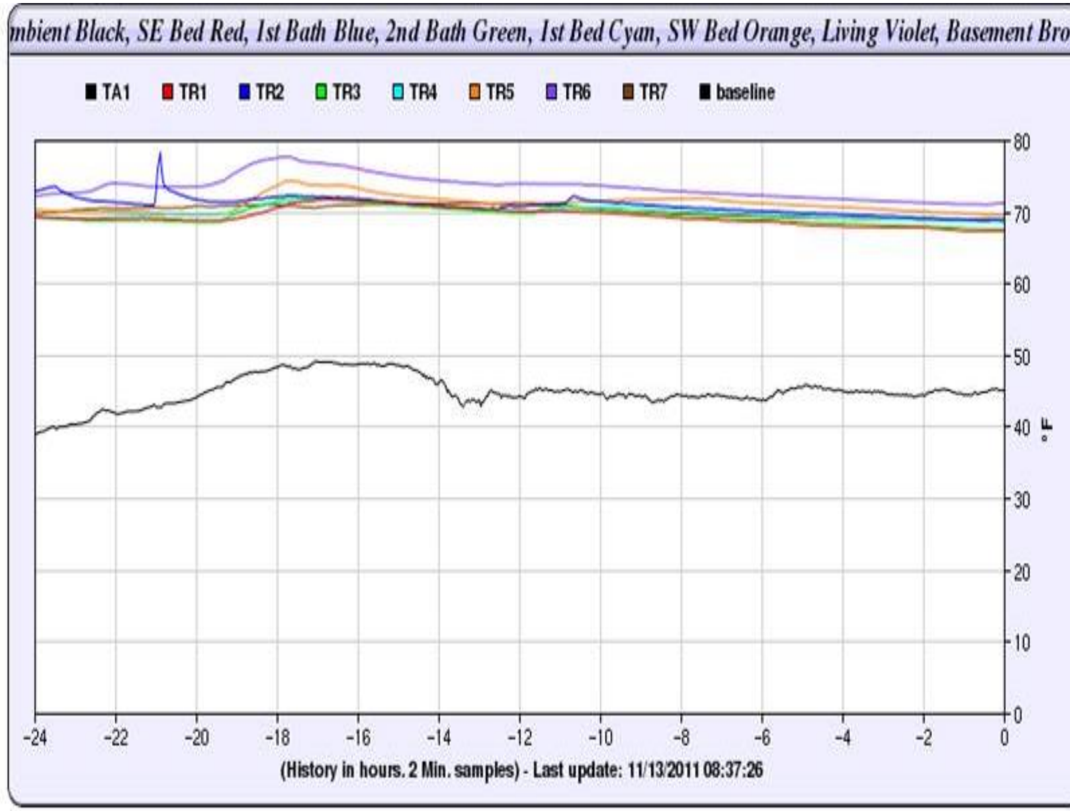
The left axis is the parts per million for CO_2 equivalent.



Source: Peter Schneider, Energy Consultant, Vermont Energy Investment Corporation, Burlington, VT

HRV Energy Use

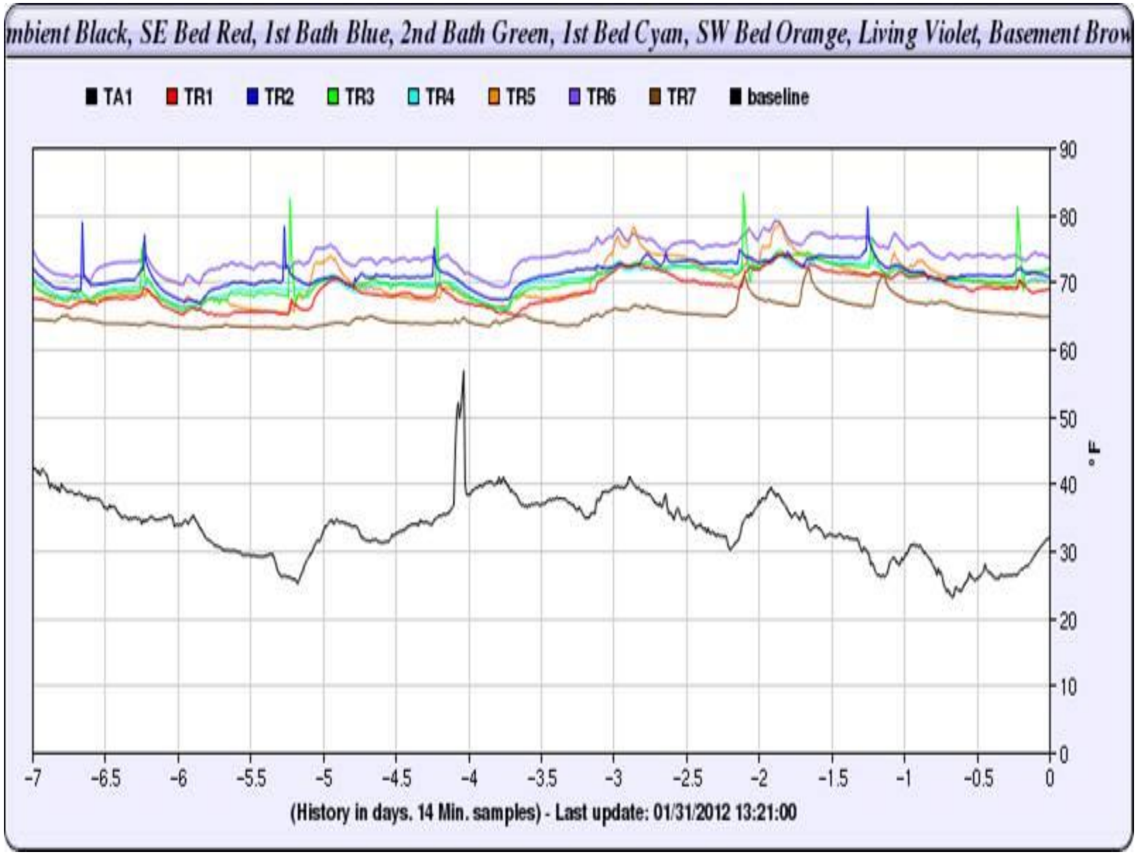
As seen here, the outside temperature hovers around 40°–50°F, and the range of the room temperatures is quite tight. However, notice the spike in temperature on the left of the graph (blue line). This spike indicates a “bath event”—the shower is used and the bathroom temperature rises. Following this event, the temperatures in the bedrooms see a little boost, which means that the heat from the bathroom is raising the incoming fresh air above the ambient temperature. This is only possible with a very high-efficiency HRV or ERV.



Source: Peter Schneider, Energy Consultant, Vermont Energy Investment Corporation, Burlington, VT

HRV Energy Use

This graph shows a trend of “bath events” that are followed by a rise in temperature in other rooms. There are a few exceptions, but the trend is obvious.

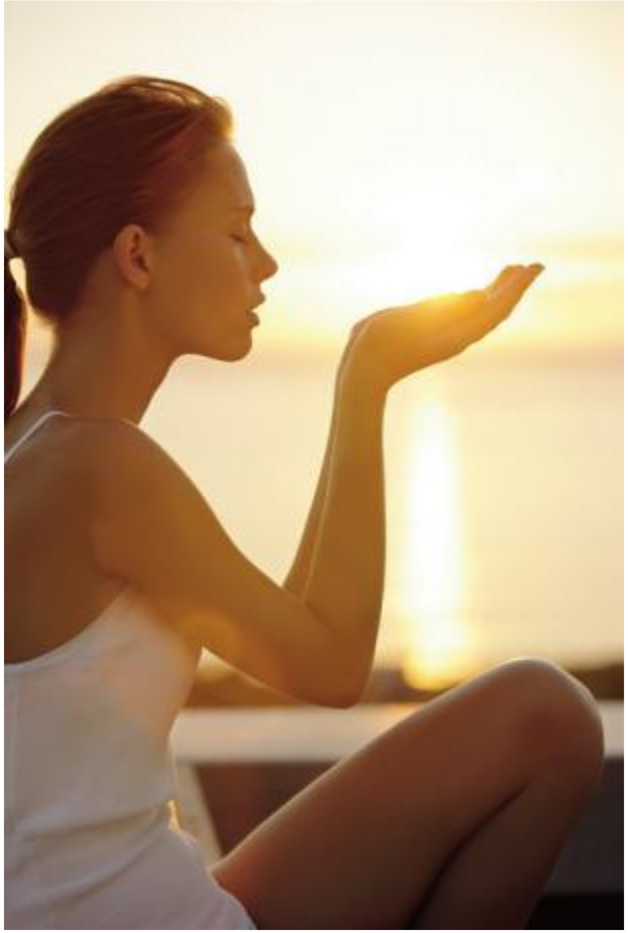


Source: Peter Schneider, Energy Consultant, Vermont Energy Investment Corporation, Burlington, VT

Summary: Benefits of HRV Systems

Heat recovery ventilators:

- reduce the energy penalty associated with mechanical ventilation, and
- help to balance temperatures throughout the home.

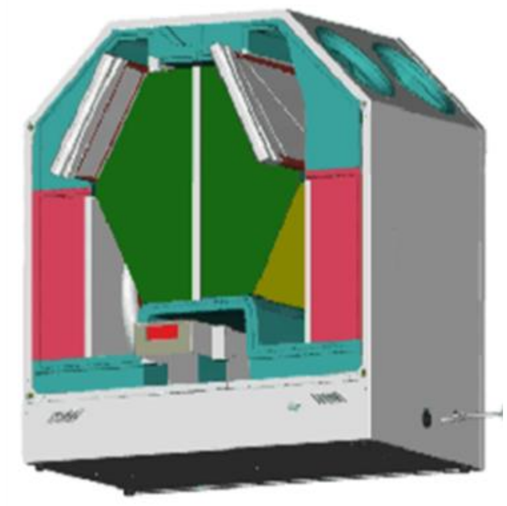


Selecting an HRV/ERV System

Introduction

In this section, we take a look at what you need to know to be able to select an efficient HRV or ERV for a home.

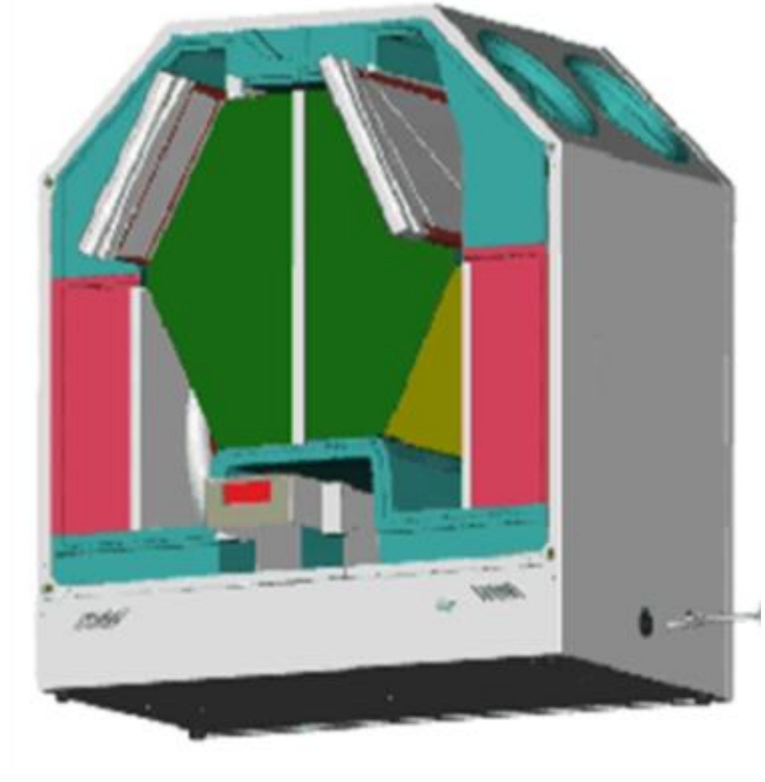
- HRV/ERV components
- Sizing the unit
- Efficiency testing
- Options (ground source preheater or precooler)



Components of HRV/ERV Devices

The following are the main components of HRV/ERV devices:

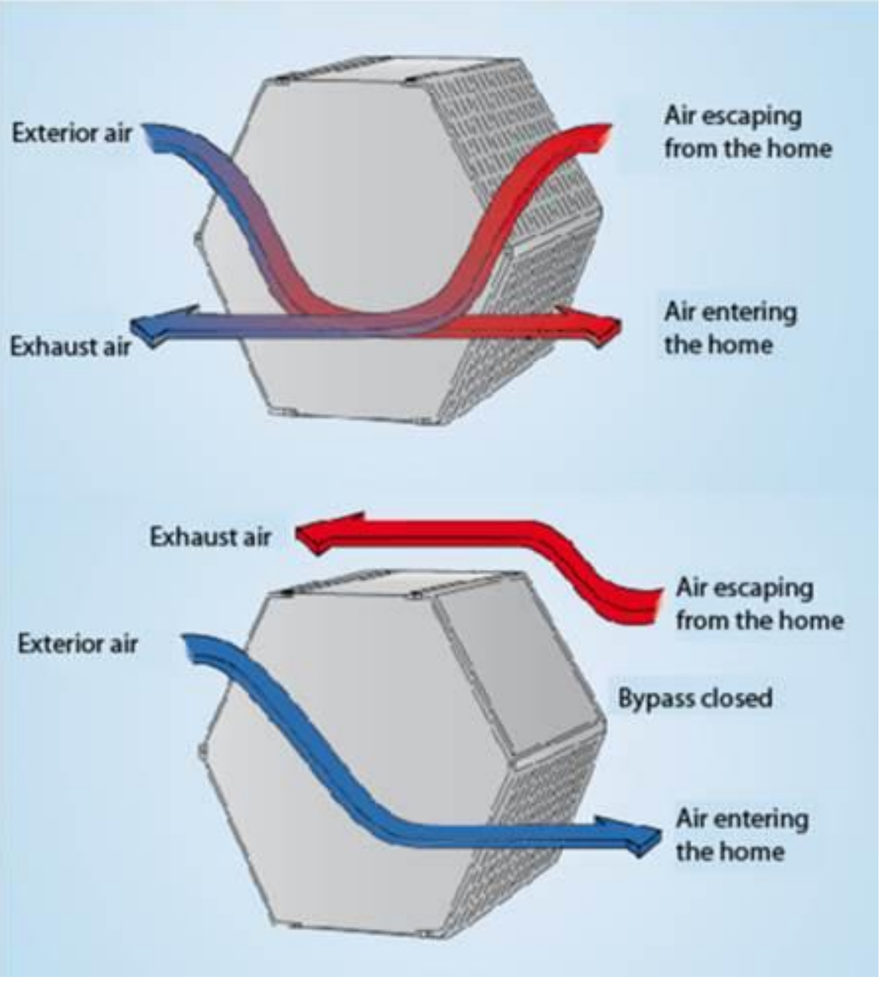
- heat exchanger (dark green core in the center)
- filters (gray parts at the upper right and left positions on the heat exchanger)
- intake and exhaust fans and motors (red boxes)
- controls (bottom center)



Components of Heat Recovery

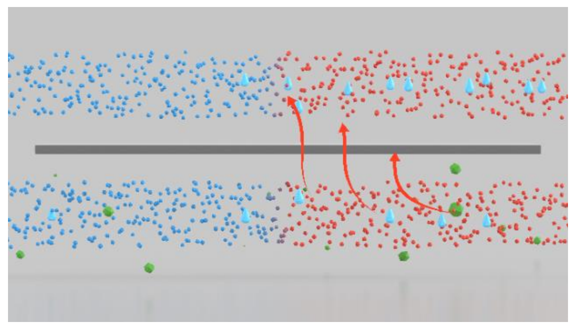
The top image shows the basic operation of an HRV or ERV. Below is an HRV or ERV operating with the summer bypass activated.

The summer bypass allows the cooler outside air to be brought directly into the dwelling when the inside temperature has increased above a set comfort temperature. This is accomplished with a damper that opens to reroute exhaust air around the heat transfer core, thus temporarily stopping heat recovery—similar to opening the windows, but without the associated disadvantages.



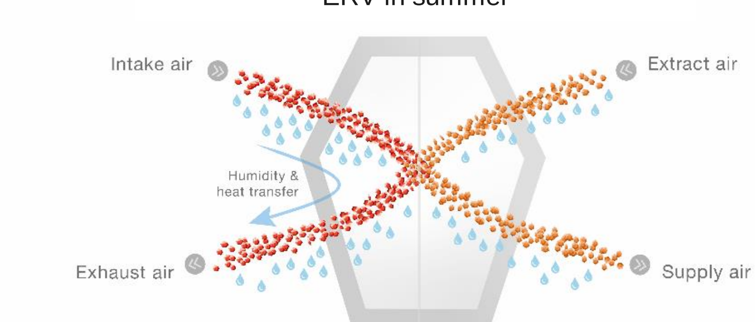
Enthalpy Recovery Systems

In an ERV that utilizes an enthalpy exchanger (illustrated below), the channels of the heat recovery core are made of a membrane that allows moisture, as well as heat, to transfer to the incoming or outgoing airstream. High-humidity air is prevented from entering a house in a hot, humid environment, or alternatively, humidity is retained in a house in a cold, dry climate.

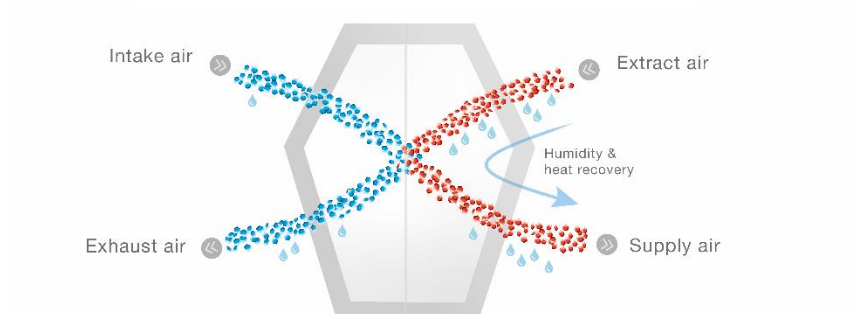


Enthalpy Exchanger Membrane

ERV in summer



ERV in winter



HRV vs. ERV

There are several factors that contribute to whether an HRV or ERV should be installed.

In the past, over-simplified, conventional wisdom stated simply that “HRVs are for cold climates and ERVs are for hot, humid climates.” Unfortunately, this perception persists. While there may have been some basis for this generalization in the past, it overlooks the diverse climate types across North America, differences in system operation from different manufacturers, and improved performance in ERV core technology.

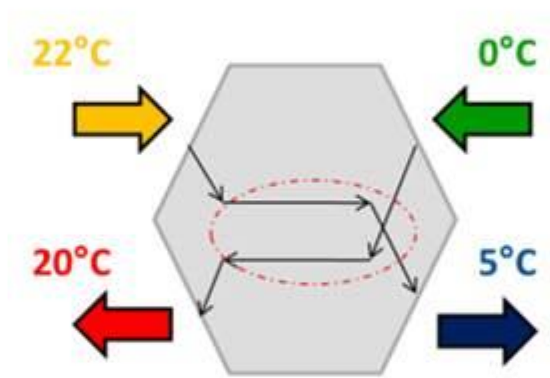
Today, while an HRV operating intermittently in a cold climate at lower than prescribed average flow rates may not cause over-drying, an HRV operating continuously at the same rate probably will. Meanwhile, an ERV that operates at the same continuous flow rate will help avoid over-drying. And the heat recovery effectiveness of many ERVs has improved substantially in recent years, so the comfort of the supply air delivered to rooms (and thus the avoided cost of more heating) is also much improved.

Today, it is very common for ERVs to be specified both in cold climates and in hot, humid climates, while HRVs are often more aptly specified in mild climates in various locations west of the Rocky Mountains.

HRV vs. ERV

For all locations, it is important to remember that an HRV has a slightly higher heat recovery efficiency, while an ERV can retain humidity in winter in cold climates and reject humidity in warm climates.

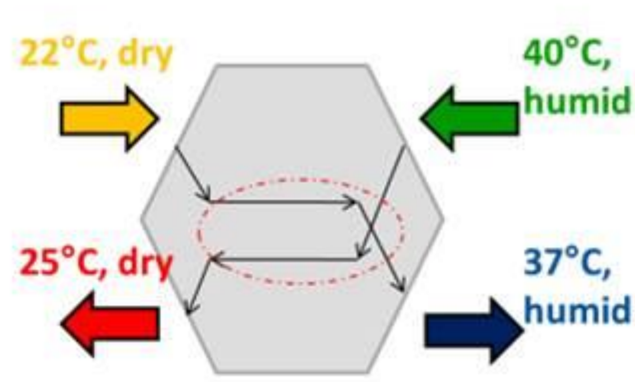
Counterflow heat exchanger



Counterflow heat exchanger

≈ 90 %

Counterflow enthalpy exchanger



Counterflow enthalpy exchanger

≈ 90 %

HRV in a cool climate and an ERV in a warm, humid climate

Sizing

To size an HRV/ERV, follow these steps:

1. Determine the necessary airflow rate for the building based on the building code or other standard that may apply.
2. Determine whether ventilation will be accomplished at a continuous rate, or if the unit will need to be sized up to account for intermittent operation requiring periods of increased ventilation.
3. Select a model that will accomplish the desired airflow rate using a maximum of 60% of the HRV/ERV's capacity.

The last point allows for multiple speed settings: low speed for periods of low occupancy, medium speed for normal use, and high speed for a temporary boost for shower or bathroom times or during cooking or large gatherings.

HRV/ERV Testing: North America

When selecting an HRV/ERV for a home, look for those with third-party testing showing, at a minimum, energy performance of the unit.

Here is an HRV being tested at the accredited HVI testing center in Toronto, Ontario, Canada.

Example: ERV Listing

This is a sample ERV listing from the HVI (Home Ventilating Institute, www.hvi.org).

Model: • Options Installed: None
Electrical Requirements: Volts: 120 Amps: 1.5
Exhaust Air Transfer Ratio: 0.03 @100 Pa/0.4 in. wg 0.03 @ 50 Pa / 0.2 in. wg
Low Temp. Vent Reduction Factor: 27.9% Supply 30.2% Exhaust • Low Temp. Imbalance Factor: 1.13

ENERGY PERFORMANCE

SUPPLY TEMP °C	°F	NET AIR FLOW L/S	CFM	POWER CONSUMED WATTS	SENSIBLE RECOVERY EFFICIENCY	APPARENT SENSIBLE EFFECTIVENESS	LATENT MOISTURE TRANSFER
0	+32	13	28	73	69	94	0.68
0	+32	45	96	137	62	74	0.48
-25	-13	25	54	102	54	83	0.58

VENTILATION PERFORMANCE

EXT. STATIC PRESSURE Pa	in wg	NET SUPPLY AIR FLOW L/s	cfm	GROSS AIR FLOW SUPPLY L/s	cfm	EXHAUST L/s	cfm
25	0.1	55	116	56	119	59	125
50	0.2	53	113	55	116	57	121
75	0.3	50	107	52	111	54	115
100	0.4	49	104	50	107	53	112
125	0.5	46	98	48	101	50	105
150	0.6	44	94	46	97	47	100
175	0.7	42	88	43	91	45	95
200	0.8	39	82	40	84	42	90
225	0.9	37	78	38	81	40	84
250	1.0	34	72	35	75	37	78

Notice that although the ASE (apparent sensible effectiveness—the gross recovery number, shown as a percentage) seems good at 94% at 28 cfm, the SRE (sensible recovery efficiency) is significantly lower. The SRE is a corrected number that takes into account the motor energy or heat, cross-flow leakage (leakage of air between the incoming and outgoing airstreams), and case leakage (heat transferred from the outside unit to the air passing through the unit). This unit uses 73 watts of power for 28 cfm—a lot of power, which is a factor in warming the incoming air and reduces the real energy efficiency of this ERV.

Example: ERV Listing

This sample ERV listing shows a more efficient unit, which uses less than 1/3 (one-third) watt of power per cfm and has a high ASE and SRE. The ASE is important for comfort, as it indicates how close to the ambient temperature the incoming air will be, while the SRE is a better overall indicator of total energy efficiency. Operating parameters can be manipulated to increase the ASE, but the SRE is corrected for these factors.

Model: Options Installed: None
Electrical Requirements: Volts: 230 Amps: 1.77
naust Air Transfer Ratio:0.004 @100 Pa /0.4 in. Wg 0.003 @ 50 Pa / 0.3 in. Wg
Low Temp. Vent Reduction Factor: 0% Supply 0% Exhaust • Low Temp.
Imbalance Factor: 1.07

ENERGY PERFORMANCE

SUPPLY TEMP °C	°F	NET AIR FLOW L/S	CFM	POWER CONSUMED WATTS	SENSIBLE RECOVERY EFFICIENCY	APPARENT SENSIBLE EFFECTIVENESS	LATENT MOISTURE TRANSFER
0	+32	31	65	20	88	93	0.01
0	+32	47	99	32	87	93	0.00
0	+32	61	129	50	85	91	0.00
-25	-13	34	71	832	49	99	0.01

VENTILATION PERFORMANCE

EXT. STATIC PRESSURE Pa	in wg	NET SUPPLY AIR FLOW L/s	cfm	GROSS AIR FLOW SUPPLY L/s	cfm	EXHAUST L/s	cfm
25	0.1	123	260	123	261	126	266
50	0.2	119	251	119	252	124	262
75	0.3	115	243	115	244	121	255
00	0.4	111	236	112	237	117	247
125	0.5	108	229	109	230	113	239
150	0.6	105	223	105	223	109	230
175	0.7	102	216	102	217	105	223
200	0.8	99	210	99	210	102	217
225	0.9	96	203	96	204	100	212
250	1.0	94	198	94	199	98	208

HRV Testing: Passive House Institute, Germany

The Passive House Institute (PHI) in Germany tests and certifies HRVs and ERVs somewhat differently from the guidelines followed in North America.

The PHI tests a unit for both heat recovery efficiency and energy use, as well as cross-flow leakage and noise levels.

Presently, North American architects, designers, and engineers predominantly use the HVI reports, whereas the Passive House movement relies more on the PHI certification.

PHI certification numbers can be applied directly to the PHPP (Passive House Planning Package) for determining the total efficiency of a dwelling.

Note: Passive House Institute US (PHIUS) is not affiliated with PHI and is developing their own criteria for product certification.

Ground Source Preheater or Precooler

An option for use with an HRV is a ground source preheater or precooler. This image shows a ground loop of glycol and a small circulating pump to preheat or precool and dehumidify incoming air with a hydronic coil.

When called for, either for prewarming to prevent frost and to increase efficiency, or for precooling to increase efficiency and possibly provide some tempering of hot or warm air, a pump in the unit circulates ground-temperature glycol through a coil, and incoming air is run across it to temper it. At a very small cost for powering the pump, significant reductions in energy use and increases in comfort can be achieved.

The ground source preheater or precooler is the beige rectangular unit shown on the right of the HRV.

Ground Source Preheater or Precooler

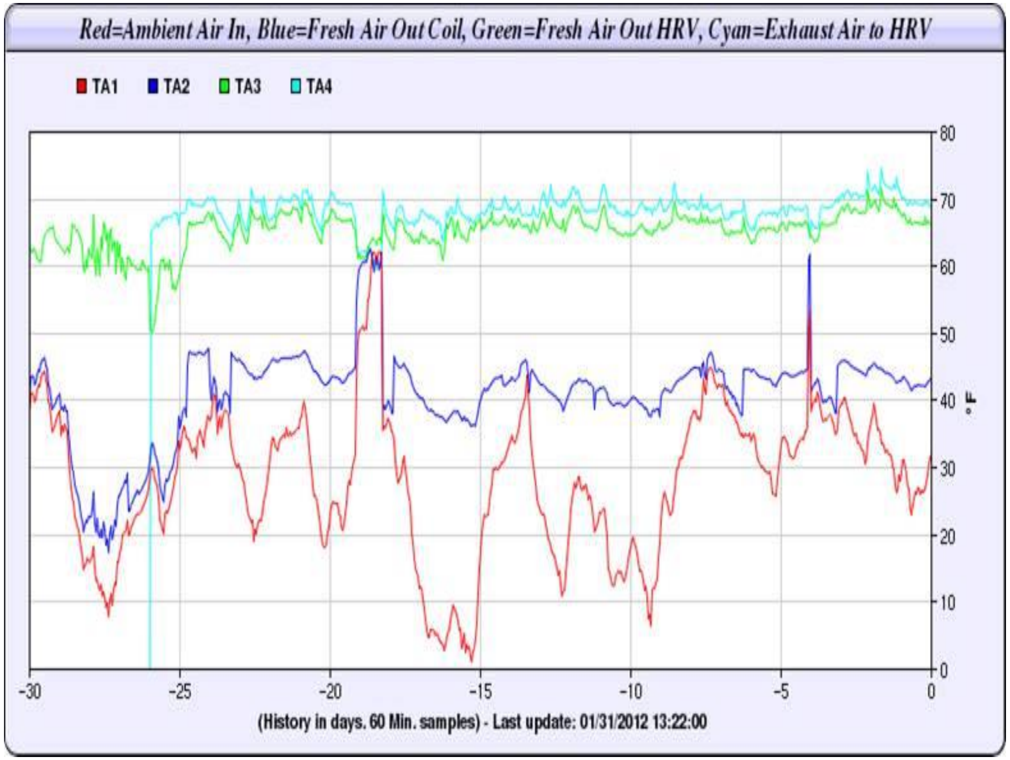
Here is a closer view of the ground source preheater or precooler. The ground source loop is shown connected by copper pipes—the incoming air is run over the coil inside the unit after passing through the filter box.

Ground Source Preheater or Precooler

The lines on this graph represent the following air temperatures:

- outside (red)
- between the ground source preheater or precooler and the HRV (blue)
- coming out of the HRV (green)
- room (light blue)

As shown, the lowest outside air temperature (near 0°F) was tempered to nearly 40°F by the ground source preheater or precooler. This air was then introduced to the interior room within a couple of degrees of the inside temperature.



Source: Peter Schneider, Energy Consultant, Vermont Energy Investment Corporation, Burlington, VT

Ground Source Preheater or Precooler

In the system shown here, the incoming air is delivered straight into the ground source preheater or precooler, then into the HRV, and then distributed through small ducts to and from the rooms in the house.

Please remember the **test password GROUND**. You will be required to enter it in order to proceed with the online test.

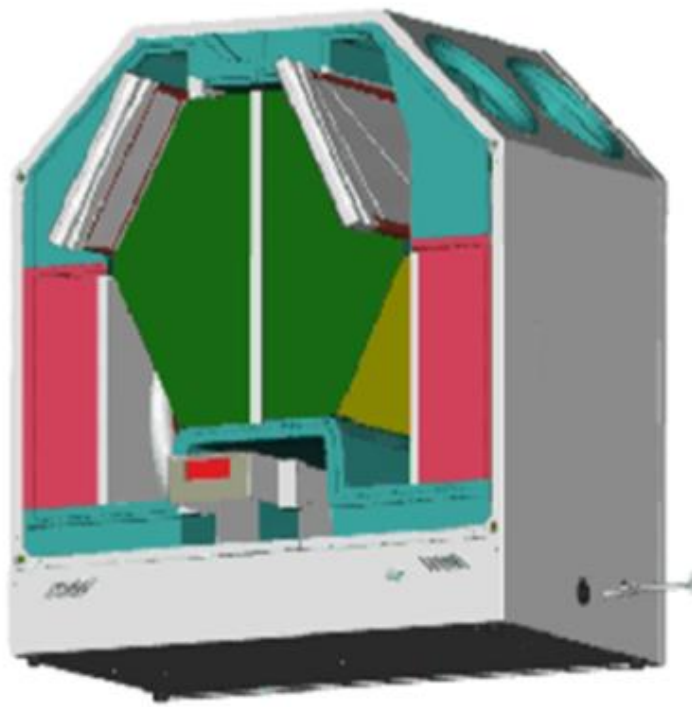
Review Question

What are the main components of an HRV/ERV device?

Answer

The following are the main components of HRV/ERV devices:

- **heat exchanger** (dark green core in the center)
- **filters** (gray parts at the upper right and left positions on the heat exchanger)
- **intake and exhaust fans and motors** (red boxes)
- **controls** (bottom center)



Installation & Commissioning

Commissioning

Commissioning (a systematic, documented process that is completed to ensure specific building systems perform in accordance with a building's operational needs) is a critical element in the installation of HRVs and ERVs.

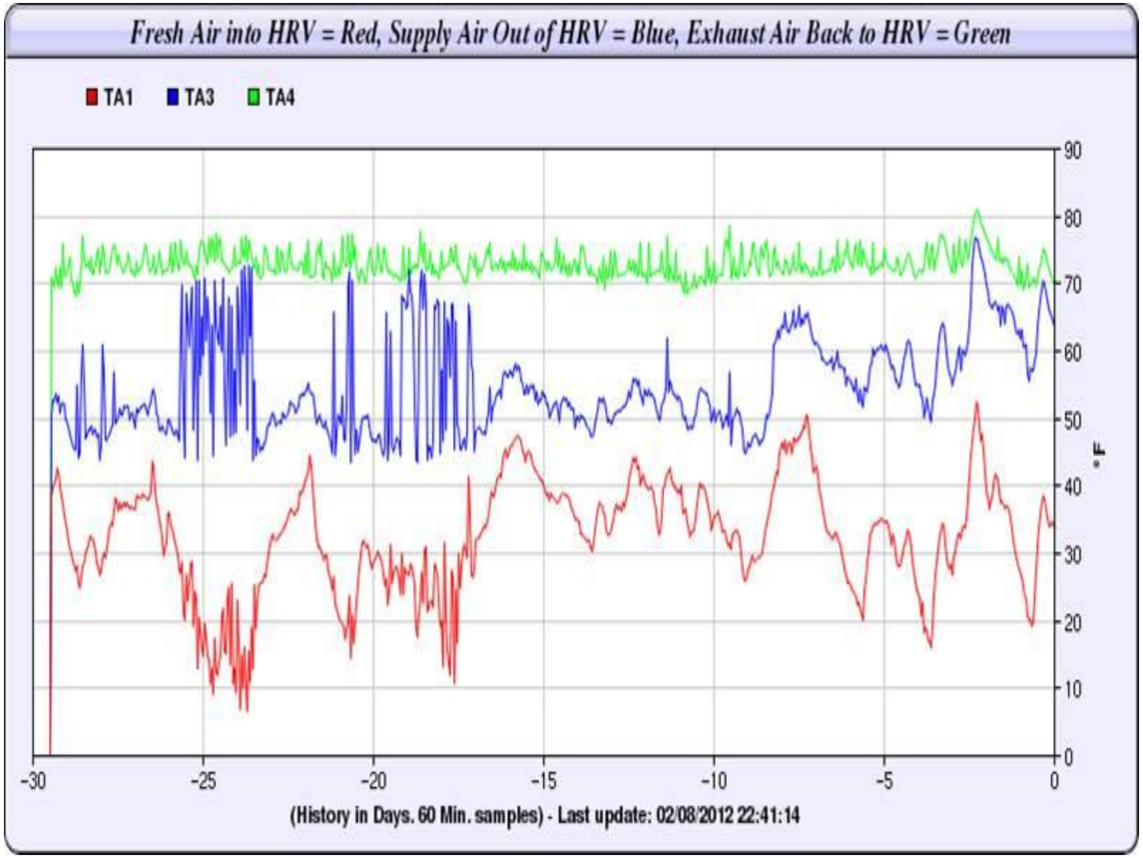
The air that flows to each register or diffuser is measured, and the total supply air and total return airflows are determined.

The total supply air and total return airflows should be balanced to provide optimum efficiency and to confirm that the supply and exhaust flows meet design and code requirements.

Installation

Many HRV and ERV installations in North America tie the HRV to the air handler of the forced air heating and cooling system. This can be problematic, as is shown in this graph.

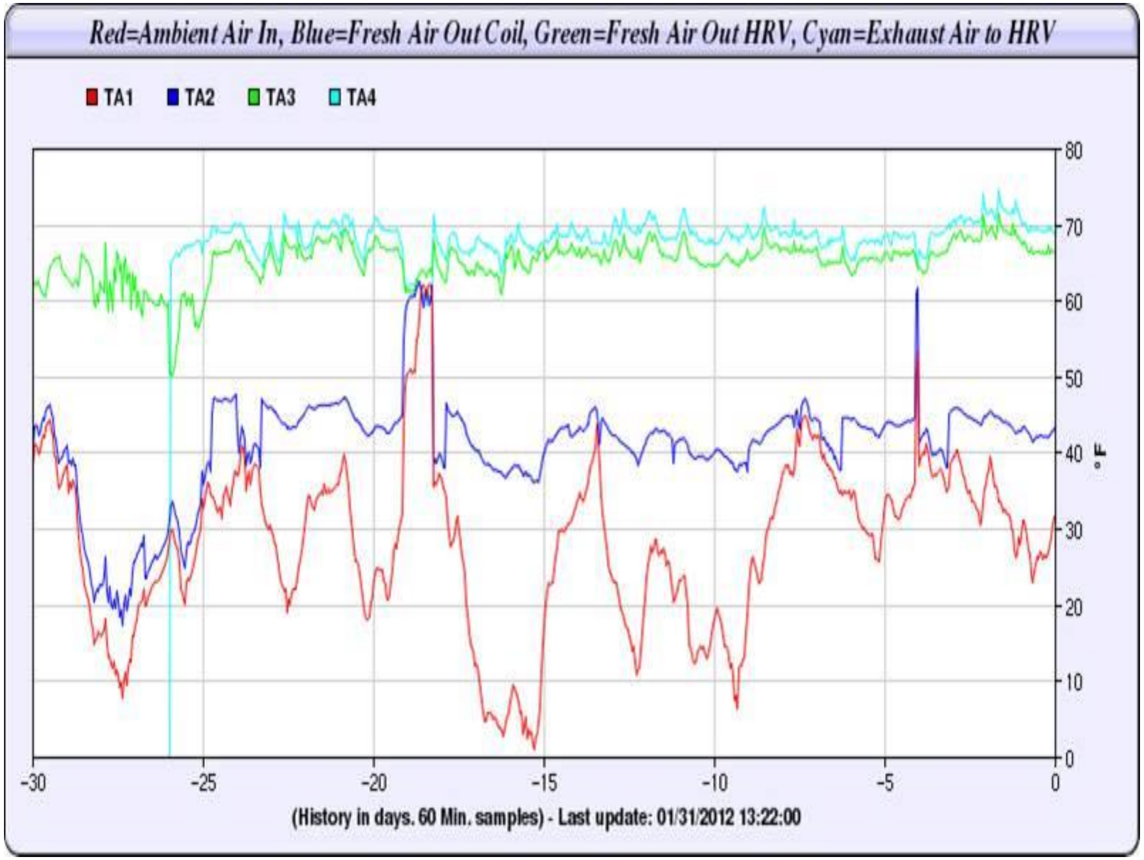
When the air handler is turned on and off, it brings about a change in the static pressure of the system. This change causes an HRV to lose balance, and efficiency of the heat recovery process suffers greatly.



Source: Peter Schneider, Energy Consultant, Vermont Energy Investment Corporation, Burlington, VT

Installation

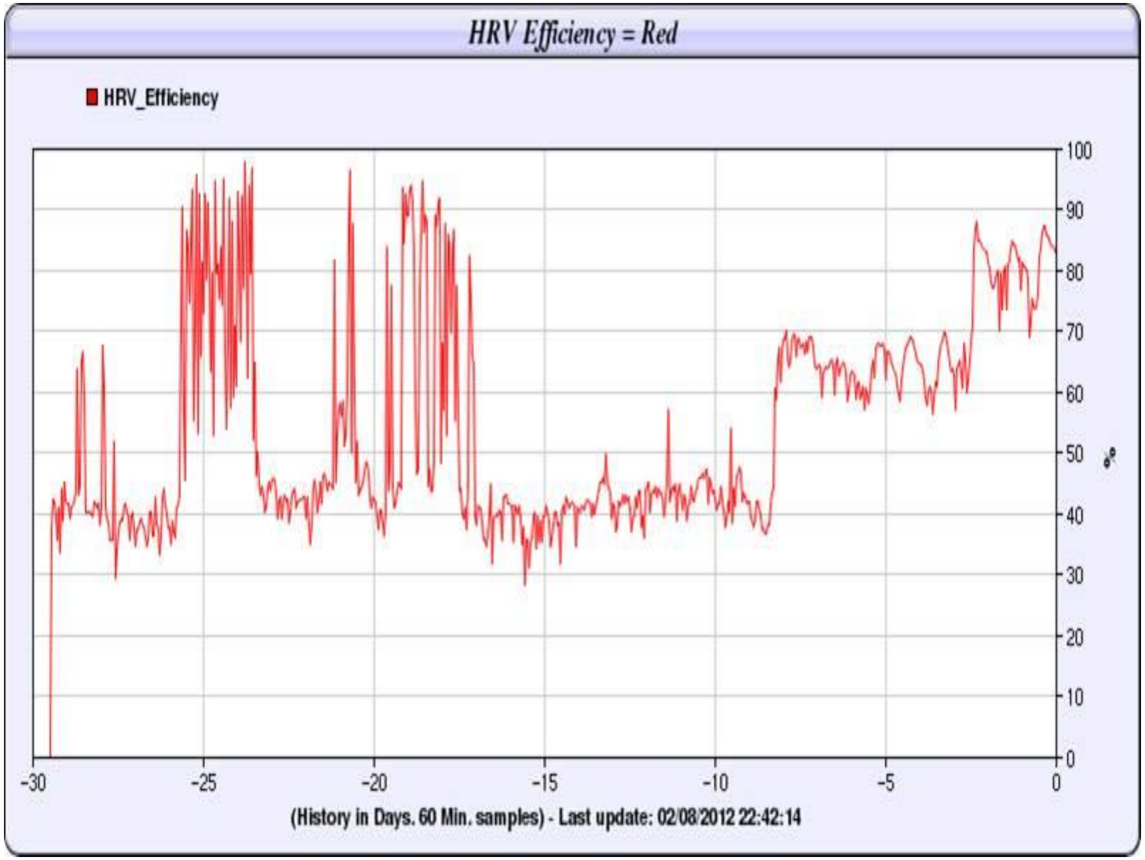
This graph shows a system with excellent balance and a high efficiency. It was commissioned for balance and utilizes a separate ducting system for the ventilation system.



Source: Peter Schneider, Energy Consultant, Vermont Energy Investment Corporation, Burlington, VT

Installation

And again, an air handler tied system.



Source: Peter Schneider, Energy Consultant, Vermont Energy Investment Corporation, Burlington, VT

Course Summary & Conclusion

In Summary…

In a residential home, three types of mechanical ventilation are possible: exhaust, supply, and balanced ventilation systems.

Balanced systems that utilize an HRV (heat recovery ventilator) transfer heat only, whereas systems with an ERV (energy recovery ventilator) also transfer moisture. Climatic conditions and geographic location of the building will determine which system is selected for a specific application.

HRV/ERV systems:

- provide a continuous supply of fresh air
- provide a uniform distribution of fresh air
- filter outside air and prevent pollen and insects from entering the interior environment
- remove air pollutants such as odors, smoke, and volatile organic compounds (VOCs)
- can help prevent the growth of mold and mildew
- can help protect a building against damage that is caused by excessive moisture and humidity
- protect the health of the building occupants
- meet the requirements of future energy performance building standards
- reduce the energy penalty associated with mechanical ventilation

Conclusion

If you desire AIA/CES, state licensing or CE credits for another organization, please click on the button to commence your online test. A score of 80% or better will allow you to print your Certificate of Completion; you may also go to your AEC Daily Transcript to see your completed courses and certificates.

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