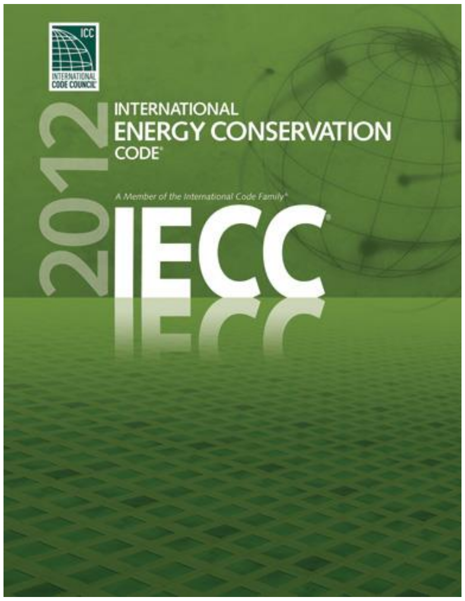
Ventilation & Energy Recovery

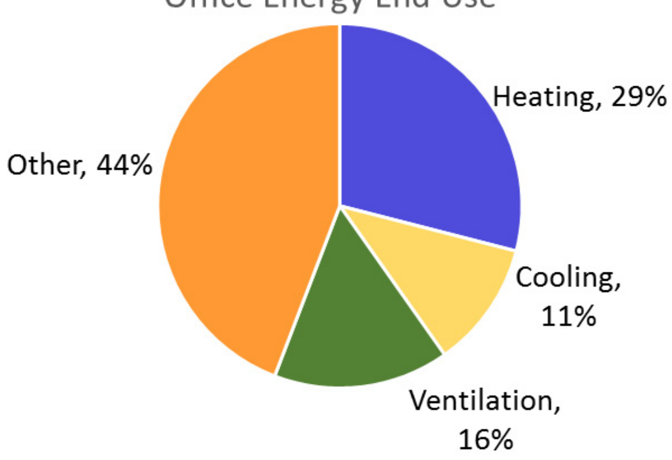
Montana Commercial Energy Code Tech Sheet

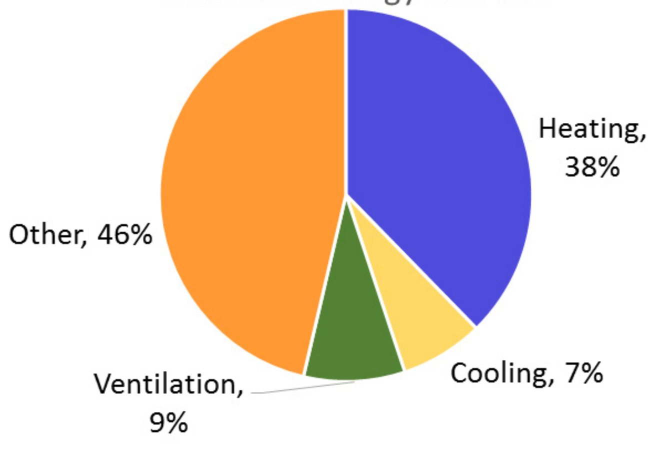
2012 IECC

Montana has adopted the *2012 International Energy Conservation Code* (IECC). The IECC allows use of *ASHRAE 90.1-2010: Energy Standard for Buildings Except Low-Rise Residential Buildings* as an alternative compliance path. The purpose of this Tech Sheet is to help designers and builders better understand the mechanical ventilation and energy recovery requirements of the energy code and how to improve energy efficiency.



The U.S. Department of Energy estimates that about 6% of the total energy consumed by commercial buildings in the U.S. is used to provide ventilation. Ventilation energy consumption differs by occupancy type. The two graphs below show energy consumption by primary end use for schools and offices. Ventilation accounts for 9% of total energy consumption in schools and 16% in offices.





Ventilation Standards

Early ventilation recommendations from the 19th century were eventually developed into standards and building codes in the 20th century. Ventilation recommendations and standards have evolved over time as our understanding of ventilation effects on health and building energy consumption has increased. The first version of ASHRAE Standard 62 (now ASHRAE 62.1, *Ventilation for Acceptable Indoor Air Quality*) was published in 1973 and provided minimum and recommended outside air amounts. For example, offices had a minimum requirement of 15 cfm per person and a recommendation of 26 cfm per person. Classrooms had a minimum requirement of 10 cfm per person and a recommendation of 10 cfm to 16 cfm per person.

With publication of the 2004 edition of ASHRAE Standard 62, both occupancy (per person) and floor area (per square foot) are used to calculate ventilation requirements. Using both occupancy and square footage to determine the outside air requirement addresses the need to dilute human bio-effluents, as well as the need to dilute contaminants off-gassing from building materials. The 2012 International Mechanical Code now recommends the following for minimum ventilation: for *offices* - 5 cfm/person and 0.06 cfm/ft^2; for *classrooms* - 10 cfm/person and 0.12 cfm/ft^2. In addition, the ventilation rates must be modified by the *zone air distribution effectiveness* and the *system ventilation effectiveness*. This has added complexity to the mechanical designer's tasks of ventilation code calculation and compliance.

Installing demand control ventilation (DCV) and energy recovery ventilators (ERVs) can reduce energy used for ventilation. Another strategy is to use a dedicated outdoor air system (DOAS) with an ERV.

What is Demand Control Ventilation (DCV)?

Demand control ventilation is a ventilation system that can automatically reduce ventilation below design rates when the space is at less than full occupancy based on CO_2 levels or other parameters in the space. A DCV system generally includes hardware, such as sensors and outside air dampers, and software which allows programming the control strategy. A new IECC section, C403.2.5.1, was added to the 2012 edition to detail DCV requirements. DCV provisions in the 2012 IECC apply to both the prescriptive and performance compliance paths. In the IECC, DCV is required for spaces greater than 500 ft^2 and with an average occupant load greater than or equal to 25 people per 1000 ft^2 of floor area. In ASHRAE 90.1-2010, DCV is required for spaces greater than 500 ft^2 and with an average design occupancy density exceeding 40 people per 1,000 ft^2 of floor area.

2012 IECC DCV Requirements Summary

Demand-controlled ventilation shall be provided for spaces > 500 ft^2 and with an average occupant load ≥ 25 people/1000 ft^2 of floor area, and served by systems with one or more of the following:

- an air-side economizer;
- automatic modulating control of the outdoor air damper; OR
- a design outdoor airflow > 3,000 cfm.

ASHRAE 90.1-2010 DCV Requirements Summary

Demand control ventilation (DCV) is required for spaces > 500 ft^2 and with an average design occupancy > 40 people per 1,000 ft^2 of floor area and served by systems with one or more of the following:

- air-side economizer,
- automatic modulating control of the outdoor air damper, or
- design outdoor airflow > 3,000 cfm.

What is an Energy Recovery Ventilator?

An energy-recovery ventilation system employs heat exchangers to recover energy from exhaust air for the purpose of preheating, precooling, humidifying or dehumidifying, outdoor ventilation air prior to supplying the air to a space. Both the IECC and ASHRAE 90.1-2010 require a minimum of 50% effectiveness for ERVs. A new section in the IECC, C403.2.6, was added to the 2012 IECC to specify ERV requirements. ERV provisions in the 2012 IECC apply to both the prescriptive and performance compliance paths. ASHRAE 90.1-2010 section 6.5.6.1 has requirements similar to those of 2012 IECC.

The requirement for installation of an ERV is determined by the design supply fan airflow rate and the percent outdoor air at full design flow. This threshold determination applies to both the IECC and ASHRAE 90.1-2010. Where the supply airflow rate of a fan system exceeds the values specified in the adjacent table, the system must include an energy-recovery system.

Energy Recovery Requirement	
Design Supply Fan Airflow Rate (cfm)	% Outdoor Air
≥ 1500	≥ 80%
≥ 2500	≥ 70%
≥ 3500	≥ 60%
≥ 4500	≥ 50%
≥ 5500	≥ 40%
≥ 11000	≥ 30%

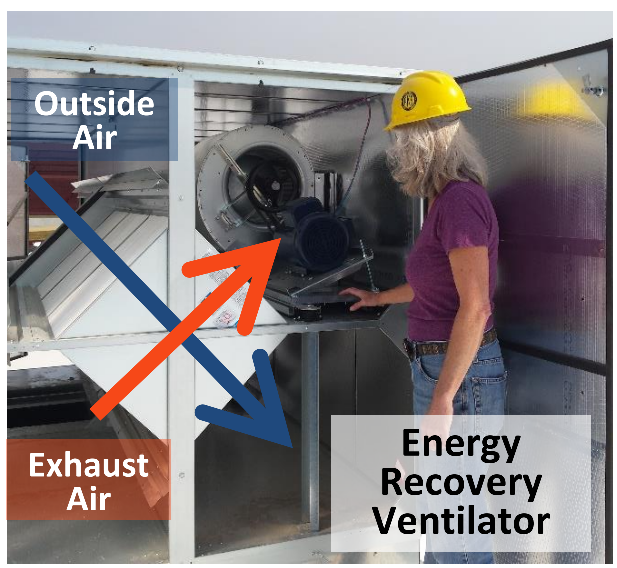
What is a Dedicated Outside Air System (DOAS)?

A dedicated outdoor air system (DOAS) is a type of HVAC system that consists of a dedicated system for delivering ventilation that handles both the latent and sensible loads of conditioning the ventilation air, and a parallel system to handle other sensible envelope and internal loads.

The DOAS's main function is to provide the required amount of ventilation air to the zones it serves. Use of a DOAS allows the HVAC system capacity to be reduced, and the fan and ductwork associated with it to be sized smaller, often resulting in installation cost savings. Use of a DOAS also allows more accurate delivery of ventilation air, provides better humidity control, and allows use of a wider variety of HVAC systems. During unoccupied hours the DOAS is shut off, which results in energy savings. Since by its nature a DOAS is a 100% outside air system, an ERV is almost always required under the energy code. The DOAS unit includes a preheat coil, fans, an ERV, usually a cooling coil, and is connected to its own set of ductwork that delivers outside air directly to the zones.

Why is it Important to Control Ventilation Airflow and to Recover Energy from Exhaust Air?

DCV has the potential to realize significant energy savings if it functions properly. The amount of ventilation air supplied to a space is designed to meet the requirements of the maximum number of people in the space. In many spaces, the actual number of occupants will be significantly less than the design load. This situation is especially common in an assembly area, such as a theatre, classroom, or church. The DCV system will then adjust the amount of ventilation air to meet the requirements of the number of people present.



Reducing ventilation air amounts saves energy, since a smaller amount of outside air needs to be heated or cooled.

A 2015 study of DCV operation and energy performance in commercial buildings funded by the Minnesota Department of Commerce showed average annual savings of $0.50 per cfm of outside air in large, variable air volume systems. This translates to a four- to eight-year simple payback. The study also found wide variations in system design, installation, and operation, and that commissioning had a significant impact on how well a DCV system met the code requirements and performed as designed. Minnesota's winter climate is similar to Montana, so heating season savings would be similar.

An ERV recovers energy, usually from exhaust air streams, by using a heat exchanger and transferring that energy to incoming ventilation air. In situations requiring large amounts of outside air (hospital surgical areas or natatoriums, for example), this type of equipment can save significant amounts of energy. The energy savings results from reduced operating time for heating and air conditioning equipment. Fan-power energy use associated with the ERV will usually increase due to additional fans and increased pressure drop across the heat exchanger. Heating and cooling equipment capacities can often be reduced, resulting in lower installation cost.

For new construction, the design of the HVAC system and the ERV should be integrated to allow the HVAC system capacity to be minimized. A rough rule of thumb is that for every 1,000 cfm of outdoor air passing through an ERV, HVAC equipment capacities can be reduced by 2.5 tons (of cooling). The savings from reduced HVAC equipment size can help offset the initial cost of the ERV and improve operating efficiencies of equipment.

Air-to-air energy recovery wheel at Montana State Data Center. Photos courtesy of MTDEQ.

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Funding for the printing of this publication has been provided through electric Universal System Benefits funds collected from NorthWestern Energy customers.

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