tech primer

Dedicated Outdoor Air Systems (DOAS) with Energy Recovery Ventilators (ERV)

Controlled ventilation for enhanced comfort and savings.

New York Botanical Garden, Marlon Co. Photography

tech overview

applicable building types
commercial

when to implement
anytime; mid-cycle; refinancing

fast facts
- reduces GHG emissions
- improves air quality
- reduces heating and cooling loads
- reduces maintenance costs
- reduces utility costs

costs & benefits*

GHG Savings

Tenant Experience Improvements

Utility Savings

Capital Costs

Maintenance Requirements

*ratings are based on system end use, see back cover for details.

be ex STL

getting to know DOAS with ERV systems

Dedicated Outdoor Air Systems (DOAS) and Energy Recovery Ventilators (ERVs) provide controlled and conditioned ventilation that improves indoor air quality and occupant health, while reducing greenhouse gas emissions and saving energy.

how do DOAS with ERV systems work?

All commercial buildings are required to supply fresh air to occupied spaces. Fresh, clean air supports human health and is critical to indoor air quality and comfort. Although ventilation methods may differ, tempering incoming fresh air to meet indoor heating and cooling needs is typically an energy-intensive process.

A Dedicated Outdoor Air System (DOAS) with a energy efficient Energy Recovery Ventilator (ERV) is a high-performance ventilation system design that can significantly reduce a building's heating and cooling loads.

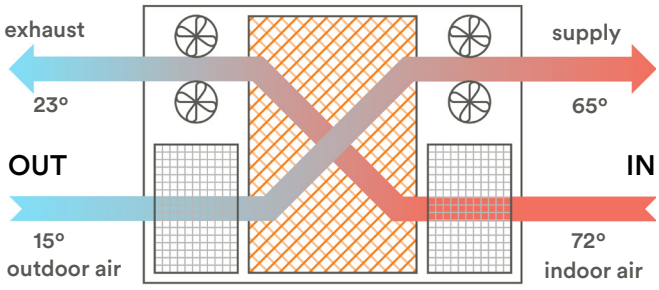
Conventional heating, ventilation, and air conditioning (HVAC) systems must fully temper fresh air before distributing it throughout a building. This contributes to high heating and cooling loads, and means that fresh air is only provided simultaneously with space heating or cooling. A DOAS, on the other hand, brings fresh air into interior spaces independently from heating and cooling, greatly increasing efficiency and allowing the downsizing of HVAC equipment.

ERVs pre-condition incoming outdoor fresh air with warm or cold indoor exhaust air, saving a significant amount of energy that would otherwise be lost with traditional ventilation methods.

ERVs work by either transfering heat from warm, indoor exhaust air to cold, incoming outdoor air, or vice versa, depending on the season (see Fig 1). This heat exchange happens through a membrane so the two air streams never mix, keeping odor and pollutants in exhausted air separate from fresh supply air.

Pairing a DOAS and ERV ventilation system with a high-efficiency, ductless heating and cooling system, such as variable refrigerant flow (VRF) or mini-split heat pumps, can further reduce energy loads while enhancing occupant comfort.

Fig 1. In winter, ERVs transfer heat from outgoing exhaust air to incoming supply air, via a heat recovery core (orange hatch). This process reverses in summer to remove heat from incoming air, helping to cool supply air.



Assess
Always consult a qualified service provider before undertaking any building upgrades.

Coordinate to Maximize Savings
Implementing a DOAS retrofit in conjunction with building envelope improvements that reduce heat loss and infiltration can enhance the ventilation system performance.

Establish a tight building envelope through general air sealing. Update windows and add insulation to further reduce heating and cooling loads.

Plan Ahead for Success
A DOAS retrofit is most easily applied to buildings with existing ventilation systems that are either floor by floor or have both supply and return air ductwork.

Buildings that are currently supply or exhaust-only ventilated will require additional duct work.

how to upgrade to DOAS and ERV systems

A DOAS and ERV will greatly reduce the heating and cooling loads of a building. Coordinate heating and cooling retrofits in order to size equipment based on these load reductions.

retrofit solutions

A DOAS and ERV system combined with a properly sized heating and cooling system and programmed controls will generate significant energy savings. The following are recommendations for upgrading your system:

A **Install a DOAS with an ERV:** Typical ERV efficiencies are around 70%. However, very high efficiency ERVs (on the order of 85% to 93%) have long been used in Europe and are now available in North America. A high performance ventilation retrofit requires the installation of an ERV at the highest efficiency available.

- A building's existing ventilation system may either be centralized, providing ventilation to the entire building, or decentralized, providing ventilation to individual floors or spaces.
- Supply and exhaust air must be balanced and ducted to the same locations. This is usually easier to acheive in decentralized systems but can also be achieved in centralized ones.
- The ERV should be sized to operate at 40%- 60% of its rated capacity during design conditions. The additional capacity allows the ERV to run as an economizer during mild weather. When the outdoor air is sufficiently cool, the ERV brings the outdoor air in to cool indoor spaces without using any energy to temper it, thereby providing free cooling.

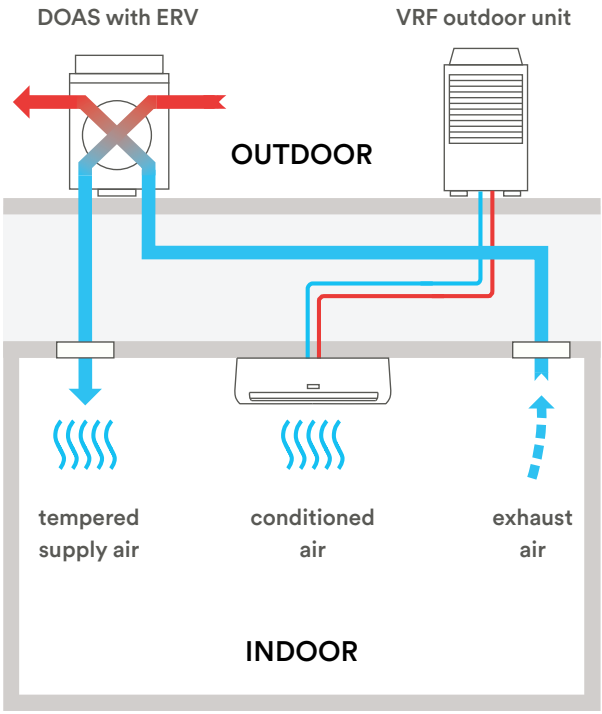
B **Install a Ductless Heating and Cooling System:** A high efficiency ductless heating and cooling system, such as VRF or mini-splits, paired with a DOAS and ERV system, creates a complete, high performance HVAC solution (see Fig 2). These systems complement each other and dramatically reduce energy costs while improving comfort.

- See the ***VRF and Mini-Split Tech Primers*** for more information about installing these systems.

C **Upgrade Controls:** Installing demand-based controls, CO2 sensors, and using occupancy scheduling can further optimize HVAC system performance.

- Controls must coordinate DOAS and ERV operation with the heating and cooling system.
- DOAS terminal units must be controlled by occupancy and CO2 sensors to provide fresh air to individual spaces when needed.
- When fresh air is not needed, controls must reduce airflow at terminal units and reduce ERV fan power to minimize energy consumption.
- The control system should automatically enable the ERV economizer setting in mild weather.

Fig 2. When paired with a high-efficiency electric heating and cooling system, such as VRF, a DOAS with ERV creates a complete HVAC solution. In cooling mode, the ERV transfers heat from incoming outdoor air to outgoing exhaust air, tempering supply air entering the building. The VRF does less work because the supply air temperature is closer to the desired indoor temperature.



costs & benefits of DOAS and ERV*

Greenhouse Gas (GHG) Savings

In a DOAS with ERV system, almost all of the energy in exhausted air can be recovered by the incoming fresh air (or vice versa), dramatically lowering heating and cooling loads and related GHG emissions. Further GHG reductions as possible when the DOAS and ERV are paired with a ductless heating and cooling system and upgraded HVAC controls.

Tenant Experience Improvements

Installing a DOAS with ERV system dramatically improves tenant satisfaction by delivering fresh air where it is needed, resulting in a controlled indoor environment with reduced temperature extremes and improved indoor air quality.

Utility Savings

Although DOAS with ERV systems significantly reduce heating and cooling loads, electricity is a currently more expensive than fuels like natural gas, oil, or district steam. Future utility cost changes should be considered when evaluating project feasibility.

Capital Costs

DOAS installation requires a high capital investment, although installation costs will depend on existing building conditions. Buildings with decentralized ventilation systems will generally be simpler and cheaper to convert. In contrast, buildings with centralized systems may be more difficult and expensive to convert, particularly when the total supply and exhaust rates are not already balanced. Further due diligence is recommended when determining site-specific costs, benefits, and retrofit considerations.

Maintenance Requirements

A DOAS with ERV system requires a low level of maintenance. ERVs and DOAS terminal units have air filters that require regular cleaning. ERV controls detect dirty filters and automatically alert operators, however it is recommended to visually inspect ERV units every 3 months and fully clean the unit every 6 months.

**The Costs & Benefits rating system is based on a qualitative 1 to 4 scale where 1 (●○○○) is lowest and 4 (●●●●) is highest. Green correlates to savings and improvements, orange correlates to costs and requirements. Ratings are determined by industry experts and calculated relative to the system end use, not the whole building.*

Note: Existing ventilation assumed to supplied floor by floor. Existing heating and cooling system to be replaced with VRF or Mini-Split system.

take action

This document is one of more than a dozen High Performance Technology Primers prepared by Building Energy Exchange and its partners to introduce decision-makers to solutions that can help them save energy and improve comfort in their buildings. Access the complete Tech Primer library: **be-exstl.org/building-blocks**

building energy exchange st. louis

Building Energy Exchange St. Louis (BE-Ex STL) advances building energy performance by mobilizing the professional expertise, funding, and technical resources needed to reduce the energy required to power our buildings. In coordination with public, private, non-profit, and community stakeholders, BE-Ex STL expands our region's capacity to increase affordability, improve the health of our community, and position St. Louis as a resilient and carbon neutral region.

Visit: be-exstl.org
Email: info@be-exstl.org
LinkedIn: linkedin.com/company/building-energy-exchange-st-louis

building energy exchange

The Building Energy Exchange (BE-Ex), located in New York City, has served as a trusted resource for the real estate, design, and construction industries for over a decade. BE-Ex supports the growth of centers of excellence across the country dedicated to reducing the effects of climate change by improving the built environment.

Launched in Spring 2021, BE-Ex STL will utilize the deep resources and expertise of BE-Ex in New York, while also creating a customized approach to services and programs in our city.

Call: (212) 349-3900
Visit: be-exchange.org
Email: info@be-exchange.org