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DEMAND-CONTROLLED VENTILATION IN MULTI-STORY, MULTI-RESIDENTIAL BUILDINGS

The case for using demand-controlled ventilation to save energy and improve comfort

WHITEPAPER

Did you know,

Energy-efficient exhaust fans can save substantially more on your heating/airconditioning than on your electrical bill.

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WHITE PAPER SUMMARY

This white paper provides an in-depth exploration of the Fan Energy Index (FEI), a transformative metric for assessing the energy efficiency of fan systems in HVAC applications, particularly within multi-story, multi-residential buildings.

Our investigation begins with a historical overview, tracing the progression from the previously established Fan Efficiency Grade (FEG) to the more advanced FEI. FEI's comprehensive approach to evaluating fan efficiency across varying operational conditions makes it particularly relevant for the complex environments of real-world scenarios.

A significant portion of this paper is dedicated to examining how Demand Control Ventilation (DCV) systems align with FEI standards.

We explore DCV's role in dynamically modulating ventilation in response to occupancy – showcasing its suitability for greater efficiency, comfort, and indoor air quality.

The discussion extends to the technical intricacies of DCV, including the integration of sensor technology, lifetime return, and retrofit implementation, particularly in the context of high-rise residential buildings.

We also shed light on the broader implications of adopting FEI in the context of global sustainability goals. We discuss how FEI, in conjunction with DCV systems, can contribute significantly to reducing the carbon footprint of multi-residential buildings.

This white paper serves as a comprehensive resource for engineers, architects, and energy professionals seeking to understand and implement FEI standards in the design and operation of HVAC systems within multi-story, multi-residential buildings. We aim to provide valuable insights and guidance for advancing the efficiency and ecological responsibility of modern building designs.

The Inadequacies of FEG as a Fan Efficiency Standard

The quest for energy efficiency in HVAC systems has been a long-standing endeavor in the building industry. FEG, introduced by the dynamic ASHRAE 90.1 standard in 2010 – was the standard metric used in the industry for years. It rated fans based on their peak performance, determined through specific airflow and pressure criteria.

However, FEG had a significant limitation– it focused solely on a fan's optimal performance point, neglecting the broader operational spectrum. This meant that while a fan could score high on the FEG scale, it might not be the most energy-efficient choice in practical scenarios, especially for smaller fans or non-ducted applications.

The Fan Energy Index (FEI) – A Paradigm Shift

With the introduction of the Fan Energy Index (FEI), a pivotal shift occurred. The latest ASHRAE 90.1-2019 iteration moved from FEG to FEI, recognizing the need for a more inclusive and realistic approach that considers the efficiency of the entire fan system, including crucial components like motors and drives.

At its core, FEI measures how energy-efficient a fan is under actual operating conditions rather than just at its peak performance. This metric is calculated by comparing the energy efficiency of the actual fan in use (or under consideration) against a reference fan. The reference fan represents an ideal model, showcasing the utmost efficiency that current technology can achieve.

The formula for calculating FEI is articulated as follows:

$$FEI = \frac{(Power\ Input\ of\ Reference\ Fan)}{(Power\ Input\ of\ Actual\ Fan)}$$

In this equation, 'power input' refers to the electrical power consumption of the fan, typically measured in kilowatts (kW). The comparison is conducted under identical operational conditions, known as the 'duty point', which includes parameters such as airflow rate, pressure increase, air density, and fan speed.

The 'duty point' concept is fundamental when evaluating fan systems through the lens of the Fan Energy Index (FEI). It embodies a series of distinct operational factors critical for a proper evaluation and comparison of energy efficiency between an actual fan and a reference model.
Key aspects included in the duty point are:

Airflow Rate
Airflow rate, typically measured in cubic feet per minute (CFM), quantifies the volume of air a fan can circulate. Fans with a higher CFM can move a larger volume of air, making them suitable for larger spaces or applications that require extensive air circulation.

Pressure Increase
This parameter measures the rise in air pressure due to the fan's operation generally quantified in inches of water gauge (IWG). It is important to understand the fan's ability to push air through a space or system. Higher pressure increases indicate a more powerful fan, capable of moving air effectively against resistance – such as in duct systems or through filters.

Air Density
A fan's performance is closely linked to the density of the air it circulates. Changes in temperature and humidity levels can alter this density, impacting the fan's energy requirements. In settings with varied temperature and humidity, it's essential for engineers to consider air density to maintain the fan's efficiency and accuracy.

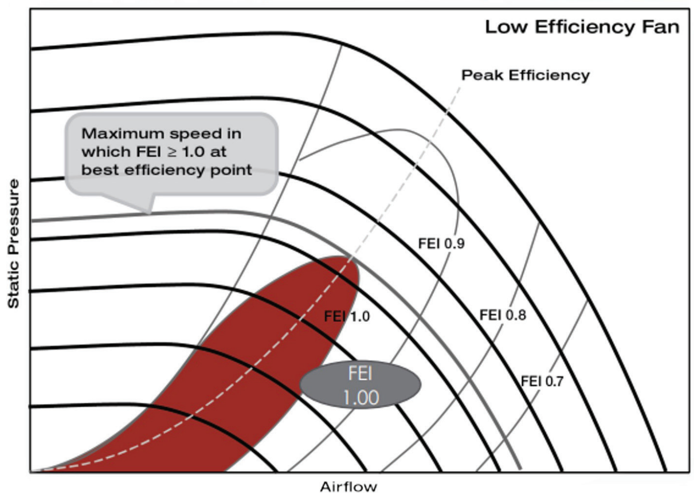
Fan Speed
The speed of the fan blades, measured in rotations per minute (RPM), directly affects the fan's ability to move air and create pressure. Different fan speeds can influence both airflow rate and pressure increase. While a higher RPM can increase airflow and pressure, it may also result in higher energy consumption and noise levels.

FEI Performance Curve & Interpreting FEI

The FEI performance curve complements the traditional fan performance curve, which typically displays fan static pressure on the y-axis and airflow on the x-axis.
The curve helps identify the compliance range of a fan, where the FEI remains consistently above 1.0. This is denoted by colored areas. Fan performance curves may include multiple curves or lines, each corresponding to different aspects of the duty point.
Here's how different FEI values should be understood and their implications:

FEI Value of 1.0

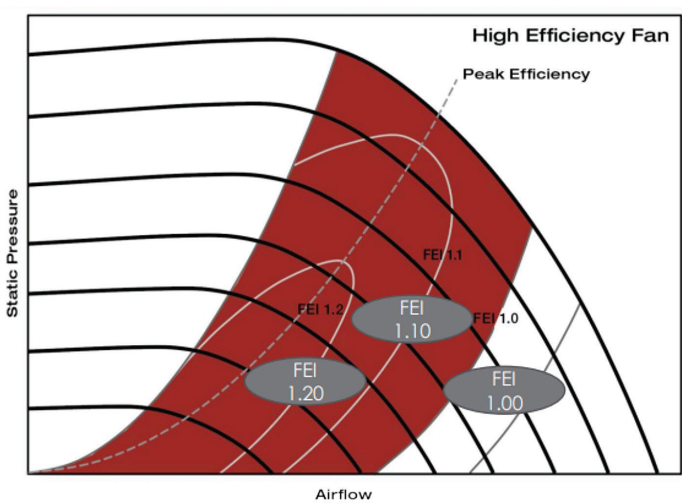
This indicates the fan's efficiency is on par with the reference model. Fans with this FEI rating meet the minimum rating being adopted by building codes.



INEFFICIENT FAN

FEI Value Greater than 1.0

A higher FEI score means the fan is more efficient than the reference. These fans are sought-after for their energy-saving potential, offering reduced operational costs and a lower environmental impact through decreased energy usage and carbon emissions.



EFFICIENT FAN

FEI Value Less than 1.0

A score below 1.0 signals lesser efficiency compared to the reference fan. Such fans, while operational, may not be energy-efficient, leading to higher long-term costs. They are often prime candidates for replacement or upgrades, especially in scenarios where energy efficiency is a critical concern.

Advantages of FEI

FEI offers several advantages over traditional efficiency metrics like the Fan Efficiency Grade (FEG):

- Extends beyond the limited scope of FEG, which only considers a fan's peak performance. It evaluates the entire fan system, including motors, drives, and controls, providing a more thorough assessment of factors influencing energy consumption.

- Values the fan's actual energy use in everyday settings over hypothetical peak efficiencies. This focus on real-world power consumption guarantees that assessments of the fan's operational efficiency are directly applicable and meaningful in daily scenarios.

- FEI's adaptability makes it suitable for a broad spectrum of fan types and sizes, enhancing its applicability across diverse HVAC applications.

- Motivates the design and selection of fans that maintain high efficiency across their entire operational range, not just at peak performance levels.

FEI's Adoption – Building Codes and Regulations

FEI is already the standard in the following:

- ASHRAE 90.1-2019

- International Energy Conservation Code (IECC)(2020)

- ASHRAE 189.1/International Green Construction Code (IGCC) (2020)

It's progressing toward adoption for California Title 24 and California Title 20.

Unfortunately, progress by the U.S. Dept. of Energy has stalled in adopting FEI as a federal efficiency guideline.

VENTILATION MULTI-STORY

Ways FEI-Rated Systems Benefit Multi-Story, Multi-Family Properties

In the context of multi-story, multi-family properties, the implementation of high Fan Energy Index (FEI)-rated systems can guarantee efficient and sustainable building operations.

These benefits extend beyond energy savings, impacting indoor air quality, regulatory compliance, and long-term financial returns. Here's a detailed look at the five key benefits:

1. Energy Consumption and Cost
Traditional ventilation systems in multi-family buildings are significant energy consumers, often accounting for over half of the total energy usage. High FEI-rated systems are designed for optimal energy efficiency, which can substantially reduce the HVAC energy consumption in these buildings.

The lower energy consumption of these systems translates directly into reduced operating costs. This is particularly significant in multi-family buildings where the cumulative cost savings can be substantial over time.

2. Indoor Air Quality and Health
High FEI-rated systems improve Indoor Air Quality (IAQ) by effectively circulating and renewing air, thus reducing the concentration of pollutants and allergens.

These systems help manage humidity levels, prevent the growth of mold and dust mites, and contribute to a healthier indoor environment, which is especially important given the extensive time residents spend indoors

3. Sustainability and Environmental Impact
The operation of buildings is a major contributor to global energy use and emissions. High FEI-rated ventilation systems, by virtue of their enhanced energy efficiency, play a significant role in reducing operational energy requirements, thereby lowering the environmental impact of urban living.

These systems align with global efforts towards sustainability, helping to mitigate the overall emissions from residential and commercial buildings.

4. Regulatory Compliance and Building Standards
With the increasing adoption of stricter energy codes at state and local levels in the U.S., high-efficiency ventilation systems are becoming essential for regulatory compliance.

Buildings equipped with high FEI-rated systems are better positioned to meet the criteria for sustainability certifications like LEED, enhancing their marketability and appeal.

5. Long-Term Cost-Benefit Analysis
The FEI model encourages considering long-term efficiency and cost-effectiveness rather than just upfront costs.

These include lower energy bills due to reduced energy usage, decreased maintenance costs, enhanced property value (environmentally conscious tenants), potential rebates or tax benefits for installing energy-efficient systems, and increased longevity of the HVAC systems leading to savings on replacement costs.

Ventilation Strategies in Multi-Story, Multi-Residential Buildings

In multi-story, multi-residential buildings, commonly referred to as "vertical subdivisions," ventilation strategies are governed by the American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) Standard 62.1. Recent advancements in these strategies focus on two primary objectives – reducing overall energy use in the building and creating a healthier living environment for occupants.

Traditionally, ventilation strategies in buildings have relied on:

Constant Outside Air Systems
These systems continuously supply fresh air from outside the building to maintain air quality. They operate regardless of occupancy or indoor air quality levels, ensuring a steady influx of outside air to dilute indoor pollutants.

Economizer Operations
Economizers are used to control indoor temperature by leveraging outside air conditions. When the outside air is cooler than the air inside, economizers draw this cooler air into the building, reducing the need for mechanically cooled air. This approach is particularly effective in mode-rate climates costs, but its effectiveness is limited under extreme weather conditions or when outdoor air quality is poor.

However, a growing focus on energy efficiency has led to the rise of Demand Control Ventilation (DCV) as a more modern and effective solution:

Demand Control Ventilation (DCV)
Initially developed in Europe, driven by the necessity to manage high energy expenses, DCV systems are gaining global recognition.

They are particularly valued for their ability to regulate indoor air quality, with a specific emphasis on controlling carbon dioxide (CO_2) levels. DCV systems dynamically adjust ventilation rates based on occupancy and air quality data, leading to more efficient energy usage while maintaining optimal air conditions.

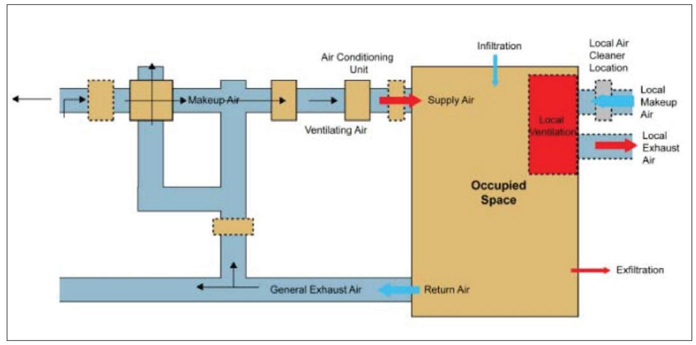


Fig. 1: Building Ventilation system showing location ventilation ANSI / ASHRAE Standard 62.1– 2007

Local Ventilation
While the three aforementioned strategies are widely adopted, there is another critical yet often underemphasized approach known as local ventilation. This strategy, governed by ASHRAE Standard 62.1, focuses on specific areas or rooms within a building, providing targeted ventilation where it's most needed.

Local ventilation maintains air quality in high-usage areas such as kitchens, bathrooms, and laundry rooms (as illustrated in Fig. 1).

Common applications for localized ventilation include bathroom and kitchen exhaust, clothes dryer ventilation, as well as exhaust systems for boilers and mechanical rooms. Although significant energy savings potential exists in these applications, it is often overlooked by designers when calculating a building's life cycle costs.

Interestingly, while designers do account for "local" exhaust air volumes when determining a building's air supply rates, the reality is that local ventilation primarily expels conditioned air from the building, ultimately working against energy conservation efforts. Consequently, it becomes challenging to incorporate local ventilation into energy recovery initiatives, primarily due to the risk of contamination with substances like odors, grease, and lint.

Exhaust System Variations for Local Ventilation

The exhaust systems of these local appliances, including clothes dryers, kitchen hoods, and bathrooms, can be implemented in one of three distinct ways:

1. Individual Ducts – Individual horizontal ducts for each appliance that direct outside. Driven by integrated appliance fans and/or external booster fans.
Challenges include maintenance complexity, lint/grease buildup, and potential difficulties in duct installation due to distance or cost constraints. Each appliance must have its own designated duct and booster fan

2. Common Vertical Shaft with Constant Fan – Multiple appliances connected to a shared vertical duct. A common fan, often referred to as a scavenger fan, continuously draws air from the shared duct at a consistent speed and exhaust rate, operating 24/7. When all appliances are not in use, a damper located at the bottom of the shaft allows replacement air to enter.

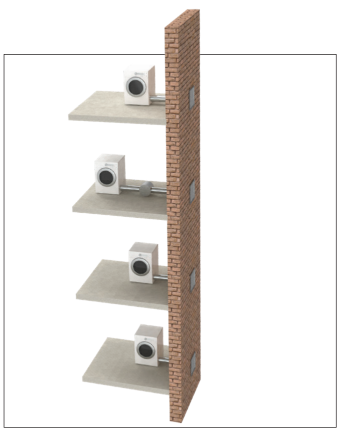


Fig. 3: Direct to the outside ex-hausted clothes dryers

Challenges include the building code requirement of sub-ducts for fire safety and the substantial energy loss resulting from round-the-clock fan operation at maximum speed, which expels conditioned air and leads to energy wastage.

3. Common Vertical Shaft with DCV – Multiple appliances connected to a shared vertical duct, but the fan runs at variable speeds to match demand. During periods of appliance dormancy, the replacement air needed is typically minimal, often drawn through each connected appliance.
This system can be likened to trickle ventilation, characterized by minimal energy loss.

Fig. 4: Common shaft with constant speed exhaust system

DCV – The Most Efficient Variation

Consider a scenario in which a 10-story building with four apartments per floor utilizes individual fans for three applications: dryers, bathrooms, and potentially kitchens, resulting in a total exhaust capacity of 10,000 CFM.
If these appliances are only active 30% of the time, a staggering 7,000 CFM or 10,080,000 cubic feet of conditioned air would be needlessly expelled daily.

Fig. 5: Common shaft with DVC system

DCV is a superior choice in this scenario because it addresses the issue by varying the fan's speed to match the actual demand.

But why not just use a single-speed fan with a Relief Damper?
To avoid negative pressure zones on the upper floors, the vertical shaft's pressure drop must be minimal (0.1-0.2" WC). Connecting the shaft to an outside relief damper via a horizontal duct requires a large and costly duct with no pressure drop, and pulling air from a parking garage, often under negative pressure, is not feasible. Even with a relief damper, conditioned air is still drawn in, making it an inefficient choice.

Explanation of Components in DCV Systems

No two DCV systems are identical – so it's important to understand the specific roles and interactions of the components within a DCV system.

A DCV system usually consists of the following components:

Exhaust Fan – The cornerstone of the DCV system is the exhaust fan, ideally equipped with a direct-drive, true variable-speed motor. Belt-driven fans, prone to wear and noise, are less suited for DCV systems due to their less efficient modulation.

Note: The 2009 International Building Code prohibits the use of fans with motors located within the airstream for multistory clothes dryer installations.

Variable speed controller – This component can be either frequency drive-based or triac-based. Most controllers are very basic with limited programming options. Triac-based controllers are common in single-phase 120VAC fans.

Pressure controller – The pressure controller works in tandem with an external pressure sensor. It communicates with the fan or frequency drive, offering extensive programming options. The controller's PID loop is tailored for smooth operation, a level of precision not achievable with standard variable frequency drives.

Pressure sensor – The pressure sensor, integral to the control system, must be of high quality and finely tuned with the pressure controller's PID loop. This setup guarantees accuracy within +/- 2% of the set point, significantly better than the +/- 20% accuracy of simpler systems. The right sensor prevents unnecessary fan speed adjustments and optimizes energy savings.

The performance and return on investment (ROI) of a DCV system heavily depend on the choice of components. Omitting a sophisticated pressure controller might seem like a cost-saving measure but can significantly impact the system's efficiency and extend the payback period.

How to Evaluate the Long-Term Benefits of DCV

When considering the adoption of a Demand Control Ventilation (DCV) system, it's vital to look beyond the immediate benefits and evaluate the long-term impact across 5 key areas:

1. System-Environment Fit – Assessing the system's compatibility with your building's design and environmental conditions.

2. Installation Complexity – Understanding the challenges and requirements of installing the DCV system, especially during renovations.

3. Adaptability and Efficiency – Gauging the system's ability to adjust to changing needs while maintaining operational efficiency, as indicated by the Fan Efficiency Index (FEI) metric.

4. Maintenance Demands – Evaluating the frequency and extent of maintenance the system will require.

5. Disposal and Reuse Potential – Considering how the system can be responsibly disposed of or repurposed at the end of its lifespan.

These factors collectively contribute to what is known as the measurable lifetime return of the ventilation system. This concept, distinct from life-cycle cost analysis (LCA), focuses on the financial benefits over the system's lifespan. In other words, what is the net financial advantage?

DCV LIFETIME RETURN

Demand Control Ventilation (DCV) offers exceptional energy and maintenance efficiency over its lifespan:

Robust Product Design – Take EXHAUSTO's DCV systems as an example. These systems are designed for intense usage, featuring heavy-duty galvanized steel construction and insulation for reduced noise. The high-quality, Totally Enclosed Fan-Cooled (TEFC) motors are designed for variable speed and low energy consumption, making them ideal for schools, hotels, sports facilities, and residential buildings.

Installation – DCV systems can reduce construction costs by requiring less material for shafts and ducts and fewer specialized installation tools. For retrofits, they can typically utilize existing structures like roof curbs and power supplies.

Minimal Maintenance Needs – DCV systems are low-maintenance, generally requiring only routine cleaning. Features like accessible doors simplify cleaning, and direct-drive motors eliminate the need for belt replacements or slippage issues.

Operational and Human Impact – In building operations, DCVs are non-intrusive and significantly quieter than other systems, improving occupant comfort. They also improve indoor air quality (IAQ) by reducing pressure issues and drafts.

End-of-Life Efficiency – At the end of their lifecycle, all components of a DCV system are recyclable. The main benefit lies in source reduction, as the manufacturing impact is minimal compared to their ability to reduce energy usage.

Calculating the Lifetime Return

From an operating perspective, a DCV system provides financial savings in two key areas over its lifespan:

- Conditioned air exhaust costs
- Fan operation savings

Over a 15-year period, a typical DCV system serving eight dryers costs 55% less to operate than a constant speed system while saving 85% of the cost of exhausting conditioned air:

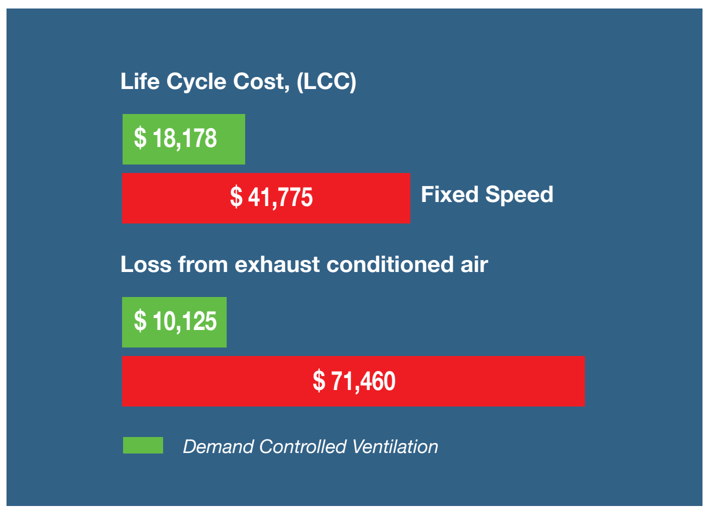


Fig. 14: Lifecycle cost of demand controlled versus constant speed ventilation systems

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CASE STYDY: COST SAVINGS

DCV System Cost Savings

A condominium in Maryland faced challenges with its ventilation system, leading to noise complaints and concerns about energy wastage. The building, comprising 14 identical shafts, each ventilating nine kitchen hoods across nine stories, originally used constant-speed exhaust fans. These fans were noisy and inefficient in terms of energy use, particularly when the kitchens were not in operation.

The Homeowner Association (HOA) explored the potential of a Demand Control Ventilation (DCV) system. Despite initial concerns about the higher acquisition cost of DCV systems due to their complex controls – the HOA decided to proceed with the retrofit.

Pre-Retrofit Analysis
Before the upgrade, each shaft required a total exhaust volume of 1,560 CFM. Based on this and other factors like cooling/heating degree days and system efficiency, the estimated annual savings post-installation were calculated to be $42,644.

Annual Savings per Shaft	Total per Year
Energy Savings (Fan Power Consumption)	$812
Energy Savings (Loss of Conditioned Air	$2,235
– Heating	1,685 Therms
– Cooling	2,127 kW
Total Annual Energy Savings	$3,046

Table 8: Calculated savings for a single shaft with nine kitchen hoods and 1,560 CFM of exhaust flow.

Post-Retrofit Performance Analysis
Post-installation, data showed significant improvements:

- When idle, the DCV system reduced exhaust flow to about 140 CFM, less than 10% of the original design volume.
- During peak operation, the exhaust volume was only 1,300 CFM.

Return on Investment (ROI) Analysis
Importantly for the HOA, the retrofit proved to be a financially beneficial decision:

- The new estimated annual savings for all 14 shafts was $38,584.
- The cost for 14 DCV systems was around $55,000, with installation costs at about $16,000.
- Total project cost stood at $71,000, leading to an estimated payback period of 22 months.
- The projected 5-year return on investment (ROI) was an impressive 172%, or 34% per year.

Payback Period						
	Initial invest-ment	Year 1	Year 2	Year 3	Year 4	Year 5
DCV Investment	71.000					
Savings Each Year	0	38,584	38,584	38,584	38,584	38,584
Cumulative Pre-interest Pre-tax Payback	-71,000	- 32,416	6,168	44,752	83,336	121,920
Payback Period in Years	1.8					

Table 9: Calculated payback for the retrofit job

CASE STYDY: ENERGY SAVINGS

DCV System Energy Savings

Quantifying energy savings from Demand Control Ventilation (DCV) systems is complex, but a Canadian study has made significant strides in this area.

The Natural Gas Technologies Centre in Montreal, for Enbridge Gas Distribution, has shed light on the potential for substantial energy savings when switching from electric to natural gas-fired dryers and integrating DCV systems.

Pre-Retrofit Analysis

Over a year-long period, the study monitored eight dryers in a multi-residential building, finding that they were operational for an average of 185 minutes daily.

Most significantly, these dryers were inactive 70% of the time daily, offering a significant opportunity for energy savings with a DCV system. Initially, the dryers' exhaust was managed by a single-speed fan running constantly, leading to substantial energy loss.

Laundry Utilization Profile		
% Dryers in Operation	Laundry Profile (% per day)	Profile Laundry Profile (minutes per day)
100	1.5	22
75	3.9	56
50	8.6	124
25	16.7	240
0	69.3	998
Total	100	1,440

Table 6: Utilization Profile for Draft

Post-Retrofit Performance Analysis

By transitioning to a variable-speed drive common exhaust fan, the study observed a 3% reduction in dryers' energy consumption and a dramatic decrease in unnecessary exhaustion of conditioned air. The DCV system:

- Significantly lowered the loss of conditioned air – from an estimated 288,000 ft³/day/dryer to just 41,000 ft³/day/dryer.
- Achieved considerable annual energy savings, with up to 8,800 kWh conserved for the exhaust fan alone.

Fig. 7: Test system setup

This Canadian study not only highlights the energy savings in laundry facilities but also provides a model that can be applied to other local ventilation applications like multi-story clothes dryers and kitchen and bathroom exhaust systems.

TIPS FOR DCV SYSTEM IMPLEMENTATION

– A Cost Perspective

DCV systems can be effectively integrated into both new construction projects and retrofitting initiatives. While new construction offers greater design flexibility and the potential for space and material savings, the energy-saving potential remains consistent in both scenarios.

Diversity Factor
A critical starting point is analyzing a system's utilization profile, enabling the calculation of a diversity factor. This factor compares the maximum demand to the maximum system capacity. For instance, a 70% diversity factor means that the total load will never exceed 70% of the maximum system capacity. Consider the "worst-case scenario" as part of the diversity factor.

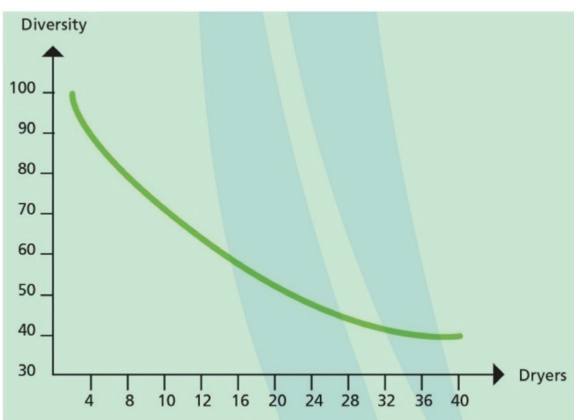

Fig. 8: Diversity factor vs. number of dryers served.

By incorporating the diversity factor into the common exhaust duct design, it becomes possible to create a more space-efficient duct size.

Unlike designs that assume maximum capacity at all times, this approach not only saves valuable space but also reduces both labor and material expenses during the installation process.

Note: Not all building codes or local regulations permit the use of a diversity factor to reduce fan capacity. In cases where this is not allowed, the fan system must be designed to handle the total cubic feet per minute (CFM) of the appliances and overcome the total pressure within the exhaust system.

Air Exfiltration
Implementing DCV leads to reduced air exfiltration, resulting in decreased conditioned air infiltration. This, in turn, lowers the load on heating and cooling equipment. As a result, HVAC systems can be downsized, leading to substantial cost savings.
Efficiently controlling the exhaust rate with DCV is also significantly more efficient than enthalpy heat recovery wheels.

Aesthetics
Opting for a central DCV system instead of individual "direct-to-outside" vents can eliminate aesthetic concerns associated with architectural termination caps on exterior walls.

Simplified Installation
One central fan is easier to install compared to multiple fans with individual dryer interlocks, as required by building codes.

Space Efficiency
A central system also frees up usable building space, which can be sold or rented to the tune of thousands.

Use Existing Infrastructure
DCV proves to be an excellent choice for retrofit projects due to the pre-existing infrastructure of ducts, fan connections, and electrical power.

The main tasks involve integrating the exhaust fan controller and pressure sensing devices, both of which can be conveniently installed near the fan for a smooth and hassle-free retrofit process.

ENERGY SAVINGS

Estimating Energy Savings f or Specific Projects

Engineers or energy professionals looking to transition to a DCV system can estimate potential energy savings with the following procedure:

1. Determine the exhaust flow from appliances connected to the common duct – Identify the common shaft and its exhaust fan.
If feasible, measure the airflow within the duct. If not, measure the airflow at the fan exit point using an anemometer to gauge average fan exit velocities (FPM) and multiply this value by the fan opening size (Ft^2) to calculate the airflow (CFM).

2. Define the utilization profile – In the absence of an actual utilization study, refer to the profile provided in Table 6.

3. Establish the number of heating and cooling days specific to your location – Use this Degrees Day calculator from ENERGY STAR.

4. Calculate the estimated energy savings resul-ting from the reduction in conditioned air exhaustion – Utilize the energy savings formula alongside the actual heating and cooling degree days for your location to compute the annual energy losses incurred by exhausting conditioned air.

5. Compute the savings derived from reduced fan operation – Obtain any relevant data from the fan or motor manufacturer.

6. Utilize the obtained results to estimate the return on investment (ROI) and payback period.

$$\textit{Payback Period (Years)} = \frac{\textit{Initial Cost of DCV System}}{\textit{nnual Energy Savings}}$$

Example Scenario for Energy Savings

Engineers or energy professionals looking to transition to a DCV system can estimate potential energy savings with the following procedure: look beyond the immediate benefits and evaluate the long-term impact across 5 key areas:

1. Let's assume you measure the airflow at the fan exit point since accessing the duct is challenging. The average fan exit velocities (FPM) measured are 500 FPM, and the fan opening size is 2 square feet (Ft^2).

2. Your on-site utilization study shows that exhaust systems are active approximately 30% of the time during the day and 10% of the time at night for a weighted average of 25%.

3. There are 2,400 heating-degree days (HDD) and 1,800 cooling-degree days (CDD) in a year for your specific location.

4. By transitioning to a DCV system, you reduce conditioned air exhaustion during both heating and cooling seasons. You calculate that this results in annual energy savings of 15,000 kWh.

5. The manufacturer provides information indicating that transitioning to a DCV system will reduce fan operation costs by $2,000 per year.

6. You calculate that the payback period for implementing the DCV system is approximately 3 years, with a significant ROI over the system's lifetime.

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OFFSETTING CO_2 TAX LIABILITY

In regions with carbon pricing mechanisms such as carbon taxes or cap-and-invest systems, businesses and property owners are increasingly looking for strategies to mitigate the financial impact of these regulations.

New York's Cap-and-Invest Program

New York State has been at the forefront of implementing innovative policies to combat climate change, and one such policy is the Cap-and-Invest Program. This system, also known as the Regional Greenhouse Gas Initiative (RGGI), is a cooperative effort among several northeastern states in the United States. Its primary goal is to reduce carbon emissions from the power sector while fostering economic growth and energy efficiency.

Allowance auctions are central to the functioning of the Cap-and-Invest program. Participating states, including New York, periodically hold auctions to sell a portion of the emission allowances.

These allowances represent the right to emit a certain amount of CO_2. Businesses subject to the program must acquire sufficient allowances to cover their emissions.

Funds generated through allowance auctions are reinvested in clean energy projects, energy efficiency initiatives, and other programs aimed at reducing carbon emissions. Businesses that invest in energy-efficient technologies, such as FEI-rated fans and DCV systems, can lower their overall CO_2 tax liability by reducing their carbon emissions. This means less CO_2 allowances need to be purchased in the regional market.

These initiatives also position the business as leaders in carbon reduction and responsible corporate citizenship – a competitive advantage, attracting environmentally conscious customers and investors.

Carbon Credits

Companies that operate more efficiently and produce fewer emissions than their allocated allowances or targets have the opportunity to sell their excess allowances, also known as carbon credits, in the regional carbon market.

This not only offsets their initial investment in energy-efficient retrofits and technologies but also generates an additional stream of revenue.

Carbon credit value depends on the market, but most fall in the $40-80 per metric ton of carbon dioxide range.

DCV AND LEED CERTIFICATION

The rising emphasis on sustainability and green building practices has amplified the demand for products that contribute positively to the LEED Building Rating System, established by the U.S. Green Building Council.

The more points a building project earns, the higher the level of LEED certification it can achieve. LEED certification levels include Certified, Silver, Gold, and Platinum, with Platinum being the highest level of recognition.

Projects earn LEED points by meeting specific criteria and requirements in various categories, including energy efficiency, water conservation, indoor air quality, sustainable materials, and more. Each category has a set number of points available, and projects must meet or exceed the requirements to earn those points.

DCV systems can help developers to score points in key LEED categories:

Energy & Atmosphere (EA)

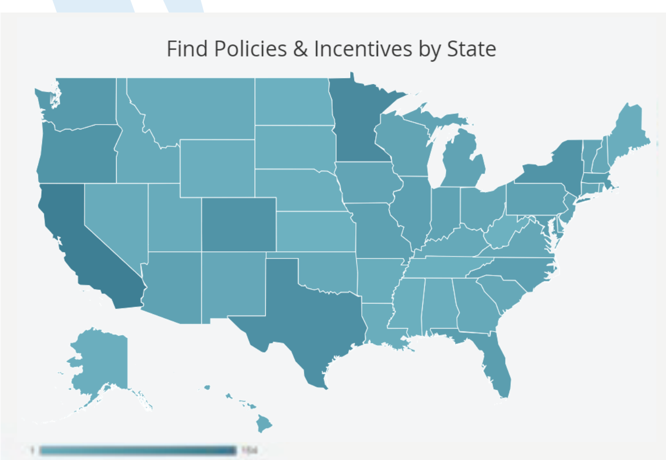
- Minimum energy performance
- Optimize energy efficiency

Indoor Environmental Quality (IEQ)

- Minimum IAQ performance
- Increased ventilation
- Controllability of systems, thermal comfort
- Thermal comfort design

DCV and Incentives

Because of the large potential for energy savings, DCV systems usually qualify for grants or incentives from local state and federal governments. Other sources of incentives are local utilities and Energy Trusts.
One valuable resource for discovering available incentive programs across the United States is the Database of State Incentives for Renewables & Efficiency (DSIRE).



Established in 1995 and funded by the U.S. Department of Energy, DSIRE serves as a comprehensive database of incentives, rebates, and policies related to renewable energy and energy efficiency. To explore the various incentive programs that may apply to DCV systems and other energy-efficient solutions, you can visit the DSIRE website at http://www.dsireusa.org/.

An illustration of this can be seen in the cash incentives provided by Bright Energy Solutions, which offers rewards to business customers in select North Dakota municipalities. With DCV implementation, businesses can earn $35 per 1,000 square feet.

Credits and Sources

The following groups or organizations have been cited or quoted in the development of this white paper.

- Enbridge Gas Distribution
- International Code Council
- Natural Gas Technologies Center

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About ENERVEX

ENERVEX specializes in demand-controlled ventilation for heating appliances, clothes dryers, kitchens and baths. With 30+ years of experience, ENERVEX has developed a reputation worldwide for integrating deep technical and functional capabilities with design expertise to provide ventilation solutions that deliver profitable, reliable, and sustainable results.