

# Very High Efficiency Dedicated Outdoor Air System Field Evaluation Finds Persistence of Savings

Researchers at Pacific Northwest National Laboratory (PNNL) evaluated the long-term performance of the Very High Efficiency (VHE) Dedicated Outdoor Air System (DOAS) installed in eight buildings that participated in field evaluations sponsored by a Northwest Energy Efficiency Alliance (NEEA) and Institute for Market Transformation (IMT). PNNL's study found sites continued to see high energy savings (48%) and were able to decarbonize heating systems while reducing electric load.

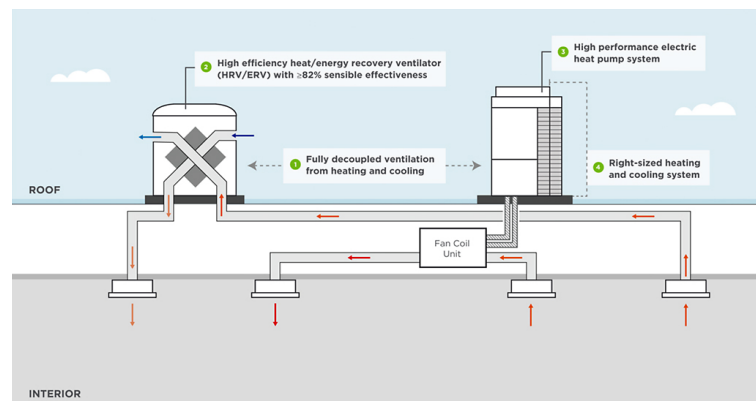
## TECHNOLOGY OVERVIEW

VHE DOASs are designed around four core principles:

1. High-efficiency heat recovery ventilation equipment.
2. High-performance space conditioning system.
3. Completely decoupled ventilation and space conditioning systems.
4. Right-sized systems based on application and design loads.

VHE DOASs provide a number of key benefits:

- **Decarbonization** through electrification of previous fossil-fuel-based heating systems without increasing electrical load.
- **Energy reduction** from increased heating, ventilation, and air conditioning (HVAC) system efficiency.
- **Improved indoor environmental quality** (IEQ) from increased ventilation rates, more effective outdoor air delivery, and better temperature and humidity control.



<sup>1</sup>NEEA (Northwest Energy Efficiency Alliance). 2022a. "Very High Efficiency Dedicated Outside Air System: Equipment and Design Best Practices for Optimal Energy Efficiency."

Accessed June 13, 2023. [https://betterbricks.com/uploads/resources/Very-High-Efficiency-DOAS\\_Requirements-Summary.pdf](https://betterbricks.com/uploads/resources/Very-High-Efficiency-DOAS_Requirements-Summary.pdf).

## PROJECT SUMMARY

This study evaluated the long-term performance of VHE DOAS retrofits at eight sites participating in field evaluation studies conducted by NEEA and IMT between 2015 and 2020.

PNNL compared the 2021–2022 energy performance data from the systems to the monitoring period data (1–2 years after retrofit) to determine if the savings had degraded over time.

Additionally, PNNL evaluated IEQ as perceived by occupants and captured building operator feedback before and after system conversion. The study found the systems:

- Consistently saved energy over the long term.
- Improved occupant comfort.
- Received positive feedback from building operators.

## MEASUREMENT & VERIFICATION METHODOLOGY

Eight commercial buildings participated in this study. Among these buildings, seven were part of the original NEEA pilot and are located in Washington, Oregon, and Montana. One site was an IMT pilot in Tarrytown, New York.

The quantitative assessment of the continued energy savings consisted of two distinct efforts:

- Monthly utility data analysis to determine the total energy savings from a new VHE DOAS compared to the previously installed (pre-conversion) system.
- Energy modeling analysis to compare a hypothetical code-minimum replacement of the sites' original system to a calibrated model of the new VHE system using advanced machine learning techniques.

## RESULTS

This re-evaluation study confirms the benefits of VHE DOASs that persisted over the subsequent years, suggesting that VHE DOASs can improve energy efficiency, reduce energy costs, and increase occupant comfort in buildings. Results from PNNL's study were consistent with NEEA and IMT's evaluation.

The pre- and post-installation results are highlighted in the figure showing performance from six sites. The sites saw similar or improved energy savings compared to the original evaluation. The smallest energy savings were ~11% compared to the pre-conversion system, and the highest energy savings were ~73%. The sites with the largest savings also showcased the most significant decarbonization impact from VHE DOASs because gas usage was nearly eliminated. Overall, the sites averaged **48 percent whole-site energy savings compared to the pre-conversion system.**

The study also investigated the changes in occupant comfort resulting from the VHE DOAS retrofits. Survey responses revealed that the system conversion resulted in a better indoor environment for the occupants. Overall, **43 percent** of the occupants indicated they were more **satisfied**, and **30 percent** reported they were **less dissatisfied** in the post-conversion period.

The results validate that VHE DOAS retrofits offer a significant opportunity to promote decarbonization through electrification of fossil-fuel-based heating systems without increasing electrical load.

