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ERV/HRV Ownership and Maintenance Market Research

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Memorandum

April 23, 2026

TO: Kirstin Moreno, MRE Scientist, NEEA

FROM: Dave Hammond, Sr. Program Manager, NEEA
Jason Jones, Program Manager, NEEA

SUBJECT: Response to ERV/HRV Ownership and Maintenance Market Research

NEEA posted the ERV/HRV Ownership and Maintenance Market Research in April 2026. This research was commissioned on behalf of NEEA's two commercial HVAC programs – Advanced Performance DOAS (Dedicated Outdoor Air Systems) and Advanced Performance RTUs (Rooftop Units). The main purpose of the research was to better understand the challenges associated with maintaining commercial ERV/HRVs in contrast to other common commercial HVAC equipment. These findings are important to NEEA since ERV/HRV performance is a key contributor to the savings potential and promoted benefits of both commercial HVAC programs. With these findings, NEEA is better positioned to a.) address potential barriers uniquely associated with ERV/HRV operation and maintenance and b.) dispel unfounded market perceptions that could limit the wider adoption of ERV/HRV technology. The purpose of this memorandum is to summarize the programs' response to the major findings and associated recommendations of this research.

Major Findings: Both NEEA commercial HVAC programs ("programs") recognize the following findings as particularly helpful in shaping future strategies, including technical resource development and market engagement activities:

- ***Maintenance Practices Reflect Broader Commercial HVAC Service Models*** – Operator and building owner feedback suggested that ERV/HRV maintenance requirements are not inherently more burdensome than other ventilation equipment. The programs see this as an important message to incorporate into program materials, dispelling commonly expressed opinions that ERV/HRVs require significant additional maintenance compared with other commercial HVAC equipment.
- ***Workforce Familiarity with ERV/HRV Systems Shapes Maintenance Outcomes*** – Unfamiliarity with ERV/HRV operation and service procedures can lead to lack of confidence and affect follow-through on basic maintenance activities. The misperceptions of ERV/HRV maintenance as being more burdensome are also a likely consequence of this recognized gap in operators/service technicians' experience with this equipment. The programs recognize an opportunity to support improved awareness and visibility of ERV/HRV manufacturer guidance among commercial building owners and operators.
- ***Systemic Interventions are Required to Support Sustained Performance*** – The observations collected through this research reinforced the understanding that all commercial HVAC systems are

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dependent on comprehensive interventions across the full system lifecycle to ensure proper operation and performance. This includes equipment design and manufacturing, building design decisions, proper installation and commissioning, controls integration and user/operator training. This aligns with NEEA's general practice of considering the barriers and opportunities across each area of the market when developing program strategies.

Recommendations: The following recommendations proposed in this research are recognized as significant to the programs' success and are understood to be within NEEA's range of influence.

Recommendation 1: Integrate ERV/HRV control strategies fully with building automation systems and verify functionality during commissioning, including economizer, bypass, and defrost operation under real operating conditions.

NEEA response: The Advanced Performance DOAS program recognizes the importance of standardized ERV/HRV controls and/or SOO (Sequence of Operations) and previously developed a draft specification that can be used by engineers to incorporate into building design documents. The programs accept this recommendation and plan to bring an updated version of this specification into the market.

Recommendation 2: Provide clearer and more accessible documentation and turnover training, including simple, location-specific maintenance instructions and guidance for building operators.

NEEA response: The programs agree with this recommendation and intend to leverage established relationships with key manufacturers and manufacturers' representatives to improve the ERV/HRV operators' access to the corresponding maintenance guidance.

Conclusion:

The programs appreciate the opportunity to reflect on these research outcomes and to leverage the recommendations through program activities moving forward. While the research did highlight a variety of challenges facing building operators and owners that could pose a risk to ERV/HRV performance, it is notable that these risks are generally applicable to all commercial HVAC equipment and do not represent challenges unique to ERV/HRV technology. If you have any questions about the programs' response to the findings of this research, please contact Dave Hammond (dhammond@neea.org) or Jason Jones (jjones@neea.org).

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Executive Summary

Context

Both of the Northwest Energy Efficiency Alliance's (NEEA) commercial Heating, Ventilation, and Air Conditioning (HVAC) programs, Advanced Performance Roof Top Units (RTUs) (previously Efficient Rooftop Units) and Advanced Performance Dedicated Outdoor Air System (DOAS) (previously High-Performance HVAC), rely on Energy Recovery Ventilators (ERVs) and Heat Recovery Ventilators (HRVs) as key components that contribute meaningful energy savings and support ventilation requirements in commercial buildings. As adoption of ERV and HRV systems increases across the Northwest Region (Idaho, Montana, Oregon, and Washington), NEEA has heard concerns from market actors that these systems can be complex to install and commission, and that they may be complicated or time-consuming to maintain and clean. These perceptions could present a barrier to wider adoption if they are not well understood and addressed.

Research Objectives

NEEA commissioned this study to better understand the experiences of market actors who own, operate, and maintain ERV/HRV systems in commercial buildings across the Northwest, with the following research objectives (ROs):

RO1: Gather perspectives on operational considerations of installing, commissioning, cleaning, and maintaining ERVs/HRVs.
RO2: Investigate what the actual ERV/HRV cleaning and maintenance looks like in the real world.

Data Collection and Methodology

The research took place primarily in Idaho, Montana, Oregon, and Washington, although feedback from participants in Minnesota and Northern California was taken into consideration as well.

The research team conducted thirteen in-depth interviews and seven site visits across multiple commercial building types, including offices, a pet clinic, a fire station, a college campus, a gym, a hotel, and others, leading to insights on how HRV/ERV systems are selected, installed, commissioned, cleaned, and maintained. The scope of this study also included a targeted review of secondary sources to provide contextual grounding, but primary data from interviews and observations served as the main foundation for the analysis.

Key Findings and Conclusions

Across interviews and site visits, challenges associated with ERV and HRV systems were generally consistent with those observed across commercial HVAC systems more broadly. Participants did not describe ERV and HRV systems as inherently difficult to maintain or operate; instead, outcomes were shaped by broader lifecycle factors, such as controls operation, documentation, workforce familiarity, and operational visibility. Where ERV- or HRV-specific considerations did emerge, they were most often related to controls configuration, performance visibility, and integration rather than to maintenance burden or inherent system complexity. Key conclusions reflect the influence of these systemic conditions across the project lifecycle:

- ERV and HRV systems were generally described as manageable to maintain when access and procedures were clear, with cleaning and routine service tasks comparable to other commercial HVAC maintenance activities
- Participants did not view ERV or HRV maintenance as more difficult, time consuming, or costly than routine HVAC equipment maintenance, and typical service tasks could be completed by one technician using basic tools
- When systems were installed with clear documentation, convenient physical access, and integrated controls, participants reported that ERV and HRV systems could operate reliably and deliver intended ventilation and energy recovery benefits. However, in some cases operators would benefit from better visibility into system operation and recovery effectiveness, to enable a more proactive approach to maintenance and repairs
- ERV and HRV systems are typically described as operating in alignment with design intent at turnover. Over time, some participants reported changes in system operation based on visual inspection, service experience, and/or occupant feedback when ongoing maintenance and system expertise were limited. Especially in regions without a large installed base of ERV/HRV, training for less experienced technicians becomes important, since they cannot always rely on the experience of other technicians within their company. Without the needed expertise, in some cases, unresolved operational issues resulted in systems being partially or fully disabled for extended periods. Further, regional differences in climate can shape maintenance needs, for example freeze related issues, moisture management, and filtration demands in colder climates
- Operational challenges are rarely attributable to a single actor or a particular technology; instead, they emerge from interactions among design decisions, installation practices, commissioning quality, controls configuration, and expertise and time related to maintenance

Taken together, these findings suggest that many of the challenges associated with ERV/HRV systems are structural, meaning they arise from factors such as controls integration, documentation, training, and operational visibility rather than being inherent to the technology itself.

Section 1 – Background and Market Context

This study was conducted in support of NEEA and its efforts to understand the performance and market dynamics of ERV (Energy Recovery Ventilator) and HRV (Heat Recovery Ventilator) systems in commercial buildings. ERV and HRV systems are key components of NEEA's commercial Heating, Ventilation, and Air Conditioning (HVAC) programs and are increasingly deployed across the Northwest. At the same time, market actors have expressed concerns that these systems can be complex to install, commission, and maintain, raising questions about whether these perceptions may act as a barrier to broader adoption. This research is intended to provide a market-grounded view of how ERV/HRV systems are designed, installed, commissioned, operated, and maintained in practice, and to identify the factors that influence performance outcomes over time.

HRVs and ERVs are widely recognized for their roles in supporting indoor air quality, managing humidity, and reducing ventilation-related energy use in commercial buildings (ASHRAE, 2019; DOE, 2022; EPA, 2021). Technical literature, manufacturer documentation, and industry guidance describe these systems as established technologies that are commonly applied in both new construction and retrofit projects (DOE, 2022; PNNL, 2020; Greenheck, 2023; RenewAire, 2023). Across the Northwest Region (Idaho, Montana, Oregon, and Washington), building energy codes and standards reference HRVs and ERVs, and in some jurisdictions these requirements play a meaningful role in system selection and design (IECC, 2021; WSEC-C, 2021; Minnesota Commercial Energy Code, 2024; Idaho Energy Code, 2025). Collectively, these sources present HRV and ERV technologies as mature, well understood, and supported by defined installation and maintenance practices.

Industry standards further shape expectations for how these systems are designed, installed, and operated. Ventilation requirements in ASHRAE Standard 62.1, maintenance guidance in ASHRAE Standard 180, and energy efficiency considerations described in publications from the U.S. Department of Energy (DOE) and Pacific Northwest National Laboratory (PNNL) outline clear roles for HRVs and ERVs in providing outdoor air ventilation while reducing energy impacts (ASHRAE, 2019; ASHRAE, 2019; DOE, 2021; DOE, 2022; PNNL 2020).

Figure 1 – Roof Top Unit (RTU) wheel-based ERV at a furniture design center.

Manufacturer documentation generally reinforces these expectations by describing standardized installation approaches and routine maintenance activities intended to sustain expected ventilation and energy recovery outcomes over time (Daikin Applied, 2022; Greenheck, 2023; RenewAire, 2023;

Zehnder Service Manuals). Together, these standards and guidance documents assume that HRVs and ERVs are intentionally integrated into broader mechanical systems and maintained on a regular basis to achieve their intended benefits.

Despite this extensive body of secondary information, comparatively little research has examined how HRV and ERV systems function in practice within small and midsized commercial buildings. These buildings often operate under varied ownership structures, rely on limited on-site facilities staff, and use inconsistent or fragmented service arrangements. We wanted to study if these factors influence how systems are installed, commissioned, maintained, and operated and whether real-world outcomes differ from expectations described in technical documents and best practice guidance.

Taken together, the policy environment and published standards establish a clear set of expectations for HRV and ERV operational outcomes and maintenance practices. The sections that follow examine how these design and operational expectations compare with the experiences and practices of market actors who work directly with HRV and ERV systems across the Northwest.

While secondary sources establish expectations for ventilation effectiveness and energy recovery function, they provide limited insight into how system performance, as defined in this study, evolves across the operational lifecycle.

Section 2 – Research Methodology

Methodology Overview

This study employed a qualitative, multi-phase research approach to examine how ERVs and HRVs are installed, operated, and maintained in real-world commercial building settings. The study included both ERV and HRV systems that appear on NEEA's commercial HVAC qualified or compliant equipment lists (that is, equipment that is supported by NEEA's program activities) and systems that are not included on those lists. This approach was intentional and enabled the research team to examine a broader range of real-world installations and ownership contexts, reflecting the diversity of equipment encountered by market actors across the region.

Data collection was conducted across the Northwest Region, with additional fieldwork and interviews in Minnesota and northern California. Minnesota was included to provide perspectives from a region with similar climate conditions to less populated areas in the Northwest, mature energy efficiency markets, and established experience with ERV and HRV technologies. The inclusion of Minnesota was supported through coordination with the Minnesota Center for Energy and Environment (MNCEE), which enabled efficient access to sites and participants. Including Minnesota enabled the study to capture both regionally specific insights and broader patterns relevant to NEEA's Market Transformation efforts.

Together, these geographies provided insight into shared practices, points of variation, and structural factors influencing ERV and HRV ownership and care. The methodology combined secondary research, on-site observations, and in-depth interviews to compare expectations established in manufacturers' guidance and standards with experiences in practice. On-site visits and virtual interviews followed semi-structured discussion guides designed to explore system selection, installation, commissioning, maintenance, and operational experience. These guides are provided in Appendix B.

Phase 1: Secondary Research

The study began with a structured review of publicly available information related to ERV and HRV systems. This review included mechanical and energy codes for each Northwest state, ASHRAE standards, utility guidance, manufacturer materials, and recent publications from DOE, National Renewable Energy Laboratory (NREL), and other similar organizations. The purpose of this phase was to establish a baseline understanding of the expectations surrounding ERV and HRV system design, installation, and maintenance. The secondary research findings helped shape the interview guide, identify areas of potential divergence between guidance and practice, and establish the context for interpreting primary data. Secondary sources used for this analysis are listed in Appendix J.

Phase 2: On-Site Observations

On-site observations were a central component of this study and provided critical primary data that complemented and, in some cases, extended insights from interviews. This phase involved site visits to commercial buildings with installed ERV and HRV systems, with selection focused on small and midsized buildings across a range of building types, mechanical configurations, system ages, and ownership structures.

Each site visit included a detailed walkthrough of the mechanical spaces where ERV or HRV units were located, visual inspection of system condition, and direct observation of access, installation characteristics, and equipment layout. When available, site visits also included discussions with HVAC contractors, building operators, and facilities staff to contextualize observed conditions and clarify maintenance practices.

These observations provided direct, first-hand visibility into system placement, filter and core condition, drainage configurations, access limitations, labeling practices, and overall equipment cleanliness. Observational data also revealed how frequently systems are accessed for maintenance, how feasible routine service is given physical access constraints, and what operational challenges building personnel encounter in practice. In several cases, the conditions observed helped explain issues described during interviews, including deferred maintenance, control overrides, and uncertainty about system operation on the part of technicians and operators.

Site visits were conducted at multiple points during the project, enabling early observations to inform subsequent interviews and later visits to refine emerging themes. The specific sites visited are indicated in Table 1.

Building's Purpose	Location	System Type	Climate Zone
Pet clinic	Eagan, MN	Indoor, plate-based ERV	6-A (cold, humid)
Fire station	St. Paul, MN	Wheel-based RTU ERVs	6-A (cold, humid)
Furniture design center	Minneapolis, MN	Wheel-based RTU ERV	6-A (cold, humid)
Gym	Bozeman, MT	Indoor, wheel-based HRV	6-B (cold, dry)
Hotel	Bozeman, MT	Indoor, plate-based ERV	6-B (cold, dry)
HVAC office	Battle Ground, WA	Indoor, plate-based HRV	5-C (cool marine)
University campus	Portland, OR	Wheel and plate-based RTU HRVs	4-C (mixed marine)

Table 1 – Locations, System Types and Climates Visited.

Phase 3: In-Depth Interviews

The third aspect of data collection consisted of interviews with a diverse set of market actors, including HVAC contractors, general contractors, Energy Service Companies (ESCOs), engineers, facility managers, tenants, and building owners. Interviews followed a semi structured format and were conducted virtually to accommodate participant availability across the region. Questions focused on system selection processes, code and permitting influences, commissioning practices, cleaning and maintenance routines, staffing and role clarity, operational challenges, and how decisions are made when systems require service or repair. Table 2 provides the list of interviewees.

Role	Perspective(s)	Representing
HVAC Technician	Customers' Buildings	Washington
Business staff	Tenant (Law Office)	Washington

Business Owner	Tenant (Retail)	N. CA
President	Building Owner (Clinic)	Oregon
HVAC Contractor	Customers' Buildings and His Own Building	N. CA
Facilities Manager	HVAC Maintenance	N. CA, Oregon, Canada
Business Staff	Tenant (Talent Agency)	Oregon
Business Staff	Building Owner (Dentist's Office)	Oregon
Business Staff	Building Owner and Tenant (Multiple Businesses)	Washington
HVAC Design Specifier	Distributor	Washington
Service Operations Manager	ESCO, Customers' Buildings, HVAC Contractors	Washington
HVAC Technician	ESCO, Customers' Buildings, HVAC Contractors	Washington
Service Sales Manager	Customers' Buildings, HVAC Contractors	Oregon
HVAC Trainer	HVAC Contractor, Customers' Buildings	Minnesota

Table 2 – Participant Profile Summary.

Participants were encouraged to describe what typically happens in their buildings or in their contracting work, including the constraints and conditions that influence maintenance practices. Interviewees also discussed how often equipment is serviced, what maintenance tasks are typically performed, how system configurations are documented, and what information is ordinarily provided at installation or turnover. Responses provided insight into both routine practices and the informal norms that shape maintenance behavior.

Analytic Approach

Findings from the observations and interviews were synthesized to identify themes that reflect real-world ERV and HRV practices in the region.

Quotes presented throughout the report are drawn from interview transcripts and represent the voices of market actors who participated in the study. Observations from site visits are similarly included to illustrate real-world equipment condition and installation characteristics. Together, these methods provide a qualitative picture of how ERVs and HRVs are used, maintained, and experienced in everyday commercial building contexts across the Northwest.

While this study did not directly measure airflow delivery, recovery efficiency, or other technical performance indicators, observational and interview data provided insight into the operational and lifecycle conditions that could influence system performance over time. For the purposes of this report, "system performance" refers to the extent to which ERV and HRV systems operate in alignment with design intent over time. This includes airflow delivery, energy recovery function, control sequencing, reliability, maintainability, and operator visibility

Section 3 – Research Findings

In this section, findings specific to ERVs/HRVs have been distinguished from those more generally consistent with the realities of the commercial HVAC practice.

3.1 Market Drivers and Adoption Patterns

This section examines how ERV and HRV systems are adopted in practice across the Northwest and compares observed market behavior with expectations described in codes, standards, and guidance. While secondary sources suggest relatively consistent drivers of adoption, primary research indicates that adoption patterns vary based on project context, building type, and local market conditions.

Secondary Findings

Secondary sources describe ERV and HRV adoption as being driven by a combination of energy codes, mechanical standards, indoor air quality (IAQ) considerations, and utility incentives across the Northwest (ASHRAE, 2019; IECC, 2021; Energy Trust of Oregon, 2024). Guidance from organizations such as ASHRAE, the U.S. Department of Energy (DOE), and Pacific Northwest National Laboratory (PNNL) generally assumes that these drivers lead to relatively consistent and predictable specification of energy recovery systems in commercial buildings, particularly where ventilation loads are significant or energy efficiency goals are prioritized (ASHRAE, 2018; DOE, 2021; PNNL, 2020). However, interview and site visit findings suggest that actual adoption patterns are more variable than these sources imply.

Primary Findings

Primary data from interviews and site visits provides a more nuanced view of how these systems are selected in practice. Participants described a mix of code-driven, incentive, and reactive adoption patterns that vary by state/municipality, building type, project team composition, and the role of engineering professionals in the design and permitting process.

Code Driven Adoption in Certain Jurisdictions

Participants in Washington and parts of Oregon frequently identified code requirements as a primary driver of HRV and ERV specification. Contractors and engineers noted that some local jurisdictions interpret ventilation requirements in ways that encourage or require energy recovery under certain conditions.

> "The incentive helps get the system installed, but what really matters is what happens after turnover and who's responsible for it."
>
> **– Service Operations Manager, WA**

Several respondents stated that once an engineer is involved and a permit is required, the likelihood of including an HRV or ERV increases. This pattern was reinforced in multiple interviews. Engineers working on institutional and public projects described HRVs and ERVs as standard practice in many designs.

Participants noted that plan reviewers and permitting authorities in some cities expect energy recovery and often question designs that do not include it.

Reactive Adoption in Smaller Commercial Buildings

In contrast, some building owners and contractors working in smaller commercial buildings described HRV and ERV adoption as shaped more by practical needs rather than by code requirements. Several participants explained that ventilation system decisions are made when an issue arises or when existing equipment fails. For example, one building owner described installing an ERV after dealing with humidity and odor problems that could not be resolved through existing ventilation.

Contractors who specialize in small commercial work confirmed that HRVs and ERVs are often added because they offer a solution to a specific problem rather than because they are mandated. In retrofit situations, system selection can depend on the layout of the building, access constraints, budget considerations, and the familiarity of the contractor with energy recovery systems.

Figure 2 - Newly added climbing wall area, serviced by an HRV.

Varied Awareness and Familiarity

While the presence of code requirements influences installation decisions, several participants noted that building owners and operators are sometimes unaware of whether their building includes an HRV or ERV or why it was selected. In cases where systems were installed for compliance reasons, building staff often reported limited involvement in the decision.

Contractors also described variability in familiarity with these systems across the market. Some contractors routinely install HRVs and ERVs and consider them standard equipment. Others encounter them rarely and may avoid recommending them because they are less confident in maintaining and/or commissioning them.

Site Visit Example: University Campus

The site visit at a prominent state university in Oregon illustrated how energy recovery is adopted in larger and more complex buildings. The campus buildings use HRVs extensively, particularly in housing and recreation buildings, where ventilation loads are high and IAQ is a priority. The university's facilities team described HRVs as "almost always the right answer" for the types of buildings they manage. This differs from smaller commercial buildings, where energy recovery is used more selectively.

This site visit also highlighted how decision making is shaped by building type, system complexity, and long-term maintenance needs. The maintenance team emphasized that while they support the use of HRVs, system selection also depends on maintenance load, physical access to the unit, and staffing capacity. This case illustrates how commercial institutions balance code expectations, operational needs, and practical considerations, such as available capital budget.

Figure 3 - Example of a very large rooftop, wheel-based HRV.

Summary of This Subsection

Interview and site visit findings indicate that HRV and ERV adoption in the region is shaped by several interacting factors:

- Code requirements, which often serve as the primary trigger for inclusion of HRVs or ERVs, particularly in new construction
- Engineering involvement, with projects that include mechanical engineers being more likely to integrate energy recovery intentionally
- Building type and size, which influence ventilation needs, system complexity, and perceived value of energy recovery

> "In a lot of cases, HRVs and ERVs are just part of the standard design now. Once engineers are involved, they're not really debated."
>
> **– HVAC Designer, WA**

- Local permitting practices, which can reinforce or de-emphasize energy recovery requirements depending on jurisdiction
- Reactive problem solving, where HRVs or ERVs are adopted in response to specific issues, such as comfort complaints, moisture problems, or indoor air quality concerns

Findings Specific to ERV/HRV Systems

- ERV and HRV adoption is more likely to be driven by code interpretation, ventilation requirements, or indoor air quality concerns than by energy savings alone
- In smaller commercial buildings, ERVs and HRVs are sometimes added reactively to address humidity, odor, or ventilation problems rather than as part of a comprehensive system redesign

Findings Consistent with Broader HVAC Practice

- Equipment selection in small and midsized commercial buildings is often influenced by contractor familiarity, availability, and budget constraints
- Building owners and tenants are frequently unaware of why specific HVAC components were selected, particularly when decisions are made for compliance or technical reasons

While secondary sources describe a landscape in which energy recovery is increasingly common, these findings suggest that real-world adoption varies based on regional conditions, project characteristics, and decision-making context. As a result, some buildings incorporate HRVs or ERVs as standard practice, while others adopt them only when prompted by a specific issue or opportunity.

3.2 System Design and Configuration Practices

Secondary Findings

Secondary guidance on ERV and HRV systems describes clear expectations for system selection, equipment sizing, airflow balancing, and integration with broader mechanical systems (ASHRAE, 2019; IECC, 2021). Industry standards and manufacturer documentation assume that ERVs and HRVs are selected based on space requirements, designed to deliver appropriate supply and exhaust airflow rates, and installed in configurations that support access and long-term maintainability (ASHRAE, 2019; Daikin Applied, 2022; Greenheck, 2023; RenewAire, 2023). DOE and PNNL guidance further characterize ERVs and HRVs as established ventilation components that can be applied across a wide range of commercial building types with manageable added complexity when standard design, installation, and commissioning practices are followed (DOE, 2021; DOE, 2022; PNNL, 2020).

Primary Findings

Primary data from interviews and site visits suggest that system design and configuration decisions in real-world commercial buildings vary based on project size, the type of design support available, and the practical constraints of each facility. Design decisions are influenced by available space, contractor familiarity, budget considerations, and the need to integrate equipment into existing buildings with limited mechanical space.

Equipment Selection and Sizing

Participants reported that ERV and HRV system selection often reflects the ventilation needs of the building, but the range of options available for smaller commercial buildings can lead to decisions based on practicality rather than on ideal performance. For example, especially for smaller commercial buildings, these units are sometimes installed in attics and closets. Several contractors noted that they rely on equipment that fits the available space or that aligns with the products they work with most often.

Design engineers described selecting systems based on airflow requirements, climate conditions, and energy goals. For larger or more complex buildings, engineers noted that they have more flexibility to make selections based on building layout and humidity concerns. In contrast, contractors working without engineering support reported that they may choose systems based on availability, ease of installation, and/or cost considerations.

Figure 4 - RTU ERV (and other HVAC) atop an office complex.

Placement and Access

Serviceability emerged as a consistent theme during site visits. Physical access to unit locations, clear interior access points for filters and cores, and unobstructed maintenance pathways materially influenced whether routine cleaning occurred as recommended. Units requiring partial disassembly or insulation removal were more likely to experience deferred service.

Drainage and Condensate Management

Interviews and site visits revealed variability in how drain lines and condensate management systems are installed. Several contractors noted that improper drain slopes, missing traps, or improvised condensate lines can affect system performance and increase the likelihood of water-related issues.

During site visits, the research team observed both well designed and improvised drain configurations. In some cases, drain traps were clearly installed according to manufacturer specifications. In others, traps were missing or not accessible, which can affect long-term operation. These observations highlight how installation decisions made during construction can influence the long-term reliability of the system.

Integration with the Mechanical and BAS Systems

Participants emphasized that ERVs and HRVs must be integrated into the broader system in order to operate effectively. Several market actors explained that mismatched airflow rates, insufficient fan capacity, or improper duct connections can reduce system performance. One technician described how difficult and costly it can be to align equipment with the Building Automation Systems (BAS).

> "The RTUs with integrated ERVs are convenient, but the factory logic does not always match the building automation system. That is where things go sideways."
>
> **– HVAC Technician, WA**

Contractors working in smaller commercial buildings described challenges integrating ERVs and HRVs into older buildings with limited mechanical infrastructure. In some cases, existing ductwork was reused or modified to accommodate new equipment, which sometimes led to airflow imbalances or noise concerns. These integration challenges can influence occupant comfort, system reliability, and long-term energy savings.

Research participants also offered several examples of these conflicts:

- In some systems, the ERV wheel continues to run during free cooling periods, reducing the benefits of outside air economizing and unnecessarily increasing fan energy use
- In other systems, economizer logic disables the ERV entirely, even when recovery would be beneficial during partial cooling or shoulder seasons
- In several site visits, technicians explained that they have seen systems with bypass dampers stuck in either fully open or fully closed positions. In one case, the damper actuator had failed two years earlier, leaving the system in permanent bypass

Documentation and Turnover Practices

Interviews revealed that documentation quality and turnover practices vary based on project structure and the parties involved. Engineers typically provide detailed specifications and commissioning plans, but building operators noted that these documents are not always accessible or easy to interpret. Several participants shared that they received limited instruction at turnover and would benefit from clearer guidance.

Contractors also described variability in whether maintenance instructions are reviewed with building owners. Some teams include a walkthrough and provide documentation, while others rely on owners to reference manufacturer manuals. This inconsistency can affect how well systems are maintained and how comfortable building operators feel performing basic cleaning tasks.

> "Everyone does their part, but no one owns the whole thing. If something is wrong, you can get three different answers about whose job it was to fix it."
>
> **– Building Owner, WA**

Participants also described access to documentation of service and maintenance guidance as a practical barrier. In many cases, Operation and Maintenance (O&M) manuals were not readily available onsite, and service procedures relied on technician memory or manufacturer websites. Some suggested that simple measures such as interior labeling, durable service instructions affixed within the unit, or QR codes linking directly to model-specific documentation could reduce uncertainty and support more consistent maintenance practices.

Summary of This Subsection

- Primary data indicates that in practice, design and configuration decisions are shaped by construction-phase realities and the unique conditions of individual buildings
- System design and configuration practices in the region reflect a combination of engineering standards, contractor familiarity, and building-specific constraints
- These design and configuration patterns influence long-term system operation and maintainability, ease of maintenance, and the likelihood that ERV and HRV systems deliver their intended benefits

Findings Specific to ERV/HRV Systems

- ERV and HRV performance depends on proper integration with ventilation, economizer, and defrost control strategies
- Control interactions between ERVs/HRVs and other ventilation components can introduce additional configuration considerations, particularly in retrofit applications

Findings Consistent with Broader HVAC Practice

- Equipment placement, access constraints, and integration challenges reflect common construction-phase tradeoffs seen across commercial HVAC systems
- Differences in design quality are strongly associated with the presence or absence of engineering involvement rather than equipment type

3.3 Maintenance and Cleaning Practices

Interviews and site visits indicated that ERV and HRV maintenance activities are generally consistent with routine commercial HVAC service practices. Participants who regularly performed these tasks described them as straightforward when system access and procedures were clear and comparable in effort to maintenance activities such as rooftop unit coil cleaning or filter replacement.

Maintenance and cleaning practices emerged as a central factor influencing whether ERV and HRV systems continue to operate as intended over time. While the guidance documents reviewed for this study describe routine and manageable maintenance activities, interview and site visit findings indicate that actual practices vary widely across buildings. Differences in awareness, access, staffing structure, and training shape whether maintenance tasks are performed consistently, deferred, or avoided altogether. This section summarizes how maintenance is understood and carried out in practice, with particular attention given to core cleaning, filter replacement, condensate management, and the organizational conditions that influence these activities.

Secondary Findings

Written guidance on ERV and HRV systems describes routine maintenance practices intended to sustain system performance over time. Manufacturer documentation and industry standards, including ASHRAE 180, emphasize regular filter inspection, periodic cleaning of energy recovery cores or wheels, verification of condensate drainage, and inspection of controls and airflow balance (ASHRAE 180; Daikin Applied 2022; Greenheck 2023; RenewAire 2023; Broan-NuTone AI Series Maintenance Guide). These sources generally present maintenance activities as manageable when incorporated into standard HVAC service schedules and assume that building staff or contracted service providers have sufficient information, access, and training to perform required tasks. Table 3 provides examples of manufacturer-recommended maintenance frequencies and service considerations.

Manufacturer	Typical Product Posture	Model/Line Examples	Maintenance Frequency (Typical)	Cleaning and Service Notes
AAON	DOAS/packaged w/ energy recovery wheels	RN Series (ER wheels)	Quarterly-annual (depends on "air class")	Inspect and clean wheel; check seals and bearings; adjust based on environment class
Broan-NuTone / Venmar	Standalone/light-commercial ERV/HRV	ERV100S, AI Series	Quarterly: filters/screens; annual: core & blower	Wash filters; vacuum core; do not soak; inspect defrost
CaptiveAire	DOAS/packaged makeup air with ERV	Paragon ERW, ERV units	Integrated into MAU/DOAS maintenance	Clean wheel per IOM; consult CaptiveAire's manual library
Carrier	ERV integrated in RTUs/AHUs	RTU ERV sections	Folded into HVAC service intervals	Replace filters; clean coils, drains; verify airflow, bypass, economizer logic
Daikin Applied	Packaged/integrated ERV (with VRV)	VAM Series ERV	Every 2-3 months	Vacuum/wash filters (≤122°F); no water on unit; observe electrical cautions
Greenheck	DOAS/packaged & standalone ERV	MiniCore, MiniVent, ERV	Standard HVAC schedules	Filter changes, inspect wheel cassette; follow service clearance notes
Lifebreath	Standalone/light-commercial HRV/ERV	METRO/Commercial	Quarterly filter inspections	Vacuum core, wipe cabinet, replace filters
Panasonic	Standalone/light-commercial	Intelli-Balance	Clean every 90 days; replace outdoor filter every 6 months	Wash washable filters; replace OA filter; reset service timer
RenewAire	Standalone/light-commercial ERV	All commercial/residential units	Filters quarterly; core annually	Vacuum core only; wipe cabinet; no washing
SEMCO (FläktGroup)	DOAS/packaged ERU, wheels	TRUE 3Å, Elite ERU	Per IOM/ environment	Minimal cleaning; inspect wheels, seals; check drives
Soler & Palau (S&P USA)	Standalone/light-commercial	TR, TRLPe, TRe	Quarterly-semi-annual	Wash/replace filters; vacuum core; inspect fans/dampers
Valent	DOAS/packaged ERV	ERW-M, ERC-E	Routine, tied to system service	Inspect/clean core or wheel; verify rotation and seals

Zehnder America	High-end light-commercial/residential	ComfoAir Q Series	Semi-annual filter change; annual check	Replace or clean filters; check alarms, perform service check

Table 3 – Sampling of Manufacturers' Recommended Cleaning and Maintenance. Note that specific brands, product lines, and models compliant with NEEA's efficient equipment specifications can be found at: 1) Very-High-Efficiency-DOAS_HRV-Compliant-Products-1.pdf; and 2) Efficient Gas RTUs: System Requirements & Compliant Equipment - BetterBricks.

To create Table 3, the research team reviewed maintenance documentation from thirteen manufacturers with products that include ERV and HRV and found broadly consistent guidance. Manufacturers generally identify filters as the first line of defense in keeping overall system performance high, recommending quarterly inspection and cleaning or replacement as needed, with more frequent checks in dusty environments. Guidance emphasizes careful handling of energy recovery media: fixed cores are typically vacuumed rather than washed, and energy recovery wheels, along with seals, bearings, and drives, are inspected and cleaned on a regular schedule. Most manufacturers also recommend an annual, more comprehensive review that includes cabinet cleaning, drain inspection, and confirmation that airflow setpoints are being met. For systems integrated into DOAS or rooftop units, these tasks are typically incorporated into standard HVAC service intervals, with additional attention to economizer, bypass, and defrost control strategies in cold climates.

Primary Findings

Knowledge of Required Tasks and Core Cleaning Practices

Many building operators and facilities staff described having some awareness of the manufacturer-recommended maintenance tasks associated with ERV and HRV systems. Filter replacement was the most commonly cited and widely understood activity. Fewer participants demonstrated familiarity with energy recovery core removal and cleaning, and several operators reported learning about core maintenance only after encountering performance issues or through informal conversations with contractors.

Contractors similarly described encountering buildings where core removal and cleaning were not part of routine maintenance practices. In these cases, uncertainty about required tasks, responsibility for maintenance, or appropriate procedures contributed to deferred or inconsistent care.

> "I would never want to use water or moisture on it. Once you get water on those things, they can start deteriorating pretty fast. I've used compressed air or a vacuum."
>
> **– HVAC Technician, MN**

Reported Core Cleaning Effort and Perceived Difficulty

Among participants who reported performing core cleaning, descriptions of the task were relatively consistent and suggested that it was very manageable when system access and instructions were clear. Operators and contractors described removing access panels, extracting the core, and cleaning it using a shop vacuum, soft brushes, or cleaning cloths.

Reported cleaning time varied by system size and location but was commonly described as ranging from approximately 30 minutes to one hour per unit. Participants who had completed the task generally described it as "not difficult," "straightforward," or comparable to other routine mechanical maintenance activities. In most cases, cleaning was reported to be performed by a single individual using basic tools.

Barriers to Core Cleaning

Several participants reported that core cleaning had not been performed because they did not know how to remove the core, were unsure whether removal was permitted, or lacked confidence that they could complete the task without damaging the equipment. Some operators described opening units but stopping short of core removal due to uncertainty about proper procedures or concern about reinstallation.

During site visits, the research team observed variation in core condition across buildings. In some cases, cores appeared relatively clean, while in others they showed visible accumulation of dust or debris. In one observed instance, an ERV installed more than two decades earlier showed no visible indication of prior core cleaning. These observations align with interview findings suggesting that inconsistency in core cleaning is driven more by awareness, access, and role clarity than by the inherent difficulty of the task.

Filter Replacement Practices

Filter replacement was the most commonly performed and best-understood maintenance activity. Many interview participants reported changing filters multiple times per year, often in alignment with manufacturer guidance. Operators generally expressed confidence in performing this task and viewed it as routine.

However, access constraints affected consistency. Filters located above ceilings, inside tight soffits, or behind other equipment discouraged regular replacement in some buildings. Contractors noted that when access is difficult, filter changes may occur less frequently than intended, particularly when filters are not easily visible during routine walkthroughs.

Condensation and Drain Line Maintenance

Interview participants described challenges related to condensate management, including inadequate slopes, clogged drain lines, or missing traps. Contractors noted that these issues can contribute to water accumulation, alarms, or system malfunction if not addressed.

Site visits reinforced these concerns. Several units had drain lines that were difficult to access or routed in ways that made routine inspection challenging. These installation characteristics can discourage operators from checking or clearing drains, increasing the likelihood that issues persist unnoticed over time.

Staffing, Role Clarity, and Training

Maintenance practices were further shaped by staffing structures and, sometimes, lack of role clarity. Some buildings relied entirely on external contractors for mechanical maintenance, while others had on-site staff responsible for routine tasks. Some participants noted they review manufacturer manuals, which were often described as lengthy or difficult to interpret. Participants further described variability in who was responsible for ERV or HRV maintenance, which sometimes resulted in tasks being overlooked or deferred.

Summary of This Subsection

Across interviews, participants consistently indicated that ERV and HRV cleaning and maintenance tasks were not inherently more difficult than those required for other commercial HVAC equipment. When systems were accessible and procedures were understood, core cleaning and filter replacement were described as routine tasks comparable in effort to coil cleaning or filter service on rooftop units. Participants who performed core cleaning reported typical labor times of 30–60 minutes per unit, generally requiring one technician and basic tools such as a shop vacuum, brushes, or cloths. Reported costs were driven primarily by labor rather than materials, with filter replacement representing the most frequent ongoing expense. When contractors were engaged, maintenance was typically bundled into standard service visits rather than treated as a specialized task.

> "No, it's not more cumbersome. Filters and cleaning in some ways it can be easier. It's definitely not a cost burden."
>
> **– HVAC Designer, WA**

Maintenance challenges were more often attributed to access constraints, unclear responsibility, or lack of training than to the equipment itself. These conditions shape whether routine tasks are performed consistently and help explain observed variation in maintenance outcomes across buildings. Key takeaways include:

- Maintenance practices for ERV and HRV systems vary widely and are shaped by awareness, access, staffing, and training rather than by technical complexity alone
- Core cleaning is infrequent in many buildings, but participants who perform it generally describe the task as manageable, requiring limited time, one technician, and basic tools
- Uncertainty about procedures and responsibility is a primary barrier to routine core cleaning
- Filter replacement is widely understood and commonly performed, though access constraints can reduce consistency
- Condensate management and drain line inspection are influenced by installation characteristics that affect accessibility
- Staffing structures and limited training at system turnover contribute to reactive rather than proactive maintenance practices

Findings Specific to ERV/HRV Systems

- Uncertainty around energy recovery core access and cleaning procedures is a common barrier to routine maintenance

Findings Consistent with Broader HVAC Practice

- Maintenance of HVAC equipment, including ERV/HRVs, is sometimes omitted when responsibility between building staff and contractors is unclear
- Maintenance frequency is heavily influenced by access constraints, staffing capacity, and training at turnover
- When maintenance tasks are clearly understood and accessible, ERV/HRV cleaning and filter replacement are comparable in effort and time to routine rooftop unit maintenance activities
- Reactive maintenance patterns are common across small and midsized commercial HVAC systems, regardless of technology

3.4 Controls, Commissioning, and Performance

Interview participants consistently characterized commissioning and control challenges as part of broader commercial HVAC practice rather than as issues unique to ERV and HRV systems. Themes such as limited commissioning scope, reliance on basic startup checks, and constrained long-term operational and recovery performance monitoring were described as common across mechanical systems in small and midsized commercial buildings. Where participants did identify ERV- or HRV-specific considerations, these related primarily to control configuration, visibility into system operation, and integration with other ventilation and HVAC components. This section summarizes both the general commissioning context and the aspects participants associated more directly with ERV and HRV systems.

Secondary Findings

Secondary sources describe ERV and HRV systems as equipment that should be commissioned to verify airflow balance, confirm control settings, and ensure that components function as intended (ASHRAE 2019; ASHRAE 62.1), particularly where energy recovery effectiveness depends on proper sequencing and integration with other ventilation components (ASHRAE, 2019; DOE, 2021; DOE, 2022). Manufacturer documentation further outlines expectations for setting fan speeds, configuring defrost control and bypass dampers, and verifying features that influence energy recovery and indoor air quality (Daikin Applied, 2022; Greenheck, 2023; SEMCO Technical Guides, 2025; RenewAire Maintenance Guides, 2025). Collectively, these sources assume that commissioning is a standard component of installation and that control settings are configured in alignment with design intent.

Secondary literature on building automation systems highlights the risk of “alarm fatigue,” in which high volumes of nuisance or poorly prioritized alerts reduce the likelihood that alarms receive timely attention (Health Facilities Management, 2019). Modern BAS platforms therefore support temporary alarm suppression, often referred to as “shelving,” to silence alerts during commissioning or maintenance activities (OPC Foundation, 2023). Guidance recommends that suppression be temporary, documented, and periodically reviewed to prevent alarms from remaining disabled indefinitely (Exida, 2017).

Primary Findings

Commissioning Practices

> "A lot of the issues we see are controls-based. When systems aren't communicating properly, operators sometimes simplify how they run them."
>
> **– HVAC Estimator, MT**

Interview participants reported that commissioning practices for ERV and HRV systems varied widely and were strongly influenced by project scale, budget, and the presence of design professionals. In projects involving mechanical engineers, commissioning was more common and often included airflow testing, equipment startup, and verification of control setpoints. Engineers described commissioning as an important step for ensuring that ventilation and energy recovery systems function as intended.

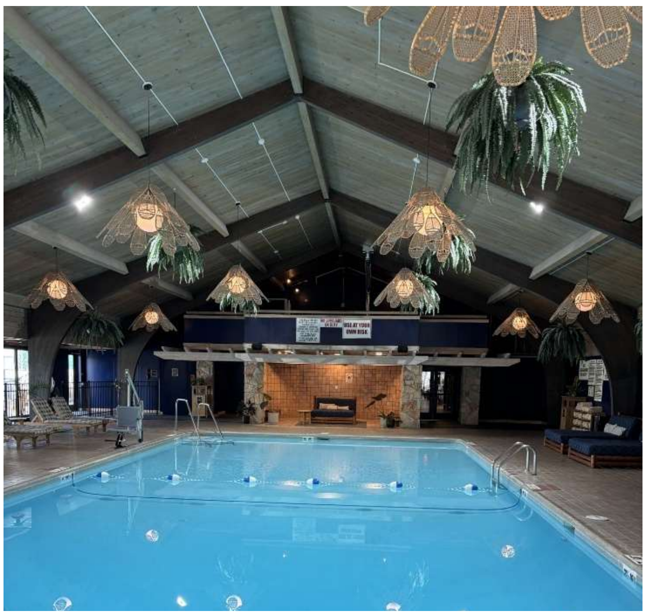

Figure 6 – Hotel pool area, with humidity control provided by an ERV.

In projects without engineering involvement, commissioning practices were described as similar to those applied to other HVAC equipment. Contractors reported performing basic startup activities such as confirming fan operation, checking for airflow, and ensuring that the unit responded to controls. Detailed balancing or functional testing specific to energy recovery was less likely to occur. Several building operators expressed uncertainty about whether ERV or HRV systems had been formally commissioned, noting that commissioning was often assumed to be part of installation rather than a distinct activity.

Overall, participants did not consistently describe ERV or HRV commissioning as more difficult than commissioning other HVAC components. Differences in commissioning quality appeared to reflect broader project conditions rather than equipment type.

Control Settings and Operational Modes

Control configuration emerged as an area where ERV and HRV systems can introduce additional complexity relative to simpler HVAC components. Participants described wide variation in how fan speeds, occupancy schedules, heat recovery modes, and frost protection were configured. Many systems were reported to operate continuously, either because control settings were unclear or because operators assumed continuous operation was required for proper ventilation.

In buildings using wall-mounted switches or simple control panels, operators had limited visibility into system status. Buildings with automation systems had greater potential visibility, but participants reported that ERV and HRV control points were often not fully integrated, labeled, or trended. Contractors noted that bypass and defrost settings were frequently left at factory defaults unless a specific issue prompted adjustment.

Participants indicated that uncertainty around ERV and HRV control behavior, particularly related to defrost cycles, bypass operation, and interaction with other ventilation equipment, sometimes discouraged operators from modifying settings. In these cases, systems were left in default or continuous operation modes as a risk-avoidance strategy.

> "If it's just strictly an HRV, there's not too much that can go wrong. You've got a motor, a wheel, a belt, filters — as long as filters are kept up, problems don't arise very much."
>
> **– Service Technician, WA**

Performance Monitoring

Ongoing performance monitoring for ERV and HRV systems was limited in many buildings. Operators described relying on indirect indicators such as occupant comfort, odor complaints, or visual inspection to assess whether systems were operating as intended. Few participants reported using airflow measurements, alarms, or trend data to verify system operation and recovery function over time.

While reliance on indirect indicators was described as common across HVAC systems, participants noted that the lack of clear feedback from ERV and HRV systems made it particularly difficult to confirm whether energy recovery functions were operating correctly. In buildings with automation systems, alarm and trend logging capabilities existed but were often not configured or actively used for ERV and HRV performance monitoring. Contractors reported that they were typically called only when a problem arose, and routine service visits rarely included performance verification unless specifically requested.

Influence of System Age and Retrofit Conditions

System age and retrofit conditions further influenced commissioning and control outcomes. Participants described older ERV and HRV units as having limited control capabilities or outdated interfaces. In retrofit situations, integrating ERV or HRV systems into existing control infrastructure was described as challenging, particularly when original documentation was unavailable.

These conditions often lead to simplified control strategies, such as continuous operation or bypassing certain modes. Participants noted that, in older buildings, performance degradation could occur gradually without clear indicators, making issues difficult to detect without targeted verification.

Summary of This Subsection

- Many commissioning and control challenges described by participants reflect broader commercial HVAC practices rather than issues unique to ERV and HRV systems
- Control configuration related to defrost, bypass, and integration with other ventilation systems was identified as an area requiring coordination, reflecting considerations common across commercial HVAC systems that include energy recovery

- Limited operator visibility into ERV and HRV operation reduces confidence in system performance and discourages adjustments to control settings
- Performance monitoring relies largely on indirect indicators, making it difficult to verify whether energy recovery functions are operating as intended
- System age and retrofit conditions were described as contributing to simplified control strategies and changes in system operation over time

Findings Specific to ERV/HRV Systems

- ERV and HRV operation depends on correct sequencing of bypass, defrost, and recovery modes, which may not be fully visible to operators
- Limited feedback on recovery operation can reduce operator confidence in adjusting control settings

Findings Consistent with Broader HVAC Practice

- Commissioning scope and depth are primarily determined by project size, budget, and contractual requirements
- Ongoing performance verification and trend analysis are uncommon in small and midsized commercial buildings for most HVAC systems
- Operators frequently rely on indirect indicators such as comfort complaints or visual inspection across HVAC equipment types

3.5 Workforce, Training, and Field Competency

Secondary Findings

Secondary sources assume that ERV and HRV systems are installed and maintained by technicians with a baseline understanding of energy recovery technologies, including core or wheel removal, condensate management, airflow balancing, and control configuration (ASHRAE, 2019). Manufacturer documentation outlines specific steps for installation and routine service and presumes sufficient technical competency to interpret instructions, configure controls, and perform maintenance tasks correctly (Daikin Applied, 2022; Greenheck, 2023; RenewAire, 2023; SEMCO Technical Guides, 2025; DOE, 2022).

> "There is a big difference between someone who has serviced twenty ERVs and someone who has never seen one. Most of the guys on my team have only worked on a handful because we do not see them every day. So they learn by trial and error."
>
> **– HVAC Contractor, WA**

Primary Findings

Variation in Contractor Familiarity

Interview participants described meaningful variation in contractor familiarity with ERV and HRV systems. Some contractors reported extensive experience and confidence working with energy recovery technologies, while others noted that their peers were less comfortable with these systems or encountered them infrequently.

Contractors working primarily in small commercial buildings often described learning on a project-by-project basis. Several participants explained that when ERVs or HRVs are rare in a service area, technicians and operators rely on manufacturer manuals, peer support, or trial and error to complete maintenance tasks.

In an interview with an energy service company, interviewers learned that training was provided both by the company and the union representing its installers and technicians, however this seemed to be the exception when compared to other discussions.

> "In school, you learn about refrigeration cycles, boilers, chillers, and rooftop units. ERVs barely get a mention. So when you get into the field, you have to learn them from scratch."
>
> **– HVAC Trainer, MN**

Training Gaps for Building Operators

Building operators also reported limited training at system turnover. Many participants stated that they were not shown how to remove the core, check condensate lines, or adjust control settings. Several said they received no documentation or manuals; where they did have some form of documentation, they said it was difficult to interpret.

In some cases, operators assumed contractors were performing tasks that were actually their responsibility, or vice versa. This ambiguity contributed to infrequent cleaning and/or incomplete inspections.

On-the-Job Learning

A common theme across interviews was that many maintenance tasks are learned informally. Operators described discovering components during troubleshooting, often after a system malfunction or airflow complaint. This on-the-job learning approach affects consistency. Tasks such as core removal, drain inspection, or bypass damper checks may be performed by some individuals but not others, depending on who learned what and when.

> "If a tech is not comfortable with the wheel or defrost logic, they may shut off the alarm or put the system in bypass just to get the calls to stop."
>
> **– Service Operations Manager, WA**

Role Clarity and Staffing Levels

Several participants emphasized that resource limitations influence maintenance outcomes. Buildings without dedicated facility staff may rely entirely on contractors, while organizations with multiple buildings divide responsibilities among teams with differing levels of experience.

These differences lead to variability in how often systems are serviced and who is responsible for specific tasks.

Manufacturer and Distributor Training

Contractors mentioned that manufacturers sometimes offer training sessions or support calls, but participation varies. Some contractors take advantage of this support, while others rely on manuals or peer experience. Distributor level support was described as helpful but not always available for smaller firms or for older equipment models.

Participants noted that consistent access to training could help address gaps in field competency, particularly in rural areas or markets where ERVs and HRVs are less common.

Observations from Site Visits

Site visits confirmed that workforce competency is closely tied to equipment condition. Buildings with trained staff generally maintained cleaner cores, more accessible drain lines, and better documentation. Buildings without trained staff often showed evidence of infrequent maintenance, such as clogged filters, dust accumulation on internal components, or disconnected drain traps.

At one location, facilities staff described more structured approaches to ERV maintenance and a higher level of system familiarity. Technicians reported receiving practice and guidance over time, although formalized training was still limited.

Summary of This Subsection

- Contractor familiarity with ERV and HRV systems differs substantially, particularly in small commercial markets where these systems are encountered less frequently
- Building operators often receive limited training at system turnover, leading to uncertainty about maintenance tasks and responsibility
- Many ERV and HRV maintenance practices are learned informally through on-the-job experience, contributing to inconsistencies across buildings
- Staffing levels, role clarity, and access to manufacturer or distributor training influence whether systems are maintained proactively or reactively
- Site visits suggest a relationship between workforce competence and equipment condition, with more informed staff associated with better-maintained systems

Findings Specific to ERV/HRV Systems

- ERVs and HRVs receive limited coverage in formal HVAC training programs relative to more common equipment types
- Technicians with limited exposure to energy recovery systems rely more heavily on manufacturer documentation or peer support

Findings Consistent with Broader HVAC Practice

- Workforce experience varies widely across regions and firms based on installation volume and market maturity

- Informal, on-the-job learning is common for many commercial HVAC technologies, particularly in small commercial markets

3.6 Owner and Tenant Awareness and Engagement

Secondary Findings

Secondary sources often assume that building owners, operators, and tenants are aware of ERV and HRV systems, understand their benefits, and recognize the importance of regular maintenance (DOE, 2022; EPA, 2021; PNNL, 2020). Guidance from manufacturers and industry organizations presents ERVs and HRVs as components that contribute to indoor air quality, comfort, and energy performance and generally presumes a baseline level of engagement and awareness among building decision makers (ASHRAE, 2019; DOE, 2021; Daikin Applied, 2022; Greenheck, 2023; RenewAire, 2023).

Primary Findings

In practice, awareness and engagement among owners and tenants vary, influencing how systems are operated, maintained, and prioritized over time. Many of the awareness, communication, and engagement challenges described in this section are not unique to ERV and HRV systems and reflect broader patterns observed in commercial HVAC operation.

Limited Awareness of System Type and Function

"We didn't know it had never been cleaned until the right people happened to be on the roof and opened it up."

– Facilities Manager, MN

Interview participants frequently noted limited understanding among owners and tenants regarding what type of system they have and how it operates. Several building owners could not identify whether the system provided heat recovery, energy recovery, or simple ventilation. Facility managers reported that some tenants assumed fresh air came from the main HVAC system and were unaware of a standalone ERV or HRV. A lack of understanding was particularly pronounced when building ownership or tenants changed.

This limited awareness affects expectations about air quality and may reduce engagement in maintenance practices.

Understanding of Maintenance Needs

Participants described varying levels of owner involvement in maintenance decisions. Building operators reported that some owners were not aware of tasks such as core cleaning, drain inspection, or airflow verification. Others assumed contractors were performing these tasks without confirming what was included in service agreements. This disconnect between expected and actual maintenance can lead to deferred cleaning or overlooked issues.

Communication Between Owners, Tenants, and Service Providers

Interviewees described gaps in communication between owners, tenants, and contractors that influenced system performance. Tenants often reported comfort or odor concerns without understanding the role of the ERV or HRV in addressing these issues. Contractors noted that they sometimes discovered long standing ventilation problems only after receiving multiple tenant complaints.

> "They haven't needed to call about the system not working in the five or six years they've had it."
>
> **– Building Owner, OR**

Building operators also noted that tenants do not typically have visibility into system operation and may not know what to report when issues arise.

Influence of Leasing and Space Use Patterns

Participants emphasized that the degree of owner and tenant engagement often depends on leasing arrangements and building use. In multi-tenant buildings, owners may rely on contractors to handle mechanical equipment and expect minimal involvement from tenants. In contrast, owner occupied buildings, particularly those with dedicated facilities staff, tend to show higher awareness and engagement.

Several contractors noted that retail and restaurant tenants are more likely to notice ventilation issues because of indoor air quality or odor concerns but are less likely to know the cause or to proactively raise maintenance questions. In buildings with frequent tenant turnover, institutional knowledge about the ERV or HRV system is often lost.

Tenant Behavior and Impact

In some cases, tenant behavior affects system performance. Operators described instances where tenants adjusted thermostats, shut doors to mechanical rooms, or blocked supply and exhaust vents without realizing the effect on ventilation. These behaviors contribute to airflow imbalances and reduced ventilation performance.

Engagement Observed During Site Visits

Site visits reinforced the finding that owner and tenant engagement varies widely. In several small commercial buildings, operators reported minimal awareness from owners or tenants regarding the ERV or HRV system. In contrast, the visit to a university campus showed higher engagement, with staff knowledgeable about system functions and actively involved in maintenance. This environment also provided opportunities for communication between facilities staff and building users, although staff noted that most users were unaware of specific ventilation components.

Even in settings with higher engagement, participants described that tenants and occupants often respond to comfort conditions rather than system behavior. This suggests that while staff engagement can be strong, user level awareness remains limited across building types.

Summary of This Subsection

- Many owners and tenants have limited understanding of system type, function, and maintenance needs, which can reduce engagement in routine care and oversight
- Gaps in communication between owners, tenants, and service providers influence how ventilation issues are identified and addressed
- Leasing arrangements, building use, and tenant turnover shape the level of owner and tenant involvement in system operation and maintenance
- Tenant behavior can affect system performance, particularly when occupants are unaware of how ventilation systems function
- Site visits suggest that higher levels of staff engagement are associated with greater system familiarity, though tenant-level awareness remains limited even in more engaged settings

Findings Specific to ERV/HRV Systems

- Owners and tenants are often unaware of the presence or function of ERV and HRV systems because these systems operate in the background and they rarely interact with them directly
- ERV/HRV benefits related to energy recovery and ventilation effectiveness are not always visible to occupants without explicit explanation or performance feedback

Findings Consistent with Broader HVAC Practice

- Owners and tenants generally have limited awareness of HVAC system configuration, operation, or performance beyond comfort outcomes
- Engagement with mechanical systems tends to occur only when problems arise, regardless of equipment type
- Documentation and system education at turnover strongly influence long-term owner and tenant understanding across HVAC technologies

3.7 Regional Variations and Climate Impacts

Secondary Findings

Secondary sources describe ERVs and HRVs as technologies that can support ventilation and energy performance goals across a range of climates (DOE, 2022; PNNL, 2020; PNNL, 2023). Industry guidance recognizes that outdoor conditions influence frost control strategies, energy recovery effectiveness, defrost cycles, and condensate management, particularly in cold, humid, or marine environments (ASHRAE, 2019; ASHRAE Climate Data Center, 2020; NOAA, 2021; manufacturer technical manuals). Codes and standards applicable in the Northwest reference ERV and HRV systems as appropriate for both moderate and cold climates, assuming that equipment is selected, configured, and installed in ways that account for local weather patterns and operating conditions (IECC, 2021; WSEC-C, 2021; Minnesota Commercial Energy Code, 2024; Montana DLI, 2023).

Primary Findings

Primary data from interviews and site visits indicates that climate and regional practices do influence how ERVs and HRVs perform, how they are maintained, and how consistently they are adopted across the Northwest.

Influence of Cold Weather on Operation and Maintenance

Participants in colder parts of the region, particularly in Montana, Idaho, and parts of eastern Washington and Oregon, described operational impacts related to frost and winter conditions. For example, contractors noted that drain lines can freeze during extended cold periods if not properly installed.

> "Climate affects how you set things up, but that's true for any motor-driven equipment. Maintenance and controls still matter most."
>
> **– HVAC Estimator, MT**

Site visits in colder climates showed units with insulated drain lines and freeze protection components, but several operators reported uncertainty about how frost control operated. Some believed the system "took care of itself" and were unaware of when defrost mode was engaged. This limited familiarity may contribute to deferred maintenance or unnoticed performance declines during winter months.

Performance in Mild and Coastal Climates

Participants in coastal and milder climates, including western Washington and western Oregon, described fewer concerns about frost protection and condensate management. These buildings often have moderate outdoor temperatures that reduce the need for frequent defrost cycles. Contractors in these areas noted that they focus more on airflow balance, humidity control, and filtration than on freeze protection.

Air Quality and Smoke Events

Participants across the region, including those in urban and rural settings, described the impact of wildfire smoke on maintenance practices. Smoke events were cited as drivers for more frequent filter changes and, in some cases, temporary shutdowns.

While ERVs and HRVs are not expected to filter particulate matter to the level of dedicated air cleaning systems, smoke events highlighted the importance of maintaining filters and monitoring system performance. Some participants described adding higher quality filters during wildfire seasons or increasing maintenance budgets temporarily.

Regional Differences in Adoption and Familiarity

Interview findings indicate that ERV and HRV adoption varies across the Northwest. Participants in Washington and Oregon, particularly in larger cities, described more frequent use of energy recovery due to code requirements, incentives, and mechanical engineering involvement. In contrast, contractors in Montana and parts of Idaho noted that ERVs and HRVs are less common in smaller commercial buildings and may be installed mainly when specific ventilation problems need to be addressed.

Regions where ERVs and HRVs are more common have contractors and operators with greater experience in performing maintenance. In areas where installations are less frequent, contractors may encounter ERVs only occasionally, which can influence comfort and competency during service.

Impact of Local Practices and Permit Requirements

Participants across states described how local permitting practices influence whether ERVs and HRVs are included in project designs. In Washington, several municipalities have adopted interpretations of state codes that support energy recovery under certain conditions. In contrast, participants in Idaho and Montana described fewer requirements and more discretion in whether energy recovery is used. These differences shape both installation frequency and familiarity among contractors and operators.

Summary of This Subsection

- Climate conditions shape ERV and HRV operation, maintenance needs, and performance risks across the Northwest
- Cold climates increase the importance of effective condensate management and frost control strategies
- Coastal and marine climates place greater emphasis on airflow management, humidity control, and fouling prevention
- Wildfire smoke events increase filter loading and maintenance frequency across multiple subregions
- Regional differences in permitting practices and access to engineering support influence system adoption, configuration, and commissioning
- Variability in climate, market structure, and workforce familiarity contributes to the wide range of system conditions and maintenance practices observed during interviews and site visits

Findings Specific to ERV/HRV Systems

- Climate conditions influence frost control, condensate management, and filtration requirements for ERV and HRV systems
- Cold and mixed-marine climates introduce operational considerations related to defrost sequencing and moisture management

Findings Consistent with Broader HVAC Practice

- Regional climate conditions shape design, maintenance, and performance considerations for all commercial HVAC equipment
- Market familiarity and contractor experience vary by region and installation volume, influencing outcomes across equipment types

Section 4 – High Level Takeaways and Key Recommendations

The key takeaways that follow synthesize ERV/HRV system-level patterns observed across interviews, site visits, and secondary research. Participants generally described ERV and HRV systems as established ventilation technologies that can operate reliably when properly designed, installed, commissioned, and maintained. At the same time, participants noted that system performance over time is shaped by broader commercial HVAC lifecycle conditions, including controls integration, documentation, workforce familiarity, and operational visibility. The themes below highlight structural factors that influence whether ERV and HRV systems continue to operate in alignment with design intent throughout the system's lifecycle. Importantly, participants rarely described ERV or HRV systems as inherently difficult to maintain or operate; instead, most challenges reflected broader lifecycle conditions typical of commercial HVAC systems rather than characteristics specific to ERV or HRV technology.

4.1 System Performance Often Changes After Turnover

Across interviews and site visits, participants consistently described ERV and HRV systems receiving adequate engineering and HVAC contractor attention during design, specification, and installation, with systems generally operating in alignment with design intent at turnover. Over time, however, engagement with the system often declines once it transitions into routine operation. Participants described situations where undocumented field adjustments, limited follow-up commissioning, or changes in operational priorities gradually altered how systems functioned. Rather than abrupt equipment failure, these shifts were typically described as gradual operational drift, reflecting reduced oversight or evolving building needs rather than inherent problems with ERV or HRV technology.

4.2 Controls Integration is Foundational to Sustained System Performance

Controls integration emerged as a central factor influencing how ERV and HRV systems perform over time. Participants described systems functioning effectively when ventilation equipment, economizers, and building automation systems were configured with clear control strategies and verified during commissioning. In other cases, limited commissioning scope, incomplete documentation, or partial integration with building controls resulted in systems operating in default or continuous modes without verification of intended behavior. Participants emphasized that these challenges reflect common patterns across complex HVAC systems that rely on coordinated controls, rather than characteristics unique to ERV or HRV technology.

4.3 Maintenance Practices Reflect Broader Commercial HVAC Service Models

Maintenance practices reported for ERV and HRV systems closely resembled service patterns observed across other commercial HVAC equipment. Several operators noted that routine service tasks such as filter replacement are straightforward and commonly incorporated into existing HVAC maintenance schedules. Operators frequently described completing routine maintenance tasks on established schedules, while more involved activities such as core cleaning, drain inspection, or control verification were less consistently performed unless prompted by a specific operational concern. Importantly, participants did not describe ERV or HRV maintenance requirements as inherently more burdensome than other ventilation equipment. Instead, maintenance outcomes were shaped by familiar factors such as service access, training, documentation, and staffing constraints that influence HVAC maintenance more broadly.

4.4 Limited Operational Visibility Shapes System Management Practices

Interview and site visit findings suggest that many owners and operators have limited visibility into whether ERV and HRV systems are functioning as intended. In many buildings, minimal status indicators, incomplete documentation, or limited integration with building automation systems meant that operators had limited feedback regarding system performance. As a result, operators often relied on indirect cues such as comfort complaints, airflow observations, or unusual noise when assessing system operation. Participants noted that when clear monitoring or controls integration was present, operators reported greater confidence in system performance and were more likely to identify issues early.

4.5 Regional Climate and Market Characteristics Shape Performance Trajectories

Regional differences in climate, wildfire exposure, workforce familiarity, and codes and permitting requirements contribute to the experience of owning and maintaining ERVs and HRVs. Participants described colder climates as introducing additional considerations such as frost control and winter maintenance, while wildfire smoke events in some regions increased attention to filtration and ventilation management. Differences in program incentives, code requirements, and contractor experience also influence the level of familiarity market actors have with energy recovery systems. These regional conditions contribute to variation in how systems are implemented and supported over time. Participants emphasized that ERV and HRV systems can operate effectively across these climates when properly configured, but that regional differences influence the types of operational considerations building teams encounter.

4.6 Workforce Exposure and Training Vary Across Regional Markets

Workforce familiarity with ERV/HRV systems varies across regional markets, reflecting differences in installation volume, training opportunities, and contractor specialization. Participants working in markets with more frequent installations described greater familiarity with system configuration and service procedures. Participants noted that training materials, manufacturer guidance, and on-the-job experience all play an important role in shaping workforce competency and confidence when working with energy recovery systems.

4.7 System Bypass or Disablement Can Impact Late-Stage Outcomes

In a limited number of cases, participants described situations where ERV or HRV systems were placed into bypass modes or fully disabled after operational challenges persisted over time. These situations were typically associated with difficult service access, unresolved control alarms, or limited operator familiarity with system requirements. Participants also noted that when systems lacked clear performance indicators or integration with building controls, operators were sometimes unaware that a unit had been disabled until it was discovered during later service visits.

Although this study did not quantify alarm frequency or suppression behavior, participants described situations where unresolved alarms, unclear fault conditions, or repeated operational issues contributed to systems being bypassed or turned off. These outcomes were typically not intentional misuse but rather practical responses to persistent operational challenges. Participants emphasized that clearer fault diagnostics, improved controls integration, and better documentation could help prevent situations where systems remain disabled without operators realizing it.

4.8 Systemic Interventions Are Required to Support Sustained Performance

The sections below synthesize cross-cutting patterns observed throughout the study and illustrate the systemic nature of the challenges described above. Across interviews and site visits, participants consistently described performance outcomes as emerging from interactions across design, installation, commissioning, operation, and long-term maintenance rather than from isolated actions by individual actors. These dynamics were described as common across commercial HVAC systems more broadly and not unique to ERV or HRV technology. Taken together, the findings highlight several recurring, system-level factors that influence long-term performance, including design clarity, installation verification, serviceability, controls integration, documentation, workforce training, and operational visibility. Improving outcomes will depend less on correcting individual behaviors and more on strengthening these supporting systems across the equipment lifecycle.

Problems Originate from Structural Conditions, Not Single Actors

Participants frequently described situations in which no single actor group, whether engineers, contractors, operators, or owners, was solely responsible for a system's performance issues. Instead, gaps emerged during handoffs and transitions. These structural breaks undermine design intent, reduce operator confidence, and contribute to long-term performance drift.

Design-Installation-Operator Disconnects Require Integrated Solutions

Throughout the study, actors described misalignment between what was designed, what was installed, and what operators ultimately received. Design changes made to accommodate space and other physical constraints during installation were often undocumented. Commissioning frequently fell short of verifying system performance, and turnover training was limited or absent. Because these steps depend on each other, interventions targeting a single phase are unlikely to produce lasting change.

Controls and Maintenance Issues Reflect Systemic Patterns, Not Misuse

When operators experienced difficulties managing controls or keeping up with maintenance, these challenges were generally not attributed to unwillingness or negligence. Instead, they were most often associated with limited visibility into system operation, incomplete documentation, or unclear guidance on required tasks. In these conditions, operators reported being unaware of system requirements or uncertain about when maintenance was needed. These patterns point to broader systemic factors, including product design, training approaches, and market expectations, rather than individual mistakes.

Workforce Gaps Are the Result of Market Structure

Where contractors had limited exposure to ERV or HRV systems, workforce familiarity tended to be lower. Participants described variation in competency that aligned closely with regional installation volumes and market experience. In areas with fewer installations, contractors had fewer opportunities to build hands-on knowledge. This suggests that workforce challenges are shaped not only by training availability but also by broader market dynamics and exposure over time.

Reactive Maintenance Emerges from Constraints, Not Avoidance

Maintenance practices described during the study reflected a mix of proactive and reactive approaches. Many operators reported consistently completing routine tasks such as filter replacement and basic service. However, when staffing was constrained, priorities competed, or system visibility was limited, more involved activities such as core cleaning, drain inspection, or control verification were more likely to be deferred. Under these conditions, reactive maintenance patterns emerged not from intentional avoidance but from practical constraints and limited information about when deeper service was needed.

System Disablement Results from Cascading Failures

These actions were described as practical responses to unresolved or recurring problems rather than intentional misuse. This pattern illustrates how multiple systemic barriers can accumulate, increasing the likelihood of partial or full system inactivity under certain conditions.

4.9 Key Recommendations

The following recommendations are intended for key market actors involved in the design, installation, commissioning, and operation of ERV and HRV systems, including manufacturers, design engineers, contractors, building owners and operators, and supporting organizations such as NEEA.

- Integrate ERV/HRV control strategies fully with building automation systems and verify functionality during commissioning, including economizer, bypass, and defrost operation under real operating conditions *(design engineers, controls contractors, commissioning agents; NEEA support through guidance and program requirements)*
- Strengthen commissioning and early post-occupancy verification practices, with follow-up checks to confirm that systems continue to operate in alignment with design intent after turnover *(commissioning agents, contractors, building owners; NEEA support through program design and incentives)*
- Improve operator visibility into system operation and recovery function, including clearer fault diagnostics, status indicators, and integration with building control systems *(manufacturers, controls vendors; NEEA support through market guidance and specifications)*
- Provide clearer and more accessible documentation and turnover training, including simple, location-specific maintenance instructions and guidance for building operators *(manufacturers, contractors; NEEA support through training resources and standardization efforts)*
- Improve system serviceability through better equipment placement, access, and labeling, reducing barriers to routine maintenance and *inspection (design engineers, contractors; NEEA support through design guidance and best practices)*

Appendix A – Methods

A.1 Research Design and Goals

The research focused on the experiences of the people who design, install, commission, operate, and maintain these systems, as well as the owners and tenants who occupy the buildings.

The design combined:

- Semi structured one on one interviews
- Site visits to see and hear about the equipment installed
- Review and synthesis of extensive secondary research

The qualitative emphasis was chosen because many of the most important questions relate to behavior, practice, collaboration, and perception, which are not easily captured through quantitative surveys alone. The goal was to document recurring patterns, field issues, and success stories in enough depth that NEEA can act on them through market transformation strategies.

While the original intent was to observe cleaning and maintenance practices, this turned out not to be possible due to weather, scheduling constraints, budgets, and other roadblocks. Instead, researchers asked participants to explain how cleaning and maintenance occurred.

A.2 Sampling and Recruitment

The sample was constructed to reflect the diversity of actors who influence ERV and HRV performance, and to capture experiences across the four NEEA states: Washington, Oregon, Idaho, and Montana. Participants included:

- Mechanical contractors and service technicians
- Mechanical design engineers and sales engineers
- Controls technicians and integrators
- Facility managers and building operators
- Building owners or owner representatives
- Tenants with operational responsibility in smaller buildings
- Industry experts and advisors

These groups were selected because each plays a distinct role in the life cycle of ERV and HRV systems, from early design decisions through daily operation and eventual replacement. Participants were recruited through a combination of:

- NEEA's existing partner, utility, and program networks
- MarketWise's subcontractor's (recruitment) and owner relationships
- Referrals from initial interviewees

The final qualitative sample included twenty-one in-depth interviews, including seven site visits, distributed across a range of building types and climate zones. The sample was not intended to be statistically representative, but instead to provide rich, varied perspectives that could reveal cross cutting themes. Participants were paid $300 for interviews and $500 for site visits.

A.3 Data Collection Procedures

Interviews

Semi structured interviews were conducted primarily via online platforms (for example Microsoft Teams) or by phone, depending on participant preference and connectivity. Interviews typically lasted between 45 and 60 minutes.

Interview guides were tailored by actor group, but common topic areas included:

- System types and configurations that participants encounter
- Design and specification practices
- Installation and startup experiences
- Commissioning scope and quality
- Controls integration, including interactions with economizers and BAS
- Maintenance and cleaning practices
- Common field issues and troubleshooting stories
- Owner awareness and engagement
- Regional or climate related differences
- Perceptions of ERV and HRV value and risk

The semi structured format allowed the interviewer to probe deeply into specific systems and events while still ensuring that core topics were covered systematically across participants. Interviewees were encouraged to describe concrete examples from actual projects, rather than speaking only in generalities.

Site visits

In addition to interviews, the research included multiple in-person site visits. These visits generally involved:

- A tour of mechanical rooms and rooftop equipment
- Visual inspection of ERV and HRV units, including access, cleanliness, and apparent condition
- Discussion of recent maintenance or service history
- Review of any available O&M documentation on site
- Context setting conversations with facility staff or contractors who know the equipment

Observations from site visits were documented in structured notes and/or transcriptions immediately after each visit.

Secondary Research

Throughout the project, secondary research was conducted and updated. This work drew on:

- Energy codes and code commentary in the four states
- Utility incentive program materials
- Manufacturer installation and maintenance manuals for leading ERV and HRV vendors
- Industry guidance on cleaning, inspection, and fouling impacts
- Prior NEEA studies on related systems, including connected controls and commercial HVAC equipment
- Relevant trade articles and case studies

Secondary research helped frame the primary research tools, informed probing during interviews, and provided a technical backdrop for interpreting field experiences.

A.4 Data Processing and Management

Most interviews and site visits were video recorded and then transcribed by human translators. Where full transcripts were not feasible, detailed expanded notes were compiled immediately after the conversation.

Data processing steps included:

- Cleaning and organizing interview transcripts and site visit notes
- Assigning each transcript a consistent naming convention for traceability
- Removing or masking personally identifiable information beyond first name and last initial

Quotes used in the report have been drawn from these transcripts and notes. They were checked for accuracy and, where necessary, lightly edited for clarity, grammar, or to remove tangential content, while preserving the substance and tone of what the speaker said.

A.5 Analysis Approach

A thematic analysis approach was used to identify patterns, differences, and cross cutting issues across the dataset.

The analysis proceeded in several steps:

- Initial reading and note taking
  - The research team reviewed all interview transcripts, site visit notes, and secondary research summaries, generating short memos that captured initial impressions, surprising findings, and candidate themes.

- Open coding
  - Transcripts and notes were coded for recurring ideas, such as defrost issues, economizer conflicts, cleaning practices, access limitations, documentation problems, workforce shortages, and blind spots.

- Theme development
  - Individual codes were grouped into higher level themes, for example: controls and commissioning, design and configuration, maintenance and cleaning, workforce and training, owner awareness, and regional variation

- Cross actor comparison
  - Themes were examined across actor groups to identify where perspectives aligned and where they diverged. For instance, contractor and owner views on maintenance responsibility, or engineer and technician views on controls strategy

- Regional comparison
  - Statements related to climate, code environment, contractor density, and geographic conditions were compared across Washington, Oregon, Idaho, and Montana

- Integration with secondary research
  - Thematic findings were compared with secondary research to confirm where field experience agreed with published guidance and where gaps or tensions existed

The goal of this process was not to quantify how frequently each problem occurs, but to understand why particular patterns arise, how they interact, and which conditions appear most pivotal for ERV and HRV performance.

A.6 Limitations and Considerations

As a qualitative study, this research has several inherent limitations that should be considered when interpreting the findings and applying them to program design.

The participants were selected for their relevance and experience, not through random sampling. The findings therefore describe how systems behave and why problems occur, but they do not indicate exact prevalence rates in the overall market.

While the study intentionally included voices from all four NEEA states and from multiple building types, some segments are represented by more interviews and site visits than others. Inland and rural markets, for example, have fewer participants than coastal urban areas, which reflects both population density and ERV/HRV adoption levels.

Some data, especially around commissioning history or past failures, is based on participant recall rather than direct observation. Triangulation with site visits and secondary research was used where possible, but some details remain interpretive.

The study concentrated on small and mid-size commercial and institutional buildings, where ERV and HRV performance is particularly variable and where local workforce capacity and owner awareness are often constrained. Large scale systems, highly resourced institutions, and specialized industrial applications may exhibit different patterns.

Despite these limitations, the consistency of themes across multiple actor groups, building types, and regions provides a strong qualitative foundation. The findings offer a coherent and credible picture of the experience of maintaining and cleaning ERVs/HRVs.

Appendix B – Interview and Site Visit Instruments

Screener/Background - HVAC Contractors

Purpose: To recruit HVAC contractors who install, repair, and/or maintain/clean Energy Recovery Ventilator (ERV)/Heat Recovery Ventilator (HRV) systems, capturing a mix of experience levels, system types, and attitudes.

1. Do you currently install, repair, and/or maintain/clean ERV or HRV systems?
   - ☐ Yes, primarily ERV
   - ☐ Yes, primarily HRV
   - ☐ Both
   - ☐ I'm new to this, but I'm interested in gaining more experience
   - ☐ No, and I don't have interest (disqualify)

2. What types of energy/heat exchangers do you have access to within your customer base?
   - ☐ Wheel
   - ☐ Plate
   - ☐ Other
   - ☐ Don't know (disqualify)

3. What types of ERV/HRV configurations do you typically install, repair, and/or maintain/clean? *<screen for at least one of the first five>*
   - ☐ Dedicated outdoor air system (DOAS) - Centralized unit that conditions and delivers 100% outdoor air separately from heating/cooling systems
   - ☐ Packaged/integrated unit - ERV/HRV integrated into rooftop or air-handling units
   - ☐ Standalone/field-installed ERV/HRV - Independent unit added to existing HVAC systems
   - ☐ Other *<ask candidate to describe to ensure fit>*
   - ☐ None

4. How long have you been working with ERV/HRV systems? *<screen for a mix amongst HVAC contractors>*
   - ☐ Less than 1 year
   - ☐ 1-5 years
   - ☐ 6-10 years
   - ☐ More than 10 years

5. How would you describe your general attitude toward ERV/HRV systems? *<screen for a mix amongst HVAC contractors>*
   - ☐ Skeptical
   - ☐ Neutral/uncertain
   - ☐ Enthusiastic

6. Can you show me how you maintain and clean (2-3 examples) ERV/HRV systems within your customer base if we travel together for a day?
   - ◻ Yes
   - ◻ No (disqualify)

7. Will your customer relationships likely enable introductions/discussions with building owners, facilities personnel, the energy manager, etc., while we're there?
   - ◻ Yes
   - ◻ If they're available
   - ◻ Probably not

8. Are you willing to allow me to record our discussions on the day we work together?
   - ◻ Yes (note the media release agreement)
   - ◻ No

Screener/Background - Owners/Tenants/Maintainers

Purpose: To recruit participants who own, operate, and/or are directly responsible for day-to-day use and maintenance/cleaning of a particular building's ERV/HRV systems.

1. What type of building do you own, occupy, and/or maintain? *<screen for a mix>*
   - ◻ Government buildings (e.g., city hall, firehouse, etc.)
   - ◻ School or school district
   - ◻ Retail location
   - ◻ Hospital/healthcare
   - ◻ Office building (small/medium)
   - ◻ Other (disqualify if not similar in size/use to first three categories; avoid manufacturing)
   - ◻ None (disqualify)

2. What type of ventilation equipment do you have? *<screen for a mix>*
   - ◻ ERV
   - ◻ HRV
   - ◻ Both
   - ◻ Not sure, but I know it's a heat exchange system
   - ◻ None (disqualify)

3. How long has the system been in place?
   - ◻ Less than 1 year
   - ◻ 1-5 years
   - ◻ 6-10 years
   - ◻ More than 10 years
   - ◻ Not sure

4. How would you describe your attitude toward ventilation equipment? *<screen for a mix>*
   - ◻ Skeptical
   - ◻ Neutral
   - ◻ Enthusiastic

- ☐ Uncertain

6. Who is primarily responsible for the maintenance/cleaning of your system? *<screen for a mix>*
   - ☐ Owner
   - ☐ Tenant
   - ☐ Facilities personnel
   - ☐ Outside contractor
   - ☐ Other (specify)

Informal Discussion Guide - Site Visits

Purpose: To gather insights from both HVAC contractors and owners/tenants/maintainers during site visits, capturing both technical and operational perspectives.

<u>Building & System Context</u>

What is the primary function of this building?

When was the ERV/HRV system installed (new build vs. retrofit)? Which parts of the building are ventilated, and why? What type of HVAC system was there before?

What type of system is in place (ERV vs. HRV, wheel vs. plate, integrated vs. bolt-on, DOAS (dedicated outdoor air system - Centralized unit that conditions and delivers 100% outdoor air separately from heating/cooling systems) vs. ERTU)?

<u>System Operation</u>

How is the system controlled and monitored on a day-to-day basis?
Is the system integrated with a building management system? If so, how well does it integrate?
What indicators do you use to evaluate performance (comfort, airflow, energy use, complaints, etc.)?

<u>Maintenance/Cleaning Practices</u>

Who is primarily responsible for maintenance/cleaning (in-house staff, tenants, outside contractors, etc.)?

How often is routine maintenance/cleaning (HVAC and ERV/HRV specifically) performed, and what does it include? How long does it usually take? Does it sometimes occur only after system failures have occurred?

Has poor maintenance ever led to premature equipment failure or the need for replacement?

What tools, cleaning agents, and processes are commonly used for core cleaning? In terms of hours and supplies, what type of cost is associated with maintenance and cleaning? How about for repairs?

Do maintenance teams have written procedures, or is it left to technician discretion?

What are the biggest obstacles to cleaning and maintenance (cost, staff time, training, access, replacement parts availability, etc.)?

What is the trickiest part of the actual cleaning process? Why? Did the person (or people) receive training concerning how to clean the ERV?

What access challenges have you encountered (rooftops, snow/ice, confined spaces, etc.)?

Have you noticed declines in system performance when not cleaned and maintained properly? Are you aware of the studies suggesting a 10-15% performance degradation from dirt and debris? Does that seem right to you? How does this influence maintenance schedules?

Costs and Resources

What budget and staffing resources are typically allocated to maintenance/cleaning? Is it enough?

Have rising costs or a lack of skilled contractors affected your ability to maintain the system?

Regional/Policy Context

How does the regional climate (e.g., Minnesota vs. Northwest) affect system performance or maintenance/cleaning?

Barriers and Challenges (HVAC Contractors Only)

How often do installations in commercial buildings follow manufacturer best practices for ducting, sealing, and airflow balancing? Is commissioning done (or assisted) by factory-trained personnel, or general HVAC contractors?

What shortcuts or design compromises are most common in the field, and what drives them (cost, space constraints, lack of training, etc.)?

How often are post-installation performance verifications, also known as commissioning practices (e.g., airflow, temperature recovery, etc.) completed and documented?

What common challenges have you encountered (installation quality, fouling, training gaps, controls issues, etc.)?

Do you believe the person/people responsible for maintenance/cleaning are properly trained?
What are the most frequent failure points you observe?

Improvement Opportunities

For contractors: What would make installation, maintenance, and/or cleaning easier?

For owners/maintainers: What would make operation and maintenance/cleaning easier?

What product, design, or training improvements would be most valuable?

Formal Discussion guide - 1:1 Interviews (Building Owners, Tenants, and Facilities)

Purpose: To collect deeper insights from owners/tenants/maintainers about adoption, operation, and maintenance/cleaning of ERV/HRV systems.

Background

What is your role in relation to the ERV/HRV system within your organization?

How familiar are you with these technologies?

What type of ERV/HRV system is in place in your building (ERV vs. HRV, wheel vs. plate, integrated vs. bolt-on, DOAS (vs. ERTU, high-efficiency vs. standard)?

Note: We're defining DOAS in the broader system sense, as a dedicated outdoor air system designed to deliver 100% outdoor air, with energy recovery via ERV/HRV components.

When was the system installed (new build vs. retrofit), and what was there before (if applicable)?

Adoption and Decision-Making

Why was the ERV/HRV system chosen (codes, incentives, comfort, energy savings, etc.)?

Who was involved in the decision to purchase and install the system?

Installation and Commissioning

Was it easy to find a contractor knowledgeable in the installation of your ERV/HRV?

How smoothly did installation and commissioning go?

What challenges or integration issues arose during installation?

Maintenance/Cleaning and Operations

Are you aware of the service needs of ERVs/HRVs, as described by manufacturers or other experts?

Is ERV/HRV maintenance typically included in building lease agreements? If not, where does that responsibility land?

What have your typical maintenance/cleaning costs been?

Are these costs similar to traditional HVAC systems in your experience (i.e., without ERV/HRV)? How long does it typically take?

Has the presence of an ERV/HRV increased the number of maintenance calls needed?

What tools, cleaning agents and processes do you use for core and/or wheel cleaning?

Do maintenance teams have written procedures, or is it left to technician discretion?

What is your understanding of the benefits of maintaining this equipment?

Have you noticed any performance degradation since installing the system?

Probe: Are you aware of the 10-15% performance degradation from fouling? If you are aware, does that knowledge influence maintenance schedules?

How often is routine maintenance/cleaning performed, and what does it include?

Does it sometimes occur only after system failures have occurred?

If those responsible are not doing the recommended cleaning and maintenance, why aren't they?

Have any of the ERVs/HRVs you have installed experienced premature failure or replacement? If yes, has poor maintenance ever led to premature equipment failure or replacement?

Does shutting down the system for maintenance/cleaning impact the experience significantly, or is it done after hours to prevent disruption?

How is the system controlled and monitored day-to-day? Is it integrated with a building management system, and how well does that integration work?

What indicators do you use to evaluate performance (comfort, airflow, energy use, complaints)?

Training and Support

Did you receive training from manufacturers or contractors on how to maintain or clean the equipment?

Was the training sufficient for understanding how to conduct long-term maintenance/cleaning?

What additional support or training would help you maintain the system effectively?

Barriers and Challenges

What are the biggest obstacles to keeping ERV/HRV systems operating efficiently (cost, access, expertise, time, etc.)?

Do you feel the system provides the value you expected compared to its performance?

Regional/Policy Context

How has your regional climate affected system performance?

Have codes, standards, or incentives influenced your adoption or maintenance/cleaning practices?

Are there any service restrictions when below freezing? Are there certain procedures that are different when it's cold?

Improvement Opportunities

What product, design, or training changes would make ERV/HRV systems easier to use or maintain?

What advice would you give to another owner or tenant considering an ERV/HRV system?

If given the opportunity, would you make the decision to install ERV/HRV again? Why or why not?

Formal Discussion Guide - 1:1 Interviews (ESCOs, HVAC Contractors, and Manufacturer Representatives)

Purpose: To collect deeper insights from energy service companies, HVAC contractors, and manufacturers about adoption, operation, and maintenance/cleaning of ERV/HRV systems.

Background

What is your role regarding ERV/HRV systems?

What types of ERV/HRV systems have you recommended, installed and/or cleaned and maintained (ERV vs. HRV, wheel vs. plate, integrated vs. bolt-on, DOAS vs. ERTU, high-efficiency vs. standard)?

When you recommend or install ERV/HRV, what type of system is typically being replaced?

Adoption and Decision-Making

Why are ERV/HRV systems chosen (codes, incentives, comfort, energy savings, etc.)?

Are you seeing incentives being claimed for ERV/HRVs? What incentives lead to the highest levels of adoption?

Who is typically involved in the decision to purchase and install an ERV/HRV system?

Installation and Commissioning

How smoothly does installation and commissioning typically go, as compared with traditional HVAC?

What challenges or integration issues arise during installation?

Are there improvements in design, training, or other elements that would help things go more smoothly?

Maintenance/Cleaning and Operation

How familiar are you (and your customers) with manufacturer-recommended maintenance and cleaning for ERV/HRV systems?

How often is maintenance or cleaning typically performed, and what does it usually include? Is maintenance done proactively, or only when problems occur?

Who typically performs the maintenance or cleaning, and do they follow written procedures or rely on technician judgment? What tools or cleaning methods are most common for servicing cores or wheels?

Does shutting down systems for maintenance cause disruption, or is it handled after hours?

What are the typical costs and time requirements for ERV/HRV maintenance? How do these compare with traditional HVAC systems without energy recovery? Has adding ERV/HRV equipment increased maintenance calls or service complexity?

Have you observed performance degradation or failures related to poor maintenance? What's the expected lifespan of an ERV/HRV system with and without proper upkeep? Does neglecting maintenance lead to faster or more severe issues than traditional HVAC systems?

Do maintenance teams and building owners recognize the benefits of proper ERV/HRV upkeep? How do you communicate those benefits (quantitatively or through examples) to customers? Have you ever gained clients because previous maintenance was neglected, and they sought to correct it?

How are customers' systems monitored day-to-day? Are they integrated with a building management system, and if so, how well does it support maintenance and performance tracking? What indicators do you or your customers use to gauge performance (e.g., comfort, airflow, energy savings, complaints)?

Training and Support

Does your organization provide training to customers or HVAC contractors on ERV/HRV cleaning and maintenance? <Not applicable to ESCOs>

Do you think the status quo for training is sufficient, or are there areas that could be improved? If so, what are your recommendations?

What additional support or training would help customers to maintain their systems effectively?

Barriers and Challenges

What are the biggest obstacles to keeping ERV/HRV systems operating efficiently (cost, access, expertise, time, etc.)?

Do you feel the system provides the value you expected compared to its performance?

Regional/Policy Context

Have you seen system performance impacts from regional climate? Please explain what you've noticed and how the various regions should adapt.

Are there any service restrictions when below freezing. Are there certain procedures that are different when it's cold?

Do you believe codes, standards, and/or incentives have influenced the adoption or maintenance/cleaning practices of ERV/HRV?

Appendix C – Glossary of Terms

This glossary provides definitions for key technical and operational terms used throughout the ERV and HRV Market Research Study. The purpose of this appendix is to ensure that all readers, regardless of technical background, share a common understanding of the concepts referenced in the report.

Air Class

A classification system used to describe the quality of airstreams and whether air from one space or process can be transferred to another. Manufacturers often require awareness of air class when determining whether an ERV wheel can transfer contaminants or moisture between exhaust and outdoor air streams.

Air Handling Unit (AHU)

A central HVAC unit that conditions and distributes air through a building. AHUs may include components such as fans, filters, heating and cooling coils, dampers, and sometimes energy recovery devices.

Balanced Ventilation

A ventilation approach that supplies and exhausts comparable volumes of air to maintain neutral building pressure. ERVs and HRVs typically operate as balanced ventilation systems.

Building Automation System (BAS)

A digital control system that manages HVAC equipment, lighting, and other building systems. BAS platforms execute SOOs and provide monitoring, alarms, and trend data for equipment including ERVs and HRVs.

Bypass Damper

A damper that redirects air around the ERV core or wheel under specific conditions. Bypass dampers are used during economizer operation, frost protection, or under conditions where energy recovery is not desirable.

Commissioning

A structured process that verifies correct installation, system setup, and functional performance according to design intent. Commissioning includes verifying airflow, testing SOOs, and confirming proper interaction between ERVs and other HVAC components.

Connected Commissioning

A commissioning approach that uses sensors, data collection, and digital controls to evaluate system performance remotely or continuously after initial installation. This method supports ongoing or periodic verification rather than a one-time event.

Core (Plate Heat Exchanger)

A fixed energy recovery device that transfers heat, and sometimes moisture, between exhaust air and incoming outdoor air. Plate cores have no moving parts and are commonly used in HRVs.

Dedicated Outdoor Air System (DOAS)

A ventilation system that conditions and delivers outdoor air directly to occupied spaces, independent from heating and cooling systems. DOAS units often include ERVs and are widely used to meet modern ventilation and energy code requirements. *Note: industry-wide, there are a variety of definitions and types of DOAS. This definition is meant to represent the types of DOAS referenced in this report.*

Defrost SOO

A programmed controls strategy designed to prevent freezing of the ERV wheel or HRV core during cold weather. Defrost strategies may include preheat, bypass, reduced airflow, or scheduled system pauses.

Economizer

A control strategy that prioritizes the use of outdoor air for cooling when conditions are favorable. Economizers can interact with ERVs, and controls strategies must be coordinated to prevent conflicts.

Energy Recovery Ventilator (ERV)

A mechanical ventilation system that exchanges both heat and moisture between incoming and outgoing air streams. ERVs reduce heating and cooling loads by transferring energy between airstreams.

Exhaust Air

Air that is removed from a building and discharged outdoors. Exhaust air may contain moisture, heat, contaminants, or odors depending on the source.

Fan Degradation

The decline in fan performance over time due to wear, fouling, or imbalance. Fan degradation can reduce airflow and energy recovery effectiveness.

Facilities Manager

The internal person within the organization who has the responsibility of maintaining the facility, including the building (or buildings), infrastructure (plumbing, electrical, HVAC, etc.), aesthetics, and landscaping.

Filter Loading

The accumulation of dust, debris, and particulate matter on HVAC filters. Filter loading reduces airflow and increases static pressure across the system.

Fouling

The buildup of dirt, smoke, and debris, which can impact efficiency of the system by straining fans and motors.

Heat Recovery Ventilator (HRV)

A ventilation system that transfers heat, but not moisture, between outgoing and incoming air streams. HRVs are commonly used in colder or dryer climates.

Heating Degree Days (HDD)

A measure of heating demand based on outdoor temperature. Areas with high HDD values experience longer or colder winters, creating more challenging conditions for ERV and HRV operation.

Humidity Transfer

The movement of moisture between airstreams in an ERV wheel. Humidity transfer can help maintain indoor moisture levels and improve comfort.

Indoor Air Quality (IAQ)

The condition of indoor air as it relates to the health and comfort of occupants. IAQ is influenced by ventilation rates, contaminant control, filtration, and humidity levels.

Operator

Within this report, the person (or sometimes team) responsible for keeping the HVAC system (including ERV/HRV) running optimally, regardless of whether supported by a building automation system.

Owner

The owner of the commercial building, even when the property is leased to another organization or person.

Plate Heat Exchanger

A stationary component used in HRVs to transfer heat between outgoing and incoming air streams. Plate exchangers do not transfer moisture.

Programming Drift

Changes to system control settings over time due to manual overrides, sensor drift, or unintended control interactions. Drift can degrade ERV and HRV performance without obvious symptoms.

Return Air

Air that flows from occupied spaces back to the HVAC system to be conditioned or exhausted.

Rooftop Unit (RTU)

A packaged HVAC unit installed on a building's roof. RTUs may integrate heating, cooling, ventilation, and sometimes energy recovery components.

Safe Lockout

A procedure used by technicians to shut down electrical and mechanical equipment safely prior to performing maintenance. Safe lockout procedures prevent accidental start-ups during servicing.

Sequence of Operation (SOO)

A written description of how an HVAC system is intended to function, including logic for fans, dampers, heating and cooling stages, economizers, ERVs, and defrost cycles. An accurate controls strategy is essential for correct ERV control.

Sensible Heat Transfer

The transfer of heat that changes air temperature without changing moisture content. Both ERVs and HRVs exchange sensible heat.

Static Pressure

The resistance to airflow within a duct system or across a component such as a filter or ERV core. High static pressure reduces system efficiency and airflow.

Supply Air

Air delivered to occupied spaces after conditioning and ventilation processes.

Ventilation Load

The heating or cooling energy required to condition outdoor air brought into a building. ERVs and HRVs reduce ventilation load by transferring heat or moisture from exhaust air.

Wheel (Rotary Heat Exchanger)

A rotating energy recovery device that transfers heat and moisture between incoming and outgoing air streams. Wheels are used in ERVs and have moving components that require regular cleaning and maintenance.

Wildfire Smoke Loading

A rapid accumulation of airborne particulates in filters caused by regional wildfire smoke events. This condition significantly increases filter replacement frequency in affected areas.

Zonal Variation

Regional differences in climate, elevation, geography, or humidity that influence ERV and HRV behavior. Zonal variation is especially important in the Northwest due to coastal humidity and inland freeze risk.

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Appendix E – Full Set of Recommendations

E.1 Improve Controls Integration and Standardize Sequences of Operation

Develop Standardized SOOs for Common Use Cases

Developing accessible, regionally aligned SOOs for common building types or climates may help contractors, commissioning agents, and operators better align system behavior with design intent. Standardized SOOs could also support clearer turnover documentation and simplify training efforts.

Support Integration of ERVs and HRVs Into Building Automation Systems

In buildings with automation systems, integrating these units would allow operators to view system status, receive alarms, and identify performance issues earlier. Integration may also help align seasonal behavior, frost control, or bypass modes with building needs. Supporting integration can include guidance for contractors, resources for operators, or coordination with manufacturers to ensure that equipment is “controls ready” for typical regional platforms.

Provide Clear Guidance for Commissioning and Controls Verification

Commissioning played a significant role in shaping long-term system outcomes in this study. Supporting clear commissioning steps, including controls verification and setpoint confirmation, may help ensure that systems begin life aligned with the intended SOO. Even basic checklists or regionally consistent guidance could support higher-quality outcomes and reduce the likelihood of misconfigured or default settings persisting for years.

Improve Operator Access to System Status and Alerts

Because operators lack tools that show system behavior, supporting the adoption of simple status indicators, control points, or alarms may help them identify drift or failures earlier. Increased visibility may also help create a clearer connection between system performance and the value of maintenance investment.

E.2 Strengthen Commissioning and Post-Occupancy Verification

Support More Consistent and Thorough Commissioning Practices

Participants emphasized that commissioning frequently focuses on equipment startup rather than a full verification of airflow, recovery function, defrost control, and SOO alignment. Contractors described situations where balancing was skipped or controls remained at default settings. Supporting clearer regional guidance, practical checklists, or baseline expectations could help reduce variability in commissioning quality. Strengthening commissioning practice would help ensure that systems begin operation aligned with design intent and reduce the likelihood of early drift.

Emphasize Documentation of As-Built Conditions and Startup Setting

Encouraging contractors to document as-built placement, drain configuration, balancing results, and initial controls settings would support operators and help future contractors understand expected system behavior. Even basic as-built summaries or commissioning reports would help maintain continuity of knowledge.

Promote Early Post-Occupancy Verification to Catch Drift

Supporting a simple post-occupancy verification within the first six to twelve months could help identify early performance issues before they become long-term failures. This verification could serve as a touchpoint to confirm airflow, drain performance, frost control behavior, and operator understanding.

Create Clarity Around Seasonal and Climate-Specific Adjustments

Post-occupancy verification offers an opportunity to support seasonal optimization, confirm correct control modes, and help operators understand which conditions require attention. This can reduce nuisance issues such as freezing, condensation, or bypass misalignment.

Strengthen Handoff Coordination Between Designers, Installers, and Operators

Encouraging more consistent documentation exchange or simple handoff protocols during commissioning and verification may support stronger continuity through the system lifecycle.

E.3 Improve Operator Visibility into System Performance

Increase Availability of Basic Status and Fault Indicators

Supporting the adoption of simple, accessible status indicators can give operators immediate cues about system behavior. Even basic fault lights, mode indicators, or airflow warning signals can reduce the likelihood that issues remain undetected for long periods. These features also help operators differentiate between routine conditions and problems that require intervention.

Support Integration with Building Automation Systems Where Feasible

Where buildings have automation systems, integrating ERV and HRV units into the existing platform can significantly improve visibility. Integration allows operators to view setpoints, bypass status, alarms, and seasonal behavior in real time. Participants noted that most systems remain standalone even when automation is available. Guidance for contractors and operators, or coordination with manufacturers to ensure that ERVs and HRVs ship with integration-ready capabilities, could make these connections more common.

Provide Operators with Simple Diagnostic and Verification Tools

Tools that help verify airflow, core condition, drain performance, or frost control behavior could support quicker diagnosis and reduce reliance on reactive troubleshooting. These tools could range from checklists to low-cost measurement devices or regionally developed field guides.

Clarify Normal System Behavior to Reduce Unnecessary Disablement

Materials that describe typical system responses, seasonal expectations, or common indicators of proper performance could help prevent avoidable disablement and increase operator confidence.

Improve Documentation Availability and Alignment with Installed Conditions

Visibility is not limited to real-time indicators. Operators also need clear, accurate documentation that reflects as-built conditions and commissioning settings. Encouraging contractors to provide accessible as-built diagrams, startup parameters, and simple maintenance expectations can help operators verify whether the system remains aligned with design intent.

E.4 Enhance Owner Education and Turnover Training

Clarify System Purpose and Expected Benefits for Owners

Owners in many buildings described ERVs and HRVs as background equipment that was not well understood or seen as a priority. Providing clear information about the purpose of ERV and HRV systems, their contribution to ventilation and energy performance, and the risks of long-term drift or disablement can help owners recognize their importance. Educational resources that focus on practical outcomes, such as indoor air quality, equipment longevity, and operational stability, may help increase the visibility of system value.

Provide Simple, Accessible Turnover Materials at Project Completion

Turnover training varied widely across the region, with many operators receiving little or no documentation that matched installed conditions. Supporting a regional standard for turnover materials, such as brief as-built summaries, control settings, maintenance expectations, and common troubleshooting steps, can help ensure that operators start with the information they need. Effective turnover materials should be concise, practical, and aligned with the system as installed rather than the initial design drawings.

Establish Repeatable Turnover Protocols for Contractors and Commissioning Agents

Participants emphasized that continuity is often lost during the transition between installation and operation. Encouraging contractors or commissioning agents to follow a simple, repeatable protocol for turnover training can help reduce variability in what owners and operators receive. Protocols may include walk-through demonstrations of access points, drain checks, core removal, filter changes, and review of expected seasonal behavior.

Support Ongoing Owner Engagement After Initial Turnover

Even when training occurs at project completion, staff turnover or shifting priorities can erode institutional knowledge within a few years. Encouraging periodic check-ins, simple reminders, or post-occupancy education materials may help owners stay connected to system performance. This can reinforce the importance of ongoing maintenance and early detection of performance drift.

Align Education with Regional Climate and Market Conditions

Because climate and market conditions shape system behavior, turnover materials should reflect regional realities. For example, buildings in colder climates may require clear guidance on frost control and drain protection, while coastal regions may benefit from information on moisture management and filter loading conditions. Tailoring education to local conditions can improve relevance and retention.

E.5 Strengthen Contractor and Technician Capacity

Support More Accessible and Practical Training Opportunities

Training opportunities for ERV and HRV systems were described as inconsistent and often oriented toward basic product awareness rather than deeper configuration, troubleshooting, or commissioning skills. Contractors noted that manufacturer training may not always be available or may not reflect regional climates or building conditions. Supporting training that is hands-on, scenario-based, and aligned with the types of installations common in the Northwest may help build technician confidence. Short-format training or regional workshops that focus on practical skills such as drain configuration, core inspection, and frost control setup may be especially valuable.

Develop Regional Guidance for Common Installation and Commissioning Issues

Developing clear, region-specific guidance or field reference materials that address frequent installation and commissioning problems can support more consistent outcomes. These resources may also help new technicians understand the nuances of ERV and HRV systems in colder climates or buildings with limited access.

Provide Contractors with Tools to Support Better Handoffs to Operators

Resources such as simple checklists, as-built summaries, or standardized turnover templates could help contractors deliver more consistent information to operators. Better handoffs can improve operator understanding and reduce future troubleshooting calls, which contractors identified as a recurring challenge.

Encourage Knowledge Sharing Across Markets with Different Installation Volumes

Because ERV and HRV systems are more common in some jurisdictions than others, technicians in lower-volume markets have fewer opportunities to learn from repeated installation and service experiences. Supporting mechanisms for knowledge sharing, whether through regional networks, cross-company collaboration, or online technical exchanges, could help build capacity in areas where ERVs and HRVs are less frequently installed. Contractors suggested that even informal opportunities to compare experiences would be helpful.

Support Contractor Confidence in Controls and Commissioning Tasks

Commissioning and controls configuration emerged as areas where technicians often feel less confident, especially when systems are not standardized across manufacturers. Training or reference materials that clarify expected commissioning steps, common control modes, and regionally appropriate frost control strategies may help technicians complete more thorough and consistent setup. Enhanced contractor competency in these areas can significantly reduce early performance drift.

E.6 Improve Maintainability and Access to Equipment

Encourage Designs That Prioritize Safe and Practical Access

Supporting design practices that incorporate adequate service clearances, safe ladders or platforms, and logical placement of access panels can help reduce the burden on operators and make proactive maintenance more realistic.

Integrate Maintainability Considerations Early in Design and Layout Planning

Encouraging teams to evaluate maintainability at schematic design rather than addressing it after construction constraints are fixed can help ensure that ERV and HRV systems are easier to reach and service once installed. Early coordination between designers, installers, and operators may also reduce the likelihood of last-minute placement decisions that compromise access.

Support Clear Installation Guidance Focused on Long-Term Care

Improving maintainability also requires practical installation guidance that emphasizes long-term service needs. Recurring issues such as improperly sloped drain lines, inaccessible traps, and hard-to-remove cores were sometimes mentioned during interviews. Providing installers with guidance on common access pitfalls and regionally appropriate best practices can help reduce preventable maintenance challenges.

Promote Use of Equipment Features That Facilitate Maintenance

Participants described certain design features, such as hinged access doors, internal lighting, removable trays, or externally accessible filters, which make maintenance easier and more consistent. Encouraging the use of equipment models or configurations that prioritize maintainability may help operators keep systems in better condition. When operators can reach components efficiently, they are more likely to complete routine tasks and less likely to defer maintenance.

Align Turnover Training with Access Realities

Turnover training is more effective when operators understand how and where to access the system. Incorporating access demonstrations, safe access procedures, and clear documentation into turnover practices can help operators feel more comfortable performing routine inspections. This also reduces reliance on contractors for basic tasks and supports early identification of performance drift or component failure.

Expand Field Resources for Operators Who Face Challenging Access Conditions

Some buildings have inherent access limitations due to their design or age. Providing operators with additional field resources, such as simple access guides, troubleshooting tips for difficult locations, or guidance on when contractor support is recommended, may help mitigate the challenges posed by hard-to-reach systems.

E.7 Promote Consistent Documentation and Handoffs

Encourage Clear, Concise As-Built Documentation That Reflects Installed Conditions

Encouraging simple, accurate as-built documentation that captures placement, access considerations, drain configuration, balancing results, and initial control settings can help operators understand the system and maintain alignment with design intent.

Provide Structured Handoff Templates for Contractors and Commissioning Agents

Handoff quality varied widely across the region, with some operators receiving comprehensive training and others receiving only a brief explanation or no walkthrough at all. Supporting repeatable handoff templates, covering system purpose, access points, maintenance tasks, expected seasonal behavior, and troubleshooting cues, can promote consistency across contractors and projects. Even a short, standardized checklist can significantly improve communication during this critical transition.

Improve Coordination Across Design, Installation, and Operations Teams

Participants noted that information often fails to move across phases of the project. Designers may not learn how installations were adapted in the field, installers may not have full visibility into design intent, and operators often inherit systems without any context. Encouraging early coordination meetings, shared documentation platforms, or simple communication protocols can reduce these misalignments and improve long-term performance.

Support Documentation Practices That Survive Staff Turnover

Staff turnover is a consistent challenge across commercial buildings. Without accessible and durable documentation, institutional knowledge about ERV and HRV systems is easily lost. Providing operators with simple, durable records that remain with the equipment, such as laminated summaries, QR-coded digital files, or on-unit labels, can help preserve system knowledge even when personnel change.

Clarify Maintenance Expectations and Provide Simple Reference Materials

Clear maintenance expectations included in turnover materials can help operators plan preventive activities. Simple field guides, quick-reference cards, or seasonally updated reminders may help operators stay aligned with expected system behavior and identify early signs of performance drift.

E.8 Support Programmatic Approaches to Prevent Performance Drift

Develop Approaches That Provide Ongoing Operational Support Rather Than One-Time Interventions

Programmatic models, such as scheduled check-ins, periodic field verification, or structured monitoring support, can help identify early issues before they become long-term failures. Even modest periodic verification can reinforce operator confidence and catch problems that operators cannot see.

Encourage Building Owners to Adopt Routine Performance Check Frameworks

Supporting simple frameworks for routine checks, such as quarterly or semi-annual reviews of filters, drains, control modes, or airflow indicators, can help owners plan preventive action. These approaches do not need to be complex; even basic, programmatic routines can help sustain system performance and reduce the need for reactive troubleshooting.

Promote Tools That Facilitate Ongoing Monitoring Alerts

Improving visibility into system behavior is a critical element of preventing drift. Programmatic support for simple monitoring tools, alerts, or dashboards can help operators identify issues earlier. These tools do not need to be sophisticated to be effective. Even basic indicators of core condition, drain status, or airflow deviations can reduce the likelihood that issues persist unnoticed.

Integrate Performance Drift Prevention Into Turnover and Training Materials

Embedding simple drift-prevention practices, such as scheduled checks, early-season reminders, or common troubleshooting cues into turnover materials, can help operators maintain alignment with expected performance. Including these practices in training resources reinforces their importance and supports long-term care.

Coordinate Programmatic Efforts with Workforce and Owner Engagement

Supporting frameworks that clarify roles, encourage information exchange, and reinforce predictable routines may help reduce gaps at handoff points. Even modest coordination tools can strengthen operator confidence and reduce the likelihood of drift becoming long-term disablement.

Support Approaches Tailored to Regional Conditions

Climate strongly influences performance drift, particularly in colder or more humid parts of the region. Programmatic support that accounts for regional differences, such as tailored seasonal checks or climate-specific troubleshooting guidance, can improve the relevance and usability of drift prevention practices. Participants noted that drift looks different in different climates; tailoring support accordingly may increase adoption and effectiveness.

E.9 Tailor Interventions to Regional Differences

Adapt Guidance and Training to Climate-Specific Conditions

Supporting climate-specific training and guidance, such as frost control expectations, drain protection practices, humidity-related cleaning intervals, or wildfire smoke filtration considerations, can help operators and contractors address the challenges most likely to occur in their area. Tailored materials aligned with local weather patterns may also improve operator confidence and reduce long-term drift.

Account for Market Maturity and Workforce Familiarity

Tailoring interventions to market maturity, such as offering more foundational training in low-volume markets and more advanced support in high-volume markets, can help ensure that resources match local needs. Approaches such as peer-to-peer networks, regionally specific workshops, or targeted capacity-building programs may help close gaps between markets.

Align Interventions With Local Permitting and Code Environments

Participants noted that permitting environments and code enforcement vary widely across jurisdictions. Strategies that align with local regulatory contexts may find greater traction than uniform regionwide approaches. For example, intervention tools could include guidance that reflects the specific requirements or interpretations common in each state or jurisdiction, making resources more immediately usable for contractors, designers, and operators.

Support Locally Relevant Collaboration and Information Exchange

Regional differences also affect how contractors and operators share knowledge. In smaller markets, connecting practitioners across jurisdictions may help expose them to solutions not commonly seen locally. Supporting regional or sub-regional forums, knowledge exchanges, or technical working groups can help overcome geographic disparities in adoption and experience.

E.10 Partner with Manufacturers and BAS Vendors

Collaborate to Improve Build-In Diagnostics and Status Indicators

Partnering with manufacturers to encourage clearer, more accessible indicators can help operators identify issues earlier and maintain alignment with expected behavior. Even simple built-in diagnostic features or more transparent fault signaling could meaningfully reduce the likelihood of undetected failures.

Encourage Manufacturers to Support Regionally Appropriate Controls Capabilities

Coordinating with manufacturers to improve support for region-specific needs, such as enhanced frost protection logic, clearer bypass settings, or simplified mode selection, can help reduce commissioning variability and improve long-term performance outcomes.

Improve Integration Pathways Between ERV/HRV Units and Building Automation Systems

Partnering with both manufacturers and BAS vendors to streamline integration pathways, clarify wiring and communication protocols, and provide clear examples for common building types may help expand BAS visibility and reduce operator uncertainty.

Support Development of Standardized Sequences of Operation Across Equipment Platforms

Earlier recommendations emphasized the value of standardized SOOs. Manufacturers and BAS vendors can play an important role in helping develop sequences that are both technically feasible and aligned with equipment capabilities. Coordinated work in this area may help reduce field variability, increase consistency across manufacturers, and support more effective commissioning and operation.

Encourage Consistency in Documentation, Wiring Diagrams, and Controls Information

Contractors reported that documentation and wiring diagrams differ substantially across manufacturers, increasing the difficulty of installation and integration. Facilitating collaboration to improve clarity, reduce ambiguity, and align materials with typical regional applications can help reduce installation variability and strengthen overall system reliability.