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High-Performance HVAC Market Progress Evaluation Report 1

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Executive Summary

On behalf of the Northwest Energy Efficiency Alliance (NEEA), NMR Group, Inc. (NMR), working with Apex Analytics (Apex) (together, "the team") completed the 1st Market Progress Evaluation Report (MPER) of NEEA's High-Performance Heating, Ventilation, and Air Conditioning (HP HVAC) Initiative. The initiative supports NEEA's Very High Efficiency, Dedicated Outside Air System (VHE DOAS) approach, which can dramatically reduce energy consumption in commercial buildings. VHE DOAS includes four key elements:

- a high-performance electric heat pump system,
- a high-efficiency heat or energy recovery ventilator (HRV/ERV) with at least 82% sensible effectiveness,
- right-sized heating and cooling equipment, and
- fully decoupled ventilation from heating and cooling.

NEEA's market transformation initiatives include concept development, program development, and market transformation phases. NEEA's concept development for VHE DOAS lasted from 2015 until early 2017. NEEA then shifted into program development, designing the core strategy and focus of the initiative. In 2022, NEEA moved into the market transformation phase, actively addressing market barriers to broader adoption of VHE DOAS. NEEA follows a strategic roadmap laid out in the initiative's logic model to work to remove those barriers and transform the commercial HVAC market. Ultimately, the initiative's work is designed to bring VHE DOAS levels of energy efficiency into energy codes in the Northwest.

MPER #1 overarching research objectives:

Gather feedback about **NEEA's VHE DOAS educational, training, and marketing materials, and about designers' perspectives** on VHE DOAS.

Measure key MPIs related to high priority market barriers and provide a baseline for longitudinal tracking of market progress.

Qualitatively assess program influence on observed market transformation.

Key research activities:

1. Expert review of NEEA's VHE DOAS educational/marketing materials (n=2)
2. Observation of NEEA trainings (n=4) and survey of NEEA trainees (n=14)
3. Interviews with HVAC system designers (n=7)
4. Survey with HVAC designers and manufacturer representatives (n=70)
5. Review of web traffic and stakeholder websites for references to VHE DOAS
6. Review of NEEA documentation of VHE DOAS market progress

Key findings and recommendations:

1 *HVAC system designers recognize VHE DOAS as compatible with best practices, even if they are unfamiliar with the term "VHE DOAS."*

Early study tasks sought to understand designers' familiarity with VHE DOAS or the terminology used by the HP HVAC Initiative [MPI 7a], given that awareness of VHE DOAS is a key barrier. Designers are more familiar with the elements of VHE DOAS as a loosely related set of practices, rather than as a unified approach with consistently recognized terminology or jargon, or as a brand supported by BetterBricks. Further exacerbating the awareness barrier is that designers have different definitions of DOAS itself, the concept on which VHE DOAS is based.

Additionally, the study saw evidence of competing branding proliferating in the market, particularly outside of the Northwest, such as VHE HVAC, the preferred terminology of the Institute for Market Transformation for essentially the same set of practices. Despite these reasonable challenges for a relatively new and complex package of HVAC practices, HVAC designers — particularly those who appeared efficiency-minded — recognize that VHE DOAS elements are in line with best practices for high-performance all-electric HVAC.

Related recommendation. Given confusion around the definition of DOAS and VHE DOAS and competing language in other jurisdictions (VHE HVAC), NEEA could consider working with partners to coalesce around a set of definitions and consistent terminology, or proactively acknowledge the alternative terminology to highlight their commonalities. Consistent terminology and stronger branding of VHE DOAS may help further NEEA's efforts to help transform the market.

2 *While awareness is relatively high, adoption is limited by market barriers, including upfront cost and skepticism about energy savings, reliability, or ability to provide sufficient comfort. Even though designers can identify benefits of VHE DOAS, cost concerns may keep them from fully incorporating all four of its elements into their projects.*

Most designers saw the advantages of VHE DOAS [MPI 7d] and recognized it as compatible with HVAC best practices, but they also saw barriers, such as upfront cost, space constraints, and project-specific limitations. Some were skeptical of VHE DOAS, concerned about reliability, comfort, or indoor air quality. Some favored approaches they believed to be time-tested and durable (and less likely to result in customer complaints) over newer practices they perceived as overly focused on energy efficiency.

Upfront cost is a prominent barrier for decision makers. Given its higher cost compared to alternative designs (confirmed by NEEA cost research), some designers indicated VHE DOAS would be most palatable to green-minded clients who prioritize energy savings over initial cost — more typical clients may only be interested in measures with very quick payback periods (e.g., less than five years).

Related recommendation. NEEA has worked with engineering teams to estimate cost, savings, and payback periods for VHE DOAS using a variety of baseline scenarios and building types. NEEA should focus on increasing the circulation of these materials (along with case studies describing achieved savings) to demonstrate the veracity of the claimed savings, so decision makers can feel more comfortable with an approach that may have higher upfront costs compared to alternatives.

3 *VHE DOAS is gaining traction, but adoption is difficult to measure. Differing interpretations of VHE DOAS may lead some designers to overestimate the number of fully compliant projects, but even a growing number of near-VHE DOAS projects is a positive sign.*

The estimated number of VHE DOAS projects installed in the Northwest [MPI 8e] varies greatly between NEEA's confirmed installations and reports from designers surveyed for this MPER. NEEA's market intelligence identified only about 35 confirmed VHE DOAS projects between 2022 and 2024. In contrast, surveyed designers said that, on average, 24% of their projects in 2023 satisfied all of the VHE DOAS design elements. If accurate, those survey responses would represent over 250 VHE DOAS projects in a single year. Designers may be overstating the prevalence of VHE DOAS, in part due to misunderstandings about the definition of VHE DOAS, but it is also possible that many designers are accurately describing increased adoption of VHE DOAS or at least *near*-VHE DOAS practices. In that case, the low counts confirmed by NEEA may stem from the inherent challenge of identifying these projects in the real world.

Related recommendation. Designers' counts of full VHE DOAS installations may be overstated, but NEEA's counts based primarily on incentive uptake and program participation could very well *undercount* VHE DOAS projects. Future research should investigate what portion of installations are fully compliant with VHE DOAS best practices and how near-VHE DOAS projects fall short.

4 *Designers who work in Washington are more likely to include VHE DOAS in their HVAC designs. This is likely a function of VHE DOAS elements being incorporated into Washington energy code, which is itself due in part to NEEA's code influence efforts.*

NEEA helped drive the adoption of VHE DOAS elements into Washington's energy code [MPI 6c]. The inclusion of these elements in the code has helped bolster the legitimacy of the approach to a broad pool of market actors in Washington. Designers who worked in Washington reported installing and proposing VHE DOAS more frequently than those who only work in the other states. Some market actors even conflate the Washington code elements and VHE DOAS itself. NEEA has developed materials in response that compare each element. Given the similarity between code and the slightly more efficient requirements of VHE DOAS, it is clear these code requirements have driven market adoption of VHE DOAS, or at least encouraged projects to incorporate some of the VHE DOAS elements.

Related recommendation. NEEA should continue to emphasize how Washington code has incorporated VHE DOAS elements, showing potentially skeptical audiences that it is an established best practice.

5 *NEEA's trainings are a valuable resource for spreading awareness, addressing questions, and encouraging deeper engagement with VHE DOAS. In fact, designers appear much more likely to propose VHE DOAS after attending a NEEA training.*

Education and hands-on training are important tools for increasing designers' understanding and acceptance of VHE DOAS, as NEEA's BetterBricks trainings demonstrate. NEEA's VHE DOAS trainings are high quality and impactful. At observed trainings, participants were engaged and seemed to find the trainers compelling and trustworthy, and they appeared to have limited skepticism after the training. Trainees also reported they were likely to implement what they learned into their work and to recommend the trainings to others, a strong sign of their value.

Related recommendation. Attendees generally come away from sessions interested in implementing VHE DOAS. Accordingly, NEEA should continue to offer training on VHE DOAS to designers and other decision makers, and look for ways to boost attendance. To ensure follow-through, NEEA should keep attendees engaged with updates and additional informational and training offerings.

6 *NEEA's training, educational, and marketing materials serve as a valuable resource for spreading awareness of VHE DOAS.*

Across research activities for this MPER, various market actors reported that NEEA's VHE DOAS materials were clear and informative. Commercial HVAC market actors who were asked to review the materials saw value in them, and HVAC designers who participated in BetterBricks' trainings were familiar with VHE DOAS and appeared comfortable incorporating it into their projects.

Based on the web scan task that included looking for evidence of other key partners' use or citation of NEEA's VHE DOAS materials, the MPER found that a variety of stakeholders leverage NEEA's materials or drive traffic to BetterBricks' VHE DOAS content, though some do not. Industry organizations involved in policy, certifications, or promoting best practices for energy efficiency (e.g., ASHRAE, PHIUS, or the Institute for Market Transformation) were more likely to host NEEA VHE DOAS materials, while firms that sell mechanical equipment (e.g., manufacturers, manufacturer representatives, or distributors) appeared less likely to do so, even those that sell E/HRV products suitable for use in VHE DOAS applications.

Related recommendation. Consider developing a press pack with standard descriptions of VHE DOAS terminology and licensed graphics for use by partners and the media to help encourage partners and industry organizations to leverage and share NEEA's polished VHE DOAS materials.

Related recommendation. NEEA should engage with key partners and stakeholders (e.g., utilities, manufacturers, and other energy-efficiency organizations) to ensure that as many of them as possible refer their customers and audiences to NEEA's BetterBricks materials about VHE DOAS. This would be particularly valuable among electric utilities with commercial HVAC or performance-based retrofit programs, as these materials could help design teams better achieve the savings that those programs encourage.

Section 1 *Background*

NEEA's first market progress evaluation for the HP HVAC Program

The NEEA High Performance Heating, Ventilation, and Air Conditioning (HP HVAC) Initiative promotes a high-performance set of HVAC practices that NEEA has been developing for the commercial HVAC market: the very high efficiency, dedicated outside air system approach, or simply, VHE DOAS. Dedicated outside air systems (DOAS) typically separate a building's ventilation system from its heating and cooling distribution system. VHE DOAS builds on the fundamental DOAS concept, providing a set of best practices that can dramatically reduce energy consumption in appropriate applications. Based on NEEA's pilot projects, it can reduce building HVAC-related energy consumption by roughly two-thirds.

VHE DOAS consists of four key elements:

- High-performance electric heat pump system
- High-efficiency heat or energy recovery ventilator (HRV/ERV) with at least 82% sensible recovery effectiveness (SRE)
- Right-sized heating and cooling equipment
- Fully decoupled ventilation from heating and cooling

The HP HVAC Initiative works to overcome market barriers that hinder adoption of VHE DOAS, with an ultimate goal of transforming the commercial HVAC market in the Northwest by incorporating VHE DOAS-levels of energy efficiency into code. NEEA has designed interventions to address key barriers, such as lack of awareness of VHE DOAS, limited availability and high first-cost of extremely efficient E/HRVs, and lack of explicit support from established industry organizations. To address these barriers, the Initiative works toward key market outcomes, such as building VHE DOAS into industry trainings and certifications, increasing product availability and incentives, promoting broader adoption, and updating relevant test procedures.

Recent Program Activities. The HP HVAC Initiative is relatively new, as it only officially moved into its active market transformation phase in 2022. Since then, NEEA has focused on market engagement with HVAC manufacturers, HVAC system designers, utilities, energy-efficiency organizations, and HVAC industry organizations to begin addressing market barriers that prevent adoption of VHE DOAS. NEEA has also participated in code influence efforts, which have helped incorporate aspects of VHE DOAS into the Washington energy code.

One of NEEA's key efforts has included building a body of educational and training materials offered through its BetterBricks platform; these include various online educational materials and a significant number of virtual and in-person training efforts designed to increase familiarity with VHE DOAS. As described in this MPER, other institutions have used these materials to promote VHE DOAS or similar approaches.

NEEA program staff have continued to work with manufacturers to encourage them to bring to market ERVs and HRVs that satisfy the VHE DOAS specifications. There were no manufacturers of E/HRVs that provided 82% efficiency (SRE) in 2016, but with NEEA's support, the first came to market in 2016 and there are now eight in total [MPI 3b]. NEEA has continued to work with these and other potential manufacturers to increase their offerings, and eventually bring lower price-point products to market.

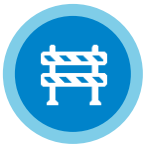
NEEA continues to collaborate with local and regional utilities and national industry associations to support program designs that promote or incentivize ventilation approaches that align with VHE DOAS. There are currently 17 partners — manufacturers, large utilities, and manufacturer representatives — that offer incentives for qualifying E/HRVs [MPI 2a]. NEEA's current incentive strategy offers $4/nominal CFM for qualified E/HRV units — up to $20,000 — to encourage adoption of eligible equipment, an amount calibrated to offset the incremental cost of using such a high-performance E/HRV over a less efficient option [MPI 2a]. NEEA offers funding support to manufacturer representative firms through contracts that include project incentives and additional support for marketing, training, and promotion, helping them gain the experience and confidence with VHE DOAS to help their customers engage with it and understand its benefits. NEEA's incentive strategy uses an upstream model, targeting manufacturer representatives — rather than working separately with designers, suppliers, and contractors.

Market Progress Evaluation Report (MPER) #1. As with NEEA's other market transformation initiatives, the HP HVAC Initiative uses a logic model to describe the pre-existing market barriers and opportunities and the program activities the initiative will deploy to mitigate those barriers. The logic model concisely describes the anticipated short, medium, and long-term outcomes the initiative expects to see in the market as a result of its interventions. Progress toward these outcomes is measured through systematic tracking of market progress indicators (MPIs). Taken cumulatively, the qualitative and quantitative data collected and documented in NEEA's market progress evaluation reports (MPERs) provide evidence of the extent to which market transformation is occurring. NEEA also documents the outputs of the program activities, such as trainings and case studies, deployed to achieve the market outcomes described in the logic model.

By conducting roughly annual assessments of the market, NEEA follows evaluation best practices for achieving and documenting change in a complex market. For its other initiatives, NEEA completes regular MPERs to measure and compare market changes against established baselines and to identify opportunities to improve its market interventions. This represents the first such assessment for the HP HVAC Initiative. Accordingly, MPER #1 sets the stage for NEEA's future MPERs to provide consistent comparisons of market progress across time, focusing on measuring key MPIs and also providing useful market intelligence for the HP HVAC Initiative team.

Research Objectives

This first MPER included formative and summative research objectives.



Formative research is exploratory and designed to help understand an issue or problem. In this case, formative research focused on 1) investigating the effectiveness of NEEA's VHE DOAS educational and marketing materials, and 2) understanding HVAC designers' perspectives on VHE DOAS, including why it may not be included in their projects.

Summative research is focused on assessing progress or impacts. For this MPER, summative tasks focused on evaluating performance against key MPIs, setting the stage for longitudinal comparisons of market progress in future MPERs. Specific topics of focus included the proliferation of NEEA's educational materials into the broader market, VHE DOAS recommendation and installation rates, designers' ability to identify VHE DOAS benefits, product availability, and incorporation of its elements into code.

Methodology

The team undertook a variety of research tasks to address VHE DOAS market transformation as a result of NEEA's HP HVAC Initiative. More details about the methodology of each research task can be found in the respective appendices. All surveys and interview guides can be found in Appendix H.

Core Study Tasks

Expert Review of Training Materials (n=2). The team provided NEEA's new training and marketing materials to experienced HVAC engineers in the Northeast, who provided feedback about the materials and VHE DOAS, offering opportunities to improve the materials and insight into engineers' initial reaction to VHE DOAS.

Observation of NEEA Trainings (n=4) and Trainee Survey (n=14). The team observed BetterBricks VHE DOAS trainings to assess the quality and impact of the trainings. The team also distributed a small-scale survey to trainees immediately after the training, allowing them to provide feedback about the training and VHE DOAS.

Interviews with HVAC System Designers (n=7). The team interviewed commercial HVAC system designers (engineers) to gather qualitative feedback about their perspectives on and experience with VHE DOAS, including barriers to adoption. Designers also provided feedback about VHE DOAS terminology, to ensure that the MPER's designer and manufacturer survey used appropriate technical phrasing that designers could readily understand.

Designer and Manufacturer Survey (n= 70). The team conducted a web survey with HVAC designers and manufacturer representatives. Respondents were recruited primarily from industry contact lists and professional networking sites. The survey assessed familiarity with and perspectives on NEEA, DOAS/VHE DOAS, and NEEA-sponsored training on VHE DOAS.

Web Scan and Web Traffic Review. The team conducted a web scan to find instances of other stakeholders using NEEA's VHE DOAS materials. The team also assessed the frequency and provenance of visitors to BetterBricks' VHE DOAS online materials.

Document Review of NEEA Materials. NEEA provided a great deal of documentation that NMR used to assess progress for key market indicators in the early stages of NEEA's VHE DOAS initiative. NMR reviewed these materials to extract relevant MPI measurements (in addition to measurements gathered from the MPER's primary research) to track efforts toward the adoption and awareness of VHE DOAS, incentive offerings for qualifying ERVs/HRVs amongst priority suppliers and utilities, updates to the ASHRAE materials, the inclusion of DOAS in commercial energy codes, and so on.

Synthesis sessions. Across the duration of the project, NMR and Apex led multiple synthesis sessions to informally present preliminary findings and discuss future research efforts.

Report Organization

The overall report structure is as follows:

Report Body

- Executive Summary: a high-level summary of key findings and recommendations
- Background: a summary of the MPERs' goals and methodology, including information about NEEA's market transformation efforts and MPER process
- Key Findings: a narrative summary of high-level takeaways. This section covers formative and summative research topics. As appropriate, MPI measurements are identified in the course of the narrative (Appendix G provides a full listing of all MPI measurements included in the MPER).
- Other Findings: a narrative summary of additional findings

Appendices (including detailed methods and findings for each research activity)

- Appendix A Training Materials Expert Review
- Appendix B Training Observations and Survey
- Appendix C Designer Interviews
- Appendix D System Designer and Manufacturer Rep Survey
- Appendix E Web Scan and Traffic Review
- Appendix F NEEA Document Review
- Appendix G MPI Measurements and Output Tracking
- Appendix H Instruments

Key Limitations and Sources of Uncertainty

Sample frame limitations for HVAC designers. The study gathered input from HVAC designers active in the Northwest, recruited primarily from an industry contact list purchased and refined by NEEA, based on company NAICS codes. NAICS codes are not granular enough to readily identify HVAC system designers, meaning the initial contact list, though large, had many ineligible potential respondents, and it was challenging to identify how many of the sample frame were actually appropriate targets for interviews or surveys.

Potential bias. Bias could play a role in a variety of ways. Despite recruitment efforts that avoided targeting efficiency-minded respondents, it is possible that the people who responded to the survey and interview requests were themselves more predisposed to favor energy-efficient approaches, and thus provided skewed feedback about the prevalence of VHE DOAS in the market. Additionally, recruitment could simply have yielded high response rates from people who participated in past NEEA VHE DOAS trainings (20% of survey respondents), or who work in Washington, which has VHE DOAS elements included in the energy code (74% of survey respondents).

Reliance on NEEA materials. For confirming program outputs and progress on a variety of MPIs, the MPER relied on materials provided by NEEA, including interviews and conversations with staff, email records, internal documents, and so forth, rather than fully relying on primary data collection gathered independently of NEEA's involvement.

Section 2 *Key Findings*

1 *HVAC system designers recognize VHE DOAS as compatible with best practices, even if they are unfamiliar with the term "VHE DOAS."*

VHE DOAS has four key elements, each with technical specifications.[1] This inherent complexity represents a barrier to adoption, which NEEA addresses with educational and marketing efforts. The challenge of succinctly describing VHE DOAS was clearly visible in this MPER, where evaluators needed to carefully explain the elements of VHE DOAS to HVAC designers as a part of surveys and interviews. In general, designers seem more familiar with VHE DOAS as a loosely related set of practices, rather than as a unified approach with consistent terminology. For additional details about the results of the surveys and interviews, see Appendix C and Appendix D, respectively.

Inconsistent familiarity with VHE DOAS. Before seeing the definition, 41% of surveyed HVAC designers said they were not at all familiar with VHE DOAS (*unaided* awareness). After seeing the definition (*aided* awareness), many revised their responses — 26% went from "not at all familiar" to a higher level of familiarity (Figure 1). (Interviews with designers yielded similar results. See Figure 6.) Ultimately, only one in five surveyed designers said they were "not at all familiar" with VHE DOAS after reviewing the definition; 60% were at least "somewhat familiar" and had worked with VHE DOAS at least occasionally.

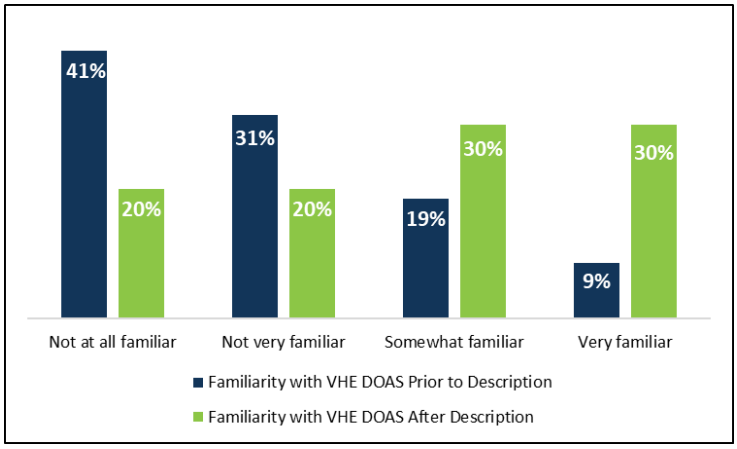


Figure 1: Familiarity with VHE DOAS
(n=70)

[1] https://betterbricks.com/wp-content/uploads/2025/03/VHEDOAS_Comprehensive-Design-Guide.pdf

One-third (32%) of surveyed designers correctly identified three of the four VHE DOAS key elements [MPI 7a] from a list of potential options (including some incorrect choices, shown in gray in Figure 2). Only 15% identified all appropriate answers. The most recognized element was the high-efficiency E/HRV, selected by 83% of respondents.

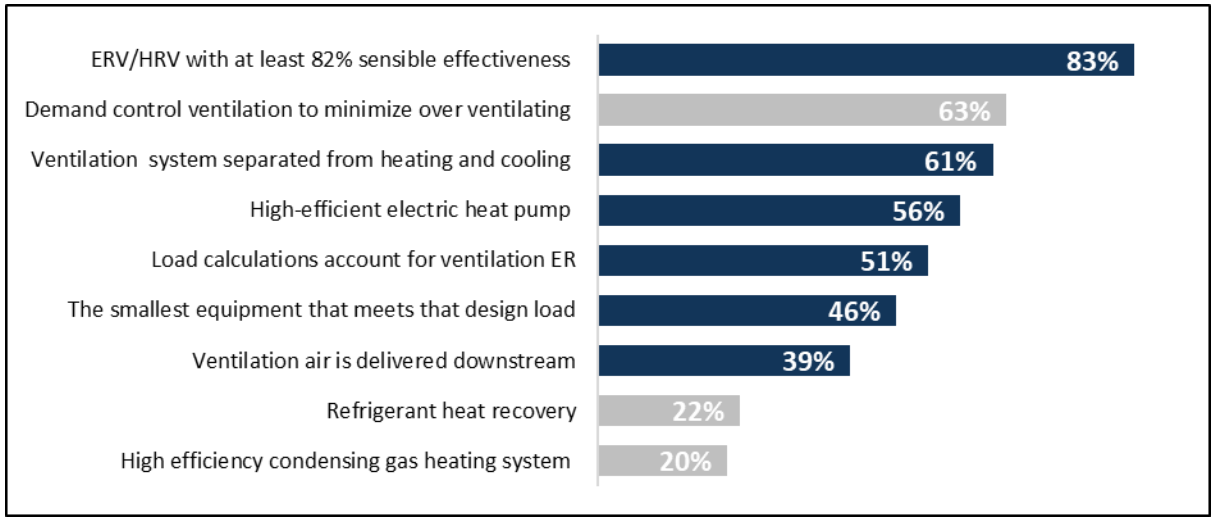


Figure 2: Identifying Key Elements of VHE DOAS
(n=41; multiple responses allowed)

Inconsistent view of DOAS fundamentals. Surveyed HVAC designers say they are extremely familiar with DOAS: 94% had heard of it and two-thirds were "very familiar" and worked with it regularly. Eight out of ten (82%) reported favorable views of DOAS. However, interviews with designers highlighted that "DOAS" means different things to different people, complicating NEEA's work to present VHE DOAS as a unified concept. For example, some interviewees described DOAS as a piece of *equipment* (i.e., an E/HRV); some described it as an *approach* to ventilation; still others described it as the *practice* of fully separating ventilation and space conditioning ducts. (See Appendix C for more detail.)

A complicated but flexible approach. NEEA designed its VHE DOAS technical guidance to offer flexibility to design teams.[2] For each design element, NEEA presents best practices and then a range of acceptable practices. This flexible approach provides useful guidance for design teams even if they cannot fully incorporate every best practice into a project. This flexibility may help design teams use VHE DOAS practices, but it does contribute to the aforementioned definitional problem — VHE DOAS becomes harder to describe when it covers not only four elements, but also a range of practices for each one.

Competing branding. Further complicating the awareness barrier is that this study saw evidence of competing branding proliferating in the market (particularly outside of the Northwest), such as VHE HVAC, the preferred terminology of the Institute for Market Transformation (IMT) to describe essentially the same set of practices. The study's web scan found that IMT appears to be a relatively prolific advocate for VHE DOAS (using the VHE HVAC terminology), including contributing to research on the

[2] https://betterbricks.com/wp-content/uploads/2025/03/VHEDOAS_Comprehensive-Design-Guide.pdf

topic under the purview of the federal government.[3] (See Appendix E for more discussion of the web scan results.)

Designers see benefits to VHE DOAS. Surveyed designers overwhelmingly reported that they saw benefits to the elements of VHE DOAS. When the survey asked designers about each of its elements individually, the vast majority agreed that each one provided a benefit in a commercial HVAC design [MPI 7d]:

- full decoupling of ventilation ducts: 91% agreed
- extremely efficient E/HRV: 89% agreed
- qualifying all-electric HVAC system: 86% agreed
- right-sized mechanical systems to account for ventilation recovery: 84% agreed

Two-thirds of surveyed designers (67%) reported that they saw a benefit to all four items.[4] Surveyed designers who attended a NEEA training (n=14) were more likely to identify advantages of VHE DOAS, with 100% reporting that they saw a benefit to fall four items, compared to 55% of non-trained designers (n=55).

WHEN ASKED TO IDENTIFY ANY POTENTIAL ADVANTAGES OF INCLUDING *ALL FOUR* VHE DOAS ELEMENTS INTO A COMMERCIAL HVAC SYSTEM (EVEN IF THEY DID NOT INITIALLY IDENTIFY AN ADVANTAGE TO THE INDIVIDUAL ITEMS), MORE THAN HALF OF RESPONDENTS (55%) NAMED ENERGY AND/OR COST SAVINGS. SEE for more detail, particularly about the benefits they saw to the various elements of VHE DOAS.

OPINIONS OF DOAS AND VHE DOAS

> "All together these make for a supremely efficient HVAC system that is more energy efficient, reduces global warming potential, can be more cost effective than traditional systems, and can provide more flexibility architecturally by reducing distribution ductwork size."
>
> **— Surveyed designer**

> VHE DOAS emphasizes the "importance of looking at the big picture and system-wide considerations."
>
> **— VHE DOAS training attendee**

The interviews confirmed that designers — particularly those who gave the impression of being interested in energy efficiency — tended to recognize the VHE DOAS design elements as in line with best practices for high-performance all-electric HVAC systems. This was true even if they did not recognize VHE DOAS as a well-defined package prior to these conversations.

Related recommendation. Given confusion around the definition of DOAS and VHE DOAS and competing language in other jurisdictions (VHE HVAC), NEEA could consider working with partners to coalesce around a set of definitions and consistent terminology, or proactively acknowledge the

[3] United States General Services Administration (GSA). 2024. Technical Specification for Very High-Efficiency HVAC. Retrieved from https://www.gsa.gov/system/files/2024-Tech%20Spec%20for%20Very%20High-Efficiency%20HVAC.pdf

[4] Ninety-seven percent reported seeing a benefit of at least two of the elements; 89% did so for at least three.

alternative terminology to highlight their commonalities. Consistent terminology and stronger branding of VHE DOAS may help further NEEA's efforts to help transform the market.

2 ***While awareness may be relatively high, adoption is limited by market barriers, including upfront cost and skepticism about energy savings, reliability, or ability to provide sufficient comfort. Even though designers can identify benefits of VHE DOAS, cost concerns may keep them from fully incorporating all four of its elements into their projects.***

Barriers to VHE DOAS adoption. As noted, most designers could see advantages to VHE DOAS, and many viewed it as compatible with HVAC best practices. But they also identified barriers to broader adoption, including cost considerations, space limitations, and other concerns about applicability for different building types. Some were skeptical of the approach itself, unsure if it was sufficiently reliable or could adequately meet the needs of building occupants in terms of comfort and indoor air quality. Designers clearly communicated these concerns in one-on-one interviews, as described in the interviewees' Opinions of DOAS and VHE DOAS

. One designer offered provided the following take on VHE DOAS, describing pros and cons.

> *VHE DOAS is basically "heat pumps/VRF with DOAS, which is the right way to design commercial buildings that are of a reasonable size. Energy efficiency and adequate ventilation are the advantages here, but there is a substantial first cost. [E]nergy modeling should be utilized on more projects to show the simple payback to the owners."*
>
> **— Surveyed designer**

During designer interviews, a skeptical contingent worried that VHE DOAS might not satisfy their clients' needs beyond energy efficiency, such as comfort, long-term durability, and maintenance costs. They expressed concern that VHE DOAS (and potentially other HVAC solutions) might be so focused on energy efficiency that it did not adequately address those other factors. These respondents appeared to favor designs they believed to be time-tested, durable, and less likely to result in customer complaints, rather than newer approaches that — in their mind — prioritized energy efficiency over all else. One designer was concerned about VHE DOAS' right-sizing equipment requirement, noting how designers are taking a risk by proposing any system that may not fully satisfy their clients.

> *"I understand [the benefit of] equipment running in its sweet spot and [the resulting] reduced cost, but no one ever calls NEEA or BetterBricks when the building is cold."*
>
> **— Interviewed designer**

This sort of skepticism was most common among respondents with less experience with VHE DOAS — they might have been unfamiliar with NEEA or VHE DOAS, or appeared to put less emphasis on energy efficiency relative to other factors. One described a distaste for VHE DOAS and any other set of prescriptive HVAC practices was unlikely to meet their customers' unique needs.

> Prescriptive approaches are "too cookbook."
>
> **— Interviewed designer**

Upfront cost. Upfront cost is a prominent barrier to VHE DOAS, and NEEA's own cost research confirms these likely higher upfront costs, along with the expected energy savings. Given its higher cost compared to alternative designs, some designers indicated during interviews that VHE DOAS would be most palatable to green-minded clients who might be willing to accept other tradeoffs for the sake of energy efficiency. These designers indicated that more typical clients may only be interested in measures with very quick payback periods — e.g., shorter than five years.

> *"In HVAC design, if you want to optimize for energy [efficiency] then you are not likely optimizing for comfort or lowest cost."*
>
> **— Interviewed designer**

Cost-cutting strategies. When prompted, some designers volunteered in interviews and surveys that simply reducing the efficiency of the proposed heat pump or the E/HRV itself was a potential way to reduce the cost of a VHE DOAS design. Reducing the efficiency of a specific component provides savings with limited additional design cost. Switching to an alternative design entirely for the sake of cost savings might be the next option, but this would require more design time. Attendees at BetterBricks VHE DOAS trainings expressed related concerns, asking about up-front costs and how to calculate expected savings and payback periods relative to a traditional HVAC system. See Training Observations and Survey for more detail.

Related recommendation. NEEA has worked with engineering teams to estimate cost, savings, and payback periods for VHE DOAS using a variety of baseline scenarios and building types. NEEA should focus on increasing the circulation of these materials (along with case studies describing achieved savings) to demonstrate the veracity of the claimed savings, so decision makers can feel more comfortable with an approach that may have higher upfront costs compared to alternatives.

3 *VHE DOAS is gaining traction, but adoption is difficult to measure. Differing interpretations of VHE DOAS may lead some designers to overestimate the number of fully compliant projects, but even a growing number of near-VHE DOAS projects is a positive sign.*

Prevalence of VHE DOAS according to NEEA market intelligence. It is challenging to accurately quantify the number of VHE DOAS projects in the Northwest. It is too new for a central database or certification program to exist and, as described previously, market actors do not universally recognize the terminology. Based on market intelligence including industry contacts, recipients of incentives from NEEA and other utility partners, NEEA has identified only 5 confirmed VHE DOAS projects in 2022, 11 in 2023, and 19 in 2024 [MPI 8e].

Prevalence of VHE DOAS according to surveyed/interviewed designers. In contrast, designers said they install VHE DOAS *much more often* than those figures would indicate. On average, surveyed designers said 24% of their commercial HVAC projects in the past year (2023) fully satisfied all four VHE DOAS criteria. If accurate, this would represent over 250 projects across the 70 respondents (10% of their cumulative projects) [MPI 8e]. Additionally, over half of designers (52%) said they had proposed at least one VHE DOAS project in that year.[5] Even if the survey respondents were more green-minded than the overall population of designers active in the Northwest, the number of projects they alone worked on dwarfs the counts provided to NEEA based primarily on incentive and utility program data. Table 1 describes what portion of each designer's projects included VHE DOAS elements in the past year.

Table 1: Features of Commercial HVAC Projects Worked on in Past 12 Months (2023)

Number of Projects that…	Average by Respondent (Unweighted)	Project-Weighted Average
Had reduced heating/cooling design loads due to ventilation energy- or heat recovery	40%	18%
Had a high-efficiency electric heating system (often VRF or other inverter driven heat pump technology)	38%	18%
Had the minimum capacity heating/cooling equipment that met the design load	37%	20%
Used DOAS with fully separate air distribution for ventilation vs heating/cooling	35%	21%
Had an ERV/HRV with at least 82% sensible effectiveness	27%	13%
Used DOAS with gas heating	17%	10%
How many met all 4 design elements of VHE DOAS	**24%**	**10%**

[5] Eleven percent said they proposed VHE DOAS more often in 2023 than in the previous year, while 17% said less often. These figures appear to have more to do with the varying number and type of projects designers work on in a given year than their views on the value of VHE DOAS.

Survey respondents could have overstated their use of VHE DOAS. Some might have been describing *near*-VHE DOAS projects, given that some of the elements listed above could be open to interpretation. That said, in-depth interviews with a small number of designers (n=4) supported the survey's results (Figure 3). Two of the interviewees, for example, included elements of VHE DOAS in at least half of their projects over the past year.[6] During these interviews, evaluators carefully reviewed the definition of VHE DOAS with the respondents, making it unlikely that these estimates were inflated due to misunderstandings about the definition of DOAS or VHE DOAS.

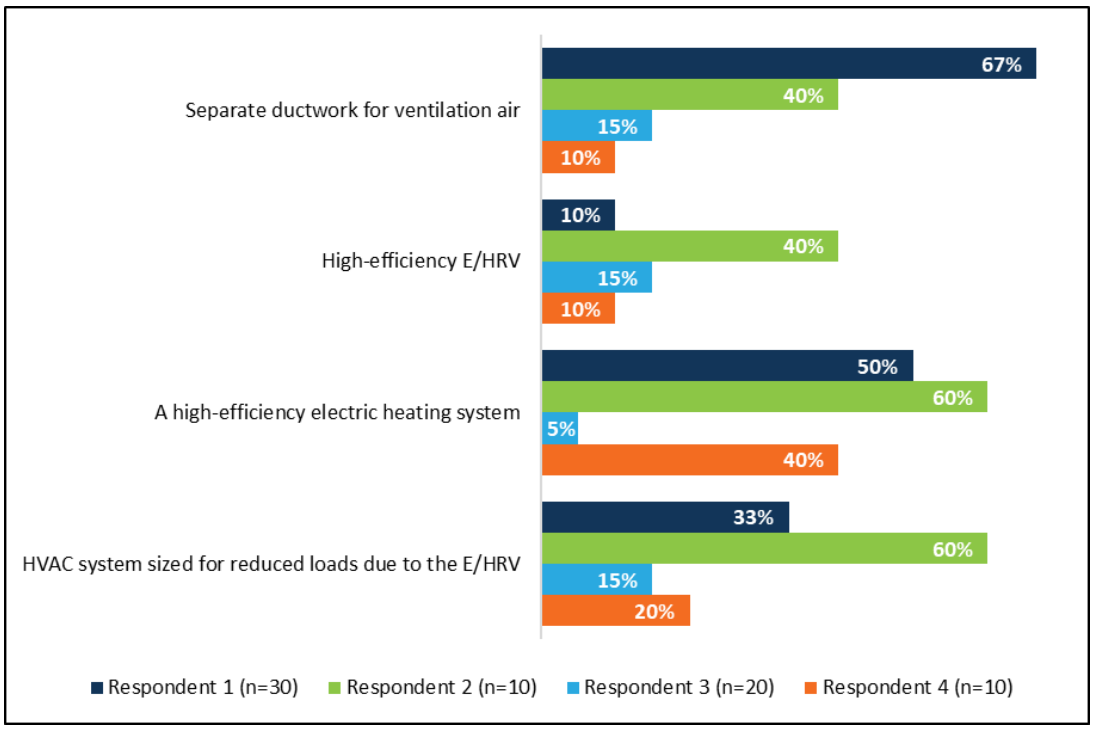


Figure 3: Percentage of Commercial Projects that Included Elements of VHE DOAS
(n=4)

Even if definitional inconsistency caused designers to overestimate their use of VHE DOAS, they clearly seem to include VHE DOAS or elements of it in their projects, a positive sign for continued progress.

Related recommendation. Designers' counts of full VHE DOAS installations may be overstated, but NEEA's counts based primarily on incentive uptake and program participation could very well undercount VHE DOAS projects. Future research should investigate what portion of installations are fully compliant with VHE DOAS best practices and in what ways near-VHE DOAS projects fall short.

[6] Interviewees were not asked to estimate how many projects included all 4 elements of VHE DOAS.

4 *Designers who work in Washington are more likely to include VHE DOAS in their HVAC designs. This is likely a function of VHE DOAS elements being incorporated in Washington energy code, which is itself due in part to NEEA's code influence efforts.*

Incorporation into WSEC — a path to increased legitimacy. The Washington State Energy Code that went into effect in March 2024 (WSEC 2021)[7] includes elements that are quite similar to the four key components of VHE DOAS [MPI 6c], in part due to NEEA's code influence efforts.[8] In fact, some designers interviewed for this MPER thought VHE DOAS was *already* required by Washington state code. Based on survey results, designers who work in Washington propose VHE DOAS far more often than their peers in other states: 67% of designers who worked in Washington said they proposed VHE DOAS at least once in the past year, compared to only 19% of designers who did not work in Washington.

Designers who work in Washington were also more likely to have VHE DOAS installed on at least one of their projects in the past year (51%) than designers who do not work in Washington (25%).[9] These huge differences are likely due to the influence of the Washington code and those designers' resulting experience with VHE DOAS. Given the similarity between the code language and the slightly more efficiency requirements of VHE DOAS, it is clear that these requirements have driven market adoption of VHE DOAS, or at least near-VHE DOAS practices.

The incorporation of VHE DOAS into code is a strong endorsement of it as a best practice. Early in the MPER, two commercial HVAC experts in the Northeast were asked to comment on NEEA's VHE DOAS materials (see Appendix B). They encouraged NEEA to highlight how the Washington code has adopted VHE DOAS elements, suggesting that this explicit connection would increase its perceived legitimacy. This same suggestion was noted during interviews with HVAC designers (see Appendix C). In fact, NEEA has already prepared materials that compare the individual elements of the Washington code and VHE DOAS, which should help NEEA continue to make this connection for market actors.[10]

Code as the key driver for some designers. Some designers who incorporate VHE DOAS into designs may be primarily acting to meet code rather than convinced of its merits. For example, when asked to identify advantages of VHE DOAS, some only that it met code requirements. A designer who attended a VHE DOAS training indicated it did not influence their decision to include VHE DOAS elements in their projects because "*it is all in the [Washington] code language, or the differences are subtle*."

Related recommendation. NEEA should continue to emphasize how Washington code has incorporated VHE DOAS elements, showing potentially skeptical audiences that it is an established best practice.

[7] Washington State Energy Code – Commercial, 2021 Edition (2024). WAC 51-11C. https://sbcc.wa.gov/sites/default/files/2024-01/2021_WSEC_C_2ndEd_012824.pdf; see C406.2.2.6, for example, for the High Performance DOAS Option that provide credit for achieving ventilation performance similar to that of VHE DOAS.
[8] The most recent NEEA Codes Influence MPER (#5), for example, describes NEEA's involvement in recent code changes in Washington. https://neea.org/wp-content/uploads/2025/03/codes-mper-5.pdf
[9] Some projects may not be proposed in the same calendar year as they are implemented, accounting for the greater number of VHE DOAS projects installed than proposed in the past year.
[10] In fact, NEEA has developed guidance comparing VHE DOAS with WSEC 2021 code language. https://www.waenergycodes.com/pdf/VHEDOAS_WSEC-Comparison_091120.pdf

5 *NEEA's trainings are a valuable resource for spreading awareness, addressing questions, and encouraging deeper engagement with VHE DOAS. In fact, designers appear much more likely to propose VHE DOAS after attending a NEEA training.*

Evaluators observed four of NEEA's BetterBricks VHE DOAS trainings to provide qualitative insight into their effectiveness. The team also asked trainees from one session (n=14) to answer a survey about their experience (see Appendix B). The trainees' high-level of engagement and professed desire to use what they learned underscore the value of these trainings as a part of NEEA's market transformation efforts.

Knowledgeable trainers, engaged audiences, and limited skepticism. Observers from the team noted that the trainings were well-received. Attendees were curious, engaged, and asked questions aimed at learning more about VHE DOAS and how to implement it. They actively listened and took notes, suggesting many were not familiar with VHE DOAS prior to the presentation — it did not appear to be old information to many of them. Questions were relevant and detailed, specifically about VHE DOAS and how to implement it in different scenarios. In contrast to some of the feedback received during interviews with HVAC designers, the training attendees did not appear openly skeptical of VHE DOAS.

Likely to use what they learned from NEEA. Prior to a fall 2023 training, nearly half (43%) of attendees surveyed immediately after the training (n=14) said they were "not at all familiar" with VHE DOAS prior to the training (Table 2), but *all* of them — even those who learned about it for the first time during the training — said they were "somewhat" or "very likely" to use what they had learned in the training their work, an extremely positive signal about the trainings' ability to shift how market actors design systems.

Table 2: Trainee Familiarity with VHE DOAS Prior to BetterBricks Training (Fall 2023)

Familiarity with DOAS	Number of Respondents
Not at all familiar—never heard of it	6 (43%)
Not very familiar—heard of it but never worked with it	5 (36%)
Somewhat familiar—worked with it occasionally	3 (21%)
Very familiar—worked with it regularly	0
Total	**14**

Positive views of trainings. Most attendees were likely to recommend the training to others, many enthusiastically. On a scale of 1 to 10 (10 means "extremely likely," 1 is "not likely") 52% of attendees scored their likelihood of recommending it a 9 or a 10,[11] for an overall net promoter score (NPS) of 40%.

Impact of training on VHE DOAS adoption. The MPER's main survey with designers (n=70) identified 14 designers who recalled taking a BetterBricks training about VHE DOAS (21%). Half of the designers (50%) who attended a training in the past two years said the training had positively influenced their decision to include VHE DOAS design elements in their projects since the training.

[11] 42% of designers who reported attending a training in the past two years (n=12) and 53% of post-training attendees (n=13, where only 15% of surveyed attendees worked for design firm) rated their likelihood of recommending training a 9 or 10.

NEEA's trainings are *"essential to building the knowledge, abilities, and self-assurance [for designers] to make wise choices when including VHE DOAS systems into their projects."*

— Surveyed designer

Most respondents who said the training did not influence their design said they were *already using* VHE DOAS or had not had an opportunity to do so — it was not due to lack of interest. One designer who attended trainings but did not propose VHE DOAS in the past year noted that their primary client over that time period had very prescriptive HVAC requirements and was not open to alternative approaches, suggesting an opportunity to increase VHE DOAS adoption by educating building owners and end-users.

On average, trained designers identified in the designer survey said 38% of their projects in the past year contained all four elements of VHE DOAS, compared to 20% of projects for designers who did not attend a training (Table 3). Relatedly, trained designers were also more likely to propose VHE DOAS to their clients (86%) compared to designers who had not attended a training session (47%). It is possible that green-minded designers might be more likely to attend NEEA trainings in the first place, but the feedback from trainees clearly indicates that the trainings impacted their behavior over the past year.

Table 3: Features of Commercial HVAC Projects Worked on in Past 12 Months (Respondent Averages), by Training Status and State
(n=63)

Average Amount of Projects that…	All Respondents	NEEA Training Attendance		State	
		Trained *(n=14)*	Not Trained *(n=49)*	Works in WA *(n=50)*	Does not work in WA *(n=13)*
Had reduced heating/cooling design loads due to ventilation energy- or heat recovery	40%	38%	40%	41%	34%
Had a high-efficiency electric heating system (often VRF or other inverter driven heat pump technology)	38%	38%	38%	43%	17%
Had the minimum capacity heating/cooling equipment that met the design load	37%	42%	36%	42%	20%
Used DOAS with fully separate air distribution for ventilation vs heating/cooling	35%	37%	34%	41%	12%
Had an ERV/HRV with at least 82% sensible effectiveness	27%	20%	28%	25%	32%
Used DOAS with gas heating	17%	14%	18%	17%	18%
How many met all 4 design elements of VHE DOAS	**24%**	**38%**	**20%**	**25%**	**18%**

Related recommendation. Attendees generally come away from sessions interested in VHE DOAS and with plans to implement it. Accordingly, NEEA should continue to offer training on VHE DOAS to designers and other decision makers, and look for ways to boost attendance. To ensure follow-through, NEEA should keep attendees engaged with updates and additional informational and training offerings.

6 *NEEA's training, educational, and marketing materials serve as a valuable resource for spreading awareness of VHE DOAS.*

NEEA has developed VHE DOAS training, educational, and marketing materials for other organizations to leverage.[12] The first envisioned outcome in NEEA's HP HVAC logic model, for example, describes the goal of having these material proliferate among various key organizations and stakeholders.

Useful educational materials. Across research activities, market actors reported that NEEA's VHE DOAS materials were clear and informative. Commercial HVAC experts who were asked to review the materials for the MPER saw value in them, also providing specific recommendations for increasing their utility (see Appendix A).

> *"The overall educational campaign is good and necessary work, particularly for the small commercial buildings market segment where failing HVAC systems are typically [replaced] with the same type and size of equipment as was originally installed."*
>
> **— Commercial HVAC market actor serving as expert reviewer**

Likewise, as noted previously, HVAC designers who participated in NEEA trainings valued the trainings and confirmed they were impactful — they were more aware of VHE DOAS than their untrained counterparts and appeared more likely to use it in their projects, another clear signal of their value.

While education and training are important tools for engaging designers and increasing confidence in VHE DOAS, hands-on experience could further convince skeptical professionals to take the approach from the classroom to a project. One interviewed designer who had participated in research efforts with NEEA regarding VHE DOAS in the past spoke incredibly highly of the value of the experience.

> *"It was a paradigm shift for me. … I was initially skeptical if [a] decoupled ventilation system was going to work, but … we haven't had any complaints. [Executing VHE DOAS projects with NEEA support] converted me, I'm a full supporter. Beyond that initial concern, we saw a lot of benefits to this approach. … [I went from a] skeptic to a believer."*
>
> **— Interviewed designer**

How people access BetterBricks VHE DOAS content. The study also reviewed the web traffic that accessed BetterBricks' VHE DOAS content between late 2023 and late 2024 (see Appendix E). Among visitors with an identifiable origin (63% of the traffic), most are located in the Northwest (44%) or regions where key VHE DOAS partners operate, such as New York (NYSERDA) or California (PGE, SCE, and SDG&E) (Figure 4). Expanding the reach of NEEA's VHE DOAS materials may influence different geographic markets, as designers who work in the Northwest may be based (and also work) elsewhere.[13]

[12] NEEA hosts many of these materials on the BetterBricks site: https://betterbricks.com/technologies/hvac/technologies-very-high-efficiency-doas/

[13] For example, two of the attendees at a NEEA training indicated they worked in all 50 states.

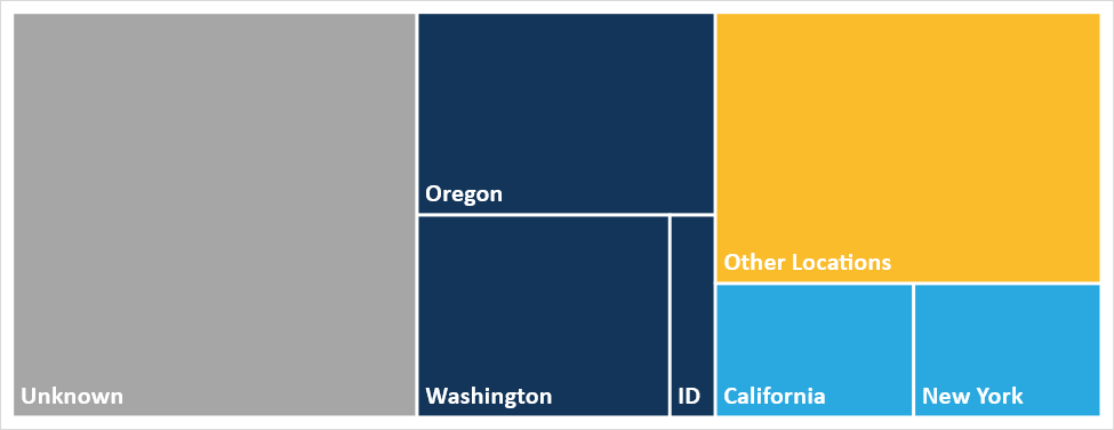


Figure 4: Location of Visitors to BetterBricks VHE DOAS Online Content

Of the site visitors, nearly two-thirds (63%) reach the content from a search engine, compared to only 3% known to arrive via links on NEEA or its partners' websites (Figure 5). It is unsurprising that the vast majority arrive through search engines, as this is how many users find online content. That said, more NEEA partners referring visitors to BetterBricks seems likely to increase the reach of NEEA's materials.

Figure 5: How Online Visitors Reached BetterBricks VHE DOAS Materials

Other entities leverage NEEA's materials. The MPER's web scan looked for instances of NEEA materials being incorporated into key partners' training, certification, or promotional efforts (see Appendix E for more detail). As of 2024, six of nine "priority institutions" identified by NEEA as targets for adopting NEEA materials (ASHRAE, PHIUS, AIA, Living Future, NBI-Getting to Zero, Greenbuild, NEEC, WSEC, and UW IDL) appeared to use or reference NEEA-developed materials in their training, marketing, and certification materials, based on the web scan [MPI 1a]. Similarly, the scan found that six priority utilities (four NEEA funding sponsors, as well as PG&E and NYSERDA), three of six qualifying E/HRV manufacturers, and one of six qualifying E/HRV reps use NEEA messaging in their promotions [MPI 1b]. Table 4 shows the results of this review of these partners' websites and online materials. Organizations confirmed to host or promote NEEA-derived content are flagged with a check mark, and those that did

not are marked with a question mark. (It is possible that some of the organizations marked with a question mark do leverage NEEA materials, but the web scan did not find them.)

Table 4: NEEA Partners Using NEEA VHE DOAS Materials

Funding Sponsors	Other Utilities	Manufacturers	Sales	Industry/Policy Orgs
? Avista	✓ NYSERDA	? Greenheck	? Air Treatment	? AIA
✓ Bonneville Power Administration	✓ PG&E	✓ Oxygen8	? Air Reps	✓ ASHRAE
? Cascade Natural Gas	? SCE	? SEMCO	? CMS	✓ NBI-Getting to Zero
✓ Energy Trust of Oregon	? SDG&E	✓ Swegon	? Dorse	? Greenbuild
✓ Idaho Power		? Tempeff	? Johnson Barrow	✓ IMT[14]
? NorthWestern Energy		✓ Ventacity	✓ Mechanical Sales	? Living Futures
? Puget Sound Energy				✓ NEEC
✓ Seattle City Light				✓ PHIUS
				✓ UW IDL
				✓ WSEC

More partners and stakeholders could promote NEEA materials. The web scan reviewed websites of a variety of organization types, as shown in Table 4 above. Industry organizations involved in policy, certifications, or promoting best practices in energy efficiency (the rightmost column) appeared more likely to host NEEA VHE DOAS materials (e.g., ASHRAE, PHIUS) than the firms that sell equipment suitable for VHE DOAS applications. Only three of the six key manufacturers and one of six manufacturer representatives appear to publicly point to NEEA VHE DOAS materials. By referring customers to NEEA's VHE DOAS materials, manufacturers and manufacturer representatives could in theory increase sales of their products as their customers come to better understand VHE DOAS.

NEEA could also encourage its funders to use VHE DOAS messaging in their promotions or websites [MPI 1b], though gas utilities may be less likely to promote VHE DOAS, given that it is currently electric only. The web traffic review discussed above and shown in Figure 5 highlights what a small portion of the traffic to NEEA's VHE DOAS materials appeared to originate from NEEA partners' websites.

Related recommendation. Consider developing a press pack with standard descriptions of VHE DOAS terminology and licensed graphics for use by partners and the media, to help encourage partners and industry organizations to leverage and share NEEA's polished VHE DOAS materials.

Related recommendation. NEEA should engage with key partners and stakeholders (e.g., utilities, manufacturers, and other energy-efficiency organizations to ensure that as many of them as possible refer their customers and audiences to NEEA's BetterBricks materials about VHE DOAS. This would be particularly valuable among electric utilities with commercial HVAC or performance-based retrofit programs, as these materials could help design teams better achieve the savings that those programs encourage.

[14] IMT is not a priority institution identified for MPI 1a, but it is a priority organization for MPI 2a, so it is included here.

Section 3 *Other Findings*

A core element of VHE DOAS is high-efficiency electric heating and cooling, which may not be feasible or desirable for some projects.

When discussing the benefits of high-efficiency electric heating and cooling as a component of VHE DOAS, several designers noted the challenges associated with proposing heat pumps in cold climates and indicated VHE DOAS is more advantageous in moderate climates. Some designers rely on backup gas or supplemental electric heat when proposing heat pumps in cold climates, like Montana; one reported success designing with water source heat pumps (rather than air source) in cold climates.

One designer recalled feeling jaded about the applicability of heat pumps during a winter week when the temperatures plunged; they received no calls from customers in gas-heated buildings.

Over one-half of designers (55%) reported using VHE DOAS principles with gas heating on at least one project within the past year, accounting for 17% of their projects on average (10% when weighting by number of projects). This illustrates the appetite for applying the other high-efficiency elements of VHE DOAS to a gas or dual fuel HVAC system, as savings could be available even to customers not interested in an all-electric approach. Several designers requested an option to allow dual-fuel systems that would couple high efficiency gas with high efficiency heat pumps.

Client demands can also drive HVAC system choices. One training attendee said they could not propose VHE DOAS because their "primary client had very prescriptive requirements for their HVAC system." Several designers mentioned only proposing VHE DOAS in areas with no access to utility gas because otherwise the gas is more cost effective.

A

Appendix A Training Materials Expert Review

Additionally, NMR provided select training and marketing materials flagged by NEEA to two well-established commercial HVAC engineers in the Northeast, who provided detailed qualitative feedback about the materials, including their design, clarity, utility, and also about the perceived value of VHE DOAS in their role as HVAC designers and engineers. Their feedback was provided to NEEA to help identify any opportunities to improve these materials, particularly for a highly technical audience that may not be familiar with this specific approach.

Methodology

In September 2023, two experienced commercial HVAC engineers from the Northeast reviewed selected NEEA training materials regarding VHE DOAS:

- VHE DOAS Technical Brief
- VHE DOAS Explainer Video
- New Day School Case Study
- Energy 350 Case Study
- VHE DOAS Training Slides

The engineers provided comments and feedback about the materials, as noted above. In this appendix, **quotes are anonymized and italicized**.

VHE DOAS Technical Brief Key Takeaways

Overall, the reviewers rated the materials as very high quality and offered limited suggestions about ways to tailor the materials. Their feedback typically focused on ensuring that the materials address specific technical concerns of engineers who might be concerned that VHE DOAS would not generate the reported savings claims in the real world. Overall comments included concerns about humidity, the importance and challenge of right-sizing the high-efficiency equipment, clarifying which aspect(s) of the approach drive the claimed energy saving, and the importance of balanced supply and exhaust air flow rates in achieving truly efficient and comfortable outcomes for end-users. The two engineers provided the following feedback on the VHE DOAS technical brief. **Quotes are anonymized and italicized.**

The education materials are valuable: *The overall educational campaign is good and necessary work, particularly for the small commercial buildings market segment where failing HVAC systems are typically [replaced] with the same type and size of equipment as was originally installed.*

Reviewers suggested providing additional details on the sources of savings: *If this is being presented to engineers with the goal of having them specify this type of system in more of their projects, I suggest providing a slightly more detailed explanation for where the savings come from. My understanding is that these are the sources:*

- *Improved COP of heat pump in heating mode compared to natural gas furnace or boiler (primary savings)*
- *Reduced ventilation load due to energy recovery*
- *Reduced fan energy due to the decoupling of the ventilation and space conditioning systems*

- *Further reduced fan energy by downsizing systems and using variable speed fans*

[That said,] in office buildings we tend to expect a cooling penalty due to the lack of economizer operation during mild/dry OA conditions

VRF provides benefits for zones with different needs: *There does not seem to be any mention of heat recovery in the VRF system, which can be a selling point. Perimeter office zones may require heating during the winter while interior spaces require cooling. VRF enable the heat to be moved around more efficiently than relying on fossil fuel sourced hot water or electric resistance for reheat in the perimeter zones. This heat recovery can also be accomplished with a four-pipe hydronic system if an air to water heat pump with energy recovery is specified.*

A constant volume DOAS system has limitations and might not be considered high performance in some designs: *The info in the tech brief and presentation describes a very simple HVAC system where all portions of the building are occupied evenly throughout scheduled occupied hours. This could be appropriate for small buildings with a single DOAS unit or a large building with multiple DOAS units and sedentary workers. When you get into larger buildings that have a single DOAS unit, adding pressure independent air valves tied to lighting occupancy sensors or CO2 sensors (also known as demand-controlled ventilation, or DCV) is a great way to modulate ventilation rates in response to occupancy. This approach primarily saves fan energy, which can be significant in an air handling unit with heat/energy recovery due to elevated pressure losses across the recovery media. Perhaps this makes the system seem too complicated, but I would not consider a constant volume DOAS system to be high-performance (it is OK but not great).*

Design elements can reduce fan penalties: *A high-efficiency DOAS unit has a recovery section that has a low static pressure loss. Oversizing the face area of the media to achieve design pressure losses of <0.6" w.g. and/or inclusion of bypass dampers are ways to reduce fan penalties. Just requiring ⩾82% sensible effectiveness does not make this system high-efficiency—there is more to it. The issue of fan penalties is particularly important in a system without DCV (as drawn in the system diagrams) since the airflow rate is always at design levels during system operating hours."*

One reviewer suggested highlighting the benefits of inverters: *"The most recent versions of IECC and ASHRAE 90.1 use a new performance metric for evaluating the energy efficiency of condensing sections on DOAS AHUs (AHRI Standard 920). The new approach pushes designers to use inverter-driven compressors to optimize dehumidification performance in the summer and heating performance in the winter. [Our firm] suggests that the tech brief and slide deck include use of inverter-driven compressors as a key ingredient of the DOAS unit in the system diagrams."*

The expert reviewers also suggested specific edits to the technical brief. Reviewers suggested areas to increase clarity in wording, point readers to compliant product lists, and increase confidence in the approach by referencing similarities to Washington state code.

VHE DOAS Technical Presentation Key Takeaways

Reviewers assessed the VHE DOAS technical presentation. **Quotes are anonymized and italicized.**

Energy savings claims in the graphics appear high and may need additional context: *The energy savings claims made in many of these graphics are pretty extreme (69% HVAC energy, 48% whole-building). I expect the vast majority of savings [are] a result of electrifying the heating … and moving from a fossil fuel … COP of 0.8 to an all-electric heat pump COP of closer to 3. … Explaining that would provide some useful context for a technical audience and would help increase confidence in the claims. In the northeast, heat pump retrofit projects almost always result in increased utility bills, unless the pre-existing heat source is electric resistance or a delivered fuel. If this is similar in the northwest, I would consider adding an explanation about how the site energy reduction figures do not necessarily scale directly with utility cost reduction.*

Hydronic systems offer some advantages over VRF. *The graphics show a VRF system but there is mention of air-to-water heat pumps in the presentation notes. … Some advantages of a hydronic system over VRF are the large reduction in refrigerant required by the system and future-proofing of the distribution system. A hydronic system is generally more 'future proof' because it allows for the self-contained heat pump to be swapped out with newer technology (or newer refrigerant) while keeping the distribution piping and fan coils in place. With VRF the indoor and outdoor units generally need to be matched and compatible with each other, so a future system overhaul could become a larger project that depends on the manufacturer's continued support for the original equipment.*

Reviewers also offered specific feedback on the technical presentation slides. Feedback included requests for clarification about the geography of the projects, emphasizing a need for balanced airflow and dehumidification, and explaining the guidance on building size.

VHE DOAS Case Studies Feedback Summary

The reviewers assessed the New Day and Energy 350 case studies. **Quotes are anonymized and italicized.**

When emphasizing indoor air quality improvements of the New Day case study, attribute the improvement to system design as well as selection. *I don't doubt that the IAQ has been improved as a direct result of this retrofit, but I suspect that it may have more to do with the continuous operation of the DOAS compared to the (assumed) cycling of the pre-existing RTU and better zoning design. That old RTU should have also provided filtered outside air to the building, but if it was only operating intermittently based on heating/cooling load, I could see the IAQ suffering.*

Provide context around the reduction in energy use. *The [New Day] reduction in HVAC energy is probably due to lower building loads as well as the change in HVAC systems. It is not accurate to suggest that the HVAC energy use was reduced by 58% only because of the change in HVAC system.*

Address the benefits of VRF systems on the Energy 350 case study. *[We suggest] adding something about the flexibility of zoning inherent to VRF systems and the continuous ventilation provided by a DOAS compared to the large zone grouping and intermittent ventilation provided by the pre-existing system would be useful. … [Page 2 of the case study has the] only mention of VRF systems.*

Appendix B Training Observations and Survey

To provide high-level feedback about the quality and impact of BetterBricks' VHE DOAS trainings, NMR and Apex staff attended and reported on four virtual and in-person training courses about VHE DOAS, hosted by industry associations in late 2023 and early 2024. The team also distributed a survey that a small number of training attendees responded to right after their training completed (n=14), allowing them to provide feedback about the trainings and VHE DOAS. The trainings are open to the public, and participants included a variety of stakeholder types. Most worked in engineering or consulting fields, but others worked for utility companies, HVAC distributors, builders, government agencies, and so forth (see Table 6 for more detail, based on post-training survey responses).

Methodology

In-person and virtual training observations. The NMR team observed four VHE DOAS trainings led by the BetterBricks VHE DOAS training implementer (Energy 350) in the fall of 2023 (Table 5).

Table 5: VHE DOAS Trainings Observed

Date	Organization	Format
September 20, 2023	ASHRAE Puget Sound Chapter	Virtual
October 12, 2023	ASHRAE Spokane Chapter	In-person
November 8, 2023	ASHRAE Boise Chapter	In-person
November 16, 2023	AEE Columbia River Chapter	Virtual & in-person

Evaluators took notes on the length of the presentation, the layout of the room (if applicable), the quality and readability of the presentation materials, audience engagement and behavior, and topics of discussion during the question-and-answer session.

Post-training survey of training attendees. An anonymous survey was distributed via email to attendees of the ASHRAE Spokane Chapter training (one partial response received) and via paper and email following the AEE Columbia River Chapter training (13 respondents). The survey asked respondents to characterize their professional roles, services provided by their organizations, state(s) they work in, awareness of DOAS and VHE DOAS prior to the presentation, likelihood of using VHE DOAS in the future, and likelihood of recommending the training to others.

TRAINING OBSERVATION FINDINGS

Knowledgeable trainers and engaged audiences. Observers noted that the trainings were well-received. Attendees were curious and engaged and asked questions aimed at learning more about the approach and how to implement it. They actively listened and took notes, suggesting many were not familiar with VHE DOAS prior to the presentation — it did not appear to be old information to many of them.

Lively question and answer periods, with limited skepticism. During the question and answer periods, attendees asked specific questions about the approach, case studies, and best practices in different scenarios. Presenters were clearly knowledgeable about the material. Observers noted that none of the attendees asking questions appeared skeptical of the approach, in contrast to some of the feedback received during this MPER's interviews with HVAC designers. Attendees appeared curious to learn more and ask the presenters' opinions.

Trainees asked relevant questions to help them understand how and when to use this approach. In general, questions focused on cost (including upfront cost, expected savings, and how to calculate the payback period for a system using this approach), and then technical questions about how the approach accommodates varying building loads, handles humidity without active dehumidification included,[15] proper design of fan speed and fan coils, and system sizing (including how much smaller the systems were than those they replaced in renovation projects).[16]

These findings align with the specific feedback received from the 14 respondents who participated in the immediate post-training survey, discussed in the next subsection.

Training logistics and presentation materials. Observers noted the in-person trainings had a layout that allowed attendees unobstructed views of the presentations. One observer found the presenter was a little quiet but could follow along. The virtual training had some technical difficulties with a delay in the audio that made it difficult to hear, but attendees typed questions in the chat to ensure they could participate in the discussion.

Observers noted that some slides could be simplified, and the text size increased to make it easier to read them from the back of the room. NEEA could consider offering handouts and/or emailing materials to attendees following the presentation.

[15] In one case, the trainer indicated humidity issues were not a major concern in the Northwest, and thus the approach generally did not suffer from humidity related issues.
[16] The trainer did confirm the pre-existing systems were oversized and being replaced by much smaller systems.

POST-TRAINING SURVEY FINDINGS

Firmographics. While most of the people who responded to the post-training survey work for engineering firms, a variety of types of people attended the VHE DOAS trainings (Table 6). This highlights that this topic is of interest to a variety of market actor types — not just engineers — and the importance of tailoring the training sessions to different audiences.

Table 6: Trainees' Employer/Organization

Organization Type	Number of Respondents
Engineering	6
Consulting	3
Utility or energy program	2
Sales/distribution	1
Builder, developer, and/or contractor	1
Government agency	1
ESCO/installer	1
Seeking employment in SEM field	1
Total	**13**

Notes: Multiple responses allowed; one respondent was not currently employed in the field

Respondents represent organizations that provide a range of services. Considering HVAC designers were the subject of the designer interviews and surveys, only two attendees reported their organization offers HVAC design. This highlights the challenge of reaching HVAC designers, and also the fact that these trainings appear relevant to a wide variety of market actors involved in the commercial space (Table 7).

Table 7: Services Offered by Trainee Employer/Organization

Service	Number of Respondents
Energy efficiency consulting/analysis	4
HVAC installations or replacements	4
HVAC system design	2
Energy efficiency incentives	2
HVAC sales	1
HVAC system repair	1
Funding	1
Utility design	1
Total	**13**

Notes: Multiple responses allowed; one respondent was not currently employed in the field

Nearly all respondents to the post-training surveys work on projects in Washington. Many respondents also reported working in Oregon (Table 8).[17] One respondent also worked in California, and two respondents who work for HVAC design firms reported that they work in all 50 states.

Table 8: States Training Attendees Work In

State	Number of Respondents
Washington	13
Oregon	9
Montana	1
Idaho	2
Total	**14**

Awareness of DOAS is high. Nearly all respondents (93%) reported that they had heard of DOAS prior to the BetterBricks training, with 64% having worked with it at least occasionally (Table 9).

Table 9: Familiarity with DOAS Prior to NEEA Training

Familiarity	Number of Respondents (%)
Not at all familiar—never heard of it	1 (7%)
Not very familiar—heard of it but never worked with it	4 (29%)
Somewhat familiar—worked with it occasionally	8 (57%)
Very familiar—worked with it regularly	1 (7%)
Total	**14**

Lower relative awareness of VHE DOAS. Fewer respondents were familiar with VHE DOAS prior to the training, with 43% reporting that they had never heard of it before participating in the BetterBricks training. Only 21% of respondents had prior experience working with VHE DOAS (Table 10).

Table 10: Familiarity with VHE DOAS Prior to NEEA Training

Familiarity with DOAS	Number of Respondents
Not at all familiar—never heard of it	6 (43%)
Not very familiar—heard of it but never worked with it	5 (36%)
Somewhat familiar—worked with it occasionally	3 (21%)
Very familiar—worked with it regularly	0
Total	**14**

[17] The Columbia River training in Portland was a hybrid event, with some attending virtually.

Strong signals of future use of VHE DOAS. All 14 respondents said they were "somewhat" or "very likely" to use what they had learned in the training in their work.[18] Many respondents had never heard of VHE DOAS, but found the trainings sufficiently compelling to get them interested in using it in the future. This qualitative assessment certainly does not guarantee future adoption, but it is a strong positive signal.

Besides technical details about the elements of VHE DOAS, attendees most frequently mentioned energy savings as the most important new information they learned during the training, an unsurprising outcome given the attendees' unfamiliarity with VHE DOAS prior to the training (Table 11).

In particular, one attendee from an energy service company (ESCO) said the most important thing they learned was about decoupling ventilation from heating and cooling and the large savings achieved by VHE DOAS, an approach that aligned with their personal focus on the "importance of looking at the big picture and system-wide considerations." Case studies also resonated with attendees, with one saying it was "fascinating" to learn about the outcomes at a specific project described in the training.

Table 11: Most Important New Information Learned During Training

New Information Learned	Number of Respondents
VHE DOAS elements, including efficiency standards for ERV/HRV and HVAC performance criteria	7 (58%)
Energy savings	4 (33%)
Case studies (specific outcomes)	2 (17%)
Resources to find Qualified Product Lists	1 (8%)
Total	**12**

Most attendees found the training clear, even those without much experience with DOAS. When asked if any information in the training was unclear or confusing, only two of ten respondents identified any issues. One respondent who had never heard of DOAS or VHE DOAS prior to the training (not an engineer) said the terminology was confusing, due to their limited technical expertise. Another respondent that worked with energy programs said that they dislike that "savings" were shown on a BTU basis without discussion of what that means for customers or utilities.

Two attendees had follow-up questions or comments regarding the material. NMR recommends these could be taken under consideration, with recognition that the payback calculation may not be simple to implement in practice.

- A commissioning engineer said: *I work with a lot of schools, and I have never heard of most of the accepted VHE DOAS manufacturers on NEEA's approved list. Is NEEA working with AAON, CA[R]RIER, etc., to see these systems also approved?*
- An energy efficiency engineering contractor said: *I'd like to see the analysis expanded to consider some of the questions asked today. How does this respond to using future predicted weather data? What is the simple payback of [VHE DOAS]?*

[18] One attendee currently seeking employment could not give a likelihood rating, but hoped to use the info in the future.

Attendees were likely to recommend the training to others. On a scale of 1 to 10, where 1 is "not at all likely" and 10 is "extremely likely," all respondents rated their likelihood of recommending the training an 8 or higher, for a net promoter score of 54% (Table 12).

Table 12: Trainees' Likelihood of Recommending VHE DOAS to Others

Likelihood of Recommending	Number of Respondents
8	6 (46%)
9	5 (38%)
10	2 (15%)
Total	**13**

Appendix C Designer Interviews

As an early task in this MPER, NMR interviewed commercial HVAC designers who work in the Northwest. The interviews gathered qualitative feedback about designers' perspectives on and experience with VHE DOAS, including possible barriers to adoption. The interviews were also used to test wording and concepts for inclusion in the subsequent survey with HVAC designers, to ensure that the survey used appropriate terminology that respondents would readily understand. Interviews specifically asked about changing the description of the key elements of VHE DOAS. The final subsection in this appendix provides that feedback about terminology.

Methodology

NMR contacted 146 HVAC system designers via email. Of those contacted, 41% had participated in at least one NEEA training — 2020 WA Code Training, Getting the Most Out of DOAS, On-Demand Getting Most-Modeling, etc. — while 59% had not attended a NEEA training.

NMR conducted seven interviews with HVAC system designers in the Northwest. The final respondents were identified from participant lists from past NEEA focus group, BetterBricks trainee lists, interviewee referrals, or industry contact lists.

Table 13: Outreach for Designer Interviews

Contact Source	Total *(n=1697)*	Contacted *(n=144)*	Contacted *(n=144)*	Completes *(n=7)*
2018 NEEA VHE DOAS Pilot participant list	5	0	0%	0
2020 Specifier Focus Group/Interviews (no BetterBricks training)	668	47	32%	2
HVAC distributor & manufacturer rep contact list developed by NEEA	29	0	0%	0
Mergent Intellect industry database	850	32	22%	1
NEEA trainee (2020 WA Code Training, Getting the Most Out of DOAS, On-Demand Getting Most-Modeling)	138	60	41%	2
Referral from MPER Interviewee	7	7	5%	2

Firmographics

Five of the seven interviewees were from engineering firms, while the remaining two were builders or developers. All interviewees shared a focus on HVAC design, limited involvement with HVAC repair, replacement, or installation. All interviewees also work in Oregon and Washington, with three working in Idaho and two in Montana.

AWARENESS OF DOAS AND VHE DOAS

All seven interviewed designers had heard of DOAS and had a favorable view of it, with six of the seven respondents having worked with it regularly. As described below, respondents had a diverse range of perspectives about what they meant by DOAS, a common theme that NEEA has also identified in their work with market actors.

Four of seven interviewees said they were at least somewhat familiar with VHE DOAS before hearing a detailed description of the approach (i.e., unaided awareness). After hearing a detailed explanation of the approach, three respondents revised their responses, and said they were actually *more familiar* with VHE DOAS than they initially reported. This finding underscores the challenge NEEA faces regarding VHE DOAS terminology — even people who seem somewhat familiar with the general concept likely may not call it VHE DOAS or recognize it as a specific package of four key elements. Given the complexity of VHE DOAS, interviewers worked carefully with the respondents to explain these elements and ensure respondents fully understood the terminology. Unsurprisingly, the respondents who were clearly most familiar with VHE DOAS had a connection with NEEA, either participating in trainings or in other NEEA research efforts.

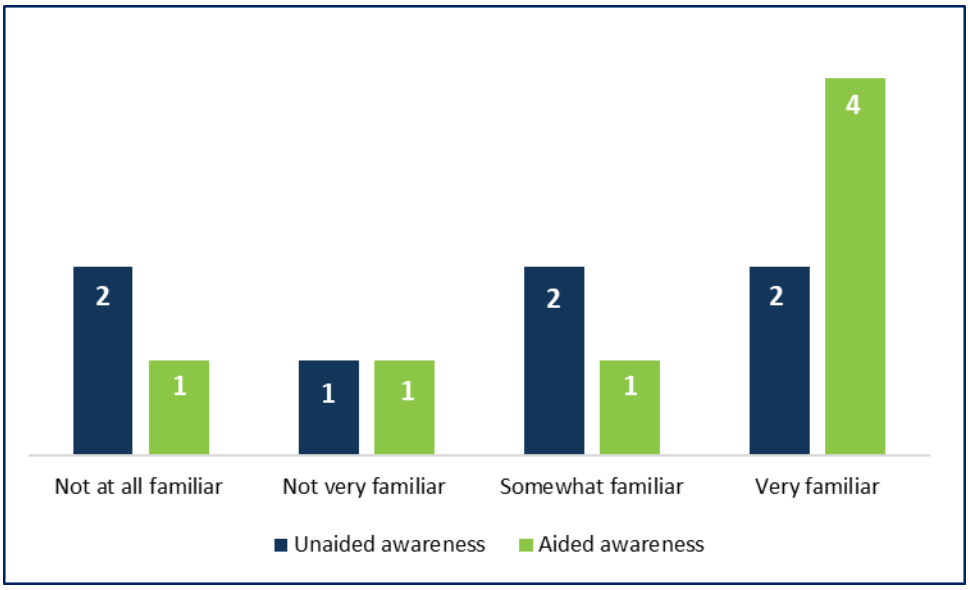


Figure 6: Awareness of VHE DOAS
(n=7)

ASSOCIATION OF VHE DOAS WITH NEEA/BETTER BRICKS

Interviewees were generally not aware of the association of VHE DOAS with NEEA/BetterBricks, despite some familiarity with the approach or NEEA. NEEA's market transformation strategy does not put NEEA front and center — there is no need or desire for market actors to associate VHE DOAS with NEEA. The study did, however, ask interviewees about their awareness of NEEA or BetterBricks, in part to better understand their background and framework for understanding VHE DOAS. Results for respondents'

awareness and association with VHE DOAS and NEEA varied. HVAC designers who participated in NEEA pilots, such as one respondent who learned about VHE DOAS through Energy350 (the BetterBricks VHE DOAS training implementer), strongly associate the approach with NEEA. Those familiar with VHE DOAS prior to the interview were not necessarily familiar with the full package of requirements or guidance included in NEEA's VHE DOAS technical specification materials. The basic tenets of a high-performance, all-electric system that used a fully separated ventilation system might have been familiar, but respondents were not always familiar with this concept as a well-defined package of design practices.

OPINIONS OF DOAS AND VHE DOAS

Interviewees recognize the benefits of decoupling ventilation and improved air quality. Two respondents valued the ability to provide ventilation independently of heating and cooling, saving energy during warm-up or cool-down periods, and providing fresh air in moderate temps. Another interviewee highlighted the benefits of DOAS in light of extreme outdoor air pollution from wildfires.

Some designers are cautious of approaches that prioritize efficiency over those perceived as tested and durable. Some designers may be skeptical of a prescribed approach, especially if they are unfamiliar with NEEA. One designer phrased this type of prescriptive guidance as *"too cookbook,"* and provided a perspective that a packaged set of protocols like this appeared to be focused on efficiency above all else. Those who gave the impression to interviewers of being generally in favor of energy efficiency and green practices generally reported that VHE DOAS was in line with what they saw as best practices for all-electric, high-performance HVAC.

Cost and perceived value emerge as key drivers and barriers to adopting VHE DOAS technology. Designers expressed concerns about cost, particularly how to market to cost-sensitive customers. Designers said many customers use the five-year payback as a *"go or no-go"* hurdle, meaning they need a client driven by wanting a highly efficient building. In describing challenges incorporating ERV and DOAS into multifamily apartment buildings to satisfy code requirements, one interviewee explained that when you go beyond a 60% SRE unit, systems that would satisfy VHE DOAS requirements are more expensive and made by a different pool of manufacturers. Another interviewee indicated that the high-efficiency E/HRVs and heat pumps are often dropped after the client asks how to reduce the project cost.

HVAC designers suggested targeted education, addressing cost concerns, and providing practical solutions to align VHE DOAS with building codes as potential solutions to barriers. Confidence in VHE DOAS is influenced by education and experience, emphasizing the importance of training initiatives.

Designers recommend marketing VHE DOAS to building owners, saying HVAC designers are more likely to suggest newer approaches if clients ask for them. They suggested emphasizing the benefits of VHE DOAS in marketing, such as energy savings and improved air quality/system control. Identifying opportunities to leverage/align with Washington code was considered beneficial for showing legitimacy.

Upfront cost is a barrier to adoption. One respondent considers this to be the biggest challenge they face in implementing high-efficiency systems because it takes a very committed owner to turn down first cost savings to favor long-term efficiency. Another designer said they would appreciate additional incentives to help customers with the cost.

RATES OF VHE DOAS PROPOSALS

Respondents reported including the four key design components of VHE DOAS in their projects, but at varying rates. Four designers responded to questions about the number of commercial HVAC projects they worked on in the past year (ranging from 10 to 30 projects). Two respondents reported including elements of VHE DOAS in at least half of their projects (Figure 7).[19]

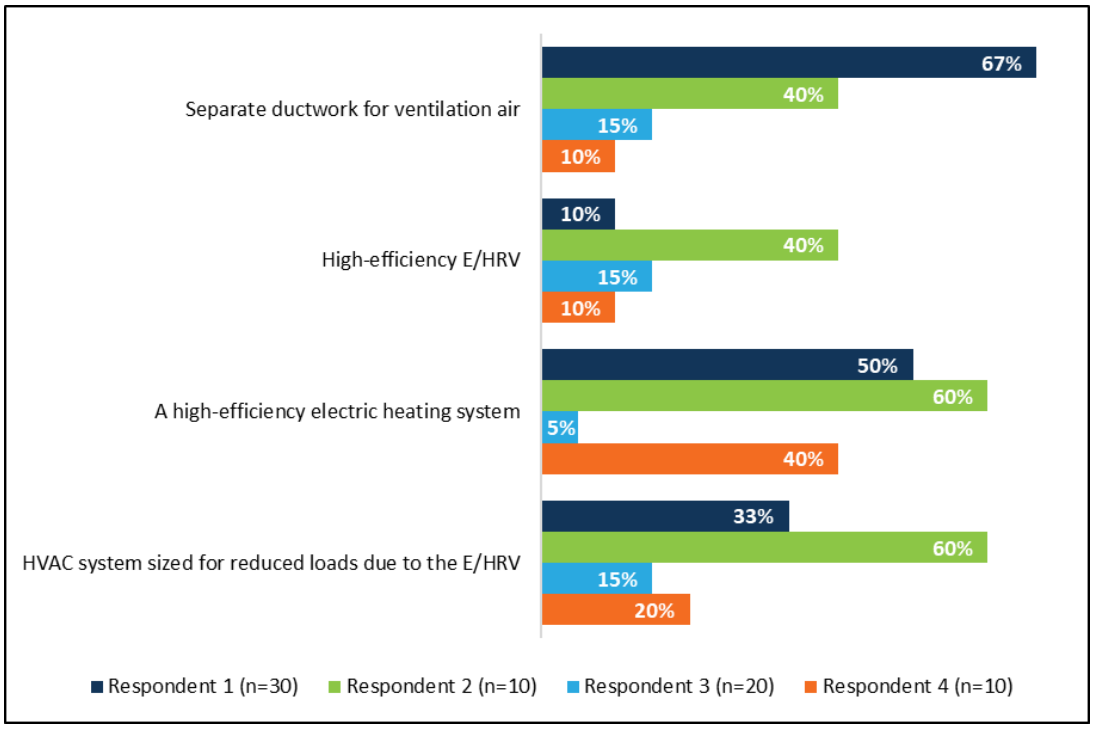


Figure 7: Percentage of Commercial Projects that Included Elements of VHE DOAS
(n=4)

FEEDBACK AND SUGGESTIONS ABOUT IMPROVING THE CLARITY OF VHE DOAS TERMINOLOGY

Interviewers worked with respondents to discuss the specific technical terminology around VHE DOAS. The NMR team was working specifically to identify opportunities to revise terminology during the interview process such that the phrasing could be as clear as possible when rolled out into the broader designer survey. The feedback below represents interviewees' suggestions when provided with the opportunity to suggest ways to ensure that the MPER's survey with HVAC designers used appropriate technical language, particularly regarding DOAS and VHE DOAS.

For summarized descriptions of DOAS, designers had suggestions, but after discussion largely recommended keeping the text the same. Overall, designers find the language of VHE DOAS acceptable, but there were suggestions to reinforce definitions and clarity of the meaning of *"high efficiency."* When

[19] Interviewees were not asked to estimate how many projects included all four elements of VHE DOAS.

asked if there were any suggestions before showing the list to other designers, they mostly suggested no changes, while a few recommend using "energy recovery" instead of ERV/HRV.

Decoupled Ventilation Design (which some might call DOAS): the ventilation air distribution system is separated from the heating and cooling system, via dedicated ductwork and supply diffusers, or at a minimum, separated so ventilation air is delivered downstream of heating and cooling terminal units). Designers generally appreciate the focus on decoupled ventilation design but suggest clarifying terms and shortening the definition for the target audience. Two interviewees agreed with current language, while another suggested addressing the applicability of the statement to systems with terminal units. One designer proposed emphasizing that DOAS could be a unit/system or an approach. One interviewee was concerned about the size of projects and the need for variable volume capability. Another designer said the *"via ductwork and supply diffusers"* piece is unclear because it only applies to systems with terminal units and does not apply to central HVAC with supply/return fans.

High Efficiency ERV or HRV: an energy- or -heat-recovery ventilator with at least 82% sensible effectiveness. Most interviewees agree with the current language. Considerations include changing *"sensible effectiveness"* to *"heat transfer effectiveness,"* and *"energy recovery"* instead of ERV/HRV.

High performance electric heating and cooling: A high-efficiency, electric heat pump system (often VRF or other inverter driven heat pump technology). Opinions are divided on the language in *"high performance electric heating and cooling*," with some expressing concerns about electric heat pumps and advocating for more robust systems, while others find the language clear. Three of the seven interviewees agreed with the current language. One designer suggested clarifying the term *"electric"* to avoid confusion with electric resistance heating. Another suggested specifying efficiency standards, such as HSPF, SEER, EER, and COP. An interviewee expressed concern with the overall approach, opposing electric heat pumps as terminal systems and suggested splitting the section into two parts:

1. *Mention the use of an electric heat reclaiming chiller.*
2. *Demonstrate separate visuals that show two approaches, one for central systems (where DOAS is best applied), and one for terminal units.*

Two respondents view VRF systems as unreliable and questioned the importance of *"inverter driven"* and VRF phrasing. They suggested alternatives such as *"air-to-water heat pump."* Another interviewee suggested "high-efficiency heat pump" instead of *"high-performance electric heating and cooling."*

Right-sized heating and cooling: Load calculations account for energy recovery and the smallest equipment that meets that design load is selected. Designers generally like the concept of *"right-sizing"* but note its subjectivity, with suggestions to emphasize zoning requirements and consider project-specific factors. Two designers appreciated the emphasis on not oversizing equipment. Interviewees expressed some concerns including the mechanical aspect of energy recovery systems and suggested project-specific considerations, and whether this aspect refers solely to DOAS or the entire building system. One respondent suggested using climate analysis for building loads.

After describing VHE DOAS, some designers thought it was required in Washington code. The designers suggested linking the code to NEEA's approach would boost legitimacy.

D

Appendix D System Designer and Manufacturer Rep Survey

The following section describes the results of the HVAC System Designer and Manufacturer Representative Survey that was distributed in the fall of 2023. NMR conducted a survey to gather feedback regarding awareness of NEEA and VHE DOAS among market actors.

Methodology

Sample Frame Development

NEEA provided a contact list containing 1,745 individual contacts at 1,067 firms that were potentially HVAC engineering or design firms or manufacturer's representatives. The list included contacts from a Mergent Intellect database purchased by NEEA, along with contact information for individuals who had participated in various focus groups and interviews for NEEA's HP HVAC program and recent commercial construction projects from Construct Connect. NEEA also provided a contact list of participants from two VHE DOAS trainings (held on February 22, 2023, and May 26, 2023), which included a total of 136 individual contacts from 110 organizations.

The team reviewed and deduplicated records of companies on multiple lists. We also removed records that NEEA had flagged as ineligible (e.g., program implementers who participated in BetterBricks trainings, past research participants who should not be re-contacted, etc.), and removed additional names that could be immediately identified as non-relevant to the study (e.g., software engineers). After this initial review, we identified 1,033 unique companies or organizations (930 of which had locations specified), with nearly all of the companies (95%) being a single location. The sample review was an extraordinarily comprehensive approach, crosschecking company websites, professional networking directories, finding new contacts, identifying contacts as irrelevant or no longer at that company, updating contact information, and so forth.

Sample Design

With an initial sample frame of over 1,000 companies, the sampling plan called for at least 63 respondents to provide survey findings at 90% confidence with 10% precision from a population of 990 firms. For the sake of round numbers and providing a slight buffer for any particular stratum, the final sampling plan targets up to 70 completes. The initial sample design targeted stratum by state and region based on the address of company headquarters. As the survey effort proceeded, it became clear that HVAC designers worked in multiple states not constrained by geographical location, and efforts turned to achieving 70 completes with a difficult-to-reach population.

Outreach

NMR sent postcards to 998 individuals at unique addresses across 742 companies. To improve response rates, NMR contracted with Braun Research to conduct HVAC System Designer Survey recruiting via phone. The team also used LinkedIn sponsored messages to reach designers not on the contact list. We contacted 1,412 designers via phone, email, postcards, or a combination of the three. The contact efforts yielded 41 completes, while the LinkedIn survey outreach yielded 29. Table 14 describes the number of designers who were contacted by each method and how we acquired their contact information — some attended multiple trainings, or their contacts were found in various lists.

Table 14: Contact Source and Response Rate for Survey

Contact Source	Called	Emailed	Postcard	Completed Survey	Total Contacted	Response Rate
Construct Connect List	17	11	0	12	25	**48%**
NMR Additional Research	22	29	11	17	50	**34%**
Referral from colleague during phone outreach	4	1	0	1	4	**25%**
2018 Pilot	5	0	0	1	5	**20%**
2020 WA Code Training	16	28	28	2	32	**6%**
2020 Specifier Focus Groups	331	490	491	6	533	**1%**
2020 Specifier Interviews	324	485	489	2	516	**0%**
Mergent Intellect	573	117	387	2	658	**0%**
On-Demand Getting Most-Modeling	3	13	4	0	10	--
Distributor and representative list	21	1	0	0	22	--
2019 E350 Outreach	7	1	0	0	8	--
Total	**1,041**	**764**	**998**	**70**	**1,412**	

Fielding and Responses

The survey was fielded from December 2023 to February 2024 and received valid responses from 70 distinct attendees at 65 unique companies. The team excluded 20 responses from analysis based on their job descriptions; in one case, a respondent initially stated they did not work in NEEA territory. Survey participants were compensated with $100 gift cards as an incentive for their responses.

Table 15: Survey Disposition

Contact Source	Completed Surveys	Source Frequency
LinkedIn Survey	31	44%
NMR Additional Research	15	21%
Construct Connect List	12	17%
2020 Specifier Focus Groups	6	6%
2020 Specifier Interviews	5	3%
2020 WA Code Training	2	3%
Mergent Intellect	2	1%
2018 Pilot	1	1%
Referral from colleague during phone outreach	1	1%
Total Distinct Respondents	**70**	100%

Notes: Includes multiple responses e.g., attendees of several training sessions

FIRMOGRAPHICS

Respondents primarily work as HVAC designers. Nearly all survey respondents (94%) described themselves as HVAC designers at an architecture, construction, or engineering firm. The other respondents identified as engineers (3%)[20] and manufacturers' representatives (3%).

Of the 70 responses received, 20% reported attending VHE DOAS training. The majority of respondents (74%) worked in Washington in some capacity. Table 16 details the company activities broken down by attendance at NEEA training and if they conduct work in Washington.

Table 16: Company Activities
(n=70; multiple responses permitted)

Job Description	Total	Attended training *(n=14)*	Did not attend trainings *(n=56)*	Works in WA *(n=52)*	Does not work in WA *(n=18)*
HVAC system design	99%	100%	98%	98%	100%
HVAC repairs/maintenance	24%	36%	21%	21%	33%
HVAC installations/replacements	16%	7%	18%	15%	17%
HVAC sales	9%	–	11%	8%	11%
(Other) Commissioning, Acoustics.	1%	–	2%	2%	–
(Other) Energy modeling, system assessments	1%	7%	–	2%	–
(Other) Commissioning of HVAC and energy studies	1%	–	2%	2%	–

Nearly three-fourths of respondents work in Washington (74%). Respondents also conduct work in Oregon (47%), Idaho (27%), and Montana (14%) (Figure 8), with 7% working in all four states.

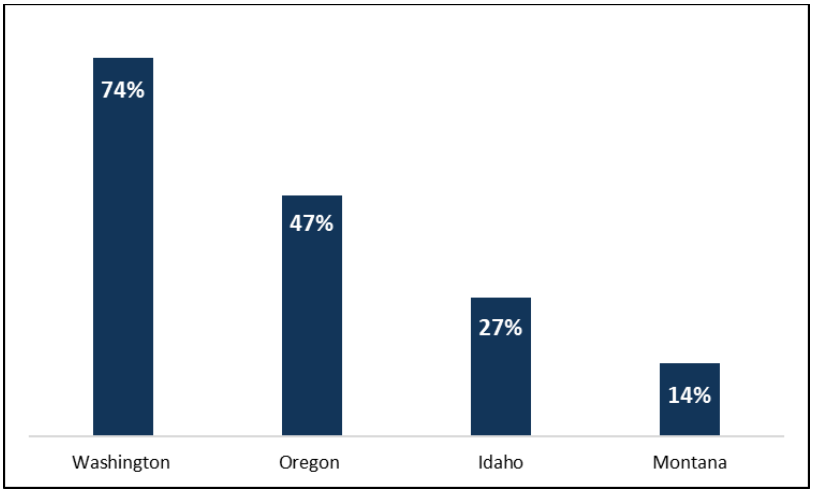


Figure 8: Where Respondents Work
(n=70; multiple responses allowed)

[20] The engineers answered affirmatively when asked whether they design or specify commercial HVAC systems.

Small and diverse businesses are represented in the survey sample. While 43% of survey respondents overall are classified as small or minority-owned businesses (Table 17), fewer than 15% of trained respondents worked for companies with these classifications. While the sample of trained installers may be too small to draw conclusions, this suggests opportunities for NEEA to target small and diverse firms for participation in training sessions.

Table 17: Company Classifications
(n=70; multiple responses allowed)

Company Description	Total (n=70)	Trained (n=14)	Not Trained (n=56)
Small Business	29%	3%	26%
Minority-owned Business Enterprise (MBE)	6%	–	6%
Women-owned Business Enterprise (WBE)	6%	–	6%
Emerging Small Business (ESB)	3%	–	3%
Disadvantaged Business Enterprise (DBE)	2%	–	2%
Service-Disabled Veteran Business Enterprise (SDVBE)	–	–	–
None of the above	63%	14%	25%

Respondents design or specify HVAC systems in a variety of building types. This question was added to the survey partway through to screen out designers who only worked with commercial facilities that were very large or have extremely specific mechanical system needs, where NEEA does not anticipate VHE DOAS being an appropriate approach. This includes hospitals or industrial/manufacturing facilities. However, no respondents indicated their company worked exclusively with either building type.

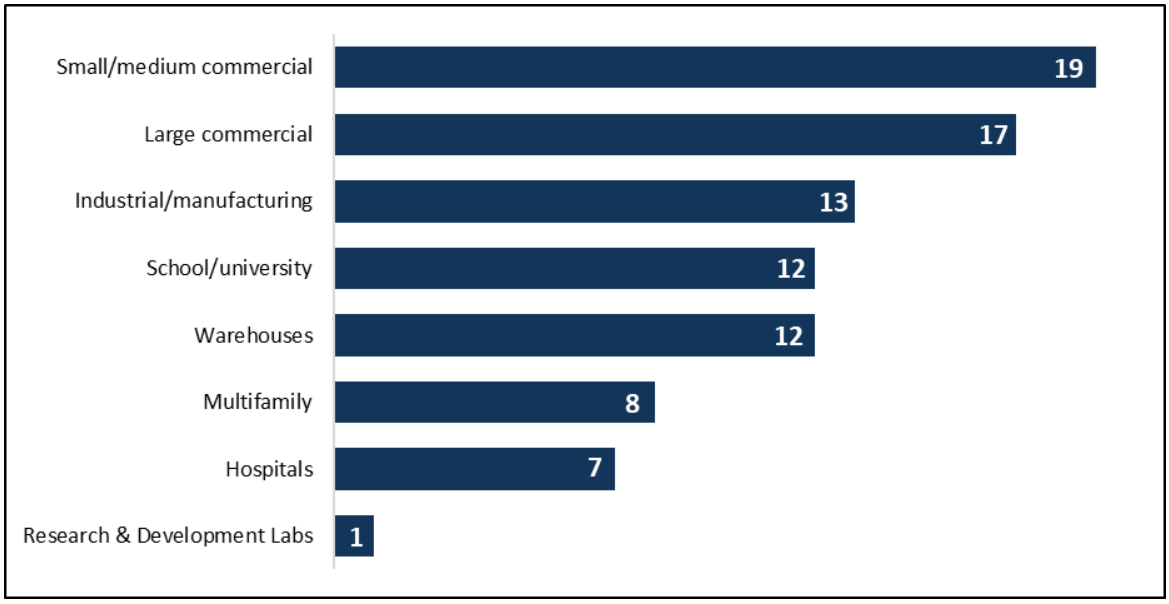


Figure 9: Commercial Building Types where Respondents Design/Specify HVAC Systems
(n=29; multiple responses allowed)

FAMILIARITY WITH NEEA AND BETTER BRICKS

Respondents are more likely to be familiar with NEEA than BetterBricks. One-half of respondents (52%) were somewhat familiar or very familiar with NEEA, compared to 36% reporting to be at least somewhat familiar with BetterBricks, an informational resource developed by NEEA about high-efficiency commercial HVAC systems.

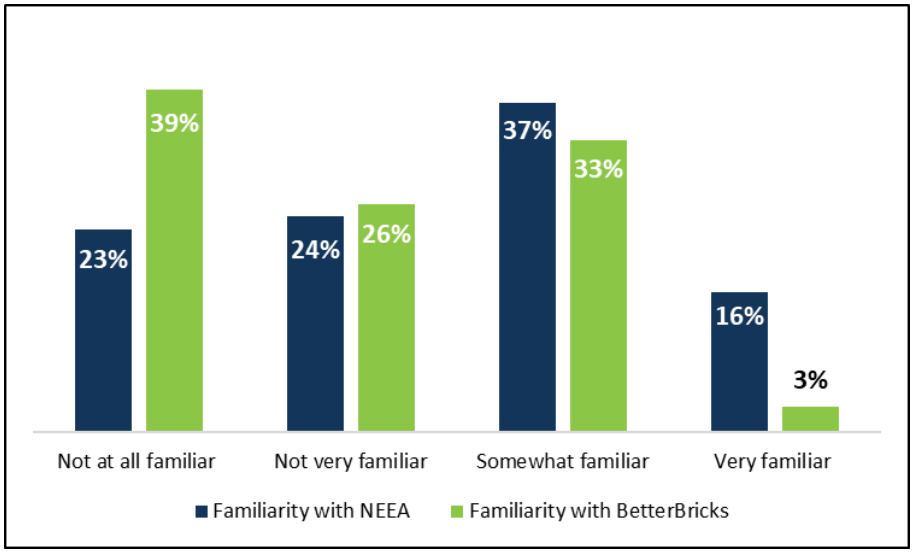


Figure 10: Familiarity with NEEA and BetterBricks
(n=70)

AWARENESS OF DOAS AND VHE DOAS

DOAS is a well-known concept — nearly all respondents (94%) had heard of DOAS prior to the survey, with two-thirds saying they were "very familiar with it" and worked with it regularly. All respondents who attended a NEEA-sponsored training (n=14) reported familiarity with DOAS. Respondents who work in Washington were more likely to be familiar with DOAS, with almost all (98%) indicating they had at least heard of it, compared to 83% of respondents who do not work in Washington.

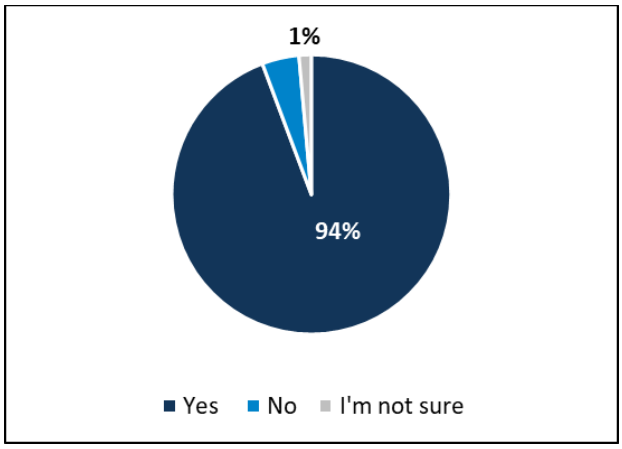


Figure 11: Familiarity with DOAS Prior to Survey
(n=70)

Before reviewing a definition of VHE DOAS, two in five respondents (41%) said they were "not at all familiar" with it. After viewing the definition, only one in five respondents (20%) reported no familiarity, indicating that while the terms may be unfamiliar, elements of VHE DOAS are reasonably familiar. After seeing the definition, 18 respondents changed their response from "not at all familiar" to a higher level of familiarity, while three changed their response to not familiar.

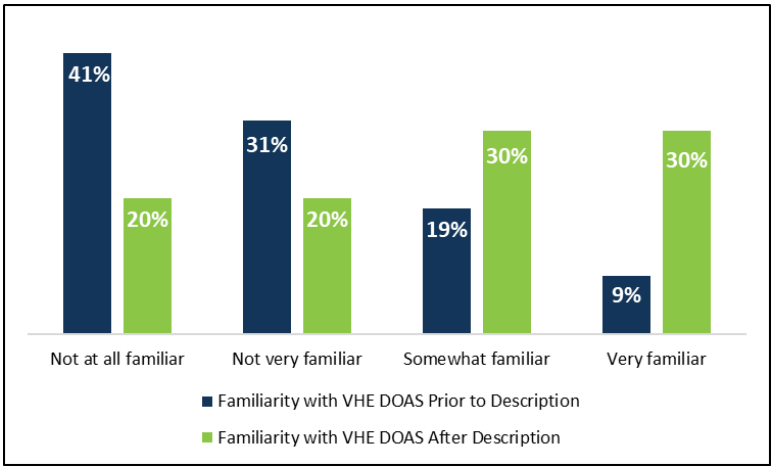


Figure 12: Familiarity with VHE DOAS
(n=70)

Designers who work in Washington state are more likely to report they have worked with VHE DOAS than designers who do not work in the state, likely due to the similarity of the approach to Washington state code. Over two-thirds of designers who work in Washington state (68%) are "very" or "somewhat familiar" with VHE DOAS and have worked with it at least occasionally, compared to 39% of designers who do not work in Washington.

Most respondents are familiar with VHE DOAS, but few associate the approach with NEEA or BetterBricks. Eighty percent of respondents rated themselves familiar with VHE DOAS, even if they had never worked with it. Only 16% said they were familiar with the approach *and* its affiliation with NEEA and/or BetterBricks, consistent with the interviewee results. NEEA does not seek to promote its own brand among market actors – this question was asked to understand how respondents learn about VHE DOAS. Notably, among respondents who reported attending a NEEA training, only 50% indicated that they were familiar with VHE DOAS *and* its affiliation with NEEA and/or BetterBricks (compared to 7% who did not attend a training), indicating that knowledge of the approach is more enduring than the brand recognition. Given that much of NEEA's work to transform markets happens behind the scenes, this is not an issue — NEEA does cultivate or desire brand recognition amongst market actors for the organization itself.

One-third of respondents (32%) could correctly identify three of the four VHE DOAS key elements [MPI 7a], with 15% identifying all four. Respondents who reported being aware of VHE DOAS in the unassisted question were shown a list of statements and asked to identify the key elements of VHE DOAS. The survey also included three "distractor" statements that are not elements of VHE DOAS, highlighted in grey in Figure 13. While some respondents selected distractor statements, the choices offered were not so inappropriate for a high-performance system that they indicate a cause for concern about the designers' responses; rather their selections just show an opportunity to clarify the core tenants of VHE DOAS. Trainees and designers who work in Washington were just as likely to identify these distractor statements as non-trainees or non-Washington designers.

The most recognizable element of VHE DOAS is an ERV/HRV with at least 82% sensible effectiveness (selected by 83% of respondents).

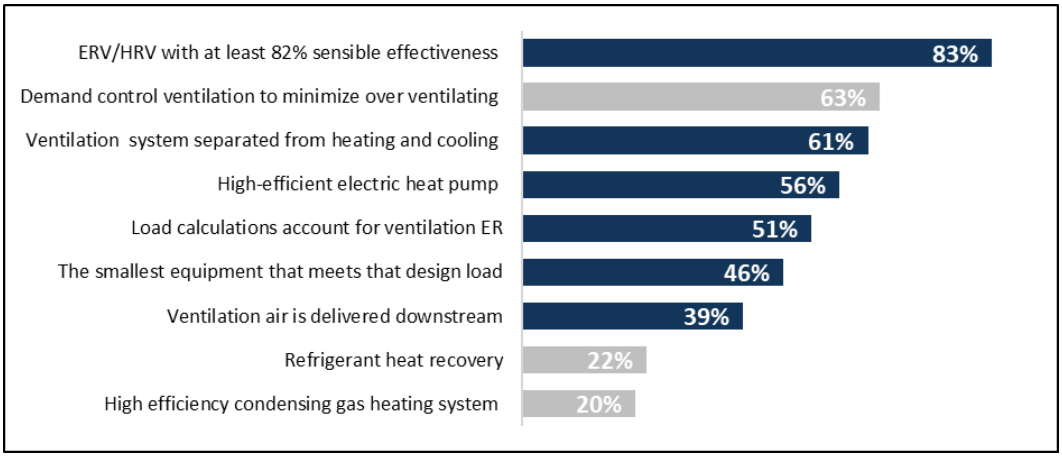


Figure 13: Identifying Key Elements of VHE DOAS
(n=41; multiple responses allowed)

While trained respondents can better identify the elements of VHE DOAS, only half correctly identified at least three elements of the approach, indicating that the concept is difficult to master even with formal instruction. Half of trained respondents (50%) identified at least three out of four elements of VHE DOAS compared to only 24% of respondents who did not participate in a training.

OPINIONS OF DOAS AND VHE DOAS

Of the respondents who reported being familiar with DOAS, 82% report having a favorable view of the approach. Those who attended NEEA trainings were more likely to view DOAS as favorable (93%) compared to individuals who did not attend trainings (79%).

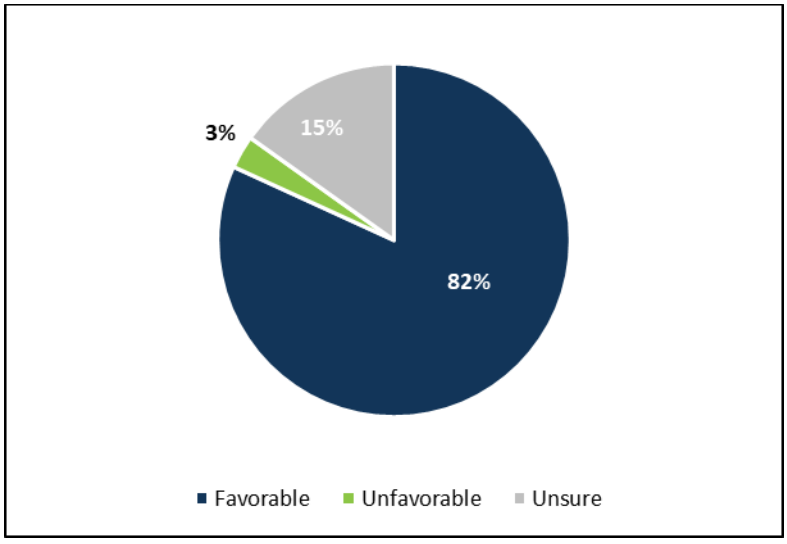


Figure 14: Respondents' View of DOAS Approach
(n=66)

Nine out of ten respondents (91%) agreed that there were advantages to including decoupled design in commercial HVAC. All trained respondents (100%) saw an advantage compared to 89% of non-trained respondents. As shown in Figure 15, respondents most often cited distribution efficiency (39%) and reduction in energy consumption/higher energy efficiency (37%) as advantages to decoupled design.

As one respondent noted, decoupled design "*helps to optimize each system for its specific purpose, [which] reduces energy consumption and lowers operating costs.*"

Nearly one in four respondents who saw an advantage to decoupled design (24%) cited flexibility in controls and increased comfort. One respondent said "*By enhancing temperature stability and enabling zones with distinct temperature controls, decoupled ventilation air from main heating and cooling air*

improves occupant comfort. [Decoupled design] can encourage better occupancy rates, help keep long-term tenants, and increase the building's marketability."

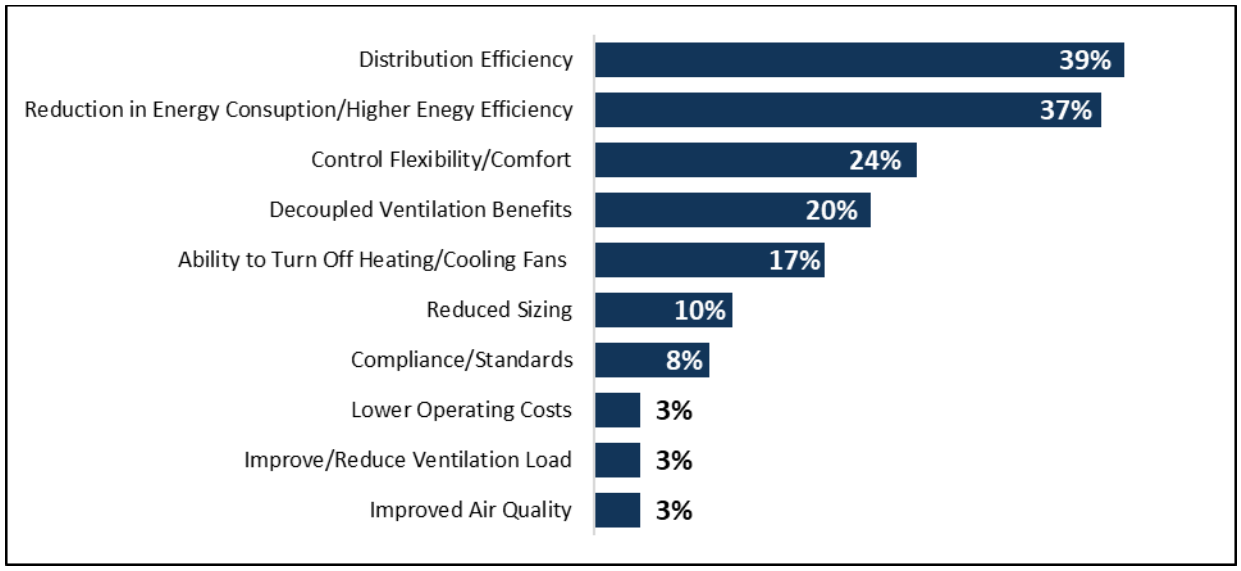


Figure 15: Advantages of Including Decoupled Ventilation Design in Commercial HVAC Systems
(n=59; multiple responses allowed)

Nine in ten respondents (90%) said they see advantages to including high efficiency ERV or HRV in a commercial HVAC system. Once again, all trained respondents (100%) saw advantages compared to 89% of untrained respondents. Energy savings (32%) and better performance and efficiency (29%) were the most frequently mentioned advantages of including high efficiency ERV or HRV in commercial HVAC system (Figure 16). Respondents who worked in all four states said, "*Ventilation is a huge load in our heating dominant climate, having high efficiency ERV/HRVs reduces the load on the HVAC system.*" Another respondent, who lives in Oregon and also works in Washington and Idaho, commented on the influence of climate on ERV/HRVs: "*[High efficiency ERV or HRV] significantly reduces loads…when it is very cold outside that is hard on all-electric DX systems.*"

One in ten respondents who saw an advantage (10%) pointed to improved indoor air quality and another 13% mentioned occupant comfort: "*By drawing in fresh, filtered air and expelling stale air, ERVs and HRVs enhance indoor air quality, making the environment healthier and more comfortable*."

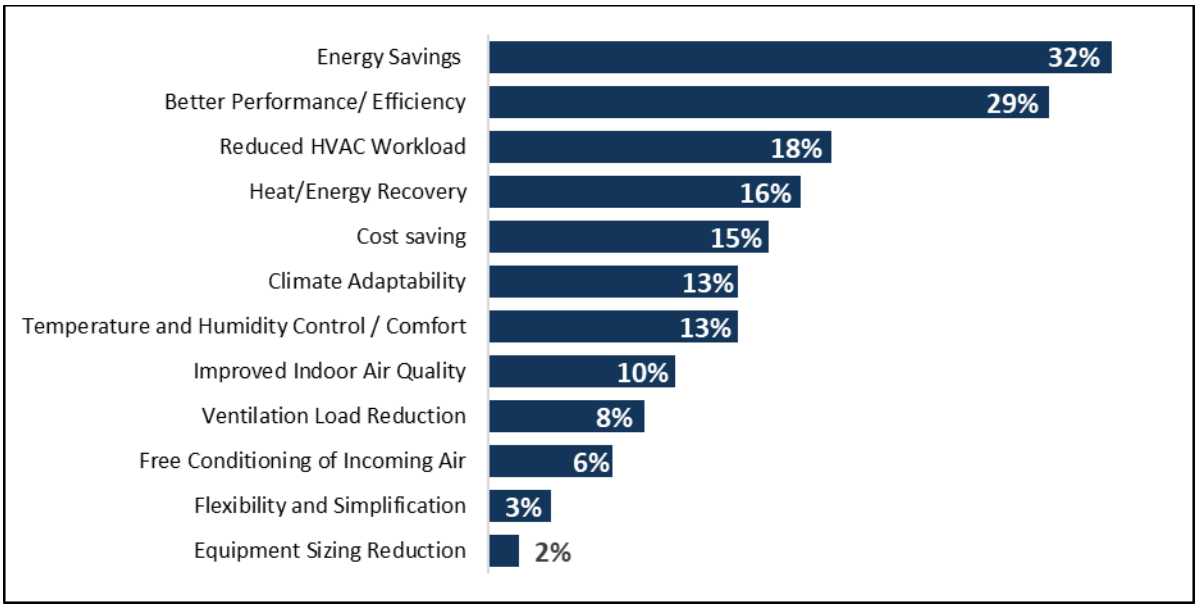


Figure 16: Advantages of Including High Efficiency ERV or HRV in Commercial HVAC Systems
(n=62; multiple responses allowed)

Most respondents (86%) said they can see advantages to including high performance electric heating and cooling in a commercial HVAC system. All trained respondents (100%) saw an advantage compared to only 80% of non-trained designers. Cost savings (31%) and energy efficiency (29%) were the most commonly mentioned advantages (Figure 17).

Nearly one in five respondents (17%) mentioned environmental benefits, with one respondent saying "*All-electric HVAC systems reduce direct operational fossil fuel combustion and greenhouse gas generation. This is particularly meaningful when the utility is already primarily made up of renewable electricity generation. This is also important in other regions without a 'clean' utility, because utilities are mostly trending towards incorporating more renewables and getting cleaner."*

Some respondents also pointed out lowering maintenance costs (7%). One respondent praised the design of these systems: "*With a high-efficiency HVAC system, not only do you save on monthly energy bills, but you also cut down on these regular maintenance and repair costs. High-efficiency systems are designed with better technology and materials that ensure longevity and fewer breakdowns.*"

Another noted its suitability for particular applications: *"Great for a single zone space in a basement due to the line set allowing for further vertical distance. I'm putting one in now in my design for this reason alone."*

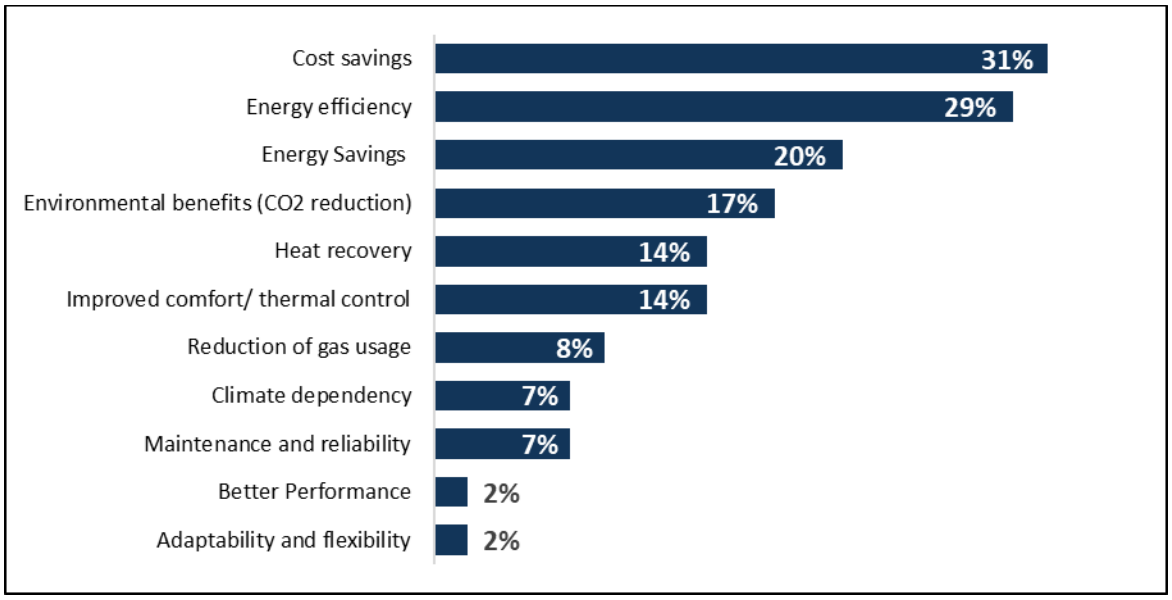


Figure 17: Advantages of Including High Performance Electric Heating and Cooling in Commercial HVAC Systems
(n=59; multiple responses allowed)

Most respondents (87%) see advantages to including right-sized heating and cooling in a commercial HVAC system. All trained respondents (100%) said they saw an advantage compared to 83% of non-trained respondents. Cost savings (44%) and energy efficiency (32%) were the most commonly mentioned advantages to including right-sized heating and cooling (Figure 18). One respondent explained, *"Right sized equipment is generally more efficient than the same piece of equipment the next size up, it is also less prone to short-cycling and thus prolongs equipment life. Sometimes you can downsize your breakers or electrical loads by right sizing, and right sizing improves building efficiency and overall electrical grid management."*

One in four respondents that saw an advantage to right-sizing (25%) named equipment reliability as an advantage of right-sizing. One respondent said, *"Extended equipment lifespan [is an advantage].*

Properly sized components experience less wear and tear, extending their lifespan and reducing replacement costs."

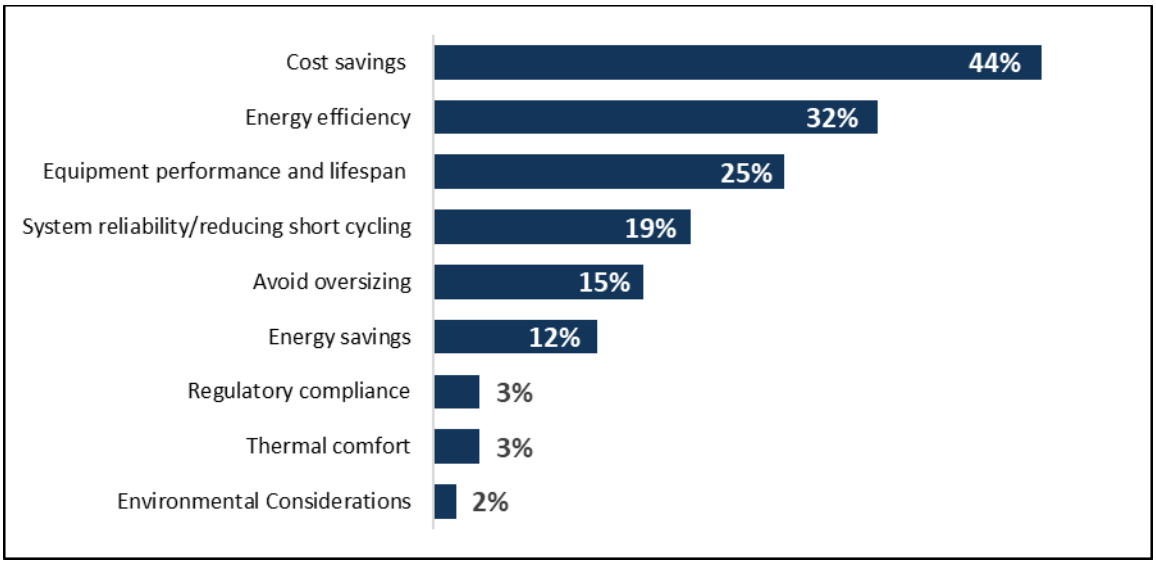


Figure 18: Advantages of Including Right-Sized Heating and Cooling in Commercial HVAC Systems
(n=59; multiple responses allowed)

Respondents had nuanced opinions on the benefits of right sizing, particularly system performance in extremely cold or hot conditions. One respondent considered a system "right-sized" if the building made it through temperature extremes with minimal issues. Another respondent said, *"It reduces the amount of compressor cycling on/off. The disadvantage is the system isn't sized large enough to handle the much higher temperatures we get on a rare basis. But overall, the lower the initial costs and operating costs are, the better for the customer."*

All respondents (100%) could name at least one advantage of the elements of VHE DOAS. When asked about the advantages of incorporating all design components together in an HVAC system, more than half of respondents (55%) mentioned cost savings and/or energy savings (Figure 19). One respondent summarized the advantages of including all four elements together saying, *"Basically reducing size of equipment and energy consumption by properly sizing equipment and delivering air efficiently. This translates to a cost savings both up front and over time."*

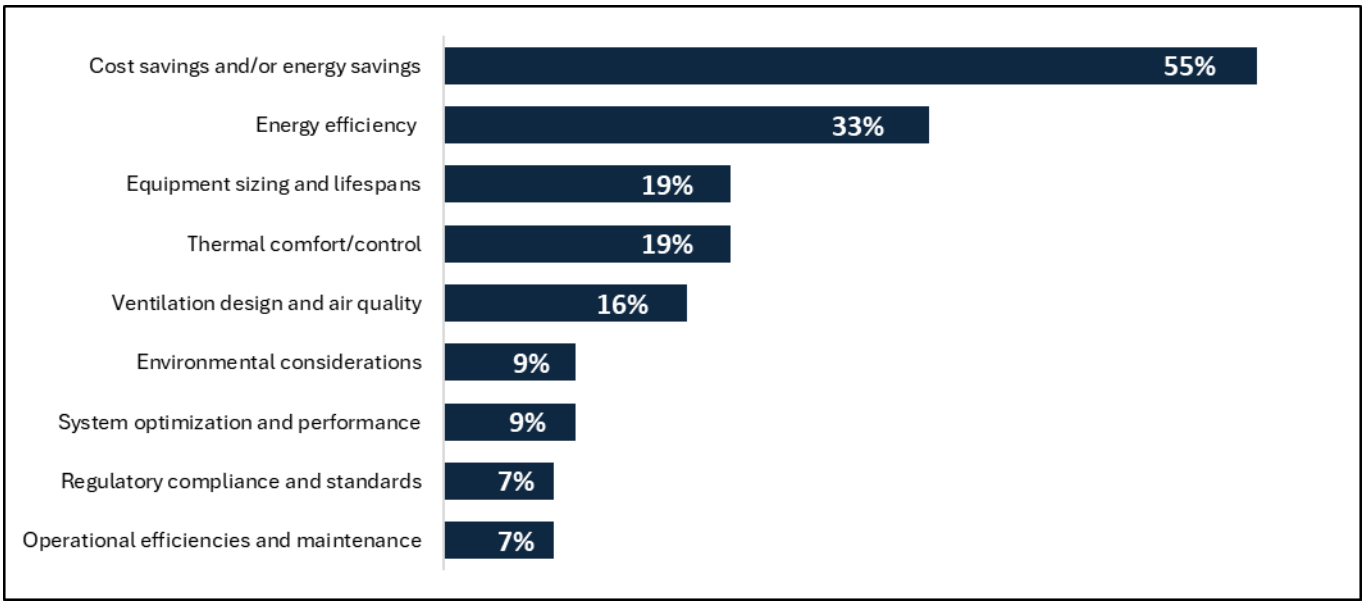


Figure 19: Advantages of Including All Components in a Commercial HVAC System
(n=67; multiple responses allowed)

Over half of the respondents (55%) say they proposed at least one project that included all four elements of VHE DOAS design in the twelve months prior to the survey. Trained designers and designers who have experience working in Washington state are more likely to propose VHE DOAS projects to their clients. Nearly all of the designers who attended a NEEA training (86%) said they proposed at least one project with met all four elements of VHE DOAS in the initial design phase, compared to fewer than half of designers who did not attend a training (47%). Two-thirds of designers in Washington (67%) proposed at least one project with all four elements of VHE DOAS, compared to only 19% of designers who do not work in Washington state, likely due to the influence of code requirements that are similar to VHE DOAS.

VHE DOAS INSTALLATIONS

Designers were asked to estimate how many commercial HVAC projects they had worked on in the last year, and how many of those projects satisfied a list of conditions, including elements of VHE DOAS. The below results present both the average percentages reported by each respondent and a project-weighted average across all respondents.

In the example below, the non-project-weighted average (rounded) is 40%:

$$\frac{10\% + 30\% + 80\%}{3} = 40\%$$

Respondent #3 installed the fewest projects last year, but most of them were VHE DOAS, compared to Respondent #1 who installed the most projects and only a fraction were VHE DOAS. The project-weighted percentage is 26%, lower than the average across respondents using the other method (40%):

$$\frac{(2 + 2 + 4)}{(20 + 6 + 5)} = 26\%$$

Table 18: Example Data to Illustrate Different Methods for Calculating Installation Rates

Respondent	Total Number of Commercial Projects (A)	Total Number of VHE DOAS Projects (B)	VHE DOAS Projects (%) (B/A)
1	20	2	10%
2	6	2	30%
3	5	4	80%

Both methods for calculating the installation rate of components of VHE DOAS are valid and could be biased in different ways by outliers or very large or small firms. The team chose to present both estimates in order to better triangulate the rate of adoption of VHE DOAS.

Companies are doing retrofits and remodels at a higher rate than any other installation type. In the 12 months prior to the survey, designers and manufacturer representatives said that retrofits account for 66% of installations, on average.[21]

Designers who responded to the survey worked on a range of commercial projects. 90% of designers worked on at least one commercial HVAC project in the past year (ranging from 0 to 750 projects). The average number of commercial HVAC projects designers worked on was 37 (median of ten). In total, designers surveyed collectively worked on over 2,500 commercial HVAC projects in the past year.

[21] The project-weighted estimate for the percent of installations that are retrofits or remodels is also 66%.

On average, surveyed designers reported that one in four projects (24%) met all four VHE DOAS requirements. Looking at all of the commercial HVAC projects reported by all respondents, 10% of those projects met all four design elements of VHE DOAS (Table 19). Notably, a similar number of projects (17%, 10% project-weighted) used DOAS with gas heating.

Table 19: Features of Commercial HVAC Projects Worked on in Past 12 Months

Number of Projects that…	Average by Respondent (Unweighted)	Project-Weighted Average
Had reduced heating/cooling design loads due to ventilation energy- or heat recovery	40%	18%
Had a high-efficiency electric heating system (often VRF or other inverter driven heat pump technology)	38%	18%
Had the minimum capacity heating/cooling equipment that met the design load	37%	20%
Used DOAS with fully separate air distribution for ventilation vs heating/cooling	35%	21%
Had an ERV/HRV with at least 82% sensible effectiveness	27%	13%
Used DOAS with gas heating	17%	10%
How many met all 4 design elements of VHE DOAS	**24%**	**10%**

Trained designers are more likely to install HVAC systems that meet all four elements of VHE DOAS. When comparing the average number of projects respondents say met elements of VHE DOAS (Table 20) and the project-weighted proportion of projects that met the elements (Table 21), trained respondents are more likely to install VHE DOAS than non-trained respondents, no matter how it is measured. While we might reasonably expect that designers who work in Washington state might be more likely to install VHE DOAS given their experiences with the Washington state code, the survey results do not present a clear narrative here. In future MPERs, the team recommends asking follow-up questions to estimate the number of VHE DOAS projects installed in Washington state. This question could lead to additional insights on whether designers are installing VHE DOAS (or near-VHE DOAS) projects in Washington state because they are required by code and whether their experience in Washington state is influencing their approach to design in other states.

Table 20: Features of Commercial HVAC Projects Worked on in Past 12 Months (Respondent Averages), by Training Status and State

(n=63)

Average Amount of Projects that…	All Respondents	NEEA Training Attendance		State	
		Trained *(n=14)*	Not Trained *(n=49)*	Works in WA *(n=50)*	Does not work in WA *(n=13)*
Had reduced heating/cooling design loads due to ventilation energy- or heat recovery	40%	38%	40%	41%	34%
Had a high-efficiency electric heating system (often VRF or other inverter driven heat pump technology)	38%	38%	38%	43%	17%
Had the minimum capacity heating/cooling equipment that met the design load	37%	42%	36%	42%	20%
Used DOAS with fully separate air distribution for ventilation vs heating/cooling	35%	37%	34%	41%	12%
Had E/HRV with at least 82% sensible effectiveness	27%	20%	28%	25%	32%
Used DOAS with gas heating	17%	14%	18%	17%	18%
How many met all 4 design elements of VHE DOAS	**24%**	**38%**	**20%**	**25%**	**18%**

Table 21: Features of Commercial HVAC Projects Worked on in Past 12 Months (Project-Weighted), by Training Status and Weight

(n=63)

Average Amount of Projects that…	All Respondents	NEEA Training Attendance		State	
		Trained *(n=14)*	Not Trained *(n=49)*	Works in WA *(n=50)*	Does not work in WA *(n=13)*
Number of comm. HVAC projects in past 12 months	**2,509**	**187**	**2,322**	**2,179**	**330**
Average projects per respondent	**40**	**13**	**47**	**44**	**25**
Had reduced heating/cooling design loads due to ventilation energy- or heat recovery	18%	36%	16%	13%	49%
Had a high-efficiency electric heating system (often VRF or other inverter driven heat pump technology)	18%	36%	16%	17%	25%
Had the minimum capacity heating/cooling equipment that met the design load	20%	36%	19%	16%	49%
Used DOAS with fully separate air distribution for ventilation vs heating/cooling	21%	29%	20%	19%	28%
Had an E/HRV with at least 82% sensible effectiveness	13%	15%	13%	8%	47%
Used DOAS with gas heating	10%	11%	10%	6%	34%
How many met all 4 design elements of VHE DOAS	**10%**	**27%**	**9%**	**7%**	**30%**

REAL-TIME TRAINING FEEDBACK AND IMPACT BATTERY

The survey included 14 participants who attended a training sponsored by NEEA or BetterBricks about VHE DOAS (21%). Most respondents recalled attending a training within the past two years (Figure 20).

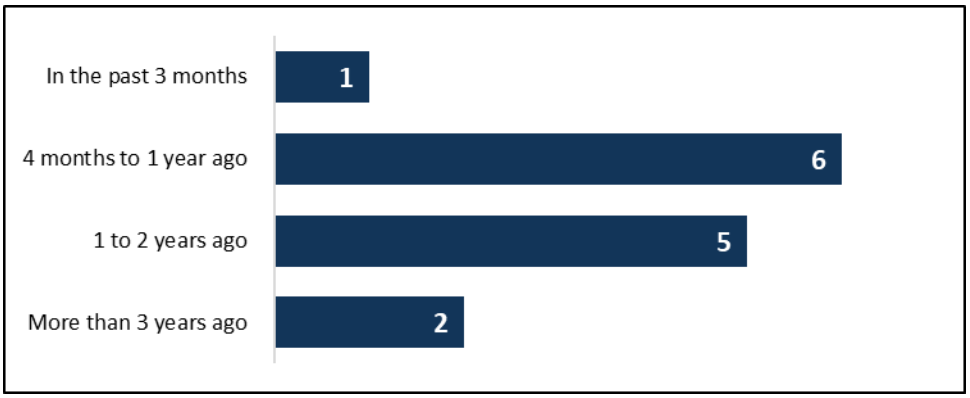


Figure 20: When Respondents Attended Training

(n=14)

The one respondent who attended a training within three months of taking the survey considered themselves "very familiar" with DOAS prior to the training but "not at all familiar" with VHE DOAS. The designer said they were very likely to use VHE DOAS in their work following the training.

Half of respondents (50%) who attended a NEEA training between three months and two years prior to the survey (n=10) said the training influenced their decision to include VHE DOAS in projects they proposed or worked on within the past year. Designers who said the training influenced their decision said the training pointed out easier design approaches and provided technical expertise and tools such as design guides and case studies. One designer said they consider NEEA training "essential to building the knowledge, abilities, and self-assurance to make wise choices when including VHE DOAS systems into their projects." Another trainee said NEEA training is influential in their decision making because it provided them with an extensive understanding of VHE DOAS design factors, such as component selection, system sizing, and integration with current systems. Following the training, this designer said their company was "better equipped to boldly suggest VHE DOAS in projects."

The designers who said the training did not influence their decisions to include VHE DOAS in their projects (n=5) indicated they were already informed about VHE DOAS prior to the training (two), already using the design components in their work (one), or were following code (one). One respondent did not have the opportunity to work on any new buildings since attending the training four to twelve months prior to the survey distribution. One attendee said they knew most or all of the information prior to the training, but doesn't agree that some (unspecified) items in the training are achievable on all projects. Still, it is notable that even though skepticism persists, this attendee was willing to continue to engage with the approach by attending the training.

One designer who attended trainings but did not propose or install any projects with VHE DOAS in the past year said that their primary client had very prescriptive requirements for their HVAC system, suggesting an opportunity to increase the adoption of VHE DOAS by educating building owners and end users of the system.

Five respondents who said the trainings influenced their decision to use VHE DOAS in their work said the most useful new information they learned in the trainings related to descriptions of energy savings (two), access to resources and tools (two), and specialized knowledge about the approach (one). One designer said, *"NEEA helps engineers like me to gain confidence in defining and executing VHE DOAS systems by offering thorough training and tools."* Another explained, "*NEEA highlights how VHE DOAS systems provide sustainable energy savings and environmental advantages. This is consistent with the increasing emphasis on sustainable building methods which enable HVAC engineers to make well-informed choices that lead to a more environmentally friendly future."*

Fewer than half of respondents (40%) thought NEEA could have provided additional information in the training. Respondents would have liked the training to include alignment with standards and building codes, additional resources for confidence building and knowledge sharing, and information about pricing for heat pump technology besides VRF. Another respondent suggested creating a database of equipment with information on changes to requirements, so they do not need to reach out to manufacturer representatives to inquire.

Trainees are likely to recommend the NEEA/BetterBricks training to others. The 12 trainees were asked on a scale of one to ten how likely they would be to recommend the training they attended. The net promoter score (NPS) is 17%, with 42% promoters and 25% detractors.

DETAILED RESULTS

This section contains full results for the HVAC designer survey. Note that sample sizes (n's) are unweighted, and percentages are weighted.

Survey Question	Response Options	Total		Works in WA		Does not work in WA		Trained		Not Trained	
		n	%	n	%	n	%	n	%	n	%
1 (n=70) In which of the following states do you work? **allows multiple responses*	Washington	52	74%	–	–	–	–	11	58%	42	75%
	Oregon	33	47%	–	–	–	–	5	26%	28	50%
	Idaho	19	27%	–	–	–	–	3	16%	16	29%
	Montana	10	14%	–	–	–	–	–	–	10	18%
	All of the above	5	7%	–	–	–	–	–	–	5	9%
2 (n=70) Which of the following best describes your job?	Manufacturer representative/vendor	2	3%	1	2%	1	6%	0	–	2	6%
	HVAC designer at an architecture, construction, or engineering firm	66	94%	50	96%	16	89%	14	100%	52	89%
	(Other) Facility engineer	1	1.5%	–	–	1	6%	–	–	2	6%
	(Other) Engineering	1	1.5%	1	2%	–	–	–	–	–	–
3b (n=29) For what type of buildings do you design/specify HVAC systems? **allows multiple responses*	Small/medium commercial (offices, grocery stores, restaurants, etc.)	19	66%	–	–	–	–	–	–	–	–
	Large commercial (high-rises, convention centers, airports, etc.)	17	59%	–	–	–	–	–	–	–	–
	Warehouse	12	41%	–	–	–	–	–	–	–	–
	Industrial/manufacturing	13	45%	–	–	–	–	–	–	–	–
	School/university	12	41%	–	–	–	–	–	–	–	–
	Hospital	7	24%	–	–	–	–	–	–	–	–
	Multifamily	8	28%	–	–	–	–	–	–	–	–
	Research and development labs	1	3%	–	–	–	–	–	–	–	–
5 (n=70) Which of the following does your company do? Select all that apply.	HVAC system design	69	99%	51	98%	18	100%	14	100%	55	98%
	HVAC repairs/maintenance	17	24%	11	21%	6	33%	5	36%	12	21%
	HVAC installations/replacements	11	16%	8	15%	3	17%	1	7%	10	18%
	HVAC sales	6	9%	4	8%	2	11%	-	-	6	11%

Survey Question	Response Options	Total		Works in WA		Does not work in WA		Trained		Not Trained	
		n	%	n	%	n	%	n	%	n	%
	(Other) Commissioning, Acoustics.	1	1%	1	2%	–	–	–	–	1	2%
	(Other) Energy modeling, system assessments	1	1%	1	2%	–	–	1	7%	–	–
	(Other) Commissioning of HVAC and energy studies	1	1%	1	2%	–	–	–	–	1	2%
6 (n=70) How familiar are you with NEEA, the Northwest Energy Efficiency Alliance?	Not at all familiar	16	23%	10	19%	6	33%	–	–	16	29%
	Not very familiar	17	24%	16	31%	1	6%	1	7%	16	29%
	Somewhat familiar	26	37%	17	33%	9	50%	4	29%	22	39%
	Very familiar	11	16%	9	17%	2	11%	9	64%	2	4%
7 (n=70) How familiar are you with BetterBricks, an information resource developed by NEEA about high-efficiency commercial building systems?	Not at all familiar	27	39%	19	37%	8	44%	-	-	27	48%
	Not very familiar	18	26%	12	23%	6	33%	4	29%	14	25%
	Somewhat familiar	23	33%	20	38%	3	17%	8	57%	15	27%
	Very familiar	2	3%	1	2%	1	6%	2	14%	–	–
8 (n=70) Before we reached out to you, had you heard the phrase "Dedicated Outside Air System" or "DOAS" in reference to commercial HVAC systems?	Yes	66	94%	51	98%	15	83%	14	100%	52	93%
	No	3	4%	1	2%	2	11%	–	–	3	5%
	I'm not sure	1	1%	–	–	1	6%	–	–	1	2%
9 (n=67) Before today, which of the following best describes your level of familiarity with DOAS?	Not at all familiar: never heard of it	1	1%	–	–	1	6%	–	–	1	2%
	Not very familiar: heard of it but never worked with it	5	7%	3	6%	2	13%	–	–	5	9%
	Somewhat familiar: worked with it occasionally	17	25%	11	22%	6	38%	3	21%	14	26%
	Very familiar: worked with it regularly	44	66%	37	73%	7	44%	11	79%	33	62%
10 (n=66) Do you have a generally favorable or unfavorable view of DOAS?	Favorable	54	82%	33	83%	8	67%	13	93%	41	79%
	Unfavorable	2	3%	2	5%	–	–	–	–	2	4%
	Unsure	10	15%	5	13%	4	33%	1	7%	9	17%

Survey Question	Response Options	Total		Works in WA		Does not work in WA		Trained		Not Trained	
		n	%	n	%	n	%	n	%	n	%
11 (n=70) BetterBricks has developed a system design approach they call Very High Efficiency DOAS (VHE DOAS). Before we describe it, how familiar are you with this approach, just based on the name?	Not at all familiar—never heard of it	29	41%	19	37%	10	56%	2	14%	27	48%
	Not very familiar: heard of it but never worked with it	22	31%	17	33%	5	28%	3	21%	19	34%
	Somewhat familiar: worked with it occasionally	13	19%	11	21%	2	11%	4	29%	9	16%
	Very familiar: worked with it regularly	6	9%	5	10%	1	6%	5	36%	1	2%
12 (n=41) To the best of your knowledge, which of the following are key elements of the Very High Efficiency DOAS approach? Select all that apply.	Ventilation air distribution system is separated from the heating and cooling system, via dedicated ductwork and supply diffusers	25	61%	22	67%	3	38%	8	67%	17	59%
	Ventilation air is delivered downstream of heating and cooling terminal units)	16	39%	13	39%	3	38%	9	75%	7	24%
	An energy- or heat-recovery ventilator (ERV/HRV) with at least 82% sensible effectiveness	34	83%	29	88%	5	63%	11	92%	23	79%
	A high-efficiency, electric heat pump system (often VRF or other inverter driven heat pump technology)	23	56%	16	48%	7	88%	10	83%	13	45%
	Building load calculations account for ventilation energy recovery	21	51%	19	58%	2	25%	6	50%	15	52%
	The smallest equipment that meets that design load is selected	19	46%	16	48%	3	38%	6	50%	13	45%
	High efficiency condensing gas heating system	8	20%	7	21%	1	13%	3	25%	5	17%
	Refrigerant heat recovery to take advantage of simultaneous heating and cooling	9	22%	9	27%	0	0%	4	33%	5	17%
	Demand control ventilation to minimize over ventilating	26	63%	23	70%	3	38%	7	58%	19	66%
	Identified at least 3 out of 4 elements of VHE DOAS	–	**32%**	–	**33%**		**25%**	–	**50%**	–	**24%**

Survey Question	Response Options	Total		Works in WA		Does not work in WA		Trained		Not Trained	
		n	%	n	%	n	%	n	%	n	%
14 (n=70) Now that you've seen that list: before we reached out to you, which of the following best describes your level of familiarity with Very High Efficiency DOAS, as described by BetterBricks? It's OK if you're not familiar; we just need your honest answer.	Not at all familiar: never heard of it	14	20%	8	15%	6	33%	–	–	14	25%
	Not very familiar: heard of it but never worked with it	14	20%	9	17%	5	28%	3	21%	11	20%
	Somewhat familiar: worked with it occasionally	21	30%	18	35%	3	17%	3	21%	18	32%
	Very familiar: worked with it regularly	21	30%	17	33%	4	22%	8	57%	13	23%
15 (n=70) Just to confirm which of the following best reflects your understanding of this VHE DOAS approach before this survey?	I am familiar with this general approach and its affiliation with NEEA/BetterBricks	11	16%	9	17%	2	11%	7	50%	4	7%
	I am at least somewhat familiar with this general approach, but unaware of any affiliation to NEEA/BetterBricks	44	63%	36	69%	8	44%	7	50%	37	66%
	I am not familiar with this approach at all	15	21%	7	13%	8	44%	–	–	15	27%
16 (n=70) In your opinion, do you see any advantages to including decoupled ventilation design in a commercial HVAC system?	Yes	64	91%	48	92%	16	89%	14	100%	50	89%
	No	3	4%	3	6%	–	–	–	–	3	5%
	I'm not sure	3	4%	1	2%	2	11%	–	–	3	5%
18 (n=69) In your opinion, do you see any advantages to including high-efficiency ERV or HRV in a commercial HVAC system?	Yes	62	90%	48	94%	15	83%	14	100%	49	89%
	No	2	3%	1	2%	1	6%	–	–	2	4%
	I'm not sure	5	7%	2	4%	2	11%	–	–	1	7%
20 (n=69) In your opinion, do you see any advantages to including high performance electric heating and cooling in a commercial HVAC system?	Yes	59	86%	45	88%	14	78%	14	100%	45	80%
	No	1	1%	1	2%	–	–	–	0%	1	2%
	I'm not sure	9	13%	5	10%	4	22%	–	0%	9	16%

Survey Question	Response Options	Total		Works in WA		Does not work in WA		Trained		Not Trained	
		n	%	n	%	n	%	n	%	n	%
22 (n=68) In your opinion, do you see any advantages to including right-sized heating and cooling in a commercial HVAC system?	Yes	59	87%	46	90%	13	72%	14	100%	45	83%
	No	3	4%	1	2%	2	12%	-	0%	3	6%
	I'm not sure	6	9%	4	8%	2	12%	-	0%	6	11%
25 (n=67) In the last 12 months, how many times have you proposed a commercial HVAC system that included all four of the Very High Efficiency DOAS design components to a client in the initial development phase?	Average	4.4	–	4.9	–	2.9		6.1	–	4.9	–
	Median	1	–	3	–	–	–	4	–	3	–
	Proposed at least 1 project w/ VHE DOAS	–	55%		67%	–	19%		86%	–	47%
26 (n=66) How does that compare to the number you proposed in the year before that?	Fewer this year	11	17%	8	16%	3	20%	5	36%	6	12%
	About the same as the previous year	48	73%	36	71%	12	80%	6	43%	42	81%
	More this year	7	11%	7	14%	–	–	3	21%	4	8%

Survey Question	Response Options	Total		Works in WA		Does not work in WA		Trained		Not Trained	
		n	%	n	%	n	%	n	%	n	%
28 (n=63, Total Projects = 2,509) Of those [PIPE IN # OF PROJECTS FROM Q27], how many…	Remodels/retrofits	1649	66%	1512	69%	137	42%	95	51%	1554	67%
	Used DOAS with fully separate air distribution for ventilation vs heating/cooling	510	20%	417	19%	93	28%	54	29%	456	20%
	Used DOAS with gas heating	253	10%	141	6%	112	34%	20	11%	233	10%
	Had an ERV/HRV with at least 82% sensible effectiveness	323	13%	169	8%	154	47%	28	15%	295	13%
	Had reduced heating/cooling design loads due to ventilation energy- or heat recovery	442	18%	280	13%	162	49%	66	35%	376	16%
	Had the minimum capacity heating/cooling equipment that met the design load	501	20%	338	16%	163	49%	65	35%	436	19%
	Had a high-efficiency electric heating system (often VRF or other inverter driven heat pump technology)	441	18%	360	17%	81	25%	68	36%	373	16%
	How many met all 4 design elements of VHE DOAS	252	10%	154	7%	98	30%	50	27%	202	9%
39 (n=10) [IF Q29 > 0] Previously, you indicated that [PIPE IN Q30 #] commercial HVAC project(s) you worked on in the past year met all four of the design components of the Very High Efficiency DOAS approach. Did the NEEA/BetterBricks training you attended influence your approach to these project(s)?	Yes	5	50%	3	38%	2	100%	–	–	–	–
	No	5	50%	5	63%	–	–	–	–	–	–

Survey Question	Response Options	Total		Works in WA		Does not work in WA		Trained		Not Trained	
		n	%	n	%	n	%	n	%	n	%
40 (n=10) [IF Q30 > 0] Previously, you indicated that [PIPE IN Q30 #] commercial HVAC project(s) you worked on in the past year met all four of the design components of the Very High Efficiency DOAS approach. Did the NEEA/BetterBricks training you attended influence your approach to these project(s)?	Yes	5	50%	3	38%	2	100%	–	–	–	–
	No	5	50%	5	63%	–	–	–	–	–	–
47 (n=11) Thinking about the commercial HVAC project(s) you worked on since the training, was there any information the training could have provided that would have been useful for you?	Yes	6	55%	4	50%	2	67%	–	–	–	–
	No	3	27%	2	25%	1	33%	–	–	–	–
	I'm not sure	2	18%	2	25%	0	0%	–	–	–	–
52 (n=66) Is your company classified by any US state as any of the following? Select all that apply.	Disadvantaged Business Enterprise (DBE)	1	2%	1	2%	0	–	–	–	1	2%
	Minority-owned Business Enterprise (MBE)	4	6%	4	8%	0	–	–	–	4	8%
	Women-owned Business Enterprise (WBE)	4	6%	3	6%	1	6%	–	–	4	8%
	Emerging Small Business (ESB)	2	3%	2	4%	-	-	–	–	2	4%
	Service-Disabled Veteran Business Enterprise (SDVBE)	–	–	–	–	–	–	–	–	–	–
	Small Business	20	30%	15	30%	5	31%	2	100%	18	35%

Appendix E Web Scan and Traffic Review

This MPER included a review of online materials to provide insight into how NEEA's VHE DOAS BetterBricks content has been used by parties other than NEEA (to inform MPIs 1a and 1b). This included a review of the web traffic to BetterBricks VHE DOAS materials, and a multi-prong web scan to identify instances of other stakeholders' repurposing of NEEA materials.

The team employed four techniques to explore the reach of NEEA-derived VHE DOAS content. First, the team reviewed the web traffic to NEEA's VHE DOAS materials hosted on BetterBricks.com. Next, the team conducted a web scan task with three components: a targeted keyword search of the web, a reverse image search of the web, and content matching, which used algorithms to identify online materials that appeared to have incorporated NEEA verbiage.

Methodology

Web Traffic Review. NMR first reviewed the Google Analytics (GA) account for the BetterBricks website, as this provides high-level insight into web traffic to the site. For this analysis, NEEA's Google Analytics tools provided (anonymized) information about visitors from October 9, 2023, to November 17, 2024; GA logged 1,526 "engaged visitors" who viewed VHE DOAS content and the web pages referring these visitors to the website. While Google Analytics is a powerful platform and provided valuable insights, it has limitations, e.g., only retaining 15 months of data to identify referring web pages of incoming traffic. This data also requires extensive winnowing to remove links between BetterBricks documents, and other entries that do not represent outside traffic to NEEA's site. For comprehensiveness, NMR explored several third-party indices such as the Google Search Console Tools, Bing Webmaster Tools, and others to supplement the GA referrer analysis results.[22]

Web Scan: Keyword Search. The keyword search involved web searches to find specific terms that likely originated from NEEA's VHE DOAS materials, to find other parties that might be incorporating NEEA's language to promote VHE DOAS or a similar approach. To do this, first, the team built an objective list of indicator terms that were more common in NEEA's VHE DOAS materials than in other materials about commercial HVAC equipment that had no connection to NEEA. The team compiled two classes of documents to form a corpus for analysis. One class contained documents known to originate from NEEA, including VHE DOAS training and marketing materials NEEA provided for this MPER, and a few other white papers from BetterBricks (31 documents), while the other consisted of subject-adjacent content such as commercial HVAC rebate offerings (30 documents) from non-NEEA entities.

NMR processed these documents to identify terminology that was more prevalent in the VHE DOAS training material class. After reviewing the algorithm's list of keywords, NMR identified five plausible terms that were far more likely to be found in NEEA materials than non-NEEA materials (VHE, very high efficiency, decoupling, Ventacity and bypass). Ultimately, the team expanded the scope of the keyword

[22] The Google Search Console Tools were not useful for our purposes, since there was not a way to limit the back-link statistics to specific documents. Bing's offering provided a list of dozens of referring websites, including a few spam websites that have cloned content from BetterBricks, and were excluded from our analysis.

search, conducting web searches with multiple search engines (Google, Bing, Yandex) for the following key phrases known to have ties to NEEA:

- "very high efficiency" "dedicated outdoor air system"
- "very high efficiency dedicated outdoor air system"
- "Very High Efficiency HVAC"
- "VHE HVAC"

NMR checked each result, scanning the materials for references to key terms like decoupling, bypass, BetterBricks, NEEA, HRVs or ERVs, then reviewed the context of any matches more closely to verify that the material was related to NEEA's VHE DOAS materials. This process turned up 64 matching documents across the web, and a handful of related entries such as Washington-inspired amendments to commercial code ventilation requirements in Minnesota, Wisconsin, and Virginia.

Web Scan: Reverse Image Search. The reverse image search involved looking for NEEA's VHE DOAS graphics on the web, to find other parties that might be using its materials. The search began with a review of VHE DOAS training materials provided by NEEA to identify informative, distinctive, or otherwise eye-catching figures used in NEEA documents, such as the diagram in Figure 21Figure 21. While this process was necessarily subjective, NMR identified twelve images (several of which were variations on the image below.)

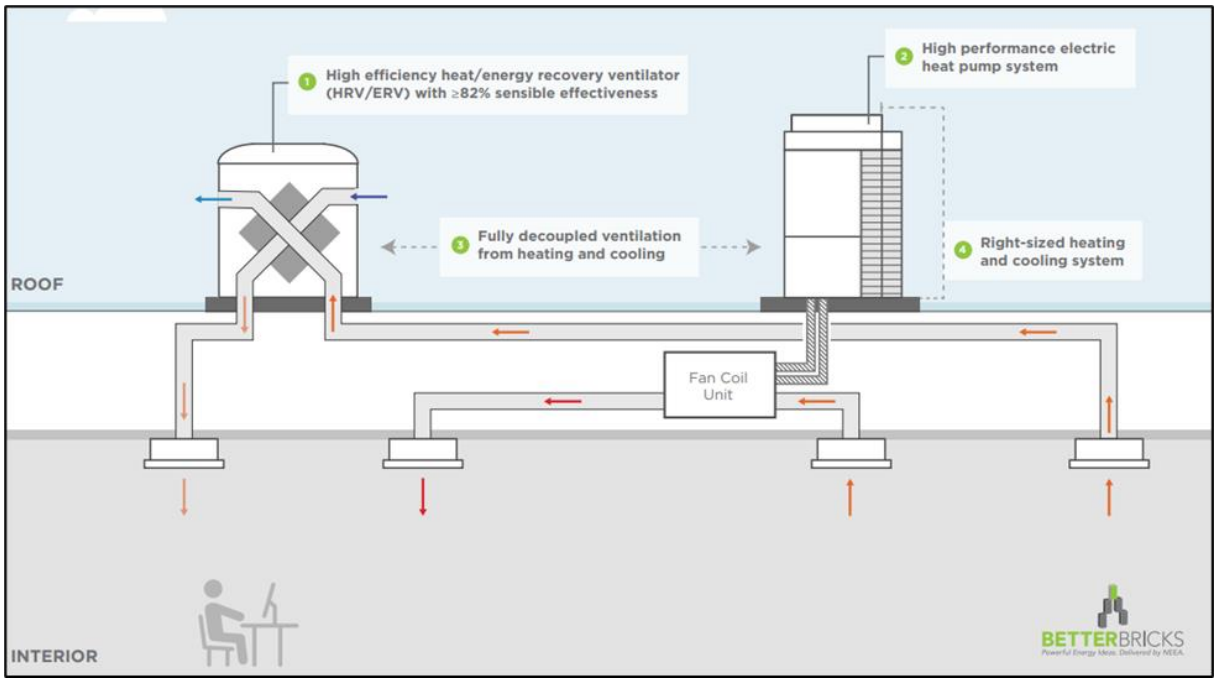


Figure 21: Example of VHE DOAS Image Used in Reverse Image Search

- Literature Review of Non-Energy Benefits Associated with Dedicated Outside Air Systems) Figure 1
- Energy Efficiency Analysis of Commercial DX-DOAS and ERV/HRV-DOAS Figures 4, 5 & 12
- Calibrated Energy Savings for Very High Efficiency DOAS in Multi-Family Housing Figures 5, 14 & 19

- Proven HVAC solutions to reduce viral spread and increase energy efficiency
- Very High Efficiency DOAS Pilot Project Summary Report Figure 1
- A Proven Approach to High-Performance HVAC Improves Efficiency, Health and Comfort p. 2

A reverse image search on Bing, Google, Yandex, and Tineye for each of these selections yielded seven matching sites that had posted these materials online, several of which had been located using other elements of the web scan.

Web Scan: Content Matching. Using the same corpus previously employed for keyword identification, NMR applied a standard algorithm for determining document topics (SBERT topic embedding), then trained multiple models (including random forest, logistic regression, etc.) to classify the document topics.

A neural network performed best, achieving 90% classification accuracy. NMR used the neural network to classify 32 documents from 10 of the partners not identified as employing NEEA-derived VHE DOAS marketing materials. The model classified five of these documents from four partners as being similar to the VHE DOAS training materials but upon manual review, none appeared to include pertinent language or links to BetterBricks' VHE DOAS content.

WEB TRAFFIC REVIEW FINDINGS

Most visitors to the VHE DOAS content on the BetterBricks websites are located in states served by NEEA or its VHE DOAS partners. Among visitors to the VHE DOAS content on BetterBricks with an identifiable origin (63% of the total web traffic), most are from the region served by NEEA (44%) or regions of partners with a natural geographic territory such as NYSERDA in New York or PGE, SCE, and SDG&E in California (Figure 22).

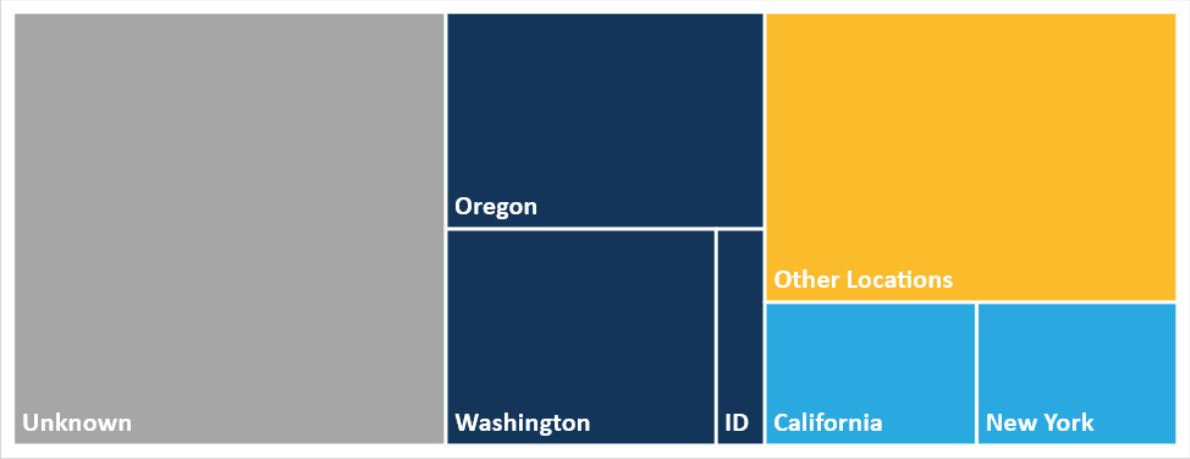


Figure 22: Location of Visitors to BetterBricks VHE DOAS Online Content

Of these visitors to VHE DOAS content on BetterBricks, nearly two-thirds (63%) reach the VHE DOAS content from a search engine, compared to only 3% whom are known to arrive via links on NEEA and its partners' websites (Figure 23). It is unsurprising that the vast majority arrive through search engines, as this is a typical way that many users find information of interest online. Rather, an opportunity to boost engagement may come from an increase in NEEA partners driving traffic to these materials.

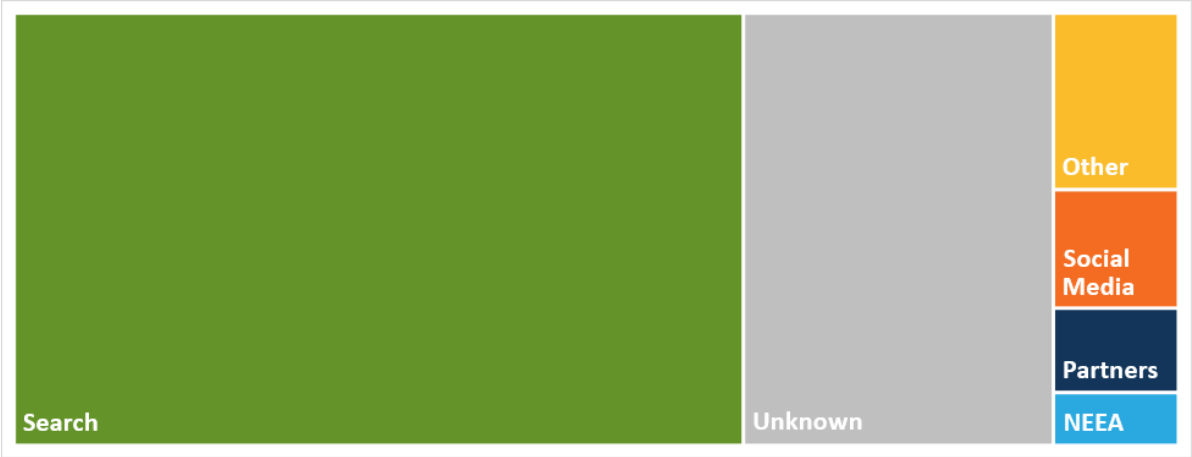


Figure 23: How Online Visitors Reached BetterBricks VHE DOAS Materials

WEB SCAN FINDINGS

Approximately half of NEEA's VHE DOAS initiative partners included NEEA terminology, talking points, and/or references to VHE DOAS on their websites. As shown in Table 22 organizations involved in policy, certifications, or promoting best practices were more likely to have verified VHE DOAS marketing materials on their websites (seven of ten partner organizations), while firms that sell relevant mechanical equipment were the least likely (one of six websites reviewed). At the time of review, NMR could not verify the presence of VHE DOAS material from NEEA on the websites of some funder sponsors, including Avista, Cascade Natural Gas, NorthWestern Energy, and Puget Sound Energy.[23] It is unsurprising to see natural gas funders not specifically promoting VHE DOAS, given that it is currently an all-electric approach.

As of 2024, six of nine institutions identified by NEEA as targets for adopting NEEA materials (ASHRAE, PHIUS, AIA, Living Future, NBI-Getting to Zero, Greenbuild, NEEC, WSEC, and UW IDL) use or reference NEEA-developed materials for trainings and certifications [MPI 1a]. Six priority utilities (four NEEA funding sponsors, as well as PG&E and NYSERDA), three out of six qualifying E/HRV manufacturers, and one of six qualifying E/HRV reps use NEEA messaging in their promotions [MPI 1b].

Table 22: NEEA Partners Using NEEA VHE DOAS Materials

Funding Sponsors	Other Utilities	Manufacturers	Sales	Policy Groups
☐ Avista	☑ NYSERDA	☐ Greenheck	☐ Air Treatment	☐ AIA
☑ Bonneville Power Administration	☑ PG&E	☑ Oxygen8	☐ Air Reps	☑ ASHRAE
☐ Cascade Natural Gas	☐ SCE	☐ SEMCO	☐ CMS	☑ Getting to Zero
☑ Energy Trust of Oregon	☐ SDG&E	☑ Swegon	☐ Dorse	☐ Greenbuild
☑ Idaho Power		☐ Tempeff	☐ Johnson Barrow	☑ IMT
☐ NorthWestern Energy		☑ Ventacity	☑ Mechanical Sales	☐ Living Futures
☐ Puget Sound Energy				☑ NEEC
☑ Seattle City Light				☑ PHIUS
				☑ UW IDL
				☑ WSEC

The content-matching model classified five documents from four partners as being similar to the VHE DOAS training materials. Upon manual review, none included pertinent language or links to BetterBricks materials. The manual review revealed that NorthWestern Energy does provide a link to the entry page of the BetterBricks website,[24] and Puget Sound Energy (PSE) has a page dedicated to a VHE DOAS cousin

[23] Although NMR examined some partners' sites without verified materials closely, it is possible that some websites did contain VHE DOAS materials. For that reason, all websites without a checkmark in Table 22**Error! Reference source not found.** are marked as "status unknown."

[24] NorthWestern Energy (NWE). 2024. Energy Resources for Businesses. Retrieved from https://www.northwesternenergy.com/account-services/for-business/energy-efficiency-for-business/resources-for-businesses

they call Advanced Rooftop Controls.[25] While PSE does not appear to directly promote VHE DOAS, it does allude to it in the FAQ for their Commercial New Construction offering.[26]

Some promoters of VHE DOAS use different terminology. The Institute for Market Transformation (IMT) appears to be the most prolific promoter of the concept (other than NEEA), based on the web scan results, but it prefers to use the term "VHE HVAC." IMT's continued efforts to promote the VHE DOAS concept have spawned numerous articles and presentations by other organizations with this alternate terminology.

Within the federal government, terminology is inconsistent; some agencies cite BetterBricks and use the term "VHE DOAS," while others refer to IMT's "VHE HVAC." IMT penned a white paper for the General Services Administration (GSA) that uses "VHE HVAC."[27] However, other federal agencies including the Pacific Northwest National Laboratory (PNNL) and the Department of Defense's Strategic Environmental Research and Development Program (SERDP) Environmental Security Technology Certification Program (ESTCP) favor the term VHE DOAS or its expansion, very high efficiency dedicated outdoor air system.[28] Although some federal sources cite BetterBricks, others do not. An example of a missed opportunity for such cross-promotion is DOE's recent publication, "Guidance Document on Space Heating Electrification for Large Commercial Buildings with Boilers."[29]

Table 23: Non-NEEA Partner Organizations Promoting VHE DOAS Concepts

Governments	Other Utilities	Industry	Policy Groups
DOE	ComEd	AEE	Building to Electrification Coalition
GSA	Consumers Energy	BOMA	Clean Energy for America
Lawrence Berkley National Laboratory		Building Operator Certification Newsletter	Electric League
Philadelphia Energy Authority		Red Car Analytics	Housing Development Consortium
PNNL			Illinois Green Alliance
Rhode Island Energy Efficiency Council			Northwest Power and Conservation Council
SERDP ESTCP			USGBC

[25] Puget Sound Energy (PSE). 2024. Advanced Rooftop Controls Rebates. Retrieved from https://www.pse.com/en/business-incentives/hvac-incentive-and-rebate-programs/advanced-rooftop-controls
[26] Puget Sound Energy (PSE). 2024. Commercial New Construction: Frequently Asked Questions. Retrieved from https://www.pse.com/-/media/PDFs/REBATES/new-construction-grants/BIZ--GRANTS/7836-Commercial-New-Construction-FAQ.pdf
[27] United States General Services Administration (GSA). 2024. Technical Specification for Very High-Efficiency HVAC. Retrieved from https://www.gsa.gov/system/files/2024-Tech%20Spec%20for%20Very%20High-Efficiency%20HVAC.pdf
[28] Office of the Deputy Assistant Secretary of Defense Energy Resilience & Optimization (DASDERO). 2023. Demonstration of Very High Efficiency HVAC in DoD Facilities. Retrieved from https://demo.serdp-estcp.mil/projects/details/ccba87b5-9e49-4e87-a418-761e20f3d8d7/demonstration-of-very-high-efficiency-hvac-in-dod-facilities
[29] United States Department of Energy (DOE). 2024. Guidance Document on Space Heating Electrification for Large Commercial Buildings with Boilers. Retrieved from https://www.energy.gov/sites/default/files/2024-04/Large%20Building%20Boiler%20Electrification%20Guidance.pdf

Appendix F NEEA Document Review

NEEA provided NMR with a great deal of documentation to help the evaluation team assess progress for key market progress indicators, in order to describe the state of the market during the early phases of NEEA's VHE DOAS market transformation efforts. NMR reviewed these materials to better understand NEEA's work to date, to serve as corroborating evidence to describe NEEA's work to develop various outputs described in the HP HVAC logic model, and to extract relevant MPI measurements from the provided materials.

Methodology

Acquisition of Materials

NEEA staff provided NMR with a significant body of materials (over 300) that served as the basis of the document review effort. Examples of materials provided included:

- Email correspondence and notes from meetings with stakeholders, including market actors, policy makers, industry association representatives, code officials
- Training, marketing, outreach, and conference materials designed to promote VHE DOAS in a variety of venues (code trainings, industry trade shows, etc.)
- Citations of when various products came to market
- VHE DOAS project costs
- VHE DOAS estimated project counts
- HP HVAC market progress reports
- Documentation from programs in the Northwest incentivizing VHE DOAS

NEEA provided some materials going back to 2017, but the team focused on materials from 2022 and forward, as it was in 2022 when the HP HVAC Initiative officially moved into the market transformation phase. NMR catalogued the provided materials, identifying the nature of the materials, summarizing them, and identifying the relevant logic model output, outcome, or MPI addressed by each one. NMR extracted relevant MPI measurements whenever possible, creating an initial assessment of the status of market progress that could be updated in future MPERs, with additional data collection efforts.

The individual MPI measurements extracted from these materials are included in Appendix G.

Additionally, NMR also produced a catalog of NEEA's VHE DOAS training and engagement materials provided by NEEA and all of the relevant materials included on the BetterBricks site. The catalog contains white papers, case studies, presentations, YouTube videos, and articles detailing VHE DOAS, yielding a directory of materials that can be expanded and used for tracking the various outputs described in the VHE DOAS logic model.

Appendix G MPI Measurements and Output Tracking

MPI Measurements

Table 24 shows the HP HVAC Initiative's logic model outcomes, associated MPIs, and measurements for the MPIs addressed in the MPER. It also identifies the data sources used to develop the MPI measurements, and as applicable, where related findings are discussed in the MPER. If MPIs were measured in two ways, both measurements are provided. The rightmost column summarizes progress for that MPI.

Table 24: MPER #1 MPI Tracking

MPI	Metric	Data Source	Location	Measurement 1	Measurement 2 (if applicable)	Summary of Progress
Outcome I. Education and training materials, and marketing collateral are increasingly included in non-NEEA training programs, building certifications, and market outreach						
1.a. Increasing # of priority institutions use or reference NEEA-developed materials (e.g., specification, presentations, handouts, etc.) for trainings or certifications.	Number of priority institutions who reference NEEA materials. (9 priority institutions[30])	Document review; web scan/ web traffic review	Appendix E	Web scan: 6 of 9 priority institutions (ASHRAE, NBI, NEEC, PHIUS, UW IDL, and WSEC)	NEEA doc review: 2 (NBI, PHIUS)	**Summary: 6 of 9 priority institutions**
1 b. Increasing number of priority utilities, qualifying E/HRV manufacturers and/or reps use NEEA messaging in their promotions.	Number of priority utilities, manufacturers, and/or reps using NEEA messaging in promotions (Priority utilities[31]; manufacturers[32], manufacturer reps[33])	Document review, web scan/ web traffic review	Appendix E	Web scan: 6 priority utilities (Bonneville Power Administration, Energy Trust of Oregon, Idaho Power, Seattle City Light, PG&E, NYSERDA); 3 qualifying E/HRV manufacturers (Oxygen8, Swegon, Ventacity); 1 qualifying E/HRV manufacturer rep (Mechanical Sales)	NEEA doc review: 2 manufacturers (Oxygen8, Swegon) promoted VHE DOAS in LinkedIn posts in 2023.	**Summary: 6 priority utilities, 3 manufacturers, 1 manufacturer rep**

[30] ASHRAE, PHIUS, AIA, Living Future, NBI, Greenbuild, NEEC, WSEC, UW IDL.
[31] NEEA funders, NYSERDA, PG&E, SCE, SDG&E.
[32] Tempeff, Ventacity, SEMCO, Swegon, Greenheck, Oxygen 8, RenewAire, and Valent.
[33] Johnson Barrow OR, Johnson Barrow Seattle, Air Treatment, Air Reps, Mechanical Sales, Inc., Dorse, CMS.

MPI	Metric	Data Source	Location	Measurement 1	Measurement 2 (if applicable)	Summary of Progress
Outcome II. Suppliers, utilities, and energy efficiency organizations increasingly offer incentives and/or discounts						
2 a. Increasing number of priority HVAC suppliers, utilities, and/or energy efficiency organizations offer incentives for qualifying E/HRVs.	Number of priority entities offering incentives	Document review		2017: No incentives 2024 (as of August), the following partners offer incentives for qualifying E/HRVs: 7 qualifying man. reps. (JBI, JBO, MSI, AirTreatment, AirReps, CMS, Dorse); 5 priority utilities (NYSERDA, Seattle City Light, SnoPUD, PSE, and Bonneville Power Administration)	N/A	**Summary: Clear progress, from 0 in 2017 to 7 reps, 5 utilities**
2b. Increasing number of building specifications (e.g., LEED) incorporate VHE DOAS principles and/or reference NEEA-developed materials.	N/A	N/A	N/A	N/A	N/A	**Not yet measured**
Outcome III. Qualifying E/HRVs become available from more major suppliers and in a greater range of capacities and price points over time						
3 a. Increasing number of manufacturers produce qualifying ERVs and/or HRVs.	Number of manufacturers producing qualifying E/HRVs	Document review	Appendix G	2017: 1 (Ventacity, incubated by NEEA) 2021: 5 (added Greenheck, Oxygen8, Tempeff, Swegon) 2022: 6 (added SEMCO) 2024: 8 (added RenewAire and Valent)	N/A	**Summary: Clear progress, from 0 in 2016 to 8 in 2024**
3 b. Increasing number of larger manufacturers offer qualifying ERVs and/or HRVs.	Number of larger manufacturers offering qualifying E/HRVs[34]	Document review	Appendix G	2024: 1 (RenewAire); (added in 2024)	N/A	**Summary: Some progress, 1 out of 4**
3 c. Priority manufacturers have at least one qualifying ERV and/or HRV with 500-1000 CFM and 1000-5000 CFM capacities.	Number of priority manufacturers that have at least one qualifying ERV and/or HRV[35]	Document review	Appendix G	2017: 1 (Ventacity) 2020: 2 (added Swegon) 2022: 3 (added Oxygen8) 2024: 5 (added Valent and Greenheck) 2025: 5 (as of April)	N/A	**Summary: Clear progress, from 0 in 2016, to 5 in 2025**
3 d. Priority manufacturers have at least one qualifying ERV and/or HRV at a lower price point.	Number of priority manufacturers[36] with at least one qualifying ERV and/or HRV at low price point	Document review	Appendix G	2017: None. 2024: None. [NEEA analyzing install costs to define "low" price points.]	N/A	**Summary: No qualifying products**

[34] Johnson Controls, United Technologies Corporation/Carrier, Trane/Ingersoll Rand, and RenewAire.
[35] Tempeff, Ventacity, SEMCO, Swegon, Greenheck, Oxygen 8, RenewAire, and Valent.
[36] Tempeff, Ventacity, SEMCO, Swegon, Greenheck, Oxygen 8, RenewAire, and Valent.

MPI	Metric	Data Source	Location	Measurement 1	Measurement 2 (if applicable)	Summary of Progress
Outcome IV. Relevant ASHRAE committees adopt elements of VHE DOAS						
4 a. ASHRAE Technical Committee TC 5.5 updates heat and energy recovery chapter in its HVAC Systems and Equipment Handbook based on NEEA input on VHE DOAS principles.	TC 5.5 is updated with heat and energy recovery chapter in its HVAC System and Equipment Handbook	Document review	Appendix G	ASHRAE confirmed in an email that the chapter was approved by the TC, the final chapter was submitted to ASHRAE on July 28, 2023, and was emailed to all voting members of the TC.	N/A	**Summary: Nearly complete**
4 b. ASHRAE Learning Institute (ALI) updates its Air-to-Air Energy Recovery Fundamentals seminar based on NEEA input on VHE DOAS principles.	Air-to-Air Energy Recovery is updated based on VHE DOAS principles	Document review	Appendix G	As of August 2024, presentation material revisions are ongoing, and will likely be complete in time for an ASHRAE conference in summer 2025	N/A	**Summary: Nearly complete**
Outcome V. E/HRV test procedure drafted by Canadian Standards Association (CSA)						
5 a. EXP18 E/HRV test procedure is drafted.	Successfully establishing a new testing procedure (SPE18) for ERVs through the CSA Group. This is a step towards seeking adoption of this testing procedure from ASHRAE and eventually DOE.	Document review	Appendix G	As of November 2024, public comments were received, and a final test procedure was published.	N/A	**Summary: Complete**
Outcome VI. Washington and Oregon and ASHRAE 90.1 codes incorporate VHE DOAS principles						
6a. WSEC and CA Title 24 include DOAS in base commercial energy codes.	DOAS requirements in WSEC and CA code	Document review	Appendix G	2017: WSEC 2015: DOAS requirement added for certain building types starting in 2017 (C403.6) (requirement launched in 2017, delayed relative to initial implementation of WSEC 2015 in 2016); DOAS requirement due at least partly to NEEA involvement[37] Since 2017: 2018 WSEC: DOAS requirement expanded to additional building types (C403.3.5) 2021 WSEC: DOAS fan power limitations introduced (C403.3.5.2)	2023: CA Title 24. CA Energy Commission (CEC) held workshop to consider bundling DOAS requirement with heat pumps for three building types. Since 2023: 2025 Title 24 includes DOAS as a compliance option (140.4(a)3Ai or 140.4(a)3Aii, 140.4(a)3E)	**Summary: Complete for WSEC for certain building types. Partial progress in CA.**

MPI	Metric	Data Source	Location	Measurement 1	Measurement 2 (if applicable)	Summary of Progress
6b. WSEC and CA Title 24 increase sensible effectiveness of E/HRVs.	Efficiency requirements for E/HRVs in WA and CA code	Document review	Appendix G	2018: WSEC 2015: 50% SRE 2021: WSEC 2018: 60% SRE or 50% enthalpy recovery ratio 2024: WSEC 2021: 68% SRE or 60% enthalpy recovery ratio (C403.3.5.1), or 80% SRE for HP DOAS option (C406.2.2.6)	2024: 2025 Title 24: [where DOAS option is selected] 60% SRE or 50% enthalpy recovery ratio (140.4(q), 140.4(a)3E)	**Summary:** **Clear progress for WSEC, from 50% SRE in 2018 to 68% in 2024 (with 80% option)**
6c. WSEC base code includes more VHE DOAS elements until all 4 key elements are included.	VHE DOAS requirements included in WSEC base code	Document review	Appendix G	2024: C403.3.5: DOAS required for several building types C406.2.2.6: near-VHE DOAS efficiency as an optional measure for compliance in other building types to comply with C406 C403.3.5.1: requires 68% SRE / 60% ERR for the building types where DOAS is required C403.7.6: requires 60% SRE for multifamily buildings and 68% SRE / 60% ERR for other large, high-load buildings C406.2.2.6: encourages pairing DOAS with minimum 80% SRE heat recovery as an optional measure for buildings where DOAS is not required (by C403.3.5) C403.1.1: requires more efficient HVAC efficiency for many building types (note: this requirement is referred to as TSPR; a significant change between 2018 WSEC and 2021 WSEC was making multifamily buildings subject to the TSPR requirement) C406: encourages selection of more efficient HVAC equipment; multiple HVAC equipment/system efficiency credit options are among the long list measure options from which projects must satisfy a minimum number to comply with Section C406 C403.3.1: requires sizing based on load calcs in accordance with C403.1.2	N/A	**Summary:** **Clear progress - WSEC includes many requirements or optional compliance packages that are similar to VHE DOAS**

[37] NEEA. 2015 Washington State Energy Code Energy Savings Analysis – Commercial Provisions (2021). https://neea.org/wp-content/uploads/2025/03/2015-Washington-State-Energy-Code-Savings-Analysis.pdf

MPI	Metric	Data Source	Location	Measurement 1	Measurement 2 (if applicable)	Summary of Progress
Outcome VII. Awareness of VHE DOAS and its value propositions increases over time, spreading to more members of different audiences						
7a. Increasing # of commercial HVAC designers and/or manufacturer representatives can identify at least three of the four system elements.	Portion of designers/manufacturer reps that can identify three of four system elements	Designer survey	Appendix D	Question 12: 32% identified at least 3 out of 4 elements	Question 12: 15% identified all 4	**Summary:** **Clear progress – 32% of surveyed designers can identify 3 out of 4 elements**
7 d. Increasing number of commercial HVAC designers and/or manufacturer's representatives can name at least one value proposition for the system.	Portion of designers/manufacturer reps that can name one or more benefit for each element	Designer survey	Appendix D	Questions 16-19: 91% see advantages to a decoupled ventilation design 90% see advantages to high-efficiency ERV or HRV 86% see advantages to high performance electric heating/cooling 87% see advantages to right-sized heating and cooling	Questions 16-19: 100% see advantage to at least 1 of 4 elements	**Summary:** **Clear progress – almost all surveyed designers can name benefit to each of the 4 elements**
Outcome VIII. Supply chain audiences increasingly designing, promoting, and installing VHE DOAS						
8a. Increasing # of manufacturer representatives and/or design engineers propose the system to their clients.	Portion of designers/manufacturer reps that propose the system.	Designer survey	Appendix D	Question 25: 55% proposed at least one commercial HVAC project that included all four VHE DOAS elements to a client in the initial development phase in the past year (2023).	Question 26: 17% proposed fewer VHE DOAS projects this year compared to year before (2023 vs 2022); 11% proposed more	**Summary:** **Clear progress – VHE DOAS proposal rate appears higher than anticipated by NEEA**
8b. Increasing # of commercial HVAC contractors propose the system to their clients.	N/A	N/A	N/A	N/A	N/A	**Not yet measured**
8c. Increasing # of architects propose the system to their clients.	N/A	N/A	N/A	N/A	N/A	**Not yet measured**
8d. Increasing sales of qualifying E/HRVs.	N/A	N/A	N/A	N/A	N/A	**Not yet measured**
8e. Increasing number of VHE DOAS installations.	Number of VHS DOAS Installations	Designer survey; Document review	Appendix D	Question 28: 48% installed VHE DOAS (or comparable approach) in at least one project in the last year (2023)	NEEA reported VHE DOAS projects: 2016: 4 2021: 4 2017: 4 2022: 5 2018: 0 2023: 11 2019: 1 2024: 19 2020: 4	**Summary:** **Some progress – designers report far higher project counts than confirmed by NEEA**

OUTPUT TRACKING

As described in NEEA's logic model, NEEA undertakes a variety of strategic interventions that could ultimately trigger market outcomes and broader transformation of the commercial HVAC market. Some of these interventions yield concrete materials (outputs) whose existence could then lead to the outcomes described in the logic model. Table 25 describes evidence of NEEA's work to create those various outputs, based on materials provided to the MPER team by NEEA.

Table 25: Output Tracking and Program Activities to Date

Output Number	Output	Relevant Outcomes	Summary of Current Status (2024)	Program Activities to Create Outputs Since (2023-2024)
1	Cost and benefit data from projects and modeling	1, 7, 8	NEEA has contributed to or gathered a variety of analyses confirming expected savings from VHE DOAS. There are no other cost analyses scheduled at the time of this report.	• 2023: Red Car Analytics produced a report on *Calibrated Energy Savings for Very High Efficiency DOAS in Multi-Family Housing,* finding that code minimum balanced ventilation systems reduced HVAC energy by 14% on average • 2023: PNNL published a report on *Very High Efficiency Dedicated Outdoor Air System Field Site Re-Evaluation;* found energy savings consistent with NEEA's estimates, 48% savings on average compared to the preexisting system • 2024: McKinstry and Alliant completed incremental cost analyses on four DOE-based building types, including Small Office, Medium Office, Retail, and School. Shows estimated costs and savings for VHE DOAS vs. different baseline equipment scenarios
2	Education and training materials, number of people trained, location of trainings, marketing collateral including value proposition and business case	1, 7, 8	NEEA continues to provide education and training materials reaching manufacturers, facility managers, and others in the commercial design and construction industry in the Northwest.	• The HP HVAC program has completed 12 case studies and more than 10 articles describing the benefits or details of a VHE DOAS system • Manufacturer reps, University Integrated Design Labs and contract partners have delivered a wide range of trainings to the market • 2023: Trainings and events reached well over 300 individuals from the commercial design and construction industry • 2024: Over 15 trainings to ~100 designers and facility managers

Output Number	Output	Relevant Outcomes	Summary of Current Status (2024)	Program Activities to Create Outputs Since (2023-2024)
3	Forums and publications where NEEA and champions promote VHE DOAS to peers	7	NEEA creates momentum for champions to promote VHE DOAS.	• 2024: NEEA champions presented at 13 forums • One champion modified an ASHRAE educational seminar to expand from traditional DOAS equipment to incorporate full VHE DOAS
4	Regional and extra-regional outreach strategy	2, 3, 7	The strategy was developed in Q2 2023 and has remained as the key guide to outreach activities since.	• The strategy involves prioritizing key utility funders, BetterBricks partners, codes and standards organizations, and nationwide energy efficiency focused utilities and organizations involved in DOAS activities.
4	Engagement with priority utilities, energy efficiency organizations, manufacturers, and representatives		NEEA's HP HVAC team maintains regular communication with representatives for the seven current manufacturers, at least three priority utilities, and at least three energy efficiency organizations.	• NEEA has maintained regular communication with representatives of seven current manufacturers • The program has periodically connected with priority utilities (with at least three HP HVAC-specific discussions with priority utilities) • NYSERDA, Passive Haus US (PHIUS), and the Institute of Market Transformation (IMT) are important energy efficiency organizations NEEA communicates with periodically to share updates on each other's activities and strategy in transforming the market.
4	Agreements to incentivize and discount		The program currently has six active participants in the incentive program, meaning they regularly commit to submitting incentive applications.	• The HP HVAC program is in contract with seven manufacturer representatives, six of which have been actively participating in the program.
5	NEEA incentive strategy	2, 3, 7	At the time of this report, the incentive strategy remains the same.	• 2022: NEEA partnered with six HVAC equipment suppliers to implement an incentive strategy to accelerate adoption of VHE DOAS • The incentive strategy offers $4/nominal cfm with the sale of compliant energy recovery ventilation (ERV/HRV) equipment in qualifying projects using high-efficiency electric heating and cooling systems.

Output Number	Output	Relevant Outcomes	Summary of Current Status (2024)	Program Activities to Create Outputs Since (2023-2024)
6	Number and amount of incentives disbursed	3	At the time of this report there are a total of 29 projects receiving $279,528 in incentives that have fully processed through the HP HVAC program.	• NEEA continues to offer incentives to manufacturer representatives to increase adoption and promote VHE DOAS.
7	System requirements and QPL	1, 3, 4, 6	The system requirements document continues to receive updates as necessary.	• NEEA/BetterBricks summarized the equipment and design best practices for optimal energy efficiency using VHE DOAS • NEEA created a VHE DOAS HRV Compliant products list
8	Codes, policy, test procedure and standards strategy	4, 5, 6, 9 , 10	NEEA continues to monitor opportunities to push for increased federal standards and codes leading to VHE DOAS adoption, primarily through ASHRAE. State codes and standards, particularly involving increased building standards is also an important tactic for our program.	• Successfully established a new testing procedure (SPE18) for ERVs through the Canadian Standards Association (CSA). This is a step towards seeking adoption of this testing procedure from ASHRAE and eventually DOE • Submitted an IECC proposal to update DOAS and ERV guidance
8	Research, proposals, comments, process participation	4, 5, 6, 9 , 10		• Submitted SPE18 testing procedure, and IECC code proposal • Completed VHE Modeling update for Washington Code • Active participation by others on behalf of the HP HVAC program with the ASHRAE 227 committee

Appendix H Instruments

Designer and Manufacturer Survey Guide—Web Version

Recruitment Email

Subj: Efficient Mechanical Systems Survey from NEEA—$100 gift card to complete

Dear [First Name] [Last Name],

I am writing to ask for your help in a study of **commercial heating and cooling systems in the Northwest.** NMR, a research firm, is conducting this study on behalf of The Northwest Energy Efficiency Alliance (NEEA). Your feedback will help ensure that NEEA's work addresses the needs of industry professionals like you.

If you specify or design HVAC systems for commercial buildings and complete a survey, you will receive a $100 electronic gift card in appreciation of your time. Your responses will be kept **confidential.** We will not publicize, share, or sell your information. Surveys are expected to take around 10-15 minutes.

We want to talk to manufacturer's representatives of ERVs and HRVs and people who specify or design HVAC systems for commercial applications. If you are not the appropriate contact at your firm, we would appreciate you forwarding this message to someone in that role.

If you have questions about the study, please contact [CONTACT INFORMATION] of NMR or [CONTACT INFORMATION] of NEEA.

We greatly appreciate your taking the time to provide thoughtful answers for this important study.

Intro

Thank you for your interest in participating in this survey. NMR, a research firm, is conducting this study on behalf of the Northwest Energy Efficiency Alliance (NEEA). Your responses will be kept anonymous and confidential. Your feedback will help ensure that NEEA's work addresses the needs of industry professionals like you.
The survey is expected to take 20 minutes or less. You will receive a $100 digital gift card for completing the survey. If you have any questions about the study, please contact [REDACTED].

Screening, Background, and Company Structure (no MPI)

1. In which of the following states do you work?
    - Oregon
    - Washington
    - Idaho
    - Montana
    - None of the above [EXCLUSIVE RESPONSE; TERMINATE]
2. Which of the following best describes your job?
    - Manufacturer representative/vendor
    - HVAC designer at an architecture, construction, or engineering firm
    - Other (please specify)
3. Do you design or specify commercial HVAC systems?
    - [IF NO: TERMINATE OR FIND ALTERNATE CONTACT.]
4. So we can send you a gift card at the end of the survey, please provide your name and email address.

    Name: _____

    Email: _____
5. Which of the following does your company do? Select all that apply.
    - HVAC installations/replacements
    - HVAC sales
    - HVAC system design
    - HVAC repairs/maintenance
    - Other; please specify: [REQUIRE TEXT ENTRY]

Awareness of NEEA/BetterBricks (no MPI)

6. How familiar are you with NEEA, the Northwest Energy Efficiency Alliance?
    - Not at all familiar
    - Not very familiar
    - Somewhat familiar
    - Very familiar
7. How familiar are you with BetterBricks, an information resource developed by NEEA about high-efficiency commercial building systems?
    - Not at all familiar: never heard of it
    - Not very familiar: heard of it but no experience with it
    - Somewhat familiar: seen or used its materials occasionally
    - Very familiar: seen or used its materials regularly

Awareness of DOAS (no MPI, but leads to MPI 7a)

[UNAIDED AWARENESS – HOW AWARE PEOPLE ARE/THINK THEY ARE BEFORE WE EXPLAIN IT TO THEM]

8. Before we reached out to you, had you heard the phrase "Dedicated Outside Air System" or "DOAS" in reference to commercial HVAC systems?
    - Yes
    - No
    - I'm not sure
9. [Q8 = IF YES OR DK] [DOAS AWARE] Before today, which of the following best describes your level of familiarity with DOAS?
    - Not at all familiar: never heard of it
    - Not very familiar: heard of it but never worked with it
    - Somewhat familiar: worked with it occasionally
    - Very familiar: worked with it regularly
10. [IF AT ALL FAMILIAR] Do you have a generally favorable or unfavorable view of DOAS?
    - Favorable
    - Unfavorable
    - I'm not sure

Awareness of VHE DOAS (MPI 7a)

[UNAIDED AWARENESS – HOW AWARE PEOPLE ARE/THINK THEY ARE BEFORE WE EXPLAIN IT TO THEM]

11. BetterBricks has developed a system design approach they call Very High Efficiency DOAS (VHE DOAS). Before we describe it, how familiar are you with this approach, just based on the name?
    - Not at all familiar – never heard of it
    - Not very familiar: heard of it but never worked with it
    - Somewhat familiar: worked with it occasionally
    - Very familiar: worked with it regularly

12. [IF AT ALL FAMILIAR WITH VHE DOAS] To the best of your knowledge, which of the following are key elements of the Very High Efficiency DOAS approach? Select all that apply. [RANDOMIZE]
    - ventilation air distribution system is separated from the heating and cooling system, via dedicated ductwork and supply diffusers
    - ventilation air is delivered downstream of heating and cooling terminal units)
    - an energy- or heat-recovery ventilator (ERV/HRV) with at least 82% sensible effectiveness
    - a high-efficiency, electric heat pump system (often VRF or other inverter driven heat pump technology)
    - building load calculations account for ventilation energy recovery
    - the smallest equipment that meets that design load is selected
    - High efficiency condensing gas heating system
    - Refrigerant heat recovery to take advantage of simultaneous heating and cooling
    - Demand control ventilation to minimize over ventilating
    - Something else (please specify _____).

[AIDED AWARENESS – HOW AWARE PEOPLE ARE AFTER WE EXPLAIN IT TO THEM, PROVIDING AN OPPORTUNITY TO REVISE INITIAL ANSWER]

13. Now we'll describe the specifics of the approach. At a high level, the Very High Efficiency DOAS approach that BetterBricks encourages designers and builders to use includes:
    1. Decoupled ventilation design: the ventilation air distribution system is separated from the heating and cooling system, via dedicated ductwork and supply diffusers, or at a minimum, separated so ventilation air is delivered downstream of heating and cooling terminal units)
    2. High Efficiency ERV or HRV: An energy- or heat-recovery ventilator with at least 82% sensible effectiveness
    3. High performance electric heating and cooling: A high-efficiency, electric heat pump system (often VRF or other inverter driven heat pump technology)
    4. Right-sized heating and cooling: Load calculations account for energy recovery and the smallest equipment that meets that design load is selected.
14. Now that you've seen that list: before we reached out to you, which of the following best describes your level of familiarity with Very High Efficiency DOAS, as described by BetterBricks? It's OK if you're not familiar; we just need your honest answer.
    - Not at all familiar: never heard of it
    - Not very familiar: heard of it but never worked with it
    - Somewhat familiar: worked with it occasionally
    - Very familiar: worked with it regularly

15. Just to confirm, which of the following best reflects your understanding of this VHE DOAS approach, before this survey?
    - I am familiar with this general approach and its affiliation with NEEA/BetterBricks
    - I am at least somewhat familiar with this general approach, but unaware of any affiliation to NEEA/BetterBricks
    - I am not familiar with this approach at all

System/Approach Benefits (MPI 7d)

In the following questions, we'll ask your opinion on each of the design components of the VHE DOAS approach, as described by Better Bricks.

16. "**Decoupled ventilation design** is when the ventilation air distribution system is separated from the heating and cooling system, via dedicated ductwork and supply diffusers, or at a minimum, separated so ventilation air is delivered downstream of heating and cooling terminal units)"

    In your opinion, do you see any advantages to including **decoupled ventilation design** in a commercial HVAC system?
    - Yes
    - No
    - I'm not sure
17. [IF YES] What are some advantages of decoupled ventilation design? [OPEN END]
18. **High-efficiency ERV or HRV**: An energy- or heat-recovery ventilator with at least 82% sensible effectiveness.

    In your opinion, do you see any advantages to including **high-efficiency ERV or HRV** in a commercial HVAC system?
    - Yes
    - No
    - I'm not sure
19. [IF YES] What are some advantages of **high-efficiency ERV or HRV** in a commercial HVAC system? [OPEN END]

20. **High performance electric heating and cooling**: A high-efficiency, electric heat pump system (often VRF or other inverter driven heat pump technology).

    In your opinion, do you see any advantages to including **high performance electric heating and cooling** in a commercial HVAC system?
    - Yes
    - No
    - I'm not sure
21. [IF YES] What are some advantages of **high performance electric heating and cooling** in a commercial HVAC system? [OPEN END]
22. **Right-sized heating and cooling**: Load calculations account for energy recovery and the smallest equipment that meets that design load is selected.

    In your opinion, do you see any advantages to including r**ight-sized heating and cooling** in a commercial HVAC system?
    - Yes
    - No
    - I'm not sure
23. [IF YES] What are some advantages of including r**ight-sized heating and cooling** in a commercial HVAC system? [OPEN END]
24. In your opinion, what are some advantages to incorporating all of these design components together in an HVAC system? [REDISPLAY DESIGN COMPONENTS - Open end]

Include VHE DOAS in Proposals (MPI 8e)

25. In the last 12 months, how many times have you proposed a commercial HVAC system that included all four of the Very High Efficiency DOAS design components to a client in the initial development phase? [REDISPLAY DESIGN COMPONENTS - whole number]
26. How does that compare to the number you proposed in the year before that? [KEEP ON SAME PAGE]
    - Fewer this year
    - About the same as the previous year
    - More this year

Installations (MPI 8e)

27. About how many commercial HVAC design projects have you worked on this the past year? Please limit your response to projects including a complete design. [NUMBER]

28. Of those [PIPE IN # OF PROJECTS FROM Q27], how many… [NUMBER]
    - were remodels or retrofits?
    - used DOAS with fully separate air distribution for ventilation versus heating/cooling?
    - used DOAS with partially separate air distribution for ventilation versus heating/cooling?
    - used DOAS with gas heating?
    - had an ERV/HRV with at least 82% sensible effectiveness?
    - had reduced heating/cooling design loads due to ventilation energy- or heat recovery?
    - had the minimum capacity heating/cooling equipment that met the design load?
    - Had a high-efficiency electric heating system (often VRF or other inverter driven heat pump technology)
29. Of those [PIPE IN # OF PROJECTS] commercial HVAC design projects you worked on in the last year, how many met all four of the design components of the Very High Efficiency DOAS approach? [REDISPLAY DESIGN COMPONENTS - NUMBER]

Marketing and Promotions (MPI 1b)

30. [MANUFACTURER REP] Has your company done any marketing or promotions in the last 12 months for ERV/HRVs with 60% Sensible Recovery Effectiveness or higher?
    - Yes
    - No
    - I'm not sure
31. Did you use messaging from any of the following resources in your marketing or promotions? [Check all that apply]
    - BetterBricks.com case studies
    - BetterBricks.com technical resources
    - BetterBricks.com explainer videos
    - BetterBricks newsletters
    - Conferences or webinars
    - Utility rebate or incentive programs
    - Tax rebates or incentive programs
    - Manufacturer marketing or technical resources
    - None of the above
    - I'm not sure

Training Screener

32a. Have you ever attended a training sponsored by NEEA or Better Bricks about the Very High Efficiency DOAS approach?

1. Yes
2. No
98. I'm not sure

32b. When was the training?

1. In the past 3 months
2. 4 months to 1 year ago
3. 1 to 2 years ago
4. More than 3 years ago
98. I'm not sure

"Real-Time Feedback" on NEEA Training Battery (Training Attendance within 3 Months)

32. Before the NEEA/BetterBricks training, what was your familiarity with "Dedicated Outside Air System" or "DOAS" in reference to commercial HVAC systems?
    1. Not at all familiar – never heard of it
    2. Not very familiar – heard of it but never worked with it
    3. Somewhat familiar – worked with it occasionally
    4. Very familiar – worked with it regularly

33. Before the NEEA/BetterBricks training, what was your familiarity with "Very High Efficiency DOAS" for commercial HVAC systems, as described by BetterBricks and NEEA?
    1. Not at all familiar – never heard of it
    2. Not very familiar – heard of it but never worked with it
    3. Somewhat familiar – worked with it occasionally
    4. Very familiar – worked with it regularly

34. How likely are you to use what you learned at the NEEA/BetterBricks training in your work?
    1. Not at all likely
    2. Somewhat likely
    3. Very likely
    98. I'm not sure

35. What was the most useful new information you learned from the training? [OPEN END]

36. [DISPLAY ON SAME SCREEN] How do you plan to use this information? If you do not plan to use this information, please tell us why. [OPEN END]

37. Was any information in this training unclear or confusing?
    1. Yes
    2. No
    98. I'm not sure
38. [IF YES] What information was unclear or confusing? [OPEN END]

"Training Impact" Battery (Training Attendance after 3 Months)

39. [IF Q25>0] Previously, you indicated you proposed [PIPE IN Q26 #] commercial HVAC project(s) in the past year that included all four of the Very High Efficiency DOAS design components. Did the NEEA/BetterBricks training you attended influence your decision to include VHE DOAS design components in your project(s)?
    1. Yes
    2. No
    3. Other; please describe: [REQUIRE TEXT ENTRY]

40. [IF Q29 > 0] Previously, you indicated that [PIPE IN Q30 #] commercial HVAC project(s) you worked on in the past year met all four of the design components of the Very High Efficiency DOAS approach. Did the NEEA/BetterBricks training you attended influence your approach to these project(s)?
    1. Yes
    2. No
    3. Other; please describe: [REQUIRE TEXT ENTRY]

41. [IF Q39 OR Q40 = "YES"] How did the training influence your decision to include VHE DOAS design components in your project? [REQUIRE TEXT ENTRY]

42. [IF Q39 OR Q40 = "YES"] What was the *most useful* part of the training you attended? [REQUIRE TEXT ENTRY]

43. [IF Q39 AND Q40 = "NO"] Why did you say the training *did not* influence your decision to include VHE design component(s) in the project(s)? [REQUIRE TEXT ENTRY]

44. [IF Q25 = 0 AND Q29 = 0] Did you apply anything you learned during the training to any projects you designed or worked on since attending the training?
    1. Yes; please specify: [REQUIRE TEXT ENTRY]
    2. No
    3. Other; please specify: [REQUIRE TEXT ENTRY]

45. [IF Q44 = NO] Why did you say that you did not apply anything you learned at the training to your commercial HVAC design project(s)? [REQUIRE TEXT ENTRY]

46. [IF Q44 = NO] Do you expect that the training will influence your work *in the future*?
    1. Yes
    2. No

47. Thinking about the commercial HVAC project(s) you worked on since the training, was there any information the training could have provided that would have been useful for you?
    1. Yes
    2. No
    98. I'm not sure

48. [IF YES] What information would have been helpful for the training to include? [OPEN END]

All Trainees (ASK OF ALL TRAINEES WITH TRAINING UP TO 2 YEARS AGO)

49. How likely are you to recommend this NEEA/BetterBricks training to others?
    1. 1 - Not at all likely
    2. 2
    3. 3
    4. 4
    5. 5
    6. 6
    7. 7
    8. 8
    9. 9
    10. 10 – Extremely likely

50. Do you have any additional questions or comments you would like to provide about the training?
    1. Yes [SPECIFY]
    2. No

Firmographics

41. Which energy- or heat-recovery ventilator brands (ERV or HRV) do you represent or recommend in your projects? Select all that apply.
    - Air Treatment
    - AirXchange
    - Core
    - Daikin
    - EnergyWall
    - Greenheck
    - Heatex
    - Klingenburg
    - Lossnay
    - Mitsubishi
    - Multistack
    - Nortek
    - Oxygen8
    - Panasonic
    - Polybloc
    - Price/Regencore
    - Recutech
    - Renewaire
    - Reversomatic
    - SEMCO
    - Swegon
    - SystemAir
    - Tempeff
    - Trane
    - Ventacity

42. Is your company classified by any US state as any of the following? Select all that apply.
    - Disadvantaged Business Enterprise (DBE)
    - Minority-owned Business Enterprise (MBE)
    - Women-owned Business Enterprise (WBE)
    - Emerging Small Business (ESB)
    - Service-Disabled Veteran Business Enterprise (SDVBE)
    - Small Business
    - None of the above

43. Which languages do you and your co-workers use in the course of doing business, including with your customers or clients? Select all that apply.
    - English
    - Spanish
    - Portuguese
    - Cantonese
    - Russian
    - Tagalog
    - Japanese
    - Other (please specify)

Closing

44. Do you have any additional thoughts about VHE DOAS systems that you'd like to share? [OPEN END]
45. [MPI 8e] NEEA is maintaining a confidential database of Very High Efficiency DOAS installations in the Northwest. Would you be willing to provide addresses of up to 5 buildings for which you designed a Very High Efficiency DOAS or similar system?
    - Yes
    - No
    - I'm not sure
46. [IF YES] Please include their addresses here: [ADDRESS FIELDS]
47. Would you be interested in potentially participating in future research efforts, such as surveys, interviews, or providing more detail about your projects?
    - Yes
    - No
    - Maybe

Termination

[TERMINATE – NOT ELIGIBLE]

48. Thank you for your interest. Unfortunately you are not eligible for our survey.

[TERMINATE – FIND OTHER DESIGNER CONTACT]

49. Thank you for your interest in the survey. Could you provide the contact information for someone else at your firm who designs commercial HVAC systems? [CONTACT INFO]

[COMPLETE]

Thank you for your participation. We will send your gift card shortly. If you have any questions, please contact [CONTACT INFORMATION].

DESIGNER INTERVIEW GUIDE

Recruitment Email

Subj: Efficient Mechanical Systems Interview from NEEA--$200 gift card to complete

Dear [First Name] [Last Name],

I am writing to ask for your help in a study of **commercial heating and cooling systems in the Northwest.** NMR, a research firm, is conducting this study on behalf of The Northwest Energy Efficiency Alliance (NEEA). Your feedback will help ensure that NEEA's work addresses the needs of industry professionals like you.

If you specify or design HVAC systems for commercial buildings and complete an interview, you will receive a $200 electronic gift card in appreciation of your time. Your responses will be kept **confidential.** We will not publicize, share, or sell your information. Interviews are expected to take between 45 minutes and an hour.

We want to talk to people who specify or design HVAC systems for commercial applications. If you are not the appropriate contact at your firm, we would appreciate you forwarding this message to someone in that role.

Are you available in the next week or two for an interview? Please feel free to email me back or call me to schedule a time to talk. If you have questions about the study, please contact [REDACTED].

We greatly appreciate your taking the time to provide thoughtful answers for this important study.

Interview Script

[Note, this is just an example script; actual conversations would differ.]

Hello, this is _____ calling from XX. The Northwest Energy Efficiency Alliance (NEEA) has partnered with NMR to better understand the experience of commercial system designers and manufacturers representatives. Your feedback will help ensure that NEEA's work addresses the needs of professionals like you.

Upon completion of the survey, **we will send you a $200 electronic gift card in appreciation of your time**. Your responses will be kept confidential. We will not publicize, share, or sell your information.

[DO NOT READ; PROVIDE IF RESPONDENT REQUESTS MORE INFORMATION*: If you have any other questions about the study, please contact [CONTACT INFORMATION]*.

Screening, Background, and Company Structure

[Note, this is an interview guide, not a survey; actual conversations will differ.]

51. Which of the following best describes your job?
    - Manufacturer representative/vendor
    - HVAC designer at an architecture or engineering firm
    - Other [Open response]

52. Do you design or specify commercial HVAC systems?
    1. [IF NO: Terminate or find alternate contact.]

53. Which of the following does your company provide (check all that apply):
    - HVAC installations/replacements
    - HVAC sales
    - HVAC system design
    - HVAC repairs/maintenance

54. In which of the following states do you work?
    - Oregon
    - Washington
    - Idaho
    - Montana
    - None of the above [EXCLUSIVE RESPONSE; TERMINATE]

55. Which energy- or heat-recovery ventilator brands do you represent or recommend in your projects? [DO NOT READ LIST; CONFIRM IF NOT KNOWN PRIOR TO CONVERSATION]
    - Air Treatment
    - AirXchange
    - Core
    - Daikin
    - EnergyWall
    - Greenheck
    - Heatex
    - Klingenburg
    - Lossnay
    - Mitsubishi
    - Multistack
    - Nortek
    - Oxygen8
    - Panasonic
    - Polybloc
    - Price/Regencore
    - Recutech
    - Renewaire
    - Reversomatic
    - SEMCO
    - Swegon
    - SystemAir
    - Tempeff
    - Trane
    - Ventacity

Awareness of DOAS - Terminology

[Unaided awareness]

We're going to talk about a specific approach to commercial heating, cooling, and ventilation. I have technical questions for you, and hope you can provide feedback about some of the terms I use. We are surveying other professionals like you soon, and want to make sure we're using terminology that is familiar to everyone. Your feedback will help.

56. Before we reached out to you, had you heard the phrase "Dedicated Outside Air System" or "DOAS" in reference to commercial HVAC systems?
    - Yes
    - No
    - I'm not sure

57. I want to make sure we're on the same page about technical definitions. Could you quickly describe for me what you think of as DOAS for commercial buildings? What is it, in your experience?
    - At a high-level, would you say you have a generally favorable or unfavorable view of this approach? Why do you say that?

58. Before our conversation, which of the following best describes your level of familiarity with DOAS?
    - Not at all familiar: never heard of it
    - Not very familiar: heard of it but never worked with it
    - Somewhat familiar: worked with it occasionally
    - Very familiar: worked with it regularly

Awareness of VHE DOAS

[Unaided awareness – how aware people are/think they are before we explain it to them]

59. BetterBricks, brought to you by NEEA, has developed a system design approach they call the Very High Efficiency DOAS approach or VHE DOAS. Others may call it very high efficiency HVAC or VHE HVAC. I'll walk you through some of the details in a minute, but for now, how familiar are you with this specific approach?
    - Not at all familiar – never heard of it
    - Not very familiar: heard of it but never worked with it
    - Somewhat familiar: worked with it occasionally
    - Very familiar: worked with it regularly

[Aided awareness – how aware people are *after* we explain it to them, providing an opportunity to revise initial answer]

60. At a high level, the VHE DOAS approach that BetterBricks encourages designers and builders to use includes:
    5. Decoupled ventilation design (which some might call DOAS): the ventilation air distribution system is separated from the heating and cooling system, via dedicated ductwork and supply diffusers, or at a minimum, separated so ventilation air is delivered downstream of heating and cooling terminal units)
    6. High Efficiency ERV or HRV: An energy- or heat-recovery ventilator with at least 82% sensible effectiveness
    7. High performance electric heating and cooling: A high-efficiency, electric heat pump system (often VRF or other inverter driven heat pump technology)
    8. Right-sized heating and cooling: Load calculations account for energy recovery and the smallest equipment that meets that design load is selected.

61. Now that we've gone through that list, before our conversation, which of the following best describes your level of familiarity with VHE DOAS, as described by BetterBricks?
    - Not at all familiar: never heard of it
    - Not very familiar: heard of it but never worked with it
    - Somewhat familiar: worked with it occasionally
    - Very familiar: worked with it regularly

Terminology, Wording, Clarity

62. I just listed the four main features of the VHE DOAS approach that BetterBricks has put together. Ultimately, we want to put this list into a survey to see how many people have heard of this specific approach, so feedback on our wording is helpful. We need people in the industry to tell us if we're using wording that everyone will understand.

    I'll read the list again and we can talk about them one by one as well. I'd like you to let me know if anything isn't as clear as it should be, or if it's not self-explanatory, if you think it should be reworded.

    1. Decoupled ventilation design (which some might call DOAS): the ventilation air distribution system is separated from the heating and cooling system, via dedicated ductwork and supply diffusers, or at a minimum, separated so ventilation air is delivered downstream of heating and cooling terminal units)
    2. High Efficiency ERV or HRV: An energy- or heat-recovery ventilator with at least 82% sensible effectiveness
    3. High performance electric heating and cooling: A high-efficiency, electric heat pump system (often VRF or other inverter driven heat pump technology)
    4. Right-sized heating and cooling: Load calculations account for energy recovery and the smallest equipment that meets that design load is selected.

    [PROBES: Is there anything that could be phrased more clearly? Are the items self-explanatory? Do any of the points need additional detail or clarification?]

63. Would you rephrase or reword any of these before showing this list to other designers?

64. The BetterBricks VHE DOAS approach includes guidance about sizing and selecting the heating and cooling system for the project. BetterBricks describes this in two parts, saying that designers should:
    1. Account for energy recovery when calculating the design load; and
    2. Select the minimum capacity heating/cooling equipment that meets the design load

    On projects that include a high-efficiency ERV or HRV, how often do you one or both of those? Why do you say that?

    - How would other designers answer that, do you think?

Barriers and Opportunities

65. We've talked about wording and terminology, but beyond that, what is your initial reaction to that list [See *62 – repeat as needed*]? Would you say the approach is a good fit for projects you typically work on? Why is that?

66. Are those things [See *62 – repeat as needed*] in line with what you think of as high-efficiency DOAS? Do you think of anything different?

67. In your experience, what key design components make VHE DOAS different from other DOAS designs?

68. Does it sound reasonable to you to have all of these in the same HVAC system [See *62 – repeat as needed*]? Why do you say that?

69. Keeping thinking about those four main design components we've been discussing [See *62 – repeat as needed*]: Why might any of these not get implemented on a project where this general approach was specified? (PROBES: how common are these challenges, how can this be addressed, etc.)

70. About how many commercial HVAC design projects have you worked on the past year? Include those that went out to bid already and those that will be going out to bid before the end of this year.
    - When we develop our survey, what would be the best way to ask this number of designers? Ask them just how many projects they worked on? Or on how many they specified HVAC systems? Something else?

71. In how many of those cases did you propose something that includes key design components comparable to the VHE DOAS approach we've discussed?
    1. How many of those projects met the following key design components covered under NEEA's VHE DOAS definition?
        i. separate ductwork for ventilation air:
        ii. a high-efficiency energy- or heat-recovery ventilator:
        iii. a high-efficiency electric heating system (often a variable speed or inverter driven heat pump):
        iv. an HVAC system sized for reduced loads due to the presence of the energy or heat recovery system:

72. What would make it more likely for this type of approach to be included in a commercial building or HVAC system that is being heavily renovated?

Information Flows (Lower Priority)

73. [IF AT ALL AWARE OF VHE DOAS BEFORE CONVERSATION] How did you find out about the VHE DOAS approach?

Closing

74. Now that we've been talking for a while, do you have any additional thoughts about VHE DOAS systems that you'd like to share?

75. Please provide us with the email address where you would like us to send your gift card or let us know if you would not like to accept it.

76. We regularly do research with professionals on this topic for NEEA. Would you be interested in potentially participating in other similar research efforts, such as surveys, or providing more detail about your projects?
    - Yes
    - No
    - Maybe

[THANK YOU, ETC.]

TRAINING OBSERVATION GUIDE

Observation Protocols Memorandum

The team will attend four training sessions as observers (one virtual and three in-person sessions). The observers will assess the attendee's level of attention, presentation materials and other resources provided to the attendees, and topics brought up by the Q&A. The team will compare the trainings and note any differences in material presented or style of presentation, attendee engagement, and resources provided. Attendee questions and presenter responses to questions will be noted and used to inform ongoing research activities as applicable.

As allowed by the host and/or presenter, the observer will distribute a survey to the attendees to collect additional data on the attendees' impressions of the training, their previous experience with DOAS and/or VHE DOAS, and their plans to implement the information provided during the training. Additional information on the training survey will be provided in a follow-up deliverable.

The observer will record the following observations and will take notes on any additional relevant training content and activity, recognizing that observers will not be able to fully assess all of these topics in each training session:

Presentation Content and Format:

- How long was the presentation, and how much time was reserved for Q&A?
- Were the slides easy to follow? Which slides were unclear? In what ways?
- Did the presenter speak clearly? Were they audible in the back of the room?
- Were the slides visible and readable from the back of the room? If not, which slides/content was problematic (e.g., text in general too small, chart/figure on slide X too small to read, etc.).
- Was the room and/or chair/table set up compatible with the needs of the presenter and of the attendees (e.g., was there a place for attendees to write, were people seated with their backs to presenter, etc.)?
- Were there any technical difficulties?

Attendee Engagement:

- How many people attended the training?
- Did the attendees appear engaged in the presentation? At what point(s) did attendees appear more or less engaged? What indications did they give of engagement/ disengagement?
- Did attendees take notes?
- Did attendees give visual indications of familiarity with VHE DOAS?
- Did attendees give visual indications of positive or negative reactions to VHE DOAS, e.g., head-nodding, pushback, etc.

Resources Provided:

- Were slides provided as a handout and/or emailed to attendees?
- What additional resources, if any, were made available to attendees?

Q&A:

- How many attendees asked questions? How many questions appeared positive vs. skeptical, negative, or hostile toward the VHE DOAS approach?
- What topics did questions cover?
- Did the presenter answer all questions satisfactorily?
- If not, which questions could not be answered? Was any follow-up offered to resolve unanswered questions?
- What additional resources, if any, did attendees request?

Notable Differences across Sessions:

- What notable differences stood out across sessions, particularly regarding audience receptivity to VHE DOAS?

REAL-TIME TRAINING FEEDBACK SURVEY

Training Survey

Thank you for participating in this brief survey. Your responses will be anonymous and confidential.

1. Which of the following best describes your organization? Please select all that apply.
   - ☐ Architecture
   - ☐ Engineering
   - ☐ Builder / Developer / Contractor
   - ☐ Commercial / Industrial Facility
   - ☐ Government Agency
   - ☐ Manufacturer / Manufacturer Representative
   - ☐ Sales / Distributor
   - ☐ Utility
   - ☐ Other; please specify:_____

2. Which of the following best describes your role? Please select all that apply.
   - ☐ Building Owner / Operator
   - ☐ Code Official/Building Inspector
   - ☐ HVAC Designer
   - ☐ HVAC Installer/Maintenance Technician
   - ☐ Manufacturer
   - ☐ Distributor/Vendor
   - ☐ Market / Consumer Research
   - ☐ Marketing
   - ☐ Other; please specify:_____

3. Which of the following does your organization provide, if any? Please select all that apply.
   - ☐ HVAC installations/replacements
   - ☐ HVAC sales
   - ☐ HVAC system design
   - ☐ HVAC repairs/maintenance
   - ☐ HVAC manufacturing
   - ☐ Other; please specify: _____

4. Which of the following states do you work in? Please select all that apply.
   - ☐ Oregon
   - ☐ Washington
   - ☐ Idaho
   - ☐ Montana
   - ☐ Other; please specify: _____

5. Before this training, what was your familiarity with "Dedicated Outside Air System" or "DOAS" in reference to commercial HVAC systems?
   - ☐ Not at all familiar – never heard of it
   - ☐ Not very familiar: heard of it but never worked with it
   - ☐ Somewhat familiar: worked with it occasionally
   - ☐ Very familiar: worked with it regularly

6. Before this training, what was your familiarity with "**Very High Efficiency** DOAS" or "**VHE** DOAS" for commercial HVAC systems?
   - ☐ Not at all familiar – never heard of it
   - ☐ Not very familiar -- heard of it but never worked with it
   - ☐ Somewhat familiar -- worked with it occasionally
   - ☐ Very familiar -- worked with it regularly

7. How likely are you to use what you learned today in your work?

□ Not at all likely □ Somewhat likely

□ Very likely □ I'm not sure

8. What is the most important new information you learned from today's session?

9. How do you plan to use the information you identified in Question 8? If you do not plan to use this information, please tell us why.

10. Was any information in the training unclear or confusing? If so, what?

11. How likely are you to recommend this training to others?

Not at all likely (1)	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**Extremely likely (10)**
□	□	□	□	□	□	□	□	□	□

Do you have any additional questions or comments you would like to provide about the training or the VHE DOAS approach in general?