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Commercial HVAC Specifier Market Research:

Opportunities, Barriers, and Market Characteristics for Gas High Efficiency Dedicated Outside Air System

Prepared For NEEA:
Kirstin Moreno, Market Research and Evaluation Scientist

Prepared By:
Emily Wheeler, Principal Researcher
Samara Omundson, Principal Researcher

OWL Research Partners
6525 N Amherst St.
Portland, OR 97203

Northwest Energy Efficiency Alliance
PHONE
503-688-5400
EMAIL
info@neea.org

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1 Executive Summary

Since 2022, the Northwest Energy Efficiency Alliance has been working to transform the market for commercial HVAC systems through its High-Performance HVAC Program. To date this program has been focused on promoting the all-electric Very High Efficiency Dedicated Outside Air System (very high efficiency DOAS), which pairs a fully decoupled heat recovery ventilation system with a right-sized electric heat pump.

Very high efficiency DOAS is targeted at small to midsized commercial buildings in Northwest states (Idaho, Montana, Oregon, and Washington). It is not necessarily an appropriate fit for larger commercial buildings, which are often conditioned by gas-fired boilers and hydronic distribution systems. To better address the heating and cooling needs of larger buildings, NEEA is exploring opportunities to expand the High-Performance HVAC Program to encompass a gas-fueled alternative, called Gas High Efficiency Dedicated Outside Air System (gas high efficiency DOAS). The gas high efficiency DOAS approach pairs a decoupled energy or heat recovery ventilator (ERV/HRV) with a condensing gas boiler and hydronic controls.

1.1 Project Overview

Through engagements with HVAC specifiers such as mechanical engineers, architects and HVAC design consultants, this study intended to identify the market characteristics, opportunities and barriers to gas high efficiency DOAS uptake in Idaho, Montana, Oregon, and Washington. Specifically, the study aimed to address three research objectives:

- **RO1: Evaluate Opportunities and Barriers.** Confirm which previously identified opportunities and barriers for very high efficiency DOAS also apply to gas high efficiency DOAS, and identify any new, program specific factors.
- **RO2: Characterize the Market Landscape.** Identify and describe building types, market actors, early adopters, value propositions and decision-making processes for gas high efficiency DOAS.
- **RO3: Assess System Configurations.** Obtain perspectives on advantages, disadvantages and considerations for the gas high efficiency DOAS configuration in a hypothetical retrofit scenario.

To capture a contextualized view of the factors shaping the commercial HVAC design process applicable to gas high efficiency DOAS, this study employed a mixed-methods research design featuring the following components:

- **Literature Review.** An analysis of commercial HVAC industry trends and gas high efficiency DOAS considerations in 13 documents, including external and NEEA-sponsored research.
- **Specifier Survey.** An online national survey of 72 commercial HVAC specifiers to identify general perceptions of opportunities, barriers and applications of gas high efficiency DOAS.

- **In-Depth Interviews.** Virtual interviews with 16 survey respondents, prioritizing specifiers in the Northwest region, to explore gas high efficiency DOAS perspectives in more detail.
- **Configuration Review Activity.** A follow-up activity with interview participants in the form of a video-response online survey, presenting a retrofit scenario and asking respondents to compare their recommended design with the gas high efficiency DOAS approach.

1.2 Conclusions

This research effort identified both opportunities and barriers to gas high efficiency DOAS adoption, as well as potential implications for the High-Performance HVAC Program expansion.

Opportunity for NEEA to lead in defining gas high efficiency DOAS

Specifier perspectives are nuanced and balance competing priorities

Specifiers face a complex set of interrelated factors that shape their decisions throughout the HVAC design process. In principle, they may aspire to prioritize energy efficiency and occupant comfort. In practice, however, projects often require trade-offs to accommodate client preferences such as budget limitations or space constraints. Adding to this complexity, specifiers must also weigh technical considerations, including design feasibility and component availability.

The mixed-methods design of this research provides a layered perspective of these dynamics. In general, survey responses surfaced specifier preferences in an idealized context, interviews illuminate barriers to adopting gas high efficiency DOAS based on market and client realities, and the configuration review activity highlighted technical design considerations. Viewed collectively, the findings revealed tensions across these dimensions of decision-making and, in particular, highlighted a gap between the technical promise of gas high efficiency DOAS and its alignment with market and client realities.

Specifier education is needed to clarify gas high efficiency DOAS

Although gas high efficiency DOAS incorporates many HVAC components familiar to specifiers, it is not yet a widely established approach. The novelty of the integrated system design creates challenges for education, marketing and communication.

This was particularly evident when some specifiers seemed to interpret NEEA's marketing visuals and language more literally than intended. For example, in response to a simplified system diagram with clearly identified components, some specifiers assumed that the chiller was a required part of the system or expressed surprise by the small number of rooms, which were intended to be extrapolated to a larger building.

These misunderstandings underscore the need to build clearer recognition of what gas high efficiency DOAS is – and equally, what it is not. NEEA has an opportunity to clarify and solidify the gas high efficiency DOAS definition, but doing so will require thoughtful communication and education efforts.

Significant impediments limit gas high efficiency DOAS adoption potential

Market potential is narrow, limited to specific use cases that match selection criteria

The gas high efficiency DOAS approach is targeted at larger commercial buildings, a smaller pool of buildings than the very high efficiency DOAS market. Within this smaller target, specifiers generally agreed that the gas high efficiency DOAS approach is feasible in certain scenarios:

- **New Construction.** Gas high efficiency DOAS may be a fit if natural gas primary heating is necessitated in areas with more extreme cold climate conditions or limitations in the capacity or reliability of the electric grid in the area, with a corresponding desire to demonstrate high standards for energy efficiency. Specifiers identified high tech companies with large campuses as a potential target.
- **Retrofits.** Large existing buildings with pre-existing gas boilers might be a fit for gas high efficiency DOAS, though specifiers may be hesitant to recommend gas high efficiency DOAS unless terminal units and centralized exhaust systems are also already in place. In particular, K-12 schools and university campuses were identified as potential fits for this type of project.

In both new construction and retrofit scenarios, specifiers indicated that alternative HVAC system designs could also meet building heating and cooling needs, potentially at a lower cost. This suggests that while gas high efficiency DOAS is largely viewed as a viable system design, it may only be the preferred selection in narrow circumstances.

Market inertia creates headwinds for broader adoption

Large commercial buildings suited to gas high efficiency DOAS often carry greater design complexity than the smaller-scale targets of very high efficiency DOAS. In these contexts, project teams may favor HVAC solutions that are familiar and easily integrated to avoid adding layers of complexity.

In many cases, these larger buildings are part of business or educational campuses with dedicated facility and maintenance teams. Owners and operators in such settings frequently prefer to maintain consistent system designs across the campus, as introducing a different HVAC configuration can complicate ongoing maintenance, increase training requirements and raise long-term labor or replacement costs.

Specifiers themselves were typically open to innovative approaches, but indicated that building owners, maintenance leaders and installers may be slower to embrace change. Overcoming this inertia will require clear demonstrations of gas high efficiency DOAS value and targeted support to address maintenance and operational concerns.

First-cost concerns overshadow lifetime savings potential

Energy efficiency remains a top priority for specifiers, especially in large commercial buildings where long-term operational savings can be substantial. However, high upfront costs for implementing an HVAC system may outweigh long-term operating costs in client decision-making. Budget pressures – particularly in publicly funded projects such as schools or municipal buildings – often drive owners toward value engineering choices that minimize first cost, even when those options increase long-term expenses. In the end, despite indicating that energy efficiency and long-term operational cost are among the most important design considerations, first cost is often the deciding factor.

For specifiers, this dynamic created tension between recommending the most efficient solution and managing client resistance to higher capital costs. Because specifiers perceive gas high efficiency DOAS as a system with high first cost, demonstrating lifecycle cost savings in compelling, accessible formats will be essential to shifting this mindset.

Transformation hinges on a unique set of market characteristics

Maintenance plays a central role in system selection for most relevant use cases

Facility or maintenance leaders hold significant influence in the decision-making process for HVAC systems in larger commercial buildings. While these market actors were identified as advisors to building owners in prior very high efficiency DOAS research, the level of prominence and influence over final system selection notably increased for gas high efficiency DOAS.

Maintenance teams were described as being deeply knowledgeable about building operations and sensitive to complexity, integration challenges and potential points of failure. As a result, they hesitate to endorse unfamiliar systems that could disrupt workflows or increase long-term maintenance burdens. Gaining their buy-in is critical for broader gas high efficiency DOAS consideration.

Despite state and local policy momentum, natural gas continues to be considered

Specifiers across the Northwest recognize a clear policy-driven shift. In Washington, for example, building codes already restrict the installation of natural gas systems in many new construction projects.

Even so, natural gas remains a practical option in certain contexts and may be especially relevant in states like Idaho and Montana that have fewer restrictions on fuel type. Specifiers pointed to natural gas as essential in cold climates where electric systems alone may be insufficient, in rural areas where grid capacity is limited and in large facilities that require backup reliability. Gas also continues to be a lower-cost fuel in the near term. These realities suggest that despite state and local momentum, natural gas systems – and by extension gas high efficiency DOAS – retain viability in specific use cases.

Narrow installation context often limits broad retrofit applicability

Although gas high efficiency DOAS was conceived partly as a retrofit solution, its perceived applicability in existing buildings remains somewhat narrow. In discussing retrofit scenarios, specifiers are reluctant to recommend any system design that requires significant renovations, such as adding fan coil units or associated ductwork. While these renovations are feasible in the right circumstances, specifiers were concerned about the potential high first cost and occupant disruption associated with these more significant renovations. Furthermore, they were sensitive to concerns about available ceiling or wall space and the complexity of projects that require a transition from local exhaust to a centralized exhaust system.

Specifiers experienced with this type of exhaust renovation were less likely to see it as a practical barrier to the gas high efficiency DOAS design. Yet even experienced specifiers considered the process complex and situational. These perceptions may further limit gas high efficiency DOAS consideration for retrofit projects, even in buildings with existing gas boilers.

Perspectives on system design indicate general acceptance

Specifiers demonstrate high component familiarity and confidence in ability to specify gas high efficiency DOAS

The equipment that makes up the gas high efficiency DOAS system is widely used and familiar. Specifiers reported regularly including ERV/HRVs in design projects, and fan coil units were also well understood. Specifiers were slightly less likely to work with condensing gas boilers frequently but remained familiar with the technology. Given this high degree of understanding in regard to system components, it is unsurprising that specifiers expressed a great deal of confidence in their ability to design a gas high efficiency DOAS system.

Though early very high efficiency DOAS research indicated some inconsistency in the level of familiarity with DOAS among market actors, this barrier appears to be diminishing. Across the board, specifiers included in this study expressed familiarity and comfort with the DOAS approach.

Experienced specifiers see more upside and opportunity in gas high efficiency DOAS adoption

While overall familiarity is high, specifiers' depth of experience influences how they view gas high efficiency DOAS adoption potential. Those who self-identified as highly experienced were better able to pinpoint situations where the system could be a preferred or viable option.

More specifically, highly experienced specifiers noted that designs that use gas heating remain necessary in some larger buildings due to either the high cost of full electric systems or limitations in grid capacity. These specifiers also described practical workarounds – such as phased retrofits or code exceptions – that could enable gas high efficiency DOAS implementation in otherwise challenging contexts. Emphasizing the componentization of the gas high efficiency DOAS system – and its inherent adaptability – may facilitate greater specifier support.

Market opportunity exists but may be constrained

Market scope is constrained due to limited applicable contexts

Adoption of gas high efficiency DOAS may be impacted by factors beyond the system's technical feasibility. Market conditions such as local climate and code requirements also play a role in limiting the viability and adoption of gas high efficiency DOAS.

While use cases exist, specifier reactions raised significant questions about its applicability. Specifiers were generally comfortable with the design, but many questioned how often it would be the best-fit solution in real world scenarios. Their skepticism reflected both an awareness of market realities and recognition that alternative HVAC options may be able to meet the same needs with fewer tradeoffs.

Familiar alternatives may be preferred unless unique value proposition is articulated

Even in scenarios where the building characteristics and market conditions perfectly align for gas high efficiency DOAS, the full system may not be perceived as the clear best solution. Specifiers suggested that they might consider whether to incorporate components such as air source heat pumps or VRF. Importantly, they were unable to clearly articulate the value proposition of the complete gas high efficiency DOAS system. Without a clear understanding of its distinct advantage, inertia may favor designs that build upon familiar components.

For gas high efficiency DOAS to gain traction, NEEA must not only prove its feasibility but also clearly demonstrate a unique value proposition – whether through cost savings, performance benefits or alignment with specific policy or energy efficiency goals. Establishing this differentiation will be crucial to driving market transformation.

1.3 Recommendations

The following recommendations are offered to assist NEEA in navigating the market dynamics, barriers and opportunities for gas high efficiency DOAS:

- Evaluate and quantify market potential in priority contexts such as corporate campuses, K-12 schools and universities, as well as projects in cold-climate or rural areas where natural gas is a preferred fuel source.
- Develop resources that clearly articulate the unique gas high efficiency DOAS value proposition, namely lifecycle cost savings, performance benefits and policy alignment relative to alternative or competitive designs.
- Demonstrate the applicability of gas high efficiency DOAS in retrofit scenarios, with an emphasis on addressing space constraints and real-world installations.
- Engage facility and maintenance leaders directly through training, case studies or peer exchanges, addressing their operational concerns reflecting their influential role in the gas high efficiency DOAS specification process.

- Incorporate findings into the High-Performance HVAC Program logic model by explicitly recognizing the role of facilities and maintenance teams and addressing perceived challenges in retrofit scenarios.

2 Methodology

2.1 Research Objectives

- **RO1: Evaluate Opportunities and Barriers.** Confirm which previously identified opportunities and barriers for very high efficiency DOAS also apply to gas high efficiency DOAS, and identify any new, program specific factors.
- **RO2: Characterize the Market Landscape.** Identify and describe building types, market actors, early adopters, value propositions and decision-making processes for gas high efficiency DOAS.
- **RO3: Assess System Configurations.** Obtain perspectives on advantages, disadvantages, and use cases of up to three (3) potential configurations of gas high efficiency DOAS.

2.2 Research Approach

To capture a contextualized view of the factors shaping the commercial HVAC engineering and design process from the perspective of HVAC specifiers, OWL Research Partners developed a mixed-methods approach featuring an explanatory sequential design that began with surveys, followed by in-depth interviews and finally an audio/video response survey. The sample achieved was lower than initially proposed (n=100 for survey and n=30 for interviews) but not expected to affect the validity of findings.

To aid in understanding, findings from the four research phases described below are identified with the unique icons throughout the report.

1. Literature Review

The first phase of the study included a literature review to support the development of materials and very high efficiency DOAS comparison. Thirteen documents were reviewed, identifying relevant trends in codes, legislation, technology and HVAC adoption patterns. The review was also undertaken to gain a strong understanding of current very high efficiency DOAS positioning for comparison with gas high efficiency DOAS findings.

The documents reviewed included a mix of High-Performance HVAC program materials, NEEA-sponsored research reports and external sources. See Appendix for detailed methodology and full list of reviewed documents.

2. Specifier Survey

An online survey of HVAC specifiers followed completion of the literature review. The survey was fielded from May 30, 2025, through June 26, 2025. Survey respondents were recruited through online panel provider User Interviews.

A total of 665 candidates applied to participate in the study. Through a screener questionnaire designed to assess degree of expertise and involvement in commercial HVAC specification, 79 participants were ultimately invited to participate, and 72 completed the online survey. See Appendix for recruitment process and survey questionnaire.

3. In-Depth Interviews

From the survey, 42 respondents were invited to participate in in-depth interviews, prioritizing respondents in the Northwest or similar climates. Nineteen accepted the invitation, but 3 were ultimately unable to participate. As a result, 16 interviews were conducted.

While all participants have prior specification experience, several serve in non-traditional market actor roles – two work on the client side in property management and construction management, and the third designs custom fit HVAC equipment. See Appendix for discussion guide.

4. Configuration Review

All 16 interview participants completed a follow-up activity intended to elicit further responses to the gas high efficiency DOAS system design and technical elements. This activity was completed as a follow-up survey with video or audio responses.

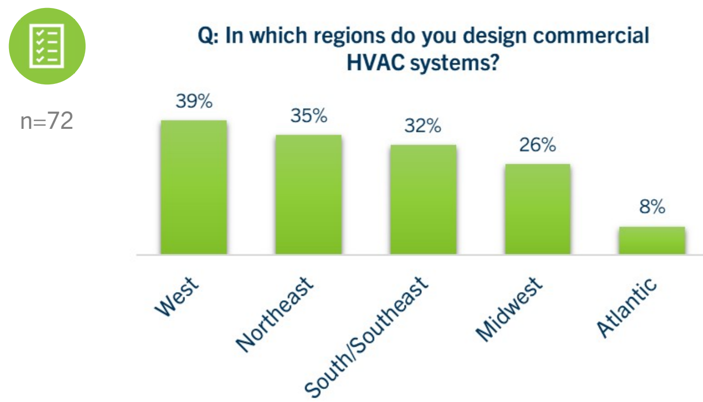
Respondents were provided with visuals and accompanying scenario descriptions then asked a series of questions about their design recommendations and reactions to the gas high efficiency DOAS implementation. See Appendix for questionnaire and design images.

Participant Profile

HVAC specifiers including architects, mechanical engineers and designers with recent experience designing HVAC systems for large commercial spaces were invited to participate in this study.

To best achieve recruitment goals, screening criteria were expanded beyond the Northwest, though invitations prioritized participants completing HVAC specification in similar climates. Participants often report working on specification projects in multiple states or regions, either in their current workplace or past positions. As a result, despite regional expertise, the specifier audience appears to be notably conscious of national perspectives and trends outside of their direct region.

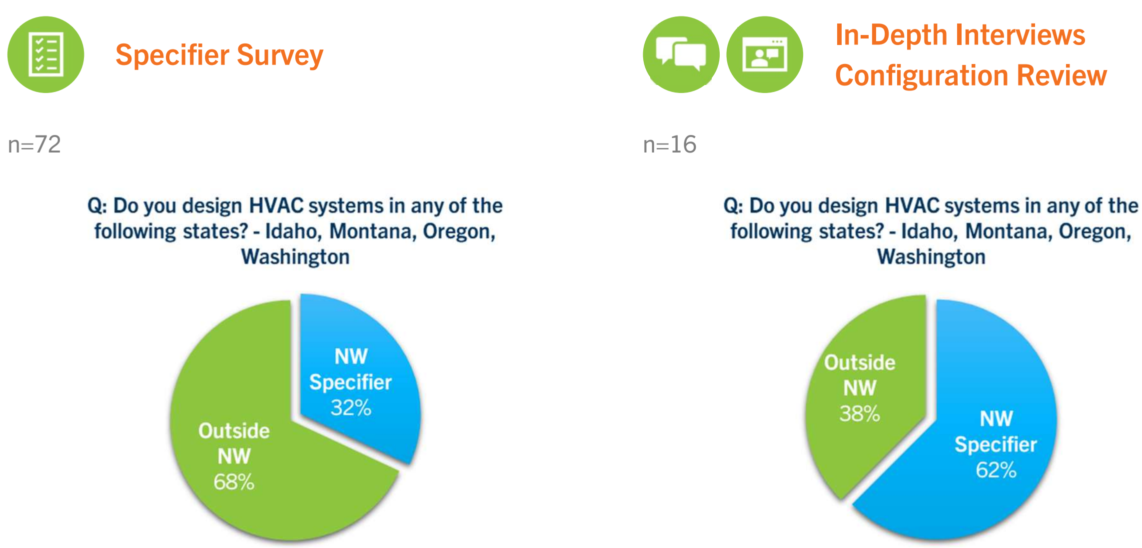
Figure 1. Survey Participant Active Regions



Participants consistently report working on specification projects in multiple states or regions. A third of survey participants (32 percent) and 62% of interview participants specify in one or more Northwest states – Washington, Oregon, Idaho or Montana.

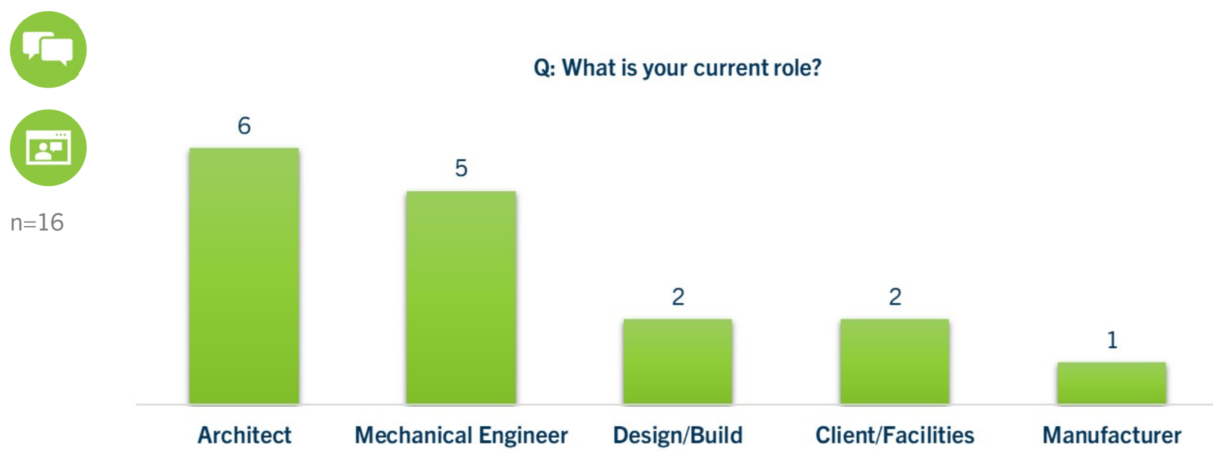
For the interviews and configuration review activity, participants with direct experience specifying in the Northwest were prioritized, to enable deeper conversations about regional considerations related to climate and code.

Figure 2. Engagement by Northwest Specifiers



Although all sixteen interview participants had experience designing HVAC systems for large commercial buildings, their current roles reflect the many potential career paths and touchpoints in the specification process. In addition to traditional architects and mechanical engineers, participants included two Design/Build experts, two specifiers currently working on the client side and one vendor – a designer of custom equipment with significant experience consulting specifiers on HVAC system designs.

Figure 3. Interview & Configuration Review Participant Roles



3 Design Considerations & Impediments

Specifiers must balance a complex set of considerations when designing an HVAC system. These considerations may reflect their own design preferences, client and market realities and technical feasibility. Yet these considerations are not always aligned, and trade-offs are often required. The mixed-methods design of this research enabled a layered analysis of these complex dynamics.

Figure 4. Perspective Variation by Study Method

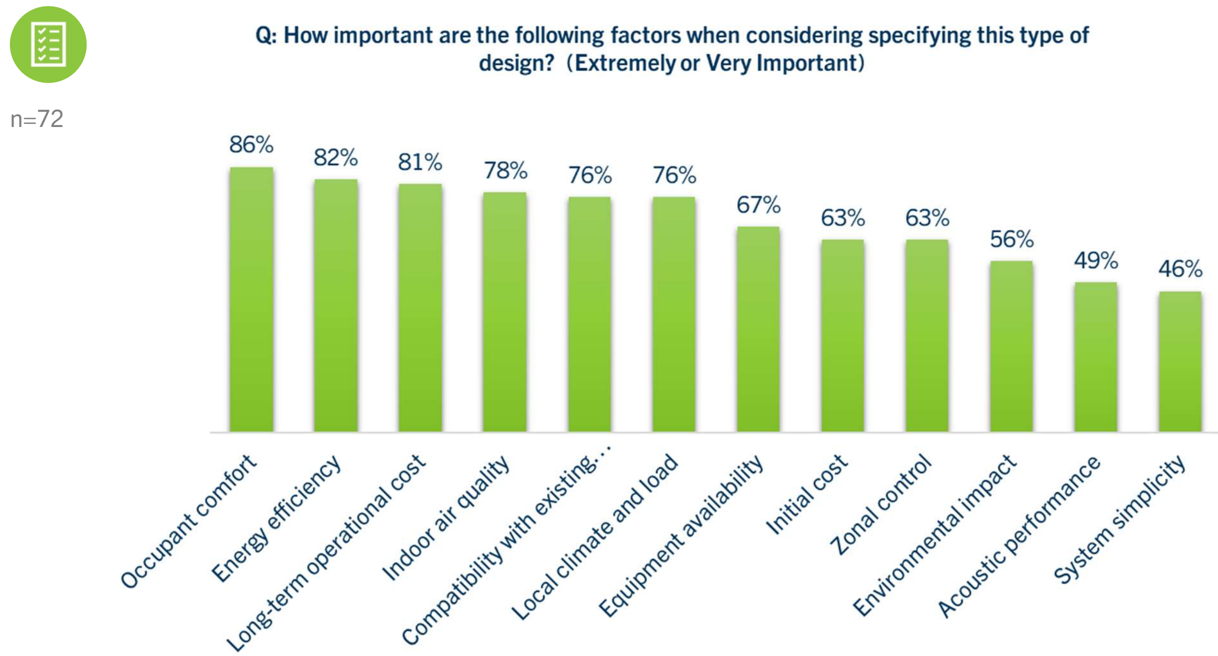
	Specifier Survey	In-Depth Interviews	Configuration Review Activity
Response Context	Ideal State	Market Dynamics & Client Realities	Technical Design
Priorities	Energy efficiency Long-term solutions	Upfront cost Client preference Code compliance	Feasibility Component availability
Questions	What design is the best fit?	What will my client approve?	Does GHE DOAS work?

As specifiers weighed these considerations against the proposed gas high efficiency DOAS design, they identified several key areas of tension that might influence decision-making and market opportunities.

3.1 Factors Influencing System Design

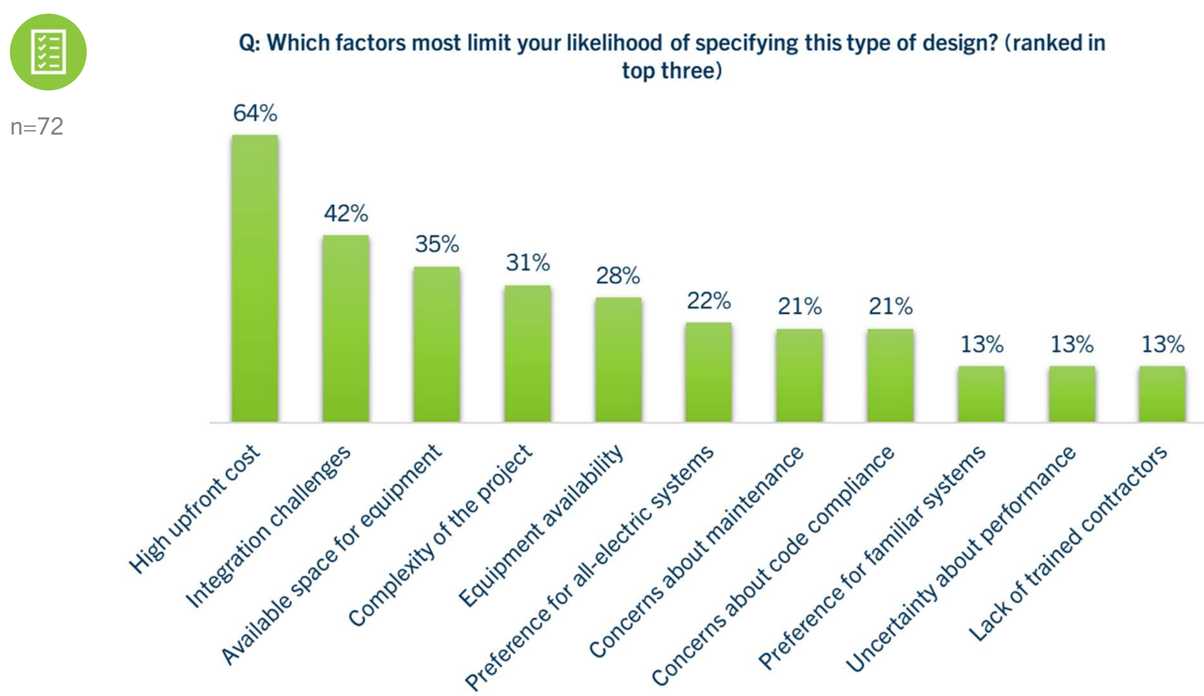
In considering gas high efficiency DOAS, the majority of specifiers identified ten different factors as ‘extremely important’ or ‘very important’ to their decision-making. These promoting factors were led by occupant comfort, energy efficiency, long-term operational cost and indoor air quality. Yet deeper conversations in interviews revealed that these factors were most often driven by an ideal state perspective, led by accepted best practices, the designer’s personal preferences or general project goals related to energy efficiency or comfort.

Figure 5. Promoting Factors in Gas High Efficiency DOAS Design



In addition to these design considerations, specifiers identified limitations that could create roadblocks to gas high efficiency DOAS adoption. These included high upfront costs, integration challenges and available space, especially in the walls or ceilings.

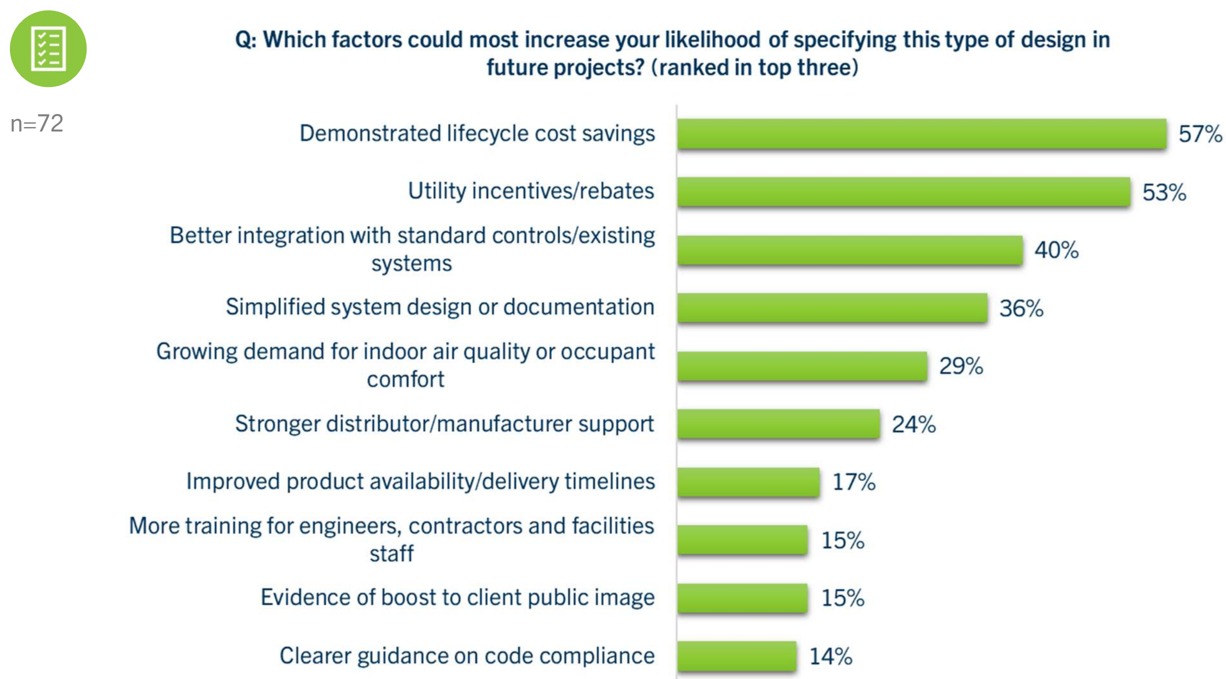
Figure 6. Limiting Factors in Gas High Efficiency DOAS Design



These limiting factors were echoed in specifier interviews in relation to real client interactions – and while they were not always the top stated project objectives, they were rarely flexible. This reality suggests that specifiers are likely challenged to strive for the best possible mix of occupant comfort, energy efficiency and long-term operational costs within the constraints of available budget (initial cost) and building characteristics (integration challenges and available space).

Specifiers also identified a few opportunities that could help to overcome or reduce these limitations, including demonstrated lifecycle cost savings and utility incentives or rebates. These results suggest that concerted efforts to address market and client realities can potentially help to improve gas high efficiency DOAS consideration by reducing the constraints of limiting factors.

Figure 7. Opportunities for Expanded Consideration



3.2 Barriers to Gas High Efficiency DOAS Selection

The juxtaposition of gas high efficiency DOAS design considerations, limitations and market factors revealed the complex and competing priorities that can influence final system design. Given the importance of these various factors, it is perhaps unsurprising that the barriers facing gas high efficiency DOAS consideration and selection are significant.

Specifiers particularly noted several challenges that must be addressed to increase consideration of the gas high efficiency DOAS design: balancing costs, integrating into existing space, addressing maintenance concerns, matching occupant needs and overcoming market inertia. These barriers were often expressed through the lens of how best to recommend or sell a gas high efficiency DOAS design to clients. As a result, many of the barriers related to communication of clear value proposition rather than technical challenges.

Balancing Initial vs Lifetime Costs

> *You know, I'm an architect, so I am pie in the sky, and I always like to think that cost-benefit over time ratio is gonna be the tipper. But tragically, it's almost always . . . upfront costs grossly outweigh life cycle costs."*
>
> *- Architect, Northwest*

Specifiers consistently ranked energy efficiency as one of the most important factors in system design, particularly for large commercial buildings where operational savings can be significant. Yet high upfront costs remained a persistent barrier. Building owners/clients who expressed interest in efficiency in early discussions often reverted to favoring lower first costs over lifecycle savings.

This dynamic places specifiers in a difficult position – they are expected to propose efficient solutions while anticipating client resistance to higher capital costs. In particular, architects described being caught between advocating for long-term benefits and managing client "sticker shock."

In cases where gas high efficiency DOAS has higher first costs than alternative systems, overcoming this barrier will require tools that clearly demonstrate lifecycle cost advantages and, where possible, strategies to reduce initial costs so energy-efficient designs can compete more directly with conventional options.

Integrating into Existing Systems & Space

> *"One of the big hurdles that I see here for an existing building is if there's no ductwork already, it's gonna be a major renovation, also depending on what the ceilings type spaces are within those spaces. If there's no hydronics in the existing building, now you gotta introduce all those lines everywhere. That's a major expense as well too. And you just don't know what you're gonna get yourself into until you start tearing the roof or the ceiling off."*
>
> *- Architect, Midwest*

Especially in retrofit situations, specifiers noted the need to craft designs that make use of the space constraints and connect to existing equipment. While space constraints can arise in mechanical rooms or on rooftops, the most common concern for the gas high efficiency DOAS design was limited ceiling or wall space. In interviews, 69 percent of specifiers flagged available wall and ceiling space as a barrier, citing the disruption and expense of adding terminal units and ductwork in already crowded conditions.

This issue was of such concern that it drove the perception that gas high efficiency DOAS would be a better fit for new construction rather than retrofits due to the challenges of integrating into existing systems. Both mechanical engineers and building owners/clients consistently described ductwork integration as a major obstacle, regardless of building type.

To reduce this barrier, NEEA may need to embrace partial or staged retrofit projects that achieve some gas high efficiency DOAS elements while accommodating existing building realities.

Addressing Maintenance Concerns

> *The big barrier is getting the buy-in from the people that are gonna maintain it. Those are the people turning the wrenches, those are the people that need to understand how the system's gonna function and how they fix it when in the middle of the night they get a phone call that something broke, something's leaking…*
>
> *- Client, Northeast*

The complexity of integrating new HVAC components into an existing building extends beyond the installation phase. Specifiers noted the importance of ongoing system maintenance in maximizing efficiency and minimizing downtime, identifying facility and maintenance teams as critical players in the successful implementation of a new HVAC system in larger commercial buildings.

Specifiers raised general concerns about maintenance of the gas high efficiency DOAS system, though none of the individual components necessarily stood out as a high need area or maintenance barrier. In fact, the ERV was described by one participant as "something that people can't really screw up." To support equipment maintenance, specifiers identified a need for control valves, sensors, a building automation system, and "top notch filtration" to keep the system running smoothly and efficiently.

According to specifiers, building facility and maintenance leaders often prefer familiar systems and may resist adopting an unfamiliar design. Engaging these teams directly – through demonstrations, training or case studies – could help build confidence and reduce resistance.

Matching Occupant Needs

> *"Everyone wants to stay at a nice temperature and to make that happen, all the disciplines have to get their work done… it's not only the weather, but the number of people and the equipment that will then decide what the final spec is."*
>
> *– Mechanical Engineer, Northwest*

Occupant comfort and indoor air quality ranked among the highest priority design considerations in the specifier survey responses. While not as frequently mentioned in specifier conversations, use cases for gas high efficiency DOAS often tried to account for specific occupant needs. In interviews, one participant commented that dentists, yoga studios and insurance offices each have different heating and cooling needs. Another discussed the unique air quality, temperature and humidity demands of lab spaces.

These discussions indicate that occupant comfort and air quality are not only considered at the whole-building level, but also for individual spaces with specialized needs.

Clarifying how the gas high efficiency DOAS design can reliably perform in various installation contexts –including those with diverse occupant requirements – could help specifiers better position the system as a flexible and viable solution.

Overcoming Market Inertia

> *"It comes with so many risks, and it takes so much time to convince somebody that new is better… Everybody's got their own horror story, and by the time somebody's in charge of projects, they've been at it a long time. There's a comfort level with what they know, because they can't be everywhere."*
>
> *– Architect, Northwest*

Although only 13 percent of survey respondents saw 'preference for familiar systems as a limiting factor in gas high efficiency DOAS adoption, familiarity was a consistent theme in interviews. Resistance to change appeared more pronounced among building owners/clients and maintenance teams than among specifiers themselves.

While specifiers expressed confidence in their ability to design gas high efficiency DOAS, they believed that building owners/clients and facility staff often prefer proven options they know will perform reliably. Their reluctance likely reflects the long-term responsibility they carry – maintaining and operating the system long after the design team has moved on.

As a result, specifiers may gravitate toward other solutions that offer comparable benefits. Air source heat pumps and VRF systems were frequently mentioned as possible alternatives, while some specifiers also noted that code requirements might lead them to consider an electric boiler as a replacement to the gas boiler. Overall, alternatives were described in relation to specific components, not a complete system alternative.

Market inertia has the potential to diminish over time as awareness of gas high efficiency DOAS grows and successful installations provide proof of performance. In the near term, however, building familiarity and trust among these market actors will be essential to overcoming inertia.

4 Market Characteristics

The selection of gas high efficiency DOAS design for a given specification is greatly influenced and constrained by project characteristics such as the market actors involved in decision-making, the type of construction project and building, specifier familiarity and expertise with gas high efficiency DOAS components, and regional market dynamics including building codes and climate.

The market characterization emerging from the specifier surveys and interviews suggests a somewhat unique dynamic that contrasts in several ways with prior market characterizations for very high efficiency DOAS. The capacity to transform the market for gas high efficiency DOAS may hinge upon either leveraging or mitigating these unique characteristics.

4.1 Industry Trends & Dynamics

Gas high efficiency DOAS market characteristics are best understood within the context of broader commercial HVAC industry trends and pressures. The literature review identified several industry trends that were further supported in specifier interviews and survey results.

HVAC Equipment Selection

Industry research indicates a rising demand for energy efficient building solutions, supported by policy initiatives and by the construction sector's shift towards indoor air quality and climate control.

This momentum is impacting HVAC equipment selection. Electric heat pumps have become an increasingly common choice in commercial HVAC, driven by energy efficiency considerations, technological advancements that have expanded applicability, and by state and local policies, among other factors.

Lifetime operating cost is another factor that influences HVAC equipment selection. Current and expected future energy prices are therefore an important consideration when selecting between system types and fuel options.

Demand for Indoor Air Quality

Post-pandemic and amid growing concerns with air pollution, there is heightened emphasis on indoor air quality (IAQ) which has spurred greater integration with advanced filtration systems, UV light purifiers, and real-time air quality monitoring in HVAC designs. The IAQ market is projected to grow significantly through 2029, reflecting increased awareness and regulatory focus.

Smart and Predictive HVAC Controls

The HVAC market is witnessing significant growth due to the increasing adoption of smart and connected HVAC systems. Advanced portable devices and monitoring systems enable end-users to effectively manage their HVAC systems. Air monitoring systems integrated into HVAC equipment play a crucial role in detecting and eliminating allergens, harmful particles, stale air, and contaminants that cause viruses. These systems also regulate moisture levels for optimal indoor air quality. The benefits include reduced wear and tear on HVAC systems, less frequent repairs, and proactive maintenance.

Smart controls have the added benefit of optimizing energy efficiency. Energy savings may be gained by resolving simpler issues – such as operating frequency, load distribution, system sizing, supply water temperature setpoint reduction, condensing boilers operating below nominal efficiency, and poor sensor data – many of which are controls related, and relatively low cost compared to equipment replacements.

4.2 Component Familiarity & Expertise

> *We have worked with all those on different projects and different capacities. . . . These are very common systems that are used in the commercial or the industrial industries.*
>
> *– Mechanical Engineer, Northwest*

Specifiers indicated a high degree of familiarity with the individual HVAC components that comprise the gas high efficiency DOAS system. This includes energy/heat recovery ventilators, terminal units such as 4-pipe fan coil units, condensing gas boilers and hydronic controls. When shown a diagram of gas high efficiency DOAS, 76 percent of survey respondents were confident that they had the necessary expertise to successfully specify this type of system.

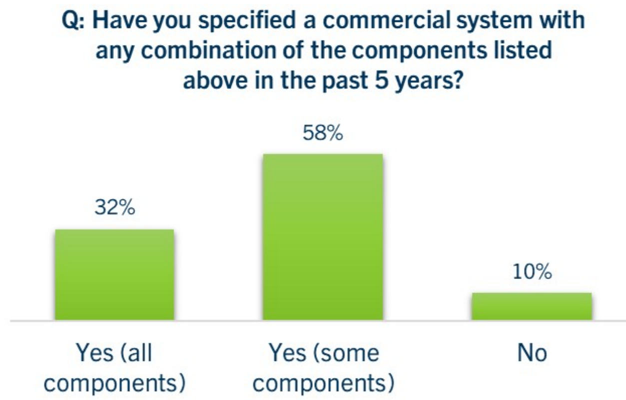
Prior research for very high efficiency DOAS indicated a familiarity gap in E/HRVs, but this study suggests the gap is rapidly narrowing. Among those interviewed, all but one had direct experience with E/HRVs, and five participants frequently use E/HRVs in their designs. The only participant without direct E/HRV experience is a mechanical engineer who expressed familiarity with the technology but acknowledged that she does not have hands-on experience. The level of familiarity with E/HRVs is notable, as this is a newer technology that was not in widespread use in prior market characterization reports for very high efficiency DOAS. Specifiers described the technology as newer but also explained that it was readily available, in common use and readily serviced by qualified contractors.

The condensing gas boiler was the least frequently used element of the gas high efficiency DOAS components. Only ten out of the 16 interview participants had direct experience specifying with condensing gas boilers, and several noted occasional past experience limited to retrofits or simple replacements.

Although familiarity with the individual gas high efficiency DOAS components was high, specifiers rarely reported opportunities to bring them together in a single project. More commonly, they used some but not all of the components. In interviews, none could point to a named past project that included all components, though several suggested that they likely had designed something similar in the past. Though details are scarce, the DOAS approach and ERV component are seen as highly familiar and regularly used in current projects.

Figure 8. Familiarity with Gas High Efficiency DOAS Components

n=72



Specifiers who self-described as highly experienced were better able to describe situations where gas high efficiency DOAS could potentially be a preferred solution. Among these highly experienced specifiers, projects that include an existing gas boiler and a need to preserve the natural gas component were seen as the most likely candidates for gas high efficiency DOAS.

4.3 Construction Characteristics

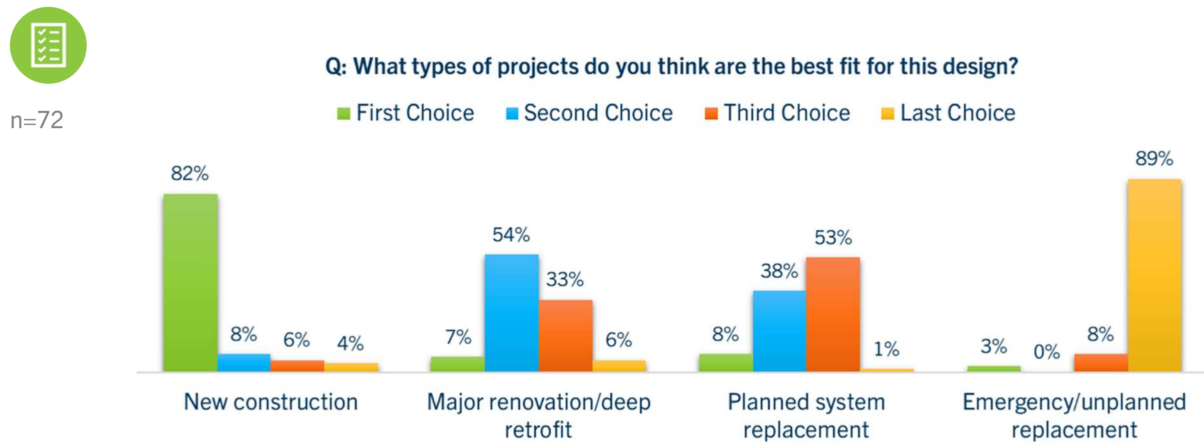
Whether retrofits or new construction, hospitals or schools, specifiers noted that larger commercial buildings have unique features that must be accommodated by the HVAC system design. As a result, opportunities for gas high efficiency DOAS installation are dependent upon the specific project characteristics and context.

Project Types

> *New construction is always easier because the ceilings aren't just packed full of everything else. I mean, it would be great for both [new and retrofits], it's just for retrofits, it's always space constraints that you're worried about.*
>
> *– Mechanical Engineer, Northwest*

Specifiers overwhelmingly saw new construction as the best fit for the gas high efficiency DOAS design. Among survey respondents, 82 percent ranked new construction as their top choice, followed by major renovations/retrofits and planned system replacements.

Figure 9. Gas High Efficiency DOAS Best Fit Project Types



This new construction preference was largely driven by the challenges of integrating the gas high efficiency DOAS design into existing systems. Specifiers noted that limited wall and ceiling space in existing buildings may limit gas high efficiency DOAS feasibility to retrofits where many of the existing components are already in place. Buildings with existing ductwork and hydronics might be a potential retrofit opportunity, but specifiers indicated that it would be prohibitively expensive and disruptive to add these components to an existing building.

New construction, by contrast, was perceived as easier because “you have the ability to design it in.” Additionally, several specifiers noted that the high initial cost of the gas high efficiency DOAS system would be better absorbed by financing for a new construction project because the HVAC system is only one line item in the total project cost. Retrofits may face greater budgetary scrutiny in comparison and may be more sensitive to initial costs.

Building Types

Yeah, probably over 150,000 square feet, probably like a big office building, a big civic building. Maybe a school, but it might be too much for that. It would have to be a really big, big building.

- Architect, Northwest

I think this is great for large public buildings like the ones that I work in, so schools, buildings with a lot of consistent rooms that serve the same type of pump function just over and over again. For instance, schools, multi-purpose room spaces in a recreation center and a community center, office spaces, stuff like that.

> *- Architect, Midwest*
>
> *Potential clients would be the tech industry, like Google, Facebook, whatever, because they require a lot of office space. . . . They have a big, big campuses, so they would utilize something like this where their maintenance team is gonna have a great understanding of the system and how technology integrates with that and the controls.*
>
> *- Architect, Northwest*

When considering the types of buildings that might be a good fit for gas high efficiency DOAS, specifiers generally felt that larger buildings and campus settings were the best candidates for this type of system. These types of buildings often have repeated, consistently-sized interior spaces that could be appropriate for the gas high efficiency DOAS zonal approach, while campus settings usually have the facilities team expertise to maintain complex systems.

Figure 10. Gas High Efficiency DOAS Best Fit Building Types

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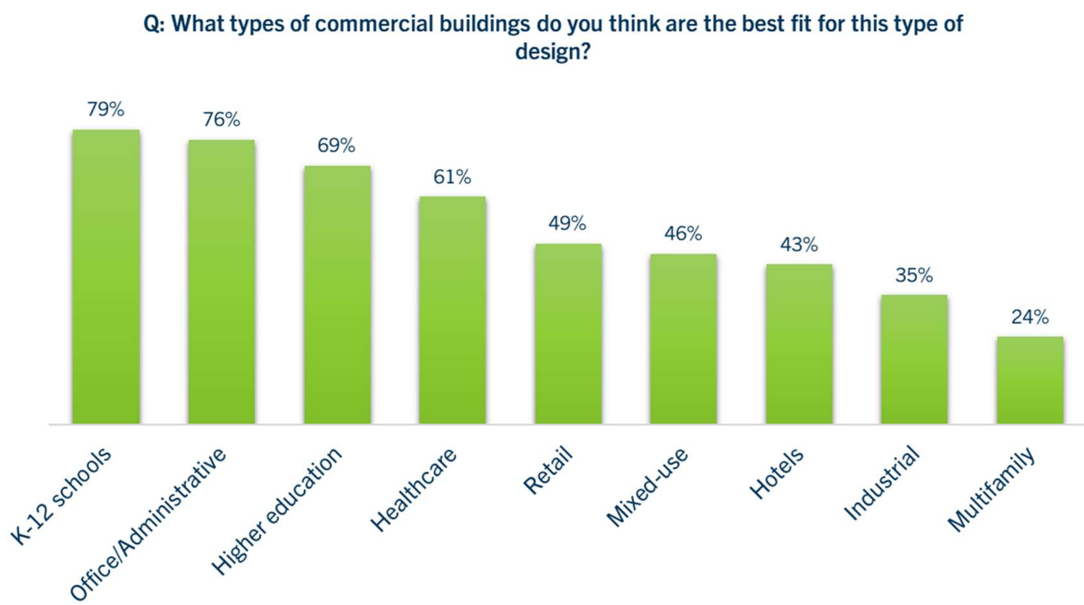


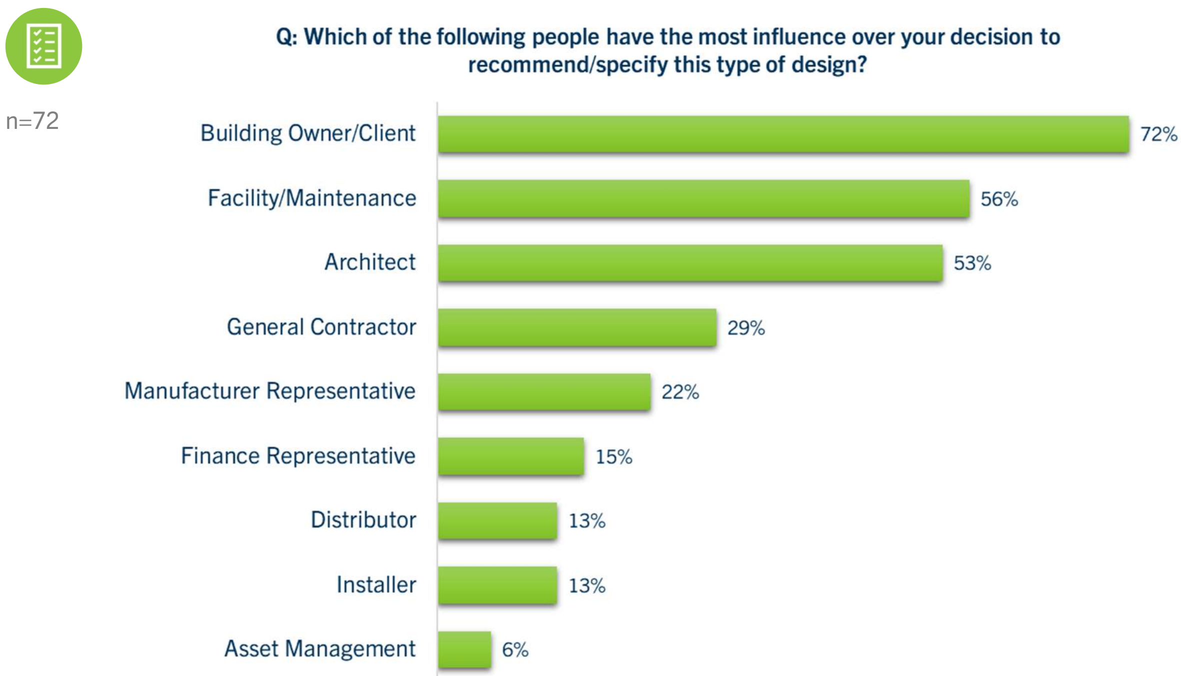
Although 61 percent of survey respondents identified healthcare settings as a potential good fit, this was a more controversial building type in interviews. One participant suggested that clinical labs might benefit greatly from DOAS due to the constant flow of fresh air. However, two specifiers expressed concerns about the humidity and air quality needs of healthcare and lab settings, leading one to say, “I would have to look at the system more carefully and just give it some more thought, maybe run some numbers to say if I would feel comfortable in approving a design like that.”

4.4 Market Actors

The HVAC specification process is undeniably a team effort, and decisions for larger commercial projects such as those targeted by gas high efficiency DOAS may be informed by perspectives from several market actors, including architects, engineers, building owners/clients, and facility/maintenance leaders.

Specifiers described a decision-making process guided by an informed and expert committee. While the architect and project client may have the most visibility into the overarching project from start to finish, all market actors play a role in informing the final design.

Figure 11. Influential Market Actors



Architects

Generally speaking, we will host meetings with the client in every phase of design, meaning schematic design, development, and the construction documents, and in schematic, oftentimes it's me having a conversation with the client without a mechanical engineer… I'll get an idea as to what kind of budget we have for the project, and then we can make a recommendation of what that system might look like in design development and construction documents. We'll get the mechanical engineer on board, and they'll get a little bit more into the specifics on it.

- Architect, Midwest

Because architects work closely with the building owner/client on building objectives and design considerations, they often have unique visibility into the broader decision-making context and dynamics that could impact HVAC system design. In this capacity, architects may be uniquely positioned to recognize opportunities for considering gas high efficiency DOAS based on project objectives or client receptivity. However, while the architect may be positioned to introduce the gas high efficiency DOAS concept and encourage its consideration, they are not responsible for the final design.

- **Role:** Though not technical experts, architects play a key role as a conduit between the building owner, facility manager and rest of the design team, helping to articulate the project needs and making general recommendations about system design or considerations. While architects rely heavily on their mechanical engineers for the details, they understand the big picture project needs and market dynamics that may influence system design.

- **Level of Influence:** *Moderate.* Architects may have potential to influence HVAC system selection broadly but are ultimately beholden to preferences and decisions made by building owners.

Mechanical Engineers

> *Myself and my senior engineer will get on the same page, come to an agreement, we'll propose something to the owner and their facilities guys, and then kind of go from there. We will sometimes consult with contractors just to see what experiences they've had with equipment, if it's been good or bad or, you know, hard to start up, stuff like that…*
>
> *- Mechanical Engineer, Northeast*

As the technical experts in the specification process, the mechanical engineer plays a pivotal and respected role in the design process, and their recommendations carry significant weight. Mechanical engineers repeatedly note needing to "check the numbers" for gas high efficiency DOAS, an indication of the importance of modeling and calculations in their decision-making process. Given this inclination, mechanical engineers may be most open to new designs and technologies if the math checks out.

- **Role:** Mechanical engineers are responsible for the final HVAC system design. They base recommendations on energy modeling, precise calculations, a deep knowledge of building codes and standards, and past experience with specific equipment and systems. As technical experts, their opinions are highly valued, although they may be less connected to broader project context that may influence design objectives.

- **Level of Influence:** *Moderate.* Mechanical engineers are highly influential in evaluating the feasibility of a proposed approach as well as the final specification. However, they are not the ultimate decision-maker in the process.

Building Owners/Clients

> *Clients in these cases tend to be pretty knowledgeable, of course. . . . Before that contract is even out, these clients have worked in-house with their maintenance staff, their ongoing suppliers, which tend to be the people that you're buying and coordinating equipment with after the fact, to say, OK, we're going like for like, or we're gonna upgrade this and we think we're gonna reuse this pipe.*
>
> *- Architect, Northwest*

Building owners and clients are the ultimate decision-makers, shaping design choices through requirements such as budget, energy efficiency goals, air quality standards and system integration needs. In the larger commercial buildings suited to gas high efficiency DOAS, these stakeholders are often supported by knowledgeable internal teams. In large campus settings this may include in-house architects, engineers and facility/maintenance staff. As a result, building owners/clients are typically more directly involved in system design than in projects suited to very high efficiency DOAS, giving them both greater influence and a stronger voice in final decisions.

- **Role:** Building owners/clients are highly knowledgeable and deeply involved in developing project requirements that will guide the specification process. These objectives may relate to costs, maintenance, energy efficiency and occupant comfort levels.
- **Level of Influence:** *Strongest.* Building owners/clients are the ultimate decision-makers for the HVAC system design but will generally follow the recommendations of in-house facility/maintenance teams as well as the consulting design team if project objectives are met.

Facility/Maintenance Management

> *[The facilities manager] isn't an engineer but has vast knowledge of everything that's going on in this building. And there's such a knowledge gap between him, the owner, and finance. So he was on board with everything that we were recommending as the engineering consulting service, but then being able to translate that to the owner and the finance people, that was more of what it took. Getting him on board definitely helped smooth the process for the other two.*
>
> *- Mechanical Engineer, Northwest*

While the market actors involved in gas high efficiency DOAS specification are generally similar to those identified in prior very high efficiency DOAS research, the pivotal role of the building facility or maintenance team is a notable difference. Architects and mechanical engineers routinely mention the importance of gaining buy-in from facilities/maintenance teams who will ultimately be responsible for maintaining the installed system. Given the complexity of large buildings and campus environments, facility/maintenance leaders often favor familiar, like-for-like replacements that minimize risk and disruption. At the same time, they can become strong advocates for gas high efficiency DOAS if convinced of its maintenance and operational advantages. Securing their support will be critical to broader adoption.

- **Role:** Facility and maintenance teams will ultimately be responsible for supporting the installed system in the long term. As a result, their role in the design process is to provide a practical perspective on the proposed approach, considering building integration needs and maintenance implications.
- **Level of Influence:** *Strong.* Building owners may be heavily influenced by the perspectives of facility/maintenance voices, and final decisions may hinge on the opinions of these market actors.

4.5 Regional Considerations

Specifiers are keenly aware that regional and state variations can greatly influence their design recommendations. For the most part, specifiers participating in this study were aligned in describing the market characteristics for gas high efficiency DOAS, regardless of their location in the Northwest or beyond.

However, region-specific considerations such as building codes and climate were more clearly influenced by the specifier’s direct experience. For this reason, the following section breaks out Northwest specifier responses for more targeted analysis of the unique market landscape within NEEA’s target region.

Codes & Standards

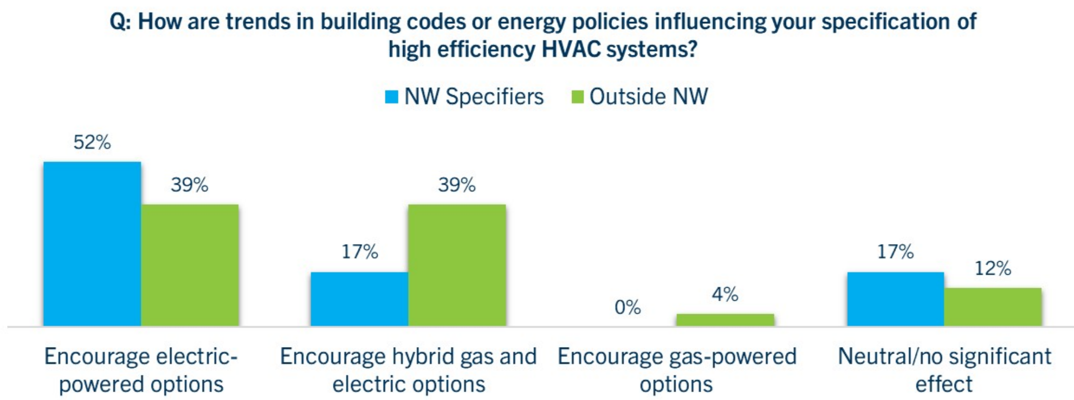
If this was new construction, then you'd never be able to put this in.

- Mechanical Engineer, Northwest (commenting on Seattle building codes)

Specifiers in the Northwest reported strong momentum toward all-electric HVAC systems. More than half of Northwest survey respondents indicated that building codes and policies encourage more electric-powered options, a 13-point difference over specifiers outside of the region. The same dynamic was even more evident in interviews. Seven out of the ten Northwest specifiers interviewed for this study indicated that they were experiencing pressure to move toward all-electric systems.

Figure 12. Code Influence on Fuel Selection

n=72



Climate

My concern would be, I would just like to see what the operational settings are in the system depending on your extreme cases of your weather, right?

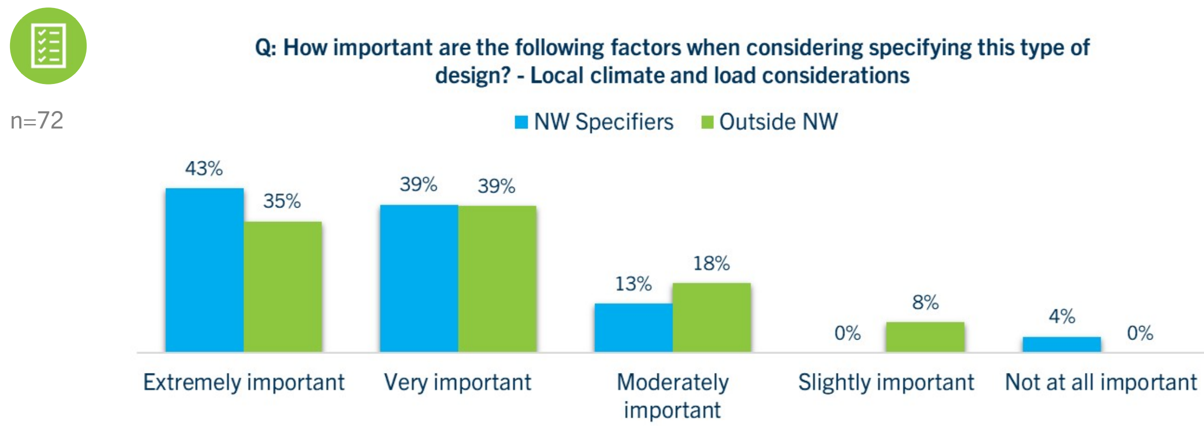
- Client, Northeast

Specifiers working in Northwest states were more likely than those outside of the region to consider local climate an ‘extremely important’ factor when considering gas high efficiency DOAS. This variance may be due to the subtle climate variation within the Northwest region as well as the high likelihood that Northwest specifiers encounter local climate variations in their work.

Among survey respondents specifying in the Northwest, 40 percent designed for buildings in two or more states, with Montana and Idaho most likely to be second states. Even among those who only work in Washington or Oregon, the climate variability between the Eastern and Western portions of the state could significantly impact building needs.

Given this regional climate complexity, Northwest specifiers placed greater importance on local climate and load considerations than those in other regions.

Figure 14. Importance of Local Climate



Receptiveness to gas high efficiency DOAS may hinge in part upon its perceived ability to accommodate local climate fluctuations, but there was little consistency in the types of climates seen as a good fit for the system.

One Washington-based architect described the design as "overkill" in the more temperate areas of the Northwest, a perception echoed by others who felt it would be a good fit for locations with extreme temperature differences. However, those working in areas that experience these extreme temperatures were more skeptical of the system's reliability. A specifier client in New York expressed concerns about freezing coils in cold winters, an issue that he has experienced with hydronic systems in the past.

5 Perspectives on System Design

While the survey and interviews conducted for this study are effective gauges of general specifier perspectives on the commercial HVAC market and the gas high efficiency DOAS system, the highly custom nature of commercial projects can obscure some real-world feedback. Specifiers frequently responded “it depends” to questions of where and when gas high efficiency DOAS would be a good fit.

To better understand specific use cases, identify competing technologies and elicit more precise technical reactions, this study included an additional activity asking interview participants for their recommended approach and gas high efficiency DOAS feedback in relation to a specific retrofit scenario.

5.1 Typical Specification Approach

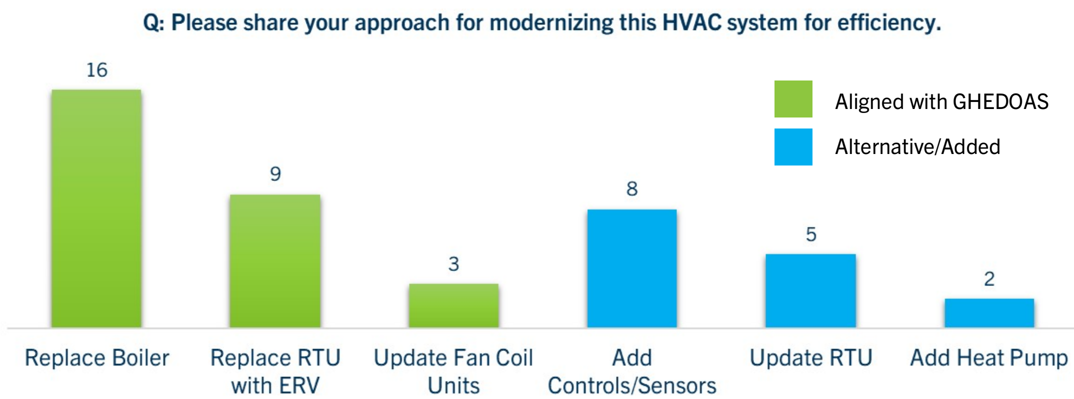
> *Taking everything into consideration here, considering there's limited electrical infrastructure that we have good condition hydraulic piping… I do think an energy recovery ventilator and condensing boiler, low water temperature loop system makes sense in this application. The energy recovery ventilator might be non-negotiable depending on the energy code applicable to the state.*
>
> *- Mechanical Engineer, Midwest*

Specifiers generally approached the retrofit scenario with recommendations to keep all functional equipment to the extent possible and make efficient equipment replacements where necessary. Replacements also concentrated on equipment in the mechanical room or rooftop – only three recommended updating the fan coil units and none suggested changes to the hydronic piping.

Controls and sensors were repeatedly recommended, though the controls mentioned varied from full building automation systems to DDC controls or DCV sensors. This emphasis also echoed specifier interviews as an important aspect of energy efficiency and modernization.

Figure 15. Recommendations in Retrofit Scenario

n=16



5.2 Reactions to Gas High Efficiency DOAS Design

> *So I think your approach is fundamentally nice. You're targeting the high impact upgrades without requiring the major system overhauls, which is a good idea. I think expanding the control scope might be something you might want to consider - the modular boilers and defining the ventilation strategy.*
>
> *- Mechanical Engineer, Northwest*

When comparing their recommendation against the gas high efficiency DOAS system, specifiers noted a high degree of alignment with NEEA's technical approach. Eleven out of sixteen responses felt that their original recommendation agreed or mostly agreed with the gas high efficiency DOAS components and principles, though it should be noted that all participants had been exposed to the gas high efficiency DOAS design previously. Those in alignment understood the gas high efficiency DOAS design as a strategic, non-invasive upgrade that offers targeted improvements without requiring an entire system replacement.

Meanwhile, the challenges associated with the gas high efficiency DOAS design varied from concerns about climate to recommendations for additional design elements. Six responses mentioned the need to add more sensors and controls to better monitor, calibrate and control the system, a common theme in both the specifier designs and feedback for gas high efficiency DOAS. Additionally, three expressed concerns about additional equipment needed for preconditioning the air from the DOAS system in colder temperatures.

5.3 Technical Considerations

Two additional questions related to the proposed gas high efficiency DOAS design asked specifiers to explore specific elements of the system and assumptions about market perceptions.

Centralized Exhaust

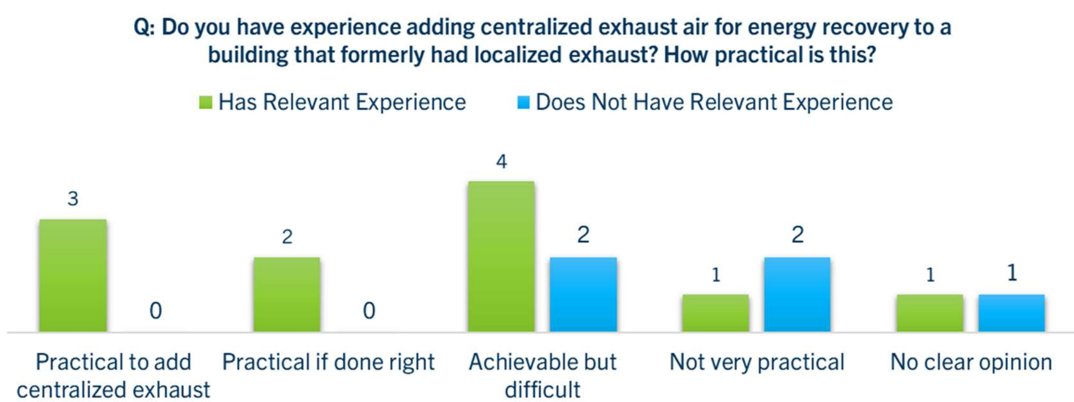
I would say the practicality depends on the building. You're gonna have to add all that duct work. If the building is old and there a possibility asbestos and then you get it asbestos removal… I mean, there's a lot more to consider there and there's probably a lot more cost. But if the space is there, if it's not too difficult to get inside, it might work.

- Architect, Northwest

Specifiers were asked to assess the practicality of replacing localized exhaust with a centralized approach for energy recovery, a step that might be necessary in some retrofit projects. Reactions to this question were revealing, as the level of experience with this type of work was a significant determining factor in whether the specifier believed it was a practical solution. Those with direct experience in this type of replacement were much more likely to consider it feasible, though most noted that the characteristics of the individual building needed to be taken into account.

Figure 16. Feasibility of Conversion from Localized to Centralized Exhaust

n=16



Accommodating Supply Water Temperature Changes

I would typically not expect the existing hydronic system and units to be able to support the temperature changes in the supply water with a reduction in load but this is completely dependent on the building layout and infrastructure. For example I have done a lot of work with large single-story schools where the length of the supply pipe causes too much of a drop in temperature which then creates issues when supplying the units and their settings. This needed the installation of variable speed drives and pumps to monitor temps and help change flow to meet the BMS settings on the units.

- Client, Northeast

So, a little difficult without actually running any numbers on whether or not the hot water coils in the existing system would accommodate the lower entering water temp, but my educated guess is that the energy recovering from the ERV is going to offset that just fine.

- Manufacturer, Northwest

Specifiers agreed that supply water temperature changes were something to take into consideration but were uncertain about the impact of the reduced ventilation load on the hydronic system or fan coil units. Echoing prior comments, five of the sixteen respondents recommended changing control valves or sensors to mitigate the potential issue.

Figure 17. Accommodating Supply Water Temperature

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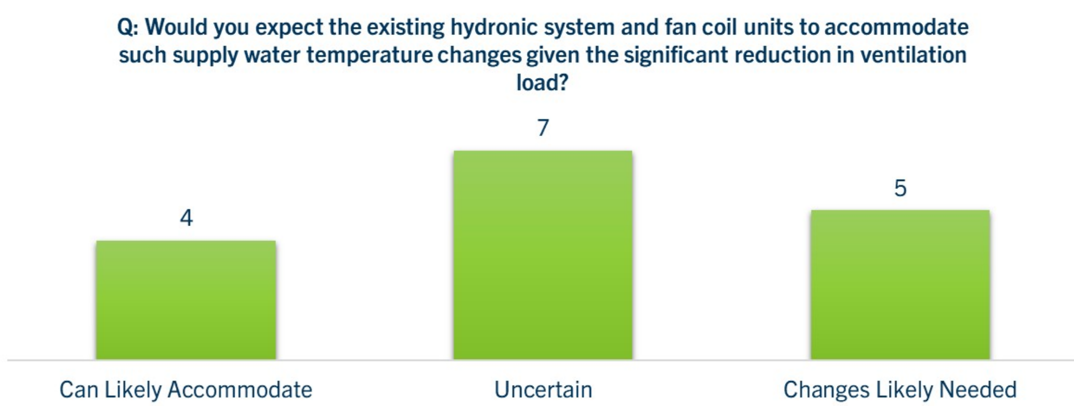


6 Very High Efficiency DOAS Comparative Analysis

Very high efficiency DOAS and gas high efficiency DOAS share many similarities. However, gas high efficiency DOAS appears to offer a narrower market opportunity due to scope constraints and additional barriers related to state and local policies, facility/maintenance personnel preferences and perceived limits to retrofit applicability.

Table 1. Very High Efficiency DOAS Comparative Analysis

	Very High Efficiency DOAS	Gas High Efficiency DOAS
Promoting Factors	**Occupant Comfort** **Energy-Efficiency** **Long-Term Operating Cost**	
	Energy Efficiency Goals & Policies	
Limiting Factors	**Initial Cost** **Market Inertia** **Design Complexity & Integration into Existing Space** **Available HVAC Alternatives**	
	Client Awareness & Understanding Collaboration Between Market Actors Product Availability Installation Timing	Facility/Maintenance Personnel Acceptance Occupant Needs
Familiarity	**General Component Familiarity & Expertise**	
	Inconsistent DOAS Understanding	Gas Boiler Experience
Primary Use Cases	Small to Midsized Commercial Planned Renovations/Retrofits	Large Commercial New Construction Select Retrofit Scenarios
Market Actors	**Client/Owner** **Architect** **Mechanical Engineer**	
	Installers	Facility/Maintenance
Regional Considerations	**Momentum Toward All-Electric Systems**	
		Colder Climates

Sources: Very high efficiency DOAS comparison drawn from research conducted in 2017, 2019, 2020

7 Conclusions & Recommendations

7.1 Conclusions

Opportunity for NEEA to lead in defining gas high efficiency DOAS

Specifier perspectives are nuanced and balance competing priorities

Specifiers face a complex set of interrelated and often conflicting factors that shape their decisions throughout the design process. Tension between promoting and limiting factors highlight a gap between the technical promise of gas high efficiency DOAS and its alignment with market and client realities.

- While gas high efficiency DOAS is seen as technically viable and aligned with preferences to maximize energy efficiency and occupant comfort, market and client realities may ultimately carry more weight in shaping decisions.

Specifier education is needed to clarify gas high efficiency DOAS

Although gas high efficiency DOAS incorporates many familiar HVAC components, it is not yet a widely established approach. The novelty of the integrated system design creates challenges for both marketing and communication.

- NEEA has the opportunity to develop and solidify the gas high efficiency DOAS definition, though education will be needed to build understanding.

Significant impediments limit gas high efficiency DOAS adoption potential

Addressing RO1: Evaluate Opportunities and Barriers. Confirm which previously identified opportunities and barriers for very high efficiency DOAS also apply to gas high efficiency *DOAS, and identify any new, program specific factors.*

Market potential is narrow, limited to specific use cases that match selection criteria

The gas high efficiency DOAS approach is targeted at large commercial buildings, an inevitably smaller pool of buildings than the very high efficiency DOAS market. Specifiers identify new construction as the primary potential use case for gas high efficiency DOAS, with retrofits considered only when pre-existing components are already in place.

- While gas high efficiency DOAS is a viable system design, it may only be the preferred selection in narrow circumstances.

Market inertia creates headwinds for broader adoption

Target buildings for gas high efficiency DOAS may be more complex in terms of design or maintenance, contributing to market inertia from building owners or facility/maintenance leaders.

- Overcoming this inertia will require clear demonstrations of gas high efficiency DOAS value and targeted support to address maintenance and operational concerns.

First-cost concerns overshadow lifetime savings potential

Specifiers report significant budget pressure in the design of larger commercial HVAC systems, a dynamic that can lead to a preference for value engineering over energy efficient options that save costs in the long term.

- Demonstrating lifecycle cost savings in compelling, accessible formats will be essential to shifting this mindset.

Transformation hinges on a unique set of market characteristics

Addressing RO2: Characterize the Market Landscape. Identify and describe building types, market actors, early adopters, value propositions and decision-making processes for gas high efficiency *DOAS.*

Maintenance plays a central role in system selection for most relevant use cases

Facility and maintenance teams are highly influential in HVAC system selection and are particularly sensitive to system complexity and integration challenges.

- Gaining buy-in from facility/maintenance teams will be critical for broader gas high efficiency DOAS consideration.

Despite state and local policy momentum, natural gas continues to be considered

Specifiers across the Northwest recognize a clear policy-driven shift. Even so, natural gas remains a practical option where code allows, especially in colder climates and rural areas.

- Natural gas systems – and by extension gas high efficiency DOAS –retain viability in specific use cases.

Narrow installation context often limits broad retrofit applicability

Although gas high efficiency DOAS was conceived partly as a retrofit solution, its applicability in existing buildings is potentially contingent on compatibility with existing HVAC systems. Specifiers are reluctant to recommend any system design that requires the addition of hydronic piping, fan coil units or associated ductwork due to the complexity and cost of renovations in ceiling spaces.

- These perceptions may further limit gas high efficiency DOAS consideration for retrofit projects, even in buildings with existing gas boilers.

Perspectives on system design indicate general acceptance

Addressing RO3: Assess System Configurations. Obtain perspectives on advantages, disadvantages and considerations for the gas high efficiency *DOAS configuration in a hypothetical retrofit scenario.*

Specifiers demonstrate high component familiarity and confidence in ability to specify gas high efficiency DOAS The components that make up the gas high efficiency DOAS system – ERV/HRVs, fan coil units, hydronic piping, condensing gas boilers - are widely used and familiar.

- Specifiers express a high degree of confidence in their ability to specify a gas high efficiency DOAS system.

Experienced specifiers see more upside and opportunity in gas high efficiency DOAS adoption

Specifiers' depth of experience influences how they view gas high efficiency DOAS adoption potential. Highly experienced specifiers are better able to pinpoint situations where the system could be a preferred option.

- Providing education to build knowledge in real-world environments may increase consideration.

Market opportunity exists but may be constrained

Market scope is constrained due to limited applicable contexts

Adoption of gas high efficiency DOAS is limited by market conditions such as local climate, code compliance and competitive positioning.

- While specifiers are generally comfortable with the gas high efficiency DOAS design, they question how often it would be the best-fit solution in real world scenarios.

Familiar alternatives may be preferred unless unique value is demonstrated

Without a distinct advantage, inertia may favor established solutions.

- For gas high efficiency DOAS to gain traction, NEEA must not only prove its feasibility but also clearly demonstrate a unique value proposition – whether through cost savings, performance benefits or alignment with specific policy or energy efficiency goals.

7.2 Recommendations

The following recommendations are offered to assist NEEA in navigating the market dynamics, barriers and opportunities for gas high efficiency DOAS:

- Evaluate and quantify market potential in priority contexts such as corporate campuses, K-12 schools and universities, as well as projects in cold-climate or rural areas where natural gas is a preferred fuel source.
- Develop resources that clearly articulate the unique gas high efficiency DOAS value proposition, namely lifecycle cost savings, performance benefits and policy alignment relative to alternative or competitive designs.
- Demonstrate the applicability of gas high efficiency DOAS in retrofit scenarios, with an emphasis on addressing space constraints and real-world installations.
- Engage facility and maintenance leaders directly through training, case studies or peer exchanges, addressing their operational concerns reflecting their influential role in the gas high efficiency DOAS specification process.
- Incorporate findings into the High-Performance HVAC Program logic model by explicitly recognizing the role of facilities and maintenance teams and addressing perceived challenges in retrofit scenarios.

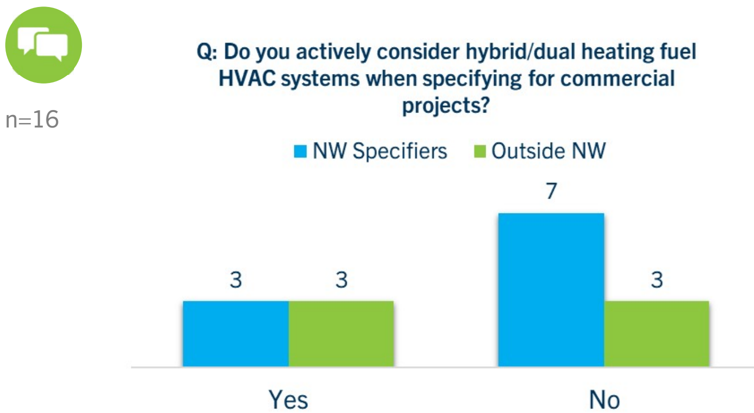
8 Appendix

8.1 Fuel Selection

When asked generally about trends in fuel selection, specifier responses were nuanced and largely reflected state and local policy dynamics.

Northwest specifiers were less likely to actively consider natural gas as a fuel source, though they acknowledged that a market still exists in the shorter term. One Seattle-based mechanical engineer suggested that code exceptions could be utilized in certain cases, though these exceptions may be limited to buildings where the load cannot be met with electricity alone.

Figure 13. Consideration of Hybrid/Dual Fuel



Cost was one driver of continued use of natural gas in the Northwest. Specifiers characterized natural gas as a “cheap energy source” and noted that the more efficient options like condensing boilers can help building owners/clients “get more out of their gas.” However, an approach that includes both electric and natural gas can also be more complex. All-electric systems were described as simpler both in terms of installation and ongoing maintenance, factors that can greatly reduce labor costs.

Location and climate can drive interest in approaches that incorporate both electric and gas components. Projects in rural areas may choose gas systems to augment limited electric grid capacity. Specifiers who have designed in cooler climates such as the Northeast and Colorado noted the value of having natural gas as a second stage or backup in extreme cold temperatures.

8.2 Literature Review

The literature review component of this study provided foundational knowledge to support research objectives, develop survey and interview questions, and inform findings.

Eleven documents were reviewed to assess program understanding related to very high efficiency DOAS as well as identify relevant trends in codes, legislation, technology and HVAC adoption patterns. The documents reviewed included a mix of High-Performance HVAC program materials, NEEA-sponsored research reports and external sources.

Literature review findings contributed to this study in several ways, including:

- Identification of commercial HVAC industry trends included in the Market Characteristics section
- Development of study materials
  - Specifier Survey Questionnaire
  - Interview Discussion Guide
- Background to inform study findings and recommendations

Guiding Questions

The following questions guided the literature review, broken out by associated research objective:

- What barriers have been identified in relation to very high efficiency DOAS?
- What are current opportunities associated with very high efficiency DOAS?
- What are the expected benefits of gas high efficiency DOAS?
- What are the risks or limitations of gas high efficiency DOAS?
- What are current industry trends in commercial HVAC that may impact gas high efficiency DOAS?

Documents Reviewed

The following documents contributed to the literature review and informed development of study materials and key findings:

High-Performance HVAC Program Documentation

- Memo: Proposed naturally occurring baseline for High-Performance HVAC market share projection, February 2022
- Gas High Efficiency Dedicated Outside Air System Equipment and Design Best Practices for Optimal Energy Efficiency, February 2025
- High-Performance HVAC Logic Model, Q2 2025

NEEA-Sponsored Research

- Opinion Dynamics, Commercial High-Performance HVAC Market Characterization, 2019
- Apex Analytics, HVAC Market Actor Profile Report, 2020
- Evergreen Economics, Rooftop HVAC Market Characterization Study, 2017
- Cadeo Group, HVAC/Very High Efficiency Dedicated Outside Air System Specifier Interviews Research, 2020

Additional Sources

- Energy & Buildings, Optimization-informed rule extraction for HVAC system: A case study of dedicated outdoor air system control in a mixed-humid climate zone, 2023
- Energy & Buildings, Insights from hydronic heating systems in 259 commercial buildings, 2024
- Armstrong Fluid Technology, VRF versus HYDRONICS - Comparing HVAC technologies and associated costs, 19 March 2021
- ASHRAE Journal (Vol. 60, Issue 4), Life-Cycle Cost for DOAS With VAV. April 2018
- Pacific Northwest National Laboratory, Field Evaluation of Very High Efficiency Dedicated Outdoor Air Systems Finds Persistence of Savings, 2023
- US Department of Energy, Guidance document on space heating electrification for large commercial buildings with boilers, April 2024

8.3 Participant Recruitment Process

Study recruitment was completed through User Interviews, an online panel provider with a focus on professional audiences. Recruitment outreach targeted HVAC designers, mechanical engineers and architects, with an overrepresentation of those living or working in the Northwest (Oregon, Washington, Idaho or Montana).

Applicants completed a screener questionnaire as the first step in applying for the study. Responses were manually reviewed by OWL Research Partners, and applicants were invited to participate if they met the following criteria:

- Specified or provided input on the design of a commercial HVAC system within the past seven years
- Specified at least one project with a hydronic commercial HVAC system or system of 25 tons or greater (priority given to those with more experience)
- Demonstrated knowledge of HVAC specification in open-ended response and no indication of AI use
- List of components indicated knowledge of relevant HVAC system components
- Job title or industry indicated relevance to HVAC specification

Additionally, participants were prioritized if they live or work in the Northwest or similar climate zones (excluding the South/Southeast).

Screener Questionnaire

Q1: In the past seven years, have you designed or provided input on the design of a commercial HVAC system?

- Yes
- No [Reject]

Q2: In the past seven years, how often have you designed or provided input on the design of a hydronic commercial HVAC system or a commercial HVAC system of 25 tons or greater?

- Once
- More than once
- Never [Reject]

Q3: Please tell us about your most recent commercial HVAC design project, such as the building type and components you recommended. [open-ended response]

Q4: Which of the following HVAC system components are you familiar with? (Select all that apply)

- hydronic loop controls
- high efficiency heat recovery ventilation (HRV) systems
- penguin protocols [Reject]

- natural gas boilers
- terminal equipment
- mechanical pencil [Reject]
- dedicated outdoor air systems (DOAS)
- rooftop units (RTUs)
- energy recovery ventilators (ERVs)

Q5: How long have you been working in commercial HVAC?

- 2 years or less
- 3-5 years
- 5 years or more

Q6: Have you designed or provided input on the design of commercial HVAC systems in any of the following states? (Select all that apply)

- Oregon
- Washington
- Idaho
- Montana

8.4 Survey Methodology

All qualified and approved study participants were invited to complete the survey, and respondents received a $50 incentive for successful completion of this phase of the study.

Survey Instrument

The Northwest Energy Efficiency Alliance is interested in hearing your perspectives on the opportunities and barriers associated with a commercial HVAC system that pairs a decoupled high efficiency energy/heat recovery ventilation (E/HRV) system with an efficient natural gas boiler, terminal equipment and hydronic loop controls. This survey is 14 questions and should take about 10 minutes to complete.

The simplified diagram below shows the components of the system referenced in the survey. Both the diagram and definition will be available for reference with each survey question.

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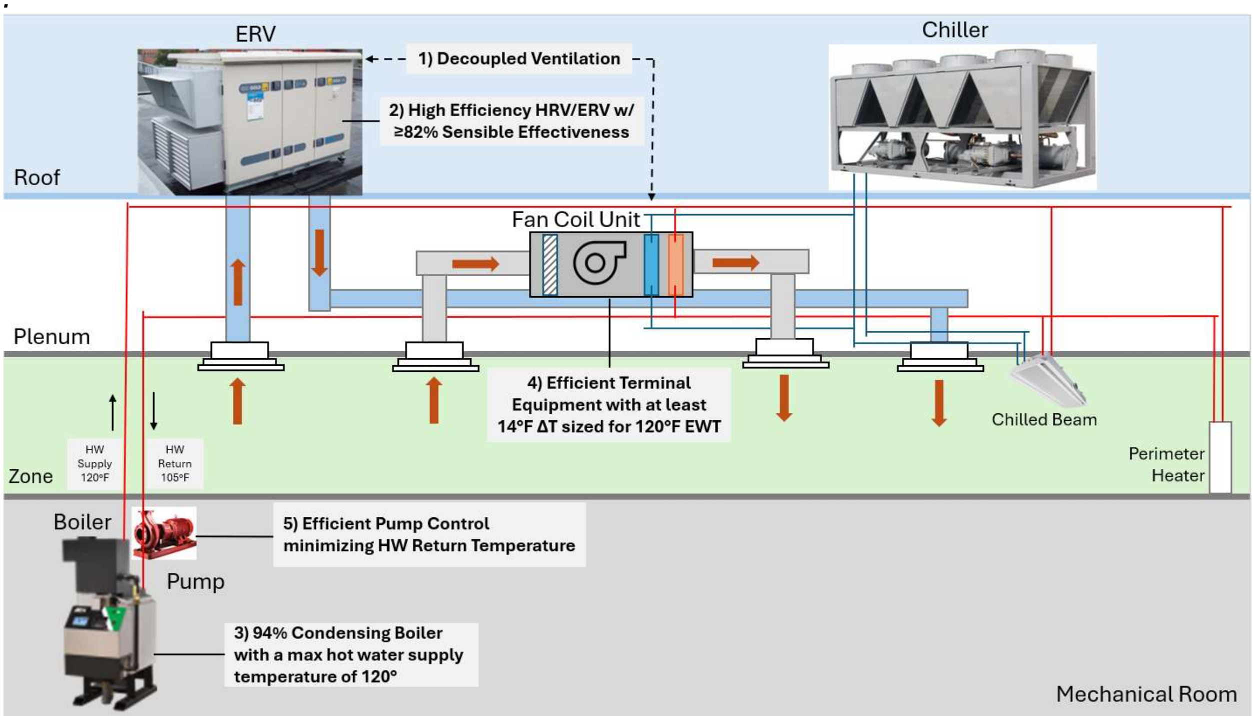


1. How familiar are you with this type of commercial HVAC design?
   a. Not at all familiar
   b. Slightly familiar
   c. Moderately familiar
   d. Very familiar
   e. Extremely familiar

2. Have you specified a commercial system with any combination of the components listed above in the past five years?
   a. Yes (some components)

    b. Yes (all components)
    c. No
    d. Not sure

3. Do you feel that you have the expertise and experience necessary to successfully specify this type of system?
    a. Yes
    b. No
    c. Not sure

4. How would you typically describe this type of system to a customer or decision-maker (building owner, architect, finance, etc.)? [open ended response]

5. How important are the following factors when considering specifying this type of design? [Rates each on a scale, not important to very important]
    a. Energy efficiency
    b. Initial cost
    c. Long-term operational cost
    d. System simplicity
    e. Indoor air quality
    f. Occupant comfort
    g. Acoustic performance (reduced noise)
    h. Environmental impact
    i. Compatibility with existing infrastructure
    j. Equipment availability
    k. Local climate and load considerations
    l. Zonal control

6. Which factors most limit your likelihood of specifying this type of design? (drag and drop to rank options - #1 should be the most limiting element and #11 should be the least likely to limit your specification)
    a. Equipment availability and supply chain constraints
    b. High upfront cost
    c. Preference for more familiar systems
    d. Complexity of the project
    e. Uncertainty about system performance
    f. Concerns about maintenance
    g. Lack of trained contractors/installers
    h. Integration challenges with existing systems
    i. Concerns about code compliance
    j. Preference for all-electric systems or renewable options
    k. Available space for equipment (roof and mechanical room)

7. Which factors could most increase your likelihood of specifying this type of design in future projects? (drag and drop to rank options)
    a. Improved product availability/delivery timelines
    b. Demonstrated lifecycle cost savings
    c. Better integration with standard controls/existing systems
    d. Simplified system design or documentation

   e. Utility incentives/rebates
   f. More training for engineers, contractors and facilities staff
   g. Growing demand for indoor air quality or occupant comfort
   h. Stronger distributor/manufacturer support
   i. Clearer guidance on code compliance
   j. Evidence of boost to client public image

8. What types of commercial buildings do you think are the best fit for this type of design? (select all that apply)
   a. Office/Administrative
   b. Multifamily
   c. K-12 schools
   d. Higher education
   e. Healthcare
   f. Hotels
   g. Retail
   h. Industrial
   i. Mixed-use
   j. Other (please specify)

9. What types of projects do you think are the best fit for this design? (drag and drop to rank options)
   a. New construction
   b. Major renovation/deep retrofit
   c. Planned system replacement
   d. Emergency/unplanned replacement

10. Which of the following people have the most influence over your decision to recommend/specify this type of design? (select up to three)
    a. Manufacturer Representative
    b. Distributor
    c. Architect
    d. Building Owner
    e. Installer
    f. Building Operator/Facility Management
    g. Asset Management
    h. Finance Representative
    i. General Contractor
    j. Other (please specify)

11. How are trends in building codes or energy policies influencing your specification of high efficiency HVAC systems?
    a. Encourage gas-powered options
    b. Encourage electric-powered options
    c. Encourage hybrid gas and electric options
    d. Neutral/no significant effect
    e. Not sure
    f. Other (please specify)

12. What other market trends do you believe may influence adoption of this type of design in the future? [open ended]

13. In which regions do you design commercial HVAC systems?

    a. West - Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, Wyoming [proceed to Q13]
    b. Northeast - Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont
    c. Midwest - Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, Wisconsin
    d. Atlantic – Delaware, District of Columbia, Maryland, Virginia, West Virginia
    e. South/Southeast - Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas

14. [If Q13 response includes West] Do you design commercial HVAC systems in any of the following states? (select all that apply)
    a. Idaho
    b. Montana
    c. Oregon
    d. Washington
    e. None of the above

We thank you for your time!

8.5 In-Depth Interviews Methodology

A selection of respondents who completed the HVAC Specifier Survey were invited to also participate in 60-minute interviews with OWL Research Partners. Invitations were sent to survey respondents who met the following criteria:

- Successfully completed the HVAC Specifier Survey
- Specify for projects in the Northwest (priority) or similar climate zones
- Open-ended responses in screener and survey demonstrated knowledge and ability to communicate about HVAC system design

Invitations were sent to 42 survey respondents, and 16 ultimately completed both the interview and configuration review phases of the study. These participants were compensated $300 for their participation.

Interviews were scheduled and conducted via Qualtrics.

Discussion Guide

The following discussion guide attempts to address these areas through a semi-structured interview of approximately 50 minutes. The discussion guide consists of 18 questions with probing/follow-up topic areas highlighted as needed.

Introductions & Background (~5 minutes)

Research Objective: Background
Goal: Understand professional role and influence in HVAC specification

1. Can you tell us a bit about your role and the types of projects you typically work on?
2. What's your typical involvement in HVAC system specification?
3. How much influence do you have over what type of system is ultimately installed?

Specification experience and considerations (~10 minutes)

Research Objective: RO1, RO2
Goal: Understand specification experience level, design process and decision factors

We would like to ask about your experience with a few specific heating and ventilation system components.

4. Have you ever specified for a project that used: a decoupled ventilation from space condition design with terminal units [e.g. 4-pipe fan coil units], an energy recovery ventilator or heat recovery ventilator, a condensing gas boiler, or a hydronic system design

and controls to maximize condensing operation of the boiler [e.g. low supply water temp and aggressive reset])?

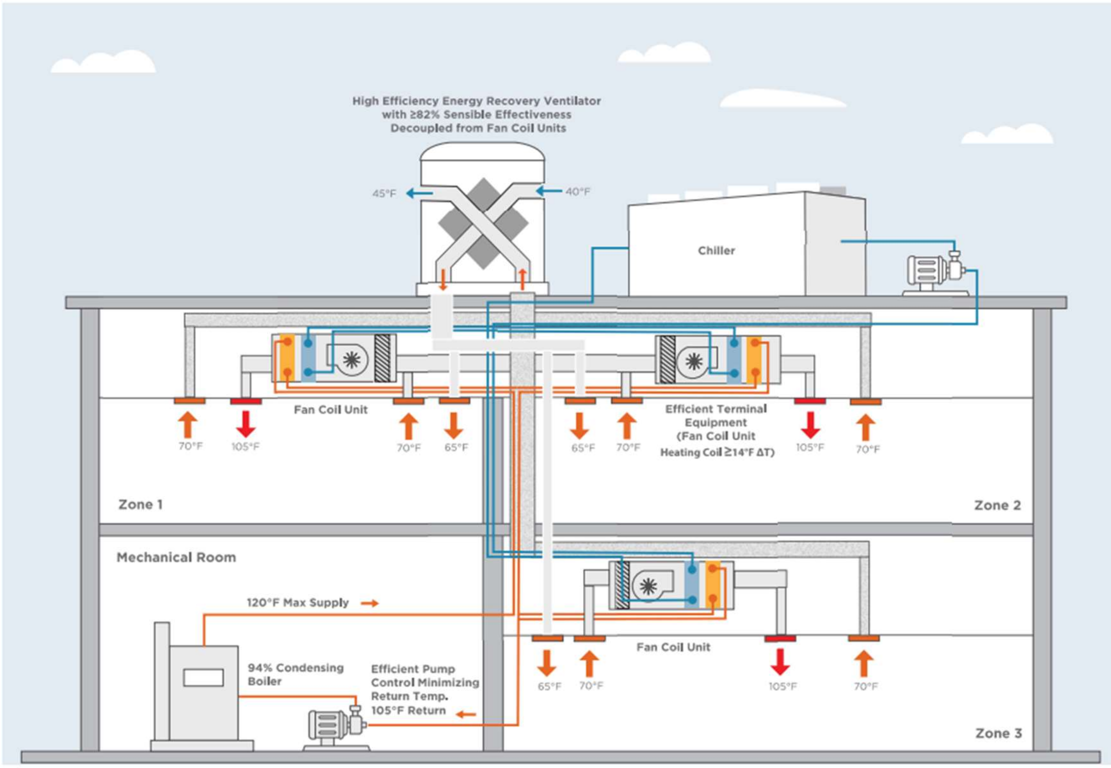
   a. If yes to all, can you describe the project in terms of building type, goals, challenges?
      i. What made this system the right fit?
      ii. What feedback did you receive from the client or contractors?
   b. If yes to some components, which components have you worked with?
      i. Why not the full configuration?
   c. If no or not sure, why do you think this type of system hasn't come up on your projects?
      i. What would need to change for you to consider it?

5. Thinking about a recent project where you had to specify a commercial HVAC system with hydronic loops, can you talk us through your decision-making process and consideration factors?
   a. What heating and ventilation systems were considered, and why? How were they evaluated?
   b. Who else contributed to the decision? Internal teams, clients, contractors, etc.?
   c. What was ultimately specified, and why?
      i. If needed, what were the key factors that tipped the decision toward that system over others?
   d. How was the decision-making process different from other commercial HVAC projects you have worked on?

Factors and Concerns (~10 minutes)

Research Objective: RO1, RO2
Goal: Deepen understanding of factors indicated in the survey that may be preventing market actors from considering Gas HE DOAS as a feasible technology

Now we would like to dig into your thoughts on a system we are calling a gas high efficiency dedicated outdoor air system (gas high efficiency DOAS). In this system, ventilation is fully decoupled from space conditioning. A high efficiency energy (or heat) recovery ventilator is used to reduce the heating and cooling load. Heat is supplied by a condensing boiler and distributed through the building to efficient terminal equipment via hydronic piping. To maximize condensing operation, supply water temperature is limited to 120 degrees Fahrenheit and the terminal equipment's heating coil is sized to produce a water temperature delta of at least 14 degrees Fahrenheit.



6. What might give you pause about specifying a system like this?
    a. Probe further on response as well as upfront costs, integration challenges, available space, complexity of design, equipment availability
7. Do you feel that you have the expertise and experience to specify this type of system?
    a. If not, what types of training, tools or documentation would help close the gap?
8. Are there certain client types, building types, or project phases where you feel this type of system would never work? Why?
9. On the flip side, can you describe specific project conditions for which this type of system would be an optimal solution?
    a. For WA specifiers who mention upgrades – probe further on potential for partial upgrades and code compliance
10. In your opinion, is the broader market ready to support this type of system?
    a. Why or why not?
11. Are there specific market actors that are more or less supportive of this type of system?
    a. Installers, contractors, building owners, etc.

Motivations and Opportunities (~10 minutes)

Research Objective: RO1, RO2
Goal: Discover what might change minds or shift beliefs in favor of considering Gas HE DOAS

Let's talk next about what might encourage more consideration of this type of system.

12. What would need to change for you to feel more comfortable or confident specifying this type of system?
    a. Probe further on response as well as impact of lifetime costs savings, utility incentives/rebates, simplified design documentation, pending building standards (if mentioned)
13. What kinds of documentation, tools or information would help you make the case for this type of system?
    a. Options might include case studies, design guides, cost comparisons, etc.
14. Have you seen a compelling example of this kind of system working really well?
    a. If yes, please describe what made it successful.
    b. Optional – if you are willing, could you share the building's name and location of this project?
15. How much of your current perspective is based on firsthand experience versus peer feedback, industry norms or other information sources?

Market Trends and Policy (~10 minutes)

Research Objective: RO1, RO2
Goal: Contextualize how external market forces – including things like policy, decarbonization goals and evolving client expectations – are shaping specification practices

For the next set of questions, we are going to ask about commercial HVAC trends generally, including smaller buildings, rooftop units or other technologies.

16. How are current or upcoming changes in building codes, energy policy or decarbonization mandates influencing your HVAC system design and specification choices?
    a. Are you seeing pressure to move toward all-electric systems, or is there still interest in high-efficiency natural gas or hybrid approaches?
    b. For those specifying in Washington, probe further into thoughts on state codes
17. Do you actively consider hybrid/dual heating fuel HVAC systems when you are specifying for commercial projects?
    a. Why or why not?

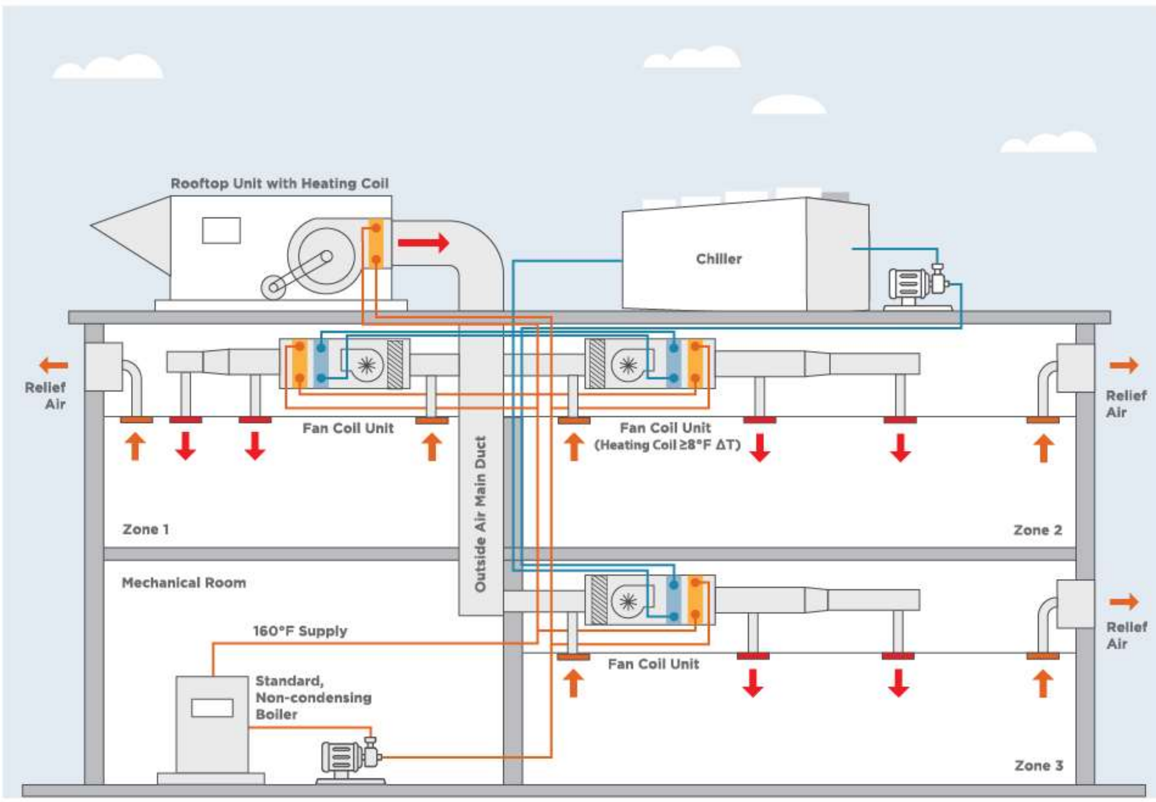
Wrap-Up (~5 minutes)
Research Objective: Sets up RO3
Goal: Capture any missed insights and prepare for configuration feedback exercise

18. Is there anything that we didn't ask that you feel is important for us to understand?

8.6 Configuration Review Methodology

Upon completion of the in-depth interviews, all participants were asked to complete a brief exercise. The survey was conducted via Qualtrics, and responses were either in audio or video format. All 16 interview participants completed this activity.

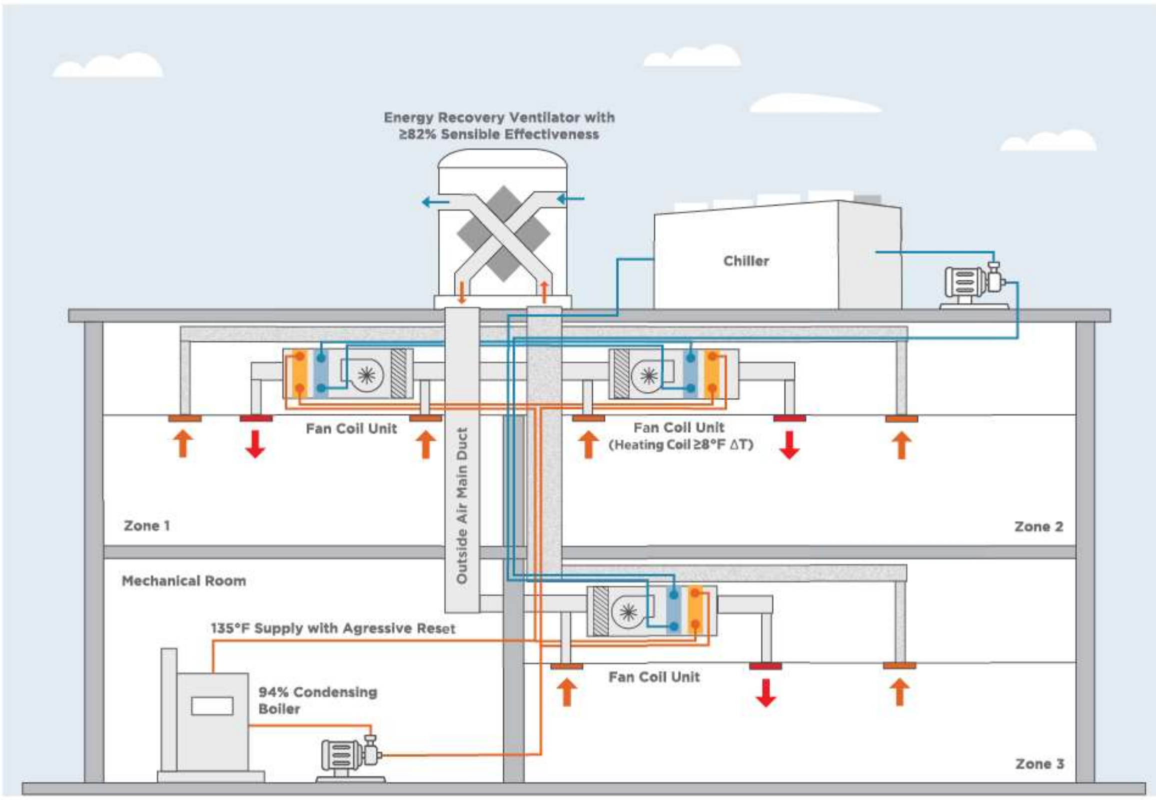
Questionnaire



Consider this older building seeking your input on how to replace its aging HVAC equipment. The building has a four-pipe fan coil system served by a chiller and an old non-condensing boiler. Ventilation is supplied by an RTU with a heating coil directly to the terminal units' heating/cooling coils. Air is exhausted through localized relief dampers.

The chiller was replaced recently, but the boiler is at its end of life. The building is interested in modernizing their HVAC system and value energy efficient technologies. They have budget for equipment replacements and optimized control strategies, but they have limited electrical capacity and the hydronic piping is in good shape.

Q1: Please share your approach for modernizing this HVAC system for efficiency.



Here again is the same older building looking to replace its aging HVAC equipment.

We are interested to hear how *your* approach to modernizing this HVAC system for efficiency aligns with our own, and importantly, what are *we* overlooking.

Q2: We propose adding an energy recovery ventilator and replacing the old boiler with a condensing model. For controls optimization, we propose lowering the boiler's supply and return water temperature to further maximize condensing operation. How does this differ from your approach and what do you see as its strengths and weaknesses?

Q3: Do you have experience adding centralized exhaust air for energy recovery to a building that formerly had localized exhaust? How practical is this?

Q4: Would you expect the existing hydronic system and fan coil units to accommodate such supply water temperature changes given the significant reduction in ventilation load? Or would you expect upgrades to the hydronic system (pumps, valves, sensors, etc.) or fan coil units to be necessary?