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Residential HVAC Contractor Market Research

Prepared For NEEA:
Lauren Bates, Sr. MRE Scientist

Prepared by:
Michelle Kirszner, Vice President
Catherine Hogan, Group Research Director
Raishawn Pitt, Junior Project Director

Lieberman Research
98 Cutter Mill Road, Suite 359
Great Neck, NY 11021

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

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Acronyms Used Throughout This Report

CFM = cubic feet per minute

DFHP = Dual fuel heat pump

EFAF = Electric forced air furnace

GFAF = Gas forced air furnace

GRD= Grills, registers, and diffusers

MSHP = Multi-stage heat pump

SSHP = Single speed heat pump

VSHP = Variable speed heat pump

Executive Summary

The Northwest Energy Efficiency Alliance (NEEA) is creating a residential Variable Speed Heat Pump (abbreviated as VSHP in this report) program, which aims to accelerate adoption of residential VSHPs in existing electrically heated homes and to improve HVAC efficiency for new and existing residential construction in the Northwest. While VSHPs are available in the Northwest, they lack differentiation when compared with other heating systems and often realize only a portion of their potential energy savings due to suboptimal design, installation, and operation. NEEA seeks to transform its residential HVAC target markets by improving product differentiation, bolstering VSHP value propositions, and disseminating the selection, design, and installation best practices.

At this early stage in the program's development, NEEA's goal is to establish a detailed, foundational understanding of current practices regarding the sale, design and installation of HVAC systems and heat pumps in residential homes.

This study had three objectives:

RO1: Characterize current sales, design, and installation practices of residential HVAC contractors for central/ducted HVAC systems, including VSHPs.

RO2: Determine any barriers or drivers for VSHP adoption.

RO3: Identify HVAC contractors who are or are likely to be early adopters of VSHPs, and their attributes.

The first two research objectives will inform NEEA's estimates for market adoption of VSHPs without intervention (NEEA's baseline for VSHP adoption). All three research objectives will support NEEA's intervention development to increase market adoption of VSHPs across the Northwest.

This study employed a mixed methods approach, comprising qualitative data from interviews with HVAC contractors and virtual ethnography (photos and videos of current sales, design and installation practices), and quantitative data from questionnaires. Interviews took place between November 2, 2021, and November 19, 2021.

Key Insights

RO1: Characterize current sales, design, and installation practices of residential HVAC contractors for central/ducted HVAC systems, including VSHPs.

Sales and design technicians work separately from the installation department, and have the greatest amount of influence on the overall process

Quite often, the individuals who manage the sale and design of a heating solution for a residential home are separate from the individuals who perform the installation. Sales and design technicians are the first point of contact for customers and a key influencer in the customer's evaluation of heating options and final purchase decision. By contrast, installers have less leverage on customer decision-making, as they enter the scene after the sale is made

> ***Recommendation:*** *Leverage the sales and design technician's influence by focusing on them as a key target as they are the gatekeeper to greater VSHP uptake. Empower the sales and design technician to be more proactive in their sales approach, providing the guidance and leadership that customers desire within a transaction, while having a greater influence over the customer decision.*

to execute the plan that was established by the sales and design technician. The only exception is in smaller businesses where one individual may perform all the steps required in the sales, design and installation process.

Customer-centric sales approach

HVAC contractors explained that much of the current sales and design approach is driven by the customer's want and needs. Sales and design technicians consider each sale to be unique, and they devote a significant amount of time to understanding each customer. Contractors explained a dynamic in which they want to provide the best products based on their expertise, yet often defer to customer feedback since their ultimate goal is to maintain customer satisfaction. At the same time, customers often rely on the contractor throughout the sales and design process since their knowledge and awareness about heating systems is typically low, therefore creating a delicate power dynamic between the two parties.

VSHPs are typically offered as a "best," premium option

In circumstances where a ducted system is the goal, VSHPs are typically classified as a 'best' option in a 'good, better, best' offering, indicating they are perceived as a top-of-the-line, premium choice. Given their positioning, they are not yet the standard go-to for homeowners despite greater options and affordability as of recent. Being the best option seems to create

> ***Recommendation:***
> *Consider equipping contractors with objection handling resources for the sales and design technicians to override any concerns about choosing the "best" option.*
>
> *Advocate for the VSHP to be positioned as a "better" option, creating the psychological appeal of it being a safer, more conservative choice than the highest-end option.*

subconscious hesitation -- customers contemplate whether they need the “best” or if its benefits are truly worth its cost.

Installing VSHPs is a standard process and almost the same process as other heat pump types

The installation of VSHPs is akin to that for other heat pump types. There was broad consensus among contractors that it takes the same amount of time and effort to install a VSHP as other SSHPs (Single-Speed Heat Pumps) or MSHPs (Multi-Stage Heat Pumps), with very minimal (if any) pain points or complexities. Only a small few claimed it takes longer to install VSHPs (up to 1 to 2 hours longer), and one claimed it takes less time. This variation may be attributed to different work efficiencies between contractors.

Likewise, installation contractors reported that installing a VSHP is a standardized process. Installers follow the required steps and refer to the manufacturer guides. Differences were minor and included: contractor thoroughness (e.g., quality control/system initialization), the order of the steps (may vary by preference), and whether some steps are done in tandem (vary depending on the size of a team).

Recommendation: *When communicating with or educating contractors about VSHP installation, focus on the aspects of the process that are unique, such as initialization and set-up.*

HVAC sales and design technicians always inspect duct conditions, but rarely conduct performance tests

Most contractors will assess duct condition by observation. They will look for damaged ducts, disconnections, or improper sealing. Some use measurements or ductulators (i.e., Air Duct Calculators) to understand duct volume and CFM. However, rarely are contractors running tests to assess duct leakage or CFM loss. These performance tests are considered less important in retrofits and onerous or time consuming.

RO2: Determine any barriers or drivers for VSHP adoption

DRIVERS: VSHP uptake is growing across the Northwest, driven by a combination of economic, legislative and societal market forces

There is growing, positive momentum toward the uptake of energy efficient heating systems in residential homes in the Northwest. Sales of VSHPs have been steadily increasing over the years, and this trend is expected to continue, with many HVAC contractors predicting VSHP sales will soon overtake sales for traditional single-speed and multi-stage heat pumps.

The modest but steady increase in VSHP uptake is being driven by several factors, namely: advancing technology and manufacturers' efforts to produce a greater variety of VSHP models than in the past, recommendations by HVAC sales technicians, heightened energy codes and initiatives aimed at promoting the switch to energy efficient heating systems, incentives and rebates to aid affordability, and customer awareness and interest in the benefits of VSHPs. Underlying this is the general, growing customer demand for residential HVAC systems across the US, which is showing no signs of slowing down.

BARRIERS: VSHP growth is encumbered mainly by cost and awareness, but consumer psychology and broader industry factors also play a role

Although VSHP uptake is growing, it is being slowed by four key categories of barriers:

1. Cost barriers
2. Knowledge barriers
3. Psychological barriers
4. Industry and logistical barriers

A summary of each of the above barriers is provided below.

COST BARRIER: Cost strongly dictates sales and purchase behaviors

Upfront cost of VSHPs: Despite continued innovation and the availability of a wider range of VSHP products in the market today, there is still a substantial upfront cost difference between VSHPs and the more traditional single-speed and multi-stage heat pumps. It is common for residential homeowners to feel "sticker shock" with VSHPs, and either opt for a cheaper-priced, mid-level heat pump, or stick with replacing their gas furnace with another gas furnace, to avoid the extra upfront cost of equipment and labor. The cost of VSHPs also influences how sales and design technicians present their cost bids to residential customers, as they sometimes avoid recommending heating systems that they don't think their customers will want to pay for.

> ***Recommendation:*** *Educate homeowners that there are many different types of VSHPs on the market today that come at different price points. Encourage homeowners to shop around and compare pricing.*

Cost of electricity vs. more affordable gas: In some parts of the Northwest, gas companies can offer gas at a lower cost compared to electricity, which may deter some customers from opting for a heat pump.

Financial assistance programs support uptake but can be hard to access: Homeowners are currently able to receive financial assistance for the purchase of a VSHP through four main forms: 1) Rebates that offset the cost of the heat pump from utility companies and NGOs, 2) Federal tax credits, 3) Incentives from manufacturers and 4) Payment assistance programs from

HVAC suppliers. While these have all been helpful to reduce cost barriers for homeowners, contractors noted various barriers for consumers to receive support, such as general lack of awareness, hurdles and red tape for HVAC contractors, obscurity around eligibility, and insufficient incentives to address the upfront cost difference.

> ***Recommendation:*** *Consider communications initiatives aimed at demystifying the range of financial assistance available and how to access them.*

KNOWLEDGE BARRIER: Homeowners lack awareness and understanding of VSHPs

While substantial progress has been made in terms of social awareness of the importance of choosing energy efficient products, homeowners tend to lack understanding about the differences between heating systems, and the advantages of electric (or hybrid) heat pumps. Customers tend to approach HVAC companies with minimal knowledge around the range of solutions available, and care mostly about cost.

> ***Recommendation:*** *Educate homeowners about VSHPs and how they work (e.g., via online resources, hard-copy resources, media campaign). Empower homeowners to make more informed choices.*

KNOWLEDGE BARRIER: There is a potential need for more VSHP training for HVAC contractors

While most HVAC contractors interviewed showed substantial clarity and depth of knowledge on heat pumps and VSHPs, HVAC installers consistently noted the errors and shortcomings of other contractors in heat pump installations, with many seeing incorrect sizing (both over- and under-sizing) and incorrect installations being done.

Additionally, while phone-based salespeople (not sizing technicians) were generally well-versed in the specifications and differences of heat pumps, a few also showed some signs of knowledge gaps.

> ***Recommendation:*** *Strengthen sales and design technicians' knowledge of VSHPs with more detailed information about ideal application and correct sizing in different situations. Equip contractors (particularly sales and design technicians) with the latest knowledge available on energy savings from VSHPs.*

PSYCHOLOGICAL BARRIER: Homeowners think about their heating needs in basic terms

Contractors noted that many homeowners think about their heating systems in simplistic terms, and often struggle to understand the value of specific product attributes, or the long-term benefits that don't feel tangible in the present moment.

Recommendation: *Consider educational initiatives to help homeowners realize the cost-savings of VSHPs over the long-term. E.g., Consider creating or driving attention to an online savings tool for homeowners to estimate energy savings through VSHPs. This tool should include a rebate calculator to estimate how much homeowners will save after incentives and rebates.*

PSYCHOLOGICAL BARRIER: Technology can be intimidating to some (usually older) homeowners

Contractors noted that certain homeowners can be less interested in heating systems with in-built computers or that have extra connectivity, especially older customers. The added technology and features in VSHPs may contribute to the perception that VSHPs are a luxury item and paying more for such heating systems is unnecessary.

RO3: Identify HVAC contractors who are or are likely to be early adopters of VSHPs, and their attributes.

The research revealed that there is widespread adoption of VSHPs among HVAC contractors across the Northwest. Among the sample of contractors who were interviewed, who stemmed from a variety of business sizes (small, medium, and large) and across urban and rural counties in all four states, all were adopters and supporters of VSHPs. The HVAC industry is by now well past the point of early adoption of VSHPs, if not late adoption, as all HVAC contractors are 'sold' on VSHPs and their advantages and are more frequently recommending VSHPs to their customers when the circumstances are right.

Recommendation: *Potential future targeted engagement efforts should avoid prioritization and encompass all HVAC businesses.*

Note: Additional information about the current and anticipated heat pump landscape can be found in Appendix A.

Research Background, Objectives and Methodology

Background

The Northwest Energy Alliance (NEEA) is creating a residential Variable Speed Heat Pump (abbreviated as VSHP in this report) program, which aims to accelerate adoption of residential VSHPs in existing electrically heated homes and to improve HVAC efficiency for new and existing residential construction in the Northwest. While VSHPs are available in the Northwest, they lack differentiation when compared with other heating systems and often realize only a portion of their potential energy savings due to suboptimal design, installation, and operation. NEEA seeks to transform its residential HVAC target markets by improving product differentiation, bolstering VSHP value propositions, and disseminating the selection, design, and installation best practices.

The VSHP program builds on NEEA's now completed Ductless Heat Pump program, the Northwest Ductless Heat Pump Project. That program revealed some challenges and barriers NEEA believes will also be relevant to the VSHP program. First, any type of heat pump requires proper design to achieve optimal performance, including sizing the system based on local climate to ensure adequate capacity to condition air in the desired space. Second, heat pumps require a more complex installation than traditional furnaces because their performance is dependent on refrigerant charge, line set length and layout, the condition of the ductwork, air flow and controls integration with backup heating systems.

To transform the residential HVAC market, NEEA is contemplating interventions with residential HVAC contractors (i.e., installers who design and then install HVAC systems in homes) in order to influence their sales, design, and installation practices. A key starting point is understanding residential HVAC contractors' current practices. The overall goal of this study is to document and learn Northwest residential HVAC contractors' "business as usual" practices.

Objectives

This study had three objectives:

RO1: Characterize current sales, design, and installation practices of residential HVAC contractors for central/ducted HVAC systems, including VSHPs.

RO2: Determine any barriers or drivers for VSHP adoption.

RO3: Identify HVAC contractors who are or are likely to be early adopters of VSHPs, and their attributes.

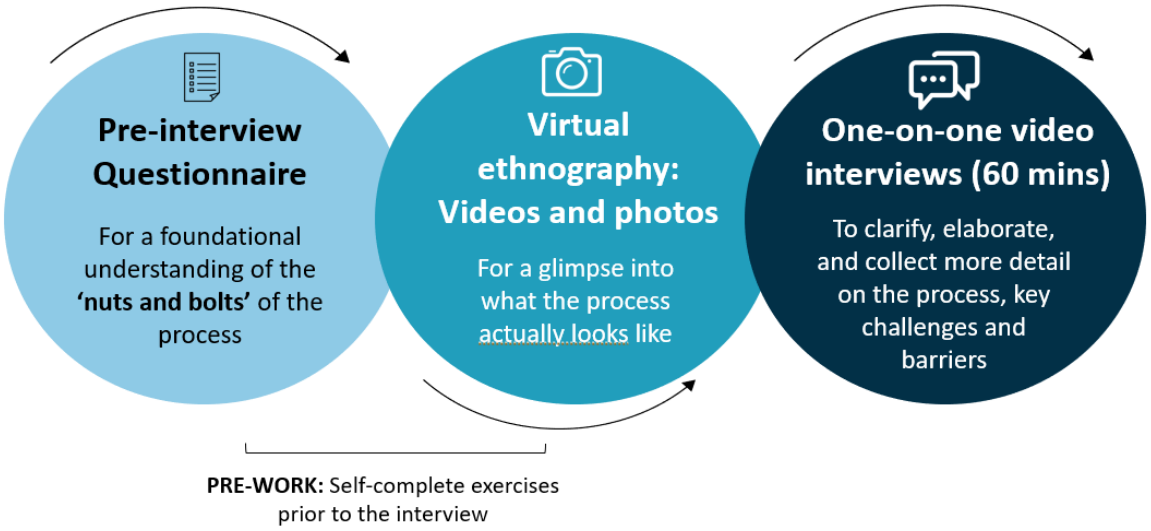
The first two research objectives will inform NEEA's estimates for market adoption of VSHPs without intervention (NEEA's naturally occurring baseline for VSHP adoption). All three research objectives will support NEEA's intervention development to increase market adoption of VSHPs across the Northwest.

Research Methodology

This study employed a mixed-methods approach, comprising knowledge-sharing sessions with NEEA's VSHP program team, a pre-interview questionnaire with HVAC contractors, virtual ethnographic data collection (photos and videos of current sales, design, and installation practices), and qualitative data from one-on-one interviews with HVAC contractors.

Questionnaires were distributed as respondents were scheduled, starting October 7, 2021, and submitted prior to their scheduled interview. Respondents submitted photos and videos on a rolling basis either before their interview or as interview follow-up. Qualitative in-depth interviews took place between November 2, 2021, and November 19, 2021.

Figure 1: 3-step data collection approach to formulate a detailed picture of current sales, design, and installation practices



Recruitment for primary research

Recruitment was conducted using a third-party contact list provided by NEEA as the primary resource. NEEA contact lists were supplemented using two third-party recruitment partners, as well as third-party referrals.

Primary research was conducted with a total of n=30 HVAC contractors in Idaho, Oregon, Montana, and Washington.

Contractors involved a mix of those involved in the sale and/or design of residential HVAC systems and those involved in installation. Contractors also represented a mix of firm sizes (i.e., small, medium, and large), and business models (i.e., Direct to consumer sales and installation, manufacturer reps who sell to HVAC contractors, and a firm who offers equipment leasing).

Table 1: Research sample

	Idaho	Oregon	Montana	Washington	TOTAL
Sales and Design Technicians	1	7	2	7	17
Installation experts	1	5	2	5	13
TOTAL	2	12	4	12	30

Pre-interview research

All respondents were asked to complete a short activity before their scheduled interviews, comprising an online questionnaire and a "virtual ethnography" task.

1. **Pre-Interview Questionnaire:** Respondents were asked to complete a short, online questionnaire on Survey Monkey covering questions around their business, such as the estimated proportion of work in new vs. existing homes and estimated breakdown of sales and installations of different heat pump types. This information was gathered before the interview to provide the research team with background context about each respondent before the interview for more tailored probing.
2. **Virtual ethnography:** Respondents were asked to share photos and videos of their current business practices regarding the sales, design, and installation process. Detailed instructions were given to all respondents, including the topics to cover in their submissions. Photos and videos were collected via email and text message.

In-depth interviews

A total of 30 interviews were conducted with sales and design technicians and installers. Interviews were 60-minutes in length and were conducted over CIVICOM, a web-enabled platform. All interviews were audio- and (when possible) video-recorded.

Analysis

The analysis of the data was iterative and began on the first day of data collection. The approach comprised a continuous process of coding, synthesis, and triangulation from all data sources (i.e., questionnaire, audiovisual material, and interviews). During the analysis, the research team applied a specific focus on uncovering similarities and differences between segments (i.e., sales and design, vs. installation), regions, firm sizes, and contractor attitudes and behaviors.

Study Limitations

Due to qualitative approach and small sample size, the findings from this research offer directional guidance only.

RO1: Characterize current sales, design, and installation practices of residential HVAC contractors for central/ducted HVAC systems, including VSHPs

This section details the typical step-by-step process for the sales, design, and installation of ducted HVAC systems, including VSHPs. The sales and design process is outlined separate from the installation process.

Overview of key personnel involved

There are multiple individuals involved in the sales, design, and installation process. Their titles and actual responsibilities vary across businesses and, depending on business size, they can be the same person. At larger companies, positions are departmentalized with different people responsible for different stages of the process. At smaller companies one person may be responsible for multiple parts of the process. However, across many businesses, a few key players were identified.

Table 2: Key personnel and their responsibilities

Customer service representative	Take the sales conversation and manage administrative tasks such as noting the name, address, and initial idea of what the homeowner is looking for.
Sales and design technician	Conduct house visits, technical assessments, measurements, and ultimately are the ones who make the HVAC recommendations. At small and mid-size companies this may be the same person who took the initial sales call. HVAC sales and design technicians play an extremely important role in the path to purchase journey as gatekeepers to customers' heating education and influencers in the final purchase decision.
Installation contractor	Responsible for the installation and physical exchange of the equipment. They engage in the necessary quality control steps while on-site to ensure the equipment was sized correctly and will work as intended. This role is typically distinct from the sales technician at most firms.
Service and maintenance team member	Conduct routine maintenance and call-back servicing when homeowners have issues with equipment. At small and mid-size companies this can be the same person who installs equipment. In some cases, they assist in the sales process by recommending new equipment to homeowners when their equipment is near end-of-life.
Subcontractors (e.g., Electrician)	Work as needed depending on the job. Some jobs require electrical work to be done, and if a contractor is not fully licensed, he or she may need to enlist the help of a licensed electrician. In the cases where extensive ductwork is needed, a subcontractor may be hired. However, this is more common at smaller companies. Larger firms tend to have these services in-house.

The Sales and Design Process

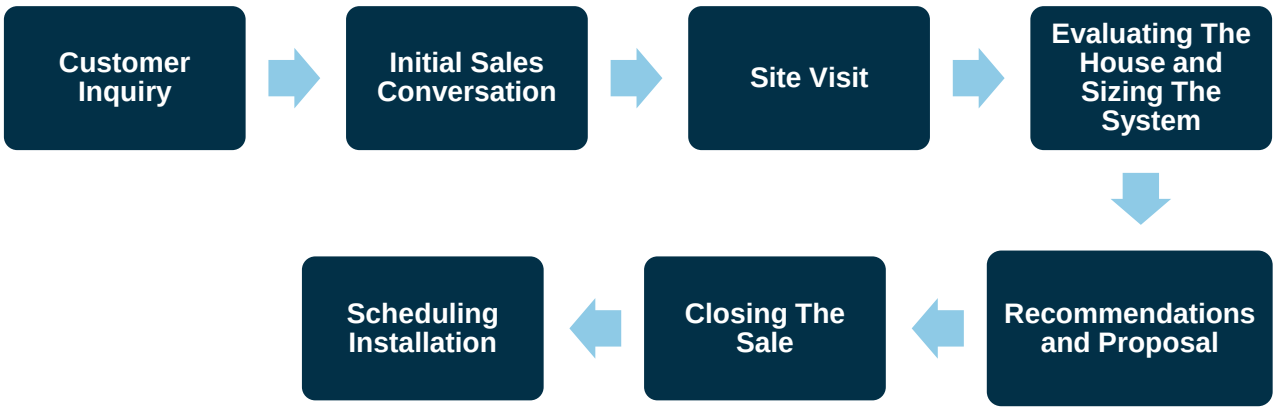
HVAC contractors wrote out their step by process as a part of the pre-work questionnaire. Then, qualitative interviews were used to expand on the process, with the moderator probing on the nuances of each step.

The overall process

Overall, the sales and design process is grounded in similarities across technicians, reporting that the key touchpoints were analogous, while individual approaches may vary somewhat. Minor differences emerged depending on the individual technician's beliefs, role, and company's business model. Most also caveated that no twos sales are alike; each sale has unique attributes, and they consider the sale's process to be customized based on the customer at hand.

The overall sales process was described in 7 steps:

Figure 2: Typical overall sales process (n=12)



Note: Optional/supplemental steps uncovered are mentioned throughout, where appropriate.

1. Customer Inquiry

The sales and design process is initiated by the customer. Customers learn about different HVAC companies by word of mouth or recommendation or as a result of research via Google searches or review websites, like Angie's List. Customers then contact companies by means of phone (most common) or online estimate forms (sometimes), with the intent to learn more about the company's services and potentially book an estimate appointment.

2. Initial Sales Conversation

A company representative fields the initial customer inquiry. Sometimes the fielding representative is the technician themselves, while other times it is an office-based customer service representative.

- Customers service representatives (CSRs) were more common in mid to large sized firms, where roles are departmentalized. CSR responsibilities included "behind the scenes" administrative tasks and were confined to in-office work, unlike the field technicians that would work mostly in-field.
- Smaller firms or those with a described "mom and pop" culture were more likely to have technicians answer customer inquiries because the sales technicians wore "many hats," and roles were typically more overlapping than those in larger firms.

The initial conversation varies in length but is typically brief, lasting around a couple minutes. However, some said the initial calls can be longer in duration based on how engaged the customers are and how many questions they ask. Describing the available options during the initial sales conversation may indicate a longer conversation that can last up to 30 minutes.

The goal of the conversation is to align with the customer in terms of project goals and acquire basic information about the customer's wants and needs.

Figure 3: Initial sales conversation topics

The initial conversation may cover topics such as:

- The reason for the call – replacement, service, maintenance, etc.
- House basics – size, age
- Current type of HVAC equipment installed in the home
- HVAC system of interest
- Background about the company
- Issues/problems with the current HVAC system
- Upsides/downsides of available HVAC options

The call typically concludes with an appointment being scheduled for an on-site visit. If it is the technician who took the call, they schedule an appointment with themselves. Otherwise, the CSR assigns a technician and updates the schedule. Notes taken during this call will be saved on file for the sales technician. Site visit appointments are booked in approximately 2–3-hour blocks.

Some sales technicians noted a pain point during this step; they said customers sometimes push for a cost upfront during this call, which can be difficult to answer without on-site

evaluation. While some will give a “ballpark estimate,” others will delay until the estimation appointment.

> *“I want to make sure that we're not wasting each other's time. Everybody's time is valuable. Theirs, mine, everybody. So [during that initial sales conversation] we want to make sure that we have a common goal, and we are a match, a fit of what we're looking to do.” – Sales & Design, WA*

> *“[The duration of the initial sales conversation] can vary drastically. I would say your average phone call's probably two to four minutes. And it's just getting information. "Who are you? Where do you live? What is it you're looking for? What do you have currently? And then when can I come out and see you? What's a good time for me to visit.” – Sales & Design, WA*

Optional step: Pre-Visit Preparation

If time allows, a few sales technicians noted that they prepare prior to the on-site visit. Preparation may include:

- **Going over initial conversation notes**: Contractors might review any call notes from the initial customer inquiry.
- **Conducting pre-research:** Contractors may conduct preliminary research, so they are not “going in blind” to the sales call. Research is typically conducted online to examine the house and neighborhood. Sites used include county websites, realty.com, Google Maps, and Zillow.
- **Initiating an Introductory phone call:** One contractor calls the homeowner prior to the site visit to introduce himself and gain initial insights since he was not the company representative who fielded the initial inquiry.

> *“If I'm not terribly busy I like to do a little bit of research on the home before I get there, just to see what it looks like. There's a wealth of information on the internet, how many stories, what's currently there. A lot of times I can find out and get a little bit of knowledge on the home.” – Sales & Design, OR*

3. Site Visit

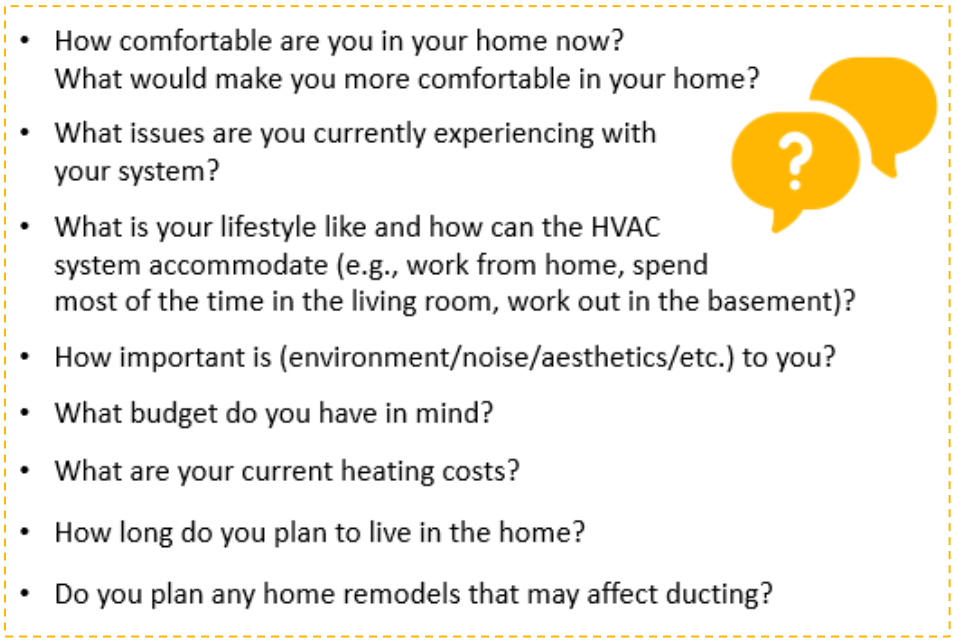
During the site visit, technicians not only assess the technical specs for a job, but also understand both the rational and emotional needs of the customer.

- **External evaluation:** Upon their arrival to the home, sales technicians already begin to make initial assumptions about the customer based on the type of neighborhood, size of

the house, types of cars in the driveway, and upkeep of house and property. These "clues" may indicate discretionary income, inclination for environmentally friendly products (e.g., Prius, Tesla), and how important home maintenance is to them (e.g., well maintained yard, etc.).

- **Customer greeting:** First, technicians greet the customers. While greeting customers may seem like a quick and basic exchange, for many technicians it is an intentional process, driven by making a sale. Upon entering a home, technicians introduce themselves, the company, explain the process for the site visit, and set time expectations (e.g., up to 2-3 hours depending on size of house). At the same time, technicians emphasized the importance of making a good first impression; they want to work on relationship and trust building from the moment they are customer-facing. Some tactics for relationship and trust building mentioned included: finding common ground, differentiating their company from others (more in-depth or skilled), and positioning their sales tactics as altruistic in nature (e.g., save customer money, no "hard-sales").
- **Customer needs assessment:** The customer needs assessment involves an in-depth conversation with the customer (e.g., ~45 min). The technician's mindset during this phase is one of a problem-solver to find solutions on how to optimize customer comfort. Through probing questions, technicians aim to understand what the customer wants and needs, both rationally and emotionally. Rational wants and needs inform the technical design of the HVAC system. Emotional drivers and barriers that are uncovered such as customer perceptions, beliefs, and preferences, inform the technician's sales approach. Common questions asked by technicians include the below. Probing questions and follow-up are often customized based on the sale/customer.

Figure 4: Customer needs assessment questions



Technicians end the needs assessment when they feel they have enough information about the customer and a sense of what type of system best meets their needs.

4. Evaluating the House and Sizing the System

After the contractors complete the customer needs assessment, contractors know what type of system(s) they are going to propose to the customer. With that in mind, the next step in their process is the operational assessment. This is where the contractors walk through the home and assess the specifics for technical reasons. Technicians want to learn not only what is needed for the system itself, but also what is causing problems or pain points within the home.

During this assessment, contractors complete the following key tasks:

- **Evaluating the layout of the house:** Technicians will note the physical layout of the house for placement planning purposes. The layout will dictate where indoor/outdoor units will be placed, line set routing, and ensure all potential paths are accessible for the installation team.
- **Checking the electrical panels:** Technicians will check the electrical panel both to note its location, whether it is up to code, and to gauge if any major electrical work will need to be done and budgeted for (e.g., add a circuit).

> *"With a ducted unit, the coil is placed inside of the furnace or the electric air handler. And then the outdoor unit is generally placed. We try to place them within 25 feet of the electrical panel. So, if the electrical panel is inside, we're trying to aim within 25 feet from the electrical panel is the easiest way for the wiring, but we also place them up to code." – Sales & Design, OR*

- **Measuring/Sizing for heat load calculations:** Most sales and design technicians (13 out of the 17) evaluate the home for sizing purposes, emphasizing that this step is critical for ensuring the new system will work properly and efficiently. Approximately 75% of the sales and design technicians reported that they typically do a full heat load calculation. At the same time, sometimes they may estimate heat load calculations for a retrofit job based on their experience and what is currently in the home (e.g., ductwork, square footage, supply air).

  However, technicians also noted that this step is the one most likely to be done inaccurately. Sizing is a comprehensive multifactorial process, which can be time-consuming and error prone. Technicians often arrive on site to find that the existing heating systems were incorrectly sized or that there are errors in how the existing systems were installed.

Key factors for sizing

- **Size of house:** Square footage of home, number of rooms
- **Age of house:** Building year will point to the codes and building materials used
- **Number/Type of Windows:** Aluminum, single pane, double pane, etc.
- **Insulation:** R-Value will impact how well the walls hold heat
- **Roof Materials/Color:** Color and materials impact heat loss
- **Siding Material:** Brick, vinyl impacts heat loss
- **Duct Evaluation:** Size dictates airflow capacity and system efficiency
- **House Layout:** Basement, attic, high ceiling, number of levels impacts heat distribution
- **Direction of house:** Shading patterns

While most technicians said the factors they evaluate are standard, the order in which they assess them may vary. How in-depth the technicians evaluate each factor may differ from technician to technician based on their experience, sales technique, and project scope.

Actual methods for sizing are diverse. Some more seasoned technicians estimate the heat load calculation in their head, while others rely on software. Some examples of tools contractors use

for calculations are: Manual J, WrightSoft, Betterbuilt Northwest, CoolCalc, RHVAC, Utility company resources (Inland Power excel sheet), and branded programs from manufacturers.

Evaluating duct work

All on-site sales and design technicians are evaluating existing ductwork to some degree, most typically assessing their conditions. Only ~30% mentioned evaluating duct performance. Technicians insinuated that conditions and sizing were most important to evaluate in a retrofit project, and some suggested their evaluation is not very in-depth.

Many said retrofit jobs often require minor, "easy" fixes (e.g., adding a return, increasing size to match furnace, increasing filtration, improving the strapping), and extensive ductwork is rare. As a result, most technicians said their firm handles duct repair and includes it in their bid.

However, extensive ductwork may be subcontracted out and priced separately from their bid. Extensive ductwork can increase the project cost by thousands. Depending on how much ductwork needs to be removed and replaced, it can cause significant delays up to 7 days from project start.

> *"So above and beyond our cost, they spent another, almost 10 grand getting ductwork removed that was wrapped in asbestos. So that was just an education piece that, here's your ideal solution or we can keep putting expensive band-aids on it. That particular job as of yesterday, they were still using their old ductwork while we did the installation. Six days later, we're finishing up all of the ductwork, the furnace, the new heat pump. They haven't been without heat the entire process." – Installation, WA*

Duct condition evaluation

Most frequently, conditions of the ductwork are assessed visually. Technicians look for issues such as strapping, connections and sealing, deterioration, damage, and chokepoints. One mentioned the use of a scope to see more in-depth. However, it is frequent that there is some guesswork involved since evaluation is limited to what is visible (e.g., in attics, crawl spaces). Permits are needed to check ductwork behind walls and it's typically considered unnecessary for the average retrofit job. Duct leakage testing was not done very frequently, and most technicians were less concerned about leakage; one mentioned he uses a blower door test.

> *"We do our best to see the duct work. It's not always visible. We can get kind of a decent idea. Typically, you'll see if there's a large problem going on. Again, lack of returns, and you see what's missing. But a lot of times we can't see the size of the entire duct that goes through the house. You kind of, in some cases, deal with what you're dealt." – Sales & Design, WA*

"We don't inspect a whole lot with the existing duct work. Basically…I'm checking the size of the duct work. I'm checking the size of their return air grill because maybe the duct work is large enough, but their grill itself is just undersized because the builder just didn't know what they were doing." – Sales & Design, WA

Duct sizing evaluation

Most contractors are also looking at the duct sizing to ensure the new system will be supported by what is currently installed. Many claim they can see if there is a major sizing issue from their experience. Some contractors measure the duct velocity, using "basic" tools such as a ductulator or static pressure gauge. The type of duct (e.g., flex, board, metal) is also considered as it may impact cubic feet per minute (CFM) calculations. Return air is evaluated by checking the duct size and the grill size, then comparing it to the volume of the air handler. Other evaluation techniques included: looking for hot and cold spots, assessing the size of the filtration cannisters, counting grills, registers, and diffusers (GRDs) to calculate CFM, and measuring main trunk lines.

Taking photos for the job plan/record keeping

Some technicians said they will take pictures of the site to keep on record as a part of their job notes. Pictures may include anything that would be helpful for the installation team's preparation such as the install space, the current HVAC system, access routes, and electrical panel.

5. Recommendations and Proposal

At this stage, technicians have all the information they need to make a proposal. While they did not clarify at what point they get equipment pricing from their wholesalers, distributors, or reps, they indicated that gathering pricing before mark-ups is a standard part of the process and/or they know ballpark figures because they work with the same suppliers routinely. They keep their number one priority in mind -- making customers happy. Recommendations are customized for each sale. Technicians want to maximize the quality of the product within a customer's budget. Proposals usually include a few options typically arranged in a good, better, best hierarchy. What is considered good, better, or best is determined by a variety of factors, but most often is stratified by equipment price and energy efficiency.

While not standard, contractors typically bucketed options into "good, better, best" categories as described below. Nearly all contractors would consider the VSHP a "best" option.

- **Good:** Budget-friendly, low or "good enough" efficiency, single-speeds: low-level furnace or single-stage heat pump, single zone air handler

- **Better:** Moderate priced, moderate efficiency, mid-level speed/zones: more efficient/modulating furnace, two-stage heat pump, multi-stage heat pump or single zone ductless mini-splits
- **Best:** High cost, maximum efficiency, variable speeds/zones: variable speed heat pumps or sometimes maximum zone mini-splits (e.g., 5 zone)

Bids are all inclusive, including pricing of equipment, installation, and ductwork repairs. In addition, some companies include one year of warranty and maintenance. Technicians proactively include incentives and rebates for each HVAC option so the customer will see the bottom line. Some sales technicians present the proposal on site, while others prepare it in the office and then email it. When presented, it is the technician's responsibility to discuss the upside and downsides of each option and field customer questions, as necessary. To close the deal they guide customers towards a choice and eliminate any customer objections.

> *"We're presenting options where it's an organic conversation you're talking through and just trying to understand what they're looking for. What we'll do is, we'll do a bid right there on the site, because we do it electronically. So, we can do drop down boxes. And what we do is we'll either do it all on the site or we'll come back to the office and do that." – Sales & Design, WA*

> *"So if they're looking for a ducted system, and so that's what they're needing, wanting, and we've determined that's what we're going to propose, then we stay in that class of ducted systems and then it would be good, better, best. Good would probably be a single speed, lower efficiency heat pump. The medium tier would probably be a step up on the variable speed air handler to a higher HSPF heat pump. And then maybe the best would be variable speed air handler with a bad to the bone, the best HSPF and SEER heat pump available. If we go out there and they're wanting a mini-split system, then maybe the good option would be a single zone in their living room and stay zonal in the rest of the house. The better would be add a zone in their bedroom and maybe the best would be let's put a five zone mini-split here." – Sales & Design, WA*

> *"[VSHP] goes into the fantastic column. I use BizPro, which has good, better, best, and fantastic." – Sales & Design, WA*

6. Closing The Sale

After the presentation and discussion of the proposal, the customer will choose an option and the technician shifts their mindset from selling equipment to planning for the installation. In instances where the recommendations are presented at the home, technicians said some customers may decide then and there, and others may take time to think through the options. If the latter, the sales technician will follow-up in the next few days, and then intermittently (e.g., weekly).

Once the customer chooses an option, technicians will fill out the appropriate forms their company requires with customer signatures and sign-off. Technicians will also handle payment options at this time and discuss financing or installment processes and gather information necessary for credit checks.

7. Scheduling Installation

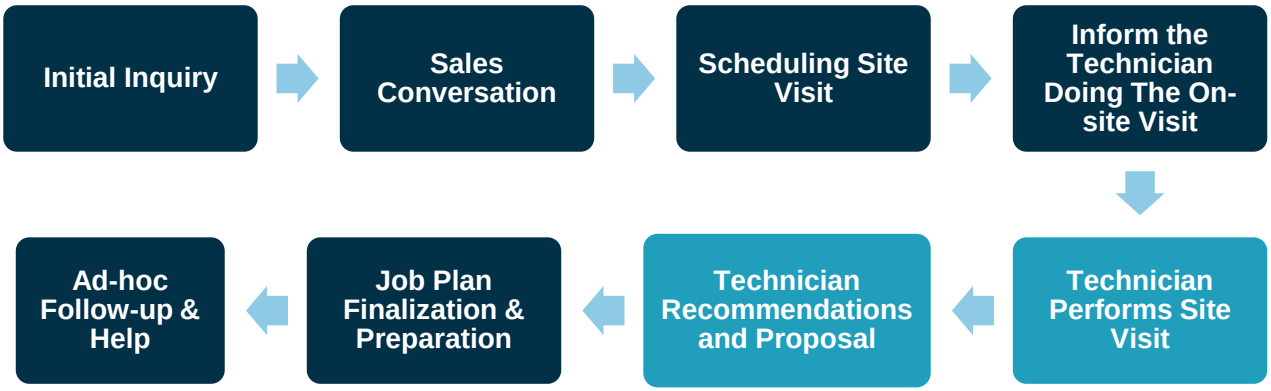
After the customer signs off on the job, the job information is sent back to the company office and the next step is getting the install on the schedule. How the installation appointment is made varies. Some contractors who have access to the company's availability will schedule the installation appointment at the home during the end of the sale. Others have their in-office staff handle scheduling based on the information sent back to the office.

Note: In preparation for installation, contractors will also acquire the necessary equipment for the job. The process of how contractors actually acquire the equipment was not explored in this research. However, some contractors spoke of relationships with manufacturer sales reps, distributors, and/or wholesalers; further research may uncover the in-depth process of how and at what point manufacture reps/distributors/wholesalers become an active part of the process.

SALES & DESIGN ROLE VARIATION: IN-OFFICE

A couple of salespeople played a different role in the sales process whereby they handled incoming sales calls but then coordinated the sizing and design visit with a separate design technician. These salespeople were in-office team members (e.g., administrative support managers or operation managers) who focused strictly on ensuring they collect the right amount of information in the first phone-call before the first site visit, playing a supporting "behind the scenes" role to the design technicians to ensure they have everything they need to secure the sale and then proceed with installation. This type of scenario occurred in larger HVAC companies where the phone-based sales team was separate to the design team.

Figure 5: Slight role variation for in-office sales team (n=2)



Initial Inquiry:

Same as the standard approach. Customers research HVAC companies and reach out via phone or website forms.

Sales Conversation:

In this step, the in-office salesperson is responsible for fielding incoming customer calls and answering website requests. They are also responsible for having the first conversation with the potential customer. The initial conversation varies in length, but is typically brief (e.g., couple of minutes). However, some sales calls may take longer if the customers are more engaged or have many questions about the available options. Sales and administration team members work to acquire basic information about the customer's wants and needs; they want enough information to adequately inform the technician who will be conducting the home visit.

Scheduling Site Visit:

The initial sales conversation is typically concluded with an appointment being scheduled for an on-site inspection. The in-office salesperson assesses the schedule, assigns a technician, and updates the schedule. Notes taken during this call will be saved on file for the technician.

"I always ask, "How big is your home? How long have you lived in your home? Did you just buy your home? Do you have heating bills? Is this new? Are we replacing something? What have you got? When was the last time it was serviced? I set up a time to have one of our technicians come out, which is one of the contractors, come out and actually look at the system, see what they have, actually see the home, talk with them." – Sales & Design, WA

Inform The Contractor Doing the On-site Visit:

Before the on-site appointment, the in-office salesperson will gather the information they have learned and brief the technician doing the on-site visitation. This may mean having a conversation in-person or updating the job notes in the company computer software. From this point, they delegate the rest of the process to the sales technician who will go to the house, conduct a needs assessment, an operational assessment, and create a proposal.

"I have to prepare my installer to know what he's going to look for. I mean, I even look up the address, I look on Google Maps, I want to see. I want to see what the house looks like. Is there junk all over the yard?" – Sales & Design, WA

Job Plan Finalization and Preparation:

At this point in the process, the on-site contractor has either already closed the sale or pitched the recommendations and is awaiting the final "go-ahead" from the customer. The technician sends the job information back to the office (e.g., home installation prep form), where the in-office sales team handles the administrative tasks which may include, but are not limited to:

- Finalize installation date with appropriate parties (if not done by on-site salesperson)
- Hire subcontractors (if needed)
- Make a cut sheet/drawing of the installation (e.g., breaker sizes, breaker types, technical specifications)
- Source necessary equipment
- Contact customer for payment/financing/credit checks

"Whether they complete the work order or accept the work order and then hit complete on their section, it sends everything back to me. And that provides me with their measurements and drawings, anything that is code related or county related because each county and city has different regulations for installations. So all that information comes back to me on what is called a home installation prep form. And then I take all that information from that paperwork. And I create a cut sheet drawing of what the installation will basically look like on this form." – Sales & Design, OR

Ad-hoc Follow-up and Support:

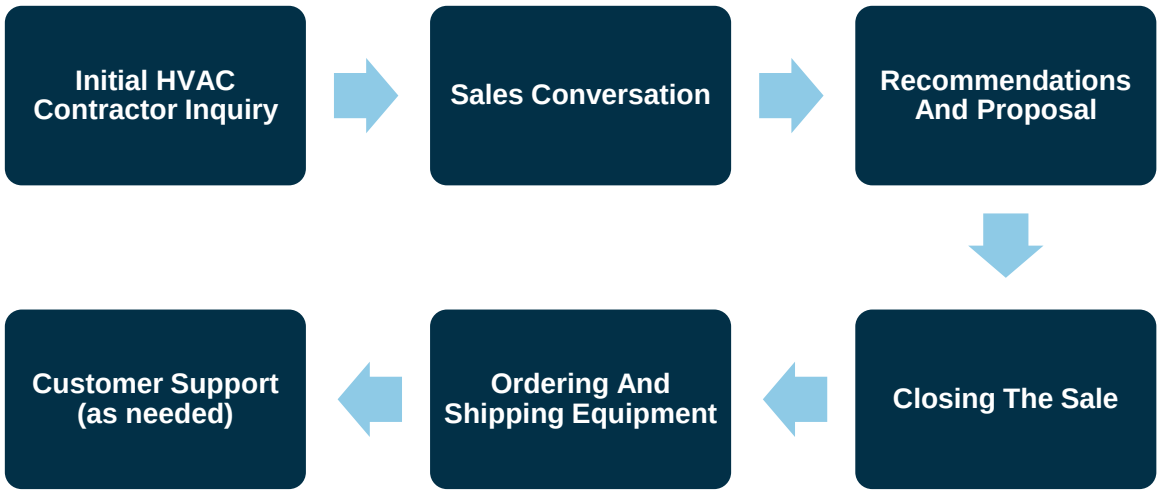
Once the job is set-up, the in-office salesperson stays on standby during the installation. They are involved, as needed, for any additional help with logistical or administrative tasks associated with the job. For example:

- Additional equipment
- Subcontractor coordination
- Permit acquisition
- Payment collection
- Customer service issues
- Warranty registration

"My role really is just being a source at the office. If they need additional parts, we run them out there, helping them collect payment, getting them the correct permits. So, they have permitting on the site. That is my responsibility. And then the technicians, they go and our install crew, they do everything, wrap it up, and then I register all of their warranties for their parts and equipment." – Sales & Design, OR

SALES & DESIGN ROLE VARIATION: INSIDE SALES or SALES REP APPROACH

Figure 6: Slight role variation for inside salespeople or sales reps, which involves less steps in the process as they sell directly to contractors (n=3)



In this research, three salespeople provided an alternative perspective to the usual business-to-consumer sales process. These three respondents considered themselves "inside sales" or "inside sales engineers" by title, and explained they work as "sales reps" for the manufacturers: one salesperson repped a small selection of brands and two repped predominantly one brand (i.e., Lennox, Samsung).

These salespeople considered themselves the "middleman," with their main customer being the contractors as opposed to the homeowners. While they had some residential experience, the majority of their time was spent with larger commercial projects, like townhomes or apartment buildings. In general, these salespeople do not interface with the end-user (homeowner), making the overall sales process more direct, with less decision making and influencing factors than sales and design technicians who work for HVAC companies.

In this sales process, contractors typically know what they want when making an inquiry, and sales are more cost driven. Contractors buy the equipment from these salespeople and then mark it up for their sale to the homeowner. These salespeople are primarily commission-based employees.

Note: This research did not explore in-depth the process of how and when this type of inside salesperson was involved in the overall sales process. Additional research may be needed to investigate the context around this.

> *"We more prepare the contractor we sell the equipment to, so we're buy resell. We represent the manufacturer. We work with the engineers to get it spec'd, and then we sell to a contractor who actually has the team to do the installation." – Sales & Design, OR*

"The homeowner oftentimes doesn't even know we're involved. We're basically like a middleman for it. But contractors are working all these jobs and they're dealing with all these different pieces of equipment. And so, they don't really have time to maintain relationships with manufacturers and know the ins and outs of the product. All they know is, "Hey, I need a variable-speed heat pump, quote it for me." – Sales & Design, ID

Initial HVAC Contractor Inquiry

The sales and design process begins with the initial customer inquiry, which in this case is the contractor reaching out to the sales rep/distributor via phone or email. The contractor represents a residential project.

"'Hey, I need a ductless split system with three heads because I'm working with three different sections of house, and I need a 16 SEER.' And so, then we'll go in and select the product and give them options. Typically, I'll do a standard efficiency unit and maybe a high efficiency unit and put together a quote and we'll send it out to them and then hopefully they get the sale, and they'll call back via email or phone call." – Sales & Design, OR

"I currently am titled as an inside sales engineer, but that's many hats. I work with a mixture of contractors. I work with residential commercial and strictly commercial and some heavy industrial customers. And my responsibility is to generate proposals and provide, I guess, project management, and install assistance to customers that purchase our products that we represent. I'll do troubleshooting over the telephone, or I will do configuration like engineering for a customer putting a unit in a house. We'll help them select the right equipment for what they need, and then we'll help them do the startup and also assist in installation."– Sales & Design, OR

Sales Conversation

The sales conversation occurs once the sales representative connects with the contractor. The manufacturer rep seeks to understand what the contractor is looking for. In these cases, the sales conversation is typically straightforward because contractors typically already know what they want. Contractors have already cased and sized the residential project. They ask the manufacturer rep for specific types of equipment and are primarily interested in availability and price. Sales reps will explain the options available based on the requested specifications and align with what is of utmost interest to the contractor.

Recommendations and Proposal

Once the contractor and sales rep are aligned on what is needed, the sales rep provides a quote for the equipment. The proposal may be put together using the likes of an online selection tool.

The tool asks for a variety of specifications (e.g., BTUs, efficacy rating, etc.) and, based on the features wanted, the software will price the system. Occasionally, the rep may try to upsell the contractor by offering value-added upgrades; however, they suggested this was more likely for large, multi-unit, commercial projects where they had more sales influence.

Closing the Sale

The contractor will accept or reject the bid based on the quote. If accepted by the contractor, the manufacturer rep will create submittals, which are a set of documents that state what is being sold, ordered, and what will be shipped to the contractor.

> *"[The choice] tends to be the contractors' deal. They're the ones looking at the space. All I can see is a box and they say, "Hey, heat and cool this." And so on. I come up with the best option to heat and cool. And if they say, "Hey, get a gas furnace for this drawing." Then that's what I'll do." – Sales & Design, ID*

Ordering and Shipping the Equipment

Once approved by the contractor, they salesperson releases a P.O. and send the contractor the equipment.

Ad-hoc Customer Support

Manufacturer reps have limited involvement after the ordering and shipping of equipment as they do not make money beyond the point of sale. However, reps want to offer support for the products they sell so they make themselves available to answer contractor questions, help troubleshoot issues, or be onsite for the commissioning (if a large project). Sales reps may also coordinate factory technician assistance, as needed for their customers.

> *"Our goal is to not spend time as service contractors, but our goal is also to support the products that we represent. And so, if necessary, we will be on top of a roof at 5:00 PM commissioning a system to make sure it works." – Sales & Design, OR*

Overall Conclusion: Sales and design technicians are key influencers in purchase behaviors

As the first point of contact for customers during the phone inquiry and subsequent home visit, the information that sales and design technicians share with customers (in addition to the critical inroads they forge to gain customer trust) can greatly impact on customers' evaluations, comparisons, and how they think about the different heating solutions available.

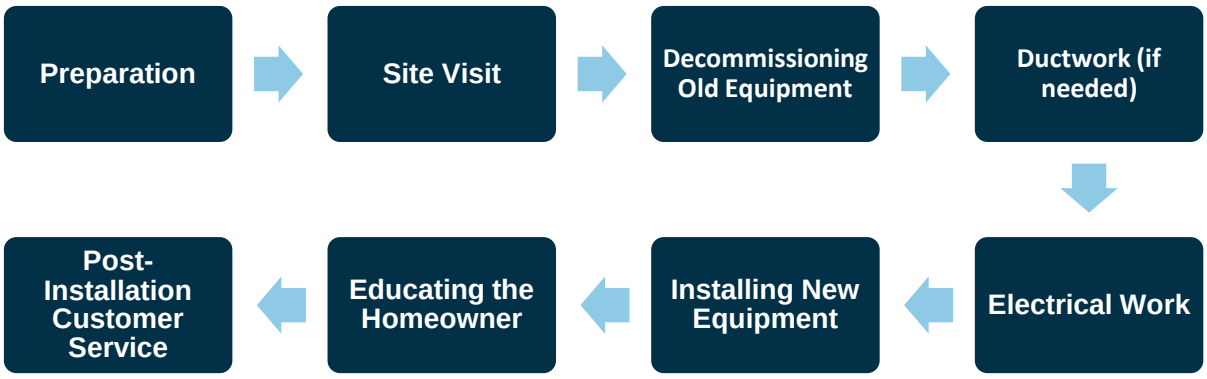
Sales and design technicians also have selection power when they curate a short-listed menu of "good, better, best" options. If the contractor is including a VSHP on the short-list, it is typically positioned as a standalone "best" option. Importantly, sales and design technicians

intentionally use soft-sell tactics to earn and maintain customer trust, and are generally "system-agnostic," meaning they are not loyal to one specific heating solution over another, as long as the heating system they recommend is appropriate based on the house and customer's wishes.

The Installation Process

Once the bid is accepted and installation is scheduled, the installation process begins. The installation process is a lot more straightforward and does not include multiple pathways compared to the sales and design process. This is because, regardless of how the equipment is sold or obtained, they are all installed in a similar manner. In fact, contractors agree there are not many differences in installing a heat pump and air handler or A/C and furnace. There are steps that every installer must follow to ensure the equipment is installed properly with minimal issues. This section explains the installation process in-depth.

Figure 7: Typical step-by-step sales installation process



1. Preparation

Preparation includes any post-sale pre-work that goes into an installation. This most often includes ordering equipment and parts needed for an installation, ensuring all the proper work permits are obtained, and briefing the installation team if it is not the same team that sold the job. At this time, if any subcontractors are needed for the job (e.g., Electrician), they are contacted to align schedules. Some contractors initiate ductwork fabrication at this stage as well. The job is reviewed before the installers arrive at the home. This is an important step as it gives contractors reassurance that the job was sized correctly and to identify any mistakes that can make an installation more difficult. In most cases, the homeowner is given a call the day before the installation to ensure they are still available. This step ends with the equipment being loaded onto a van and the installers driving to the customer's home.

When an installer becomes aware of an installation can vary from contractor to contractor. At smaller shops, the installer may have a hand in the design or verifying the correct equipment is being installed. In other shops, they may see an installation scheduled a week later. In some cases, they find out the morning of the installation via a job packet that was created by a manager or supervisor. In most cases, the installers involvement at the beginning of a job is simply learning about the job before going to the home.

> *"Typically, after the job is sold, the sales guy will order parts and equipment, and then typically put it on the schedule. That's the first time the installers will see it. When it's really hot, and we're really busy, it might be a month and a half out." – Installation, WA*

2. Site Visit

When contractors arrive at the home, they introduce themselves to the homeowner. In some cases, the salesperson is on site to introduce the installation team. The team size can vary depending on the size of the job but is typically between 1-3 people. During this stage, the installers review the job with the homeowner to make sure they are aware of all the work being done that day and to give an approximate timeline of when the job will be finished. Most jobs typically take 1 to 2 days. The importance of aligning is to make sure the homeowner approves of the installation to avoid any issues. For example, it can be costly if the homeowner decides to alter the equipment placement. At this time, contractors will also ask the homeowners to make sure workspaces and driveways are clear for easy installation. At this point, contractors will also prepare for installation with tape and drop cloths in work areas to help with clean up later.

> *"Well, we've got what we call SOPs, or standard operating procedures. So, the first step would be for the guy to show up and again, introduce himself and review the job one more time, just to make sure that, "Okay. We sold it this way. We 'fab-ed' it this way, I'm going to install it this way. Is that your understanding of what you want?" Again, looking to eliminate issues that we don't want them to come up after we've installed it." – Installation, WA*

3. Decommissioning Old Equipment

Once the installers have briefed the homeowner and spaces are cleared, they begin the installation by decommissioning the old equipment. They start by making sure the equipment can be safely removed by disconnecting the electricity and gas. They then begin to remove the old equipment they will be replacing. Sometimes what is removed can vary depending on if it is a like for like replacement. Typically, if they are replacing a ducted system with another ducted system, they will remove all the old equipment. However, if they are installing a ductless system, they may leave the old equipment in place. Electric baseboard heaters are typically only removed at the request of the homeowner.

As one member of the team is removing old equipment, the other member will begin recovering the old refrigerant from the line set with a vacuum pump. The refrigerant is pumped into a recovery receptacle to be disposed later. Contractors are aware of EPA regulations on disposing of refrigerants.

After the refrigerant is recovered the old-line sets are pulled out if they are not being reused. Typically, line sets are not reused, especially if they were filled with an older style refrigerant. If the line sets are being re-used, they will be flushed out thoroughly to ensure it is clear of all refrigerants and other contaminants.

The old equipment is typically recycled. Some contractors take apart the equipment themselves, making sure to collect anything that can't be recycled with the components, such as refrigerant and oils. They then scrap the equipment. Some contractors partner with recycling companies that pick up old equipment from the contractor's shop after installation.

> *"So, we have to disconnect power, make sure there's no power so we don't get shocked, disconnect the wires and wire-cap them to make sure, again, we don't get shocked. And then we remove the old refrigerant out of the existing system, recover it into a refrigerant recover cylinder, at which point then we cut the lines, remove the old equipment." – Installation, OR*

There are some situations where the decommission stage does not happen. In these cases, it is because the contractor is adding new equipment to an older system. Five contractors cited situations where they did not remove existing equipment and simply added to it. In one case, the contractor stated they were adding an A/C to an existing furnace for a customer who wanted to add cooling to their existing HVAC system. In the other four scenarios, contractors were adding a ductless unit to a ducted system. In this setup, the central system is still used to heat the home throughout, and indoor units are added in typically one or two rooms that homeowners state are hot or cold spots. In one instance mini-split heads were added to an entire upstairs floor and the ducted system was used to heat the main floor of the home.

4. Ductwork (if needed)

After the old equipment is taken out, any ductwork modifications that are needed are completed at this time. Depending on the size of the team this can happen in conjunction with other steps. While major ductwork modifications are not sought after due to cost, there are some things contractors can do to address any faults in the ductwork. It is important that the ductwork is evaluated beforehand during the sales and design stage. If the installers find that ductwork repairs are needed after they are on-site it can create significant delays. Some examples of duct modifications/repairs:

- Sealing and insulating existing ducts

- Repairing damaged ductwork
- Installing new branches for registers and returns
- Installing bypasses
- Cleaning out ductwork with an Air Snake

Some contractors outsource major ductwork modifications or pass on jobs as it would not be profitable if too many ductwork repairs are needed.

5. Electrical Work

Electrical work is another step that can happen in conjunction with other steps. Electrical work is sometimes completed by a subcontractor. Electrical work is not always needed for installations; however, work may be needed so the electrical panel can accommodate the new equipment. This is always the case when new equipment is a higher amperage than the current wiring can handle.

6. Installing New Equipment

Installing the new equipment can be broken down into six key steps.

Table 3: Installation steps

1	**Putting in new equipment**	New equipment is typically brought into place by at least two contractors. Once new equipment is put into place the ductwork is sealed around it. If the contractor builds sheet metal on-site, at this time the transitions will be made to connect the new system to the ductwork if there is a size difference.
2	**Running new line set**	The line set is typically covered to protect from sun degradation, or it can be set through the crawl space.

3 Evacuating new line set	The time it takes to evacuate the line set depends on how large the system is. The bigger the line set the longer it takes. Typically, the line set is flushed with pressurized nitrogen to test for leaks and contaminants. Some contractors do this nitrogen flush 3 times to ensure the line set is clear. When vacuuming out the nitrogen, the line set is connected to a micron gauge, and the system is evacuated to less than 500 microns. • Contractors engage in a decay test where they isolate the line set from the micron gauge to make sure the microns do not climb too high. They do this multiple times until the gauge levels out and does not climb anymore. • If the micron gauge continues to increase, it means there can be a leak in the line set. • Evacuating the line set before releasing the refrigerant is particularly important. Contaminants in the line set could cause premature compressor failure or holes in the line set or coils.
4 Charging the system with Refrigerant	After the line set is evacuated it can be filled with refrigerant. The amount of refrigerant is dependent on manufacturer specifications. This tends to be a calculation of an amount of refrigerant per foot of line set. The amount of refrigerant can also vary depending on the type of equipment as well. This will be highlighted in the equipment manual. Some equipment comes pre-charged for a certain length of line set, typically 15 feet.
5 Installing the Thermostat	The thermostat and wiring can be installed at any point in the installation; However, it is not programmed until the system is ready to start-up. For VSHPs, it is typically the same brand as the equipment. This is to ensure the thermostat communicates correctly with the equipment. Without the proper thermostat, a VSHP will not operate as intended, Other thermostats used: Nest, Eco-bee, Honeywell
6 Running the new system/ System Set-up	After the system is charged it can be turned on for start-up. The thermostat is programmed during this step. Operation parameters are set, such as airflow and lock-out temperature. Many manufacturers include a start-up commissioning form that contractors can use to ensure no steps are missed and the unit is operating under normal parameters. A typical last step is checking temperatures of the supplies and returns.

7. Educating The Homeowner

After the system is installed and running properly the installers have a conversation with the homeowner where they educate them about their new system. This conversation tends to include maintenance that needs to be done on the system (e.g., changing the filter), and how the new unit is different from the older unit, especially in the case of switching to a heat pump. They are educated on how the new unit will run more often, how it is much quieter, and that the heat that it produces won't be as warm as a furnace. The homeowner is also taught how to use their new thermostat. Many contractors recommend setting the thermostat and leaving it alone so that the system works as it should.

> *"I just tell them if this thing is going to produce heat at lower temperatures for you, it's going to run longer, so it's not going to start up for 25-30 minutes and shut down. This thing is meant to run to meet the load of your home, so you're going to see it moving air constantly versus starting up and shutting down frequently. We tell them that it's going to be quieter, they're not going to notice it running once it hits the target temperature." – Installation, OR*

8. Post-installation Customer Service

Contractors will typically submit paperwork on behalf of the customer for warranties and rebates. If they do not submit this information for them, they will instruct them on how to do so. Some contractors return to the house or give the homeowner a call later to see how the system works for them and if they are having any issues with the equipment.

> *"If the homeowner's there, hopefully, we give them a tutorial roughly on how to use it. Often, I have to run them through setting up the new app, and getting their thermostat hooked up to their Wi-Fi, then they have to set up an account and they have to register it. So then when that's done, I have to go and login everything with the manufacturer through my account with them, to register the unit for warranty. Then I create a warranty certificate." – Installation, OR*

Quality control

Quality control is usually conducted throughout the whole installation process. This includes steps such as making sure the equipment is the correct size and ensuring line set is not leaking and free of contaminants. They must make sure the new equipment was sealed into the ductwork properly. They test parameters such as air flow, temperature rises, voltage, and pressure to ensure the system is operating normally. Some contractors keep track of quality

control issues on Excel sheets, notes, or CRM software. This is so they can keep track of trends and identify products that have issues more often than others.

> *"If I really go fast, I can get everything done in one day. But everything's a two-day process for me because I'm super picky about the refrigerant lines not leaking, so I always leave the gauges on overnight with the nitrogen in the system. Most guys let it sit for a half hour, they don't put as much in there as I do. They let it sit for a half hour, they see no leaks, and they call it good, and then they start." – Installation, OR*

> *"You have to ensure that both the discharge line and the return, refrigerated lines are insulated properly, and that the ends of them are sealed. That's one of the things quality wise I think you have to do. You have to ensure that grounds are grounded properly, electrical things are grounded properly." – Installation, ID*

How is this process any different for VSHP?

The installation of VSHPs is akin to that for other heat pump types. There was broad consensus among contractors that it takes the same amount of time and effort to install a VSHP as other SSHPs or MSHPs, with very minimal (if any) pain-points or complexities. Only a small few claimed it takes longer to install VSHPs (up to 1 to 2 hours longer), and one claimed it takes less time. This variation may be attributed to different work efficiencies between contractors.

The main difference is in the system start-up, which is not as basic as an on-off function. VSHPs require the system to be configured through a computer program, and many VSHPs have a screen that shows the parameters the system is operating at. This can make the set-up easier and faster because the system is communicative and automatically performs the mathematic calculations required; this is what prompted a single contractor to claim installation takes less time for a VSHP. However, a couple of contractors said the start-up takes longer because the unit is modulating, so it takes extra time to test the different stages of the system. Additionally, every time a change is made to operation parameters, the system has to be restarted which takes more time.

Regardless of any varying opinion, the different set-up process for VSHPs does not create any practical, financial, or attitudinal barriers for HVAC contractors.

> *"The installers are required to start and test that system and cycle it minimum of three to four times. So there's, again, 30-40 minutes right there of just cycling that equipment three to four times to make sure it's operating properly. Now, if I have to adjust or readjust the parameter settings, then again, you can see where the time starts to add up." – Sales and Design, MT*

Backup Heat

Contractors are commonly using back-up heat with heat pumps. Contractors say this is because as the temperatures lower, the heat pump has a harder time heating the home. Even in moderate climates contractors opt to put in back-up heat. However, they state that they want to use the backup heat as little as possible. In the case of VSHPs contractors are extremely confident in the temperatures it can operate at, with some saying back-up heat is not required, but some still employ back-up heat in some cases.

The type of back-up heat used depends on the homeowner's equipment. If they are moving towards all electric, the back-up heat will typically be strip heat. Electric strip heat is paired with heat pumps frequently; although newer heat pump technology does not necessarily need it, contractors prefer to install it for emergency use. If they are opting for a hybrid system, then the gas furnace will serve as the back-up heat. In regions where gas is particularly cheap, the hybrid model can be more cost effective as a backup. In places where electricity is inexpensive, running electric strips would not be as costly. Ultimately, what is chosen depends on what contractors believe is best for the homeowner.

Back-up heat, whether gas or electric, is sized using the heating load of the house. The electric strip heat should be able to fulfill the heating load of the house in the event the heat pump locks out. For gas furnaces, this would require getting the correct ton unit for the house. For electric strips, this requires calculating the BTUs of the house and then converting that into KW for heat strips.

The lock-out temperature is important to ensure both the back-up heat does not turn on until it is needed and to make sure the heat pump is not running at inefficient temperatures, especially in the case of single stage heat-pumps. Generally, the lock-out temperature for back-up heat is between 20-35 degrees, but commonly contractors stated they set the lock out at 30 or 35 degrees. While they did not specify why they chose those temperatures, they gave some insight into what goes into their decisions.

One contractor stated different manufacturers have different recommendations on when to employ back-up heating. Most manufacturers stated higher efficiency heat pumps like VSHPs are more efficient at lower temperatures so a lower lock-out temp can be utilized without sacrificing efficiency. When electric strips are used as back-up heat, they generally can be expensive to run for extended periods, so contractors like to avoid them being used, usually

> *"So, we lock auxiliary heat sources at 30 degrees. So, if you're aware of what that means, anything above 30 degrees and above we make the heat pump do all the work. Then, we run the heat pumps down to zero, or five degrees, depending on what utility companies are using, and what programs are available in the form of rebates. Inland Power over here has it set at five degrees. Then still I run it down to zero, or don't give it a cutoff point where the heat pump can't operate. As far as locking out the auxiliary source, we lock those out at 30 degrees up here." – Sales & Design, WA*

having them staged to where they only use 5KW at a time. Gas back-up heat is generally used more liberally due to the price-point of natural gas. Some contractors stated for utility rebates, the utility company has requirements on what the backup heat temperature can be.

Thermostats

The most popular thermostats contractors install are Honeywell, Eco-bee, Nest, and manufacturer thermostats. Those in favor of third-party thermostats say they are user-friendly, easy to use. Some offer the ability to control other systems in your home. Those in favor of manufacturer thermostats state that the manufacturer has built the product, so they know which thermostats work the best. What the homeowner wants is especially important in this process as well. Depending on what features they request, such as programmable, Wi-Fi-enabled, and the ability to control multiple systems, the contractor will choose the thermostat that addresses those needs. Eco-bee and Nest thermostats are the most customer requested third-party thermostats.

When it comes to VSHPS as mentioned before, contractors must install proprietary thermostats from the manufacturer. These heat pumps require a thermostat that can communicate with the system so that it works correctly. However, this has not been cited as a pain point for contractors.

Some issues contractors have reported with thermostats stem mostly from lack of user-friendliness for homeowners. This is especially the case of higher end-models that had a variety of options that people have trouble learning.

> *"So, the variable speed heat pumps really need to perform at their peak. They need communicating thermostats, which are only available right now through the respective manufacturers and that's the one that we use. But basically, every other manufacturer I've seen requires their own communicating thermostat to make that variable speed heat pump sing." – Sales & Design, OR*

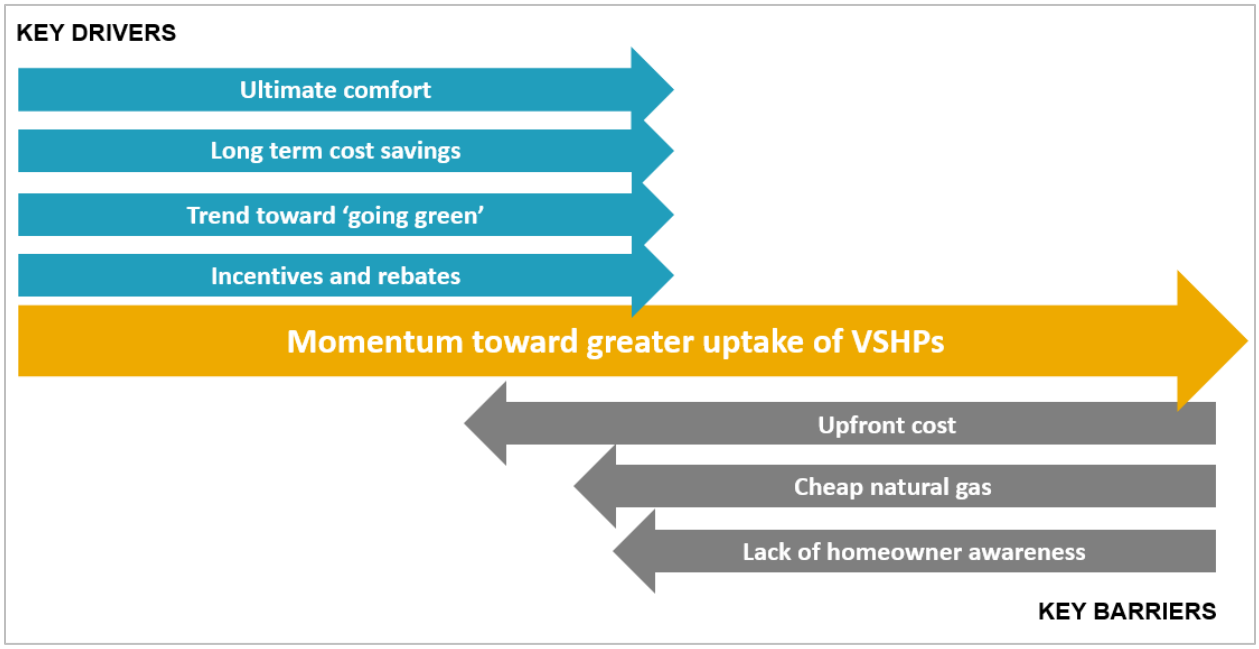
RO2: Barriers or drivers for VSHP adoption

By and large, contractors believe VSHPs offer more benefits than drawbacks. The technology is considered best in class and a top-tier option, with the systems being worth the higher price-tag, if within the customer budget. The single greatest barrier to adoption cited was the upfront cost of the equipment. Aside from cost, barriers were mostly minor but still noteworthy.

Key Drivers of VSHP uptake

VSHP uptake is driven by the product's various advantages but curtailed by market pressures.

Figure 8: Key drivers and barriers of VSHP uptake



The key drivers and barriers for VSHP adoption are explained in more detail below.

KEY DRIVER: Provides ultimate comfort and luxuries in the home

Contractors sell VSHPs with comfort as the leading driver. Ultimately, they want to make the customer comfortable, and the majority agree that VSHPs are the premium comfort product for a multitude of reasons. They provide heating and cooling that is dispersed throughout the home equally creating an even temperature distribution and balance. They can also handle a wide range of house layouts and sizes; this minimizes the occurrence of hot or cold spots in the home. VSHPS are also very quiet with low sound density ("difference between a bus and a bicycle"). This makes them less disruptive to everyday living. VSHPs are a comprehensive approach to comfort, whereas a mini-split would require you to choose heating zones. Unlike mini-splits, they are also discrete in the home, avoiding any aesthetic concern with wall mounted units.

KEY DRIVER: Long-term savings/return on investment is appealing

When accurately understood by the customer, long-term cost savings on energy bills is one of the most influential factors to sell and install a variable speed heat pump. Contractors want customers to focus on the energy savings of the product rather than focusing on its upfront cost. Emphasizing this is often the onus of the contractor, however, since customers are less aware/knowledgeable.

Contractors said that if you combine the low month-to-month cost to run the equipment and the low cost of maintenance due to its reliability, ideally the VSHP will pay for itself over time. VSHPs run on less energy because of the variable speed inverters that do not run at full-speed unless needed. As one contractor explains to customers, "no one turns on every light in their house," so there is an understanding that there is no need to have the heat pump working at full capacity all the time. VSHPs can put out more heat at lower temperatures as well, minimizing the use of back-up heat and saving additional electrical costs.

For homeowners who don't plan to live in the home for longer than five years, long-term savings is less of a driver.

KEY DRIVER: Nationwide trend/push "go green"

HVAC contractors perceived VSHPs as being environmentally friendly matches to the current state of market trends. With a high efficiency rating and relying on electricity as opposed to natural gas, the VSHP is a prime product for those who prioritize having a "green" home. Even for homeowners who do not necessarily prioritize the environment, the fact that VSHPs are environmentally friendly is considered an "added bonus."

> *"The other ones are folks who started with gas, but are really, really environmentally focused and would prefer not to burn fossil fuels. And so, you have people who feel so strongly about that, that they're willing to spend 2, 3, 4, $5,000 more." – Sales & Design, OR*

KEY DRIVER: Incentives in some areas offset upfront costs

Some contractors, especially those in OR and WA, mentioned the availability of incentives to offset the cost of more energy efficient products, like VSHPs. Oftentimes, contractors will raise the subject of incentives since customers lack the knowledge and know-how. Other times, the appeal of saving money catches the attention of customers, and they initiate questions about their candidacy. Regardless, when assistance programs are discussed, the sales conversation predominantly skews towards VSHPs as the incentives are for the most expensive, energy efficient equipment.

Four types of incentives were mentioned by contractors:

1. **Rebates from utility companies and NGOs:** Electric utility companies and NGOs offer rebates to residential homeowners that offset the cost of VSHPs.
2. **Federal tax credits:** The Federal Government offers tax credits to residential homeowners to encourage greater uptake of energy efficient HVAC systems, e.g., VSHPs.
3. **Incentives from manufacturers:** Certain manufacturers may also offer incentives. For example, Carrier offers a program called Cool Cash, which is rebate money given when purchasing a VSHP, specifically.
4. **Payment assistance programs from HVAC suppliers:** Some contractors may offer financial assistance programs to help customers afford higher-end products.

However, despite all the assistance, some contractors wish for improved programs and increased customer awareness efforts. Contractors would like programs that make a greater difference on the bottom line for the homeowner since VSHPs are still costly. Customers are often confused about how rebates work or whether they qualify given their situation. More generous programs and greater customer awareness may lead to greater adoption of VSHPs.

> *"So, our local utility district, they offer rebates for heat pumps. When you switch from an electric furnace to a heat pump specifically, there's a rebate for that, only for that conversion. And then they offer a higher rebate for the variable speed heat pumps. So that's an incentive for folks to go ahead and go up to that variable speed heat pump. So that's probably a big driver of that. It ends up closer to the same price as just the single-stage heat pump." – Sales & Design, WA*

KEY DRIVER: More affordable price points and more options in the product line make VSHPs more attainable for a larger consumer base

Contractors reported that VSHPs are a relatively new technology available within the last decade. As such, the first VSHPs that came to market were premium products. The price was a significant hurdle, and the systems could only serve an elite group. However, today, thanks to advancing technology, manufacturers are now starting to make more lower level and competitively priced models available in their product line.

The wider range of energy-efficient heat pumps creates more flexibility in choice. The new technology has meant there is a wider variety of options available at varying price points, making VSHPs somewhat more attainable for some homeowners than in the past. Although, overall, the cost of these energy-efficient systems has not reduced substantially, relative to the rate at which the range and variety has expanded. For contractors, there is more flexibility in terms of the brands and models HVAC contractors can carry and recommend to their customers. If cost competitive pricing continues, the sampled HVAC contractors anticipate

VSHPs will expand their consumer base, and as price point becomes less of an obstacle, VSHPs can be recommended for many more customers.

> *"Over the last 3 years they started releasing more competitively priced heat pumps that can work in a client's limited ductwork." – Sales & Design, WA*

> *"10 years ago, these didn't exist. The first VS came out 6-7 years ago. Less than 5% early on. The 20% you see new is an upward momentum. I expect it to be 50% or more in the next 5 years. Part of it is, the VSHP was the cream of the crop, and people would tell themselves they aren't the type to buy high end, so that was a big hurdle, but now more companies offer lower level VSHP." – Sales & Design, OR*

DRIVER: Contractors' push can be driven by commission and/or company profit

Though not a major driver, contractors do have the power to lead a customer towards a choice. If a VSHP aligns with what the contractor truly believes is best for the customer and the home, they may delicately sway homeowners toward it. However, the push can sometimes be driven by the benefits of the system, as opposed to overselling. In this case, the additional commission and company profit is a bonus when the system that best matches the needs of the home is a premium product like the VSHP.

> *"We push for the VSHP; they are just so much more efficient." – Installation, MT*

> *"They are talking about going all electric and lowering carbon footprint. The educated owner is open to this system. It's also us because we [are the ones who] introduce the product." – Sales & Design, OR*

Key Barriers to VSHP uptake

The single greatest barrier to adoption is the upfront cost of the equipment. Aside from cost, contractors generally see limited barriers to selling VSHPs. Contractors believe many objections can be overturned though education provided by the sales and design technician. They do not perceive VSHPs as complex to install, and the process has no significant differences between VSHPs and other HPs.

Growth is hindered by a few varying factors. The upfront cost of energy efficient systems is a primary and easily discernable barrier for residential customers, even despite incentives, rebates, and financial assistance programs available. However, a deeper exploration also reveals complexities and hurdles in obtaining financial support, continued knowledge gaps and misinformation and HVAC contractor training gaps. Additionally, gas affordability in many parts

of the Northwest, skilled labor shortages and, most recently, supply chain issues, are also variables working against the momentum to greater uptake of energy efficient heating systems.

Long-term savings often overshadowed by the upfront cost

The single greatest barrier to VSHP uptake is the price point. Contractors highlighted that customers hesitate since the product is at the highest end of the cost spectrum; homeowners question if they need the most expensive unit and what value they will see compared to other, more cost-effective, options. For some, the upfront cost is simply out of the budget and not an option. Other customers, who have the budget for a VSHP, often have trouble justifying the equipment cost. Customers don't tend to think long-term and there are many homeowners who lack the understanding or do not perform a calculation to see the longer-term value. So, it is often up to the contractor to justify the cost of the equipment by emphasizing the long-term savings.

Likewise, despite increasingly more homeowners who desire to "go green" and place significant value on an energy-efficient lifestyle, many still steer away from the most energy efficient solutions on the market due to the upfront cost of the most energy efficient heating systems. While homeowners may tell contractors they are seeking a quality heating system that is energy efficient, many change their mind during the pricing conversation as they struggle to justify the high upfront cost; this further proves an information gap for homeowners, as many don't realize the cost-saving potential over the long-term.

> *"There are a lot of people who like the higher efficiency, but they don't like the price tag. People tend to slide down to the lower priced items." – Sales & Design, WA*

Natural gas prices (in some areas) outcompete electric

For areas that have easy access to inexpensive natural gas, a high number of homes have existing gas systems or opt for gas furnace installs. Gas furnaces in these areas are objectively an affordable and effective way to heat a home. Variable speed heat pumps are still considered a viable option, yet, since many customers already have a gas furnace in place, continued use is often the path of least resistance. The sale, design, and customer decision associated with a switch would be more intricate and time-consuming than a like-for-like replacement.

Additionally, homeowners may also prefer the heating quality of gas heat, especially if they have used gas heat for many years and have become accustomed to the warmer heat emitted from gas systems. When considering their options for a replacement system, contractors often have to educate homeowners on the differences between the heat quality and explain that

> *"In WA, the cities in the 'corridor', there is a lot of natural gas. In my area there is no gas." – Sales & Design, WA*

heat pump heat tends to be lower temperatures than gas heat. If a homeowner likes the hot gas heat they've grown used to, there are high chances they will prefer to stick with what they know.

> *"The state is pushing for more electric now, but gas is king here. I think with the new building codes we will see more HPs." – Sales & Design, WA*

> *"It's because of the cost, and because the energy here is cheap, the savings are not that great. The savings in this market here is less vs other markets." – Sales & Design, OR*

Lack of homeowners' education and awareness about the option of VSHPs

Despite growing awareness, there is still a general lack of homeowner knowledge about VSHPs that prevent sales. Most contractors said that the majority of customers do not know much about HVAC systems, and in particular, VSHPs. In fact, some homeowners are not even aware of what a HP is. Therefore, a majority of the education is coming from the sales and design technician (e.g., "80 - 85% of the education comes from us") during the on-site visit.

Sales and design technicians try to educate the homeowner so they can understand the benefits. However, when dealing with customers who know nothing about the technology, there is some skepticism. People may be hesitant to switch to a VSHP when they don't truly understand why it is more efficient than their current system or heat. Those who opt for VSHPs tend to be of higher incomes and younger age. Like single and multi-stage heat pumps, those who do not prioritize energy efficiency will most likely not opt for a VSHP if their current system keeps them comfortable.

Some bad experiences with first generation VSHPs spread bad reputation

Less frequently, negative experiences with VSHPs in the past have resulted in a current bias against them. When VSHPs first came to market, the systems were not as refined and contractors were less familiar, which created an opportunity for user error and system-related issues. From that time, both contractors and customers experienced frustrations. Those negative experiences led to the spread of misinformation and a negative reputation of VSHPs being unreliable. Some contractors may speak poorly or incorrectly about VSHPs, and some customers may have heard bad reviews. One sales technician in Washington noted that heat pumps have had a bad reputation among some homeowners, due to breakages and system failures with older models.

Therefore, in some cases, technicians must re-educate and reassure homeowners on the advantages of the newer models. However, overall, contractors have since gained more experience, VSHP technology has advanced, and much of this bias is a nonissue. Still, for a minority, harbored animosity may remain among customers and prove to be a hurdle for a sales and design technician making a VSHP sale.

> *"We get more business because no one has ever offered the higher end things. Some contractors tell people HP are not great, and then we go in and tell them they are." – Sales & Design, WA*

VSHPs require specialized training

While most do not consider the installation of VSHPs outside their realm of expertise or different from other types of heat pumps, some contractors insinuated that the complexity of VSHPs requires a more specialized skillset for accurate design and installation. VSHPs may require a few extra steps in the design, set-up, and testing of the system. Proper training and experience (which most contractors reported having) is required so the system won't be sized incorrectly by sales and design technicians or installed improperly by installing technicians.

Compared to other systems, installing VSHPs may require an additional hour or so because of the initialization of the system. This can include bringing it online, connecting to Wi-Fi and Bluetooth. It also takes longer to set up the new system as it takes an extended time to start up; as adjustments are needed, the system needs to be restarted multiple times (e.g., "cycling through the various load a required 3-4 times and making adjustments as needed). These extra steps are not considered a hindrance to the sales of VSHPs, yet the slight differences are a matter accounted for by the company in terms of labor cost/time.

> *"So, trying to run it at 50% load, trying to run it at 10% load. I'd imagine each manufacturer has a set way that they want it done, but you'd essentially have a few extra steps to make sure that the system is variable speed as sold rather than just on/off single speed."– Installation Sales & Design, OR*

> *"Single-speed is easiest one to fire off, multi-speed would be a little bit more difficult, but not that much more difficult, and of course, the variable full can be really tough, because you have to figure out how to lock it in on high speed."– Installation, WA*

> *"Oh, gosh. Well, you install the product in very much the same way you do with a normal heat pump, until it comes to turning it on, until it comes to bringing it online. When you bring it online, you have to go into an application on a cellphone or on a laptop, or on a tablet of some kind, and initialize the process of operation with it."– Sales & Design, ID*

Consumer demographics may play a role

As mentioned earlier, contractors noted that drivers and barriers to VSHP uptake can be influenced by a variety of consumer demographics.

- **Income** is one of the most important consumer demographic factors to influence VSHP uptake. Consumers may be completely knowledgeable of the benefits of a heat pump, care deeply about their carbon footprint, and want the energy savings a VSHP can provide. However, not everyone can afford to install one; money is a limiting factor that disproportionately affects those of lower income.
- **Age** is another important factor. Age relates to a few things, including education around newer technologies and willingness to learn. Despite contractors confirming that VSHP sales vary "across the board," including a variety of demographics like age, several suggested that the older population (e.g., aged 50+) may be more hesitant to upgrade than the younger population. Their perceptions include:
    - Older homeowners may be less likely to have done their own research, so their baseline knowledge about VSHPs is often minimal. Since their knowledge is minimal, their motivation to change or advance their current system is low. Out of comfort, they may want to replace what they currently have in their home with the same product because they know it works, and they know how to use it. VSHPs offer the most advanced technology and while the comfort appeals to the older generation, the technology factor connotes complexity in terms of day-to-day operation and potentially expensive repair costs.
    - Younger homeowners are accustomed to rapidly changing technology and are both more open to and know how to learn about new technologies.

> *"The older the individual, the more likely they are to say, 'Hey, look, I know nothing about this,' The single-speed and multistage are existing and they had that, and they just went back to it. [We] want it to be as basic as possible for the older generation." – Sales & Design, WA*

> *"The younger people that I'm selling to it's not as much of the problem. They're used to seeing technology change, they're used to seeing it change fast. Older groups are, the last fridge lasted, whatever, 50 years, 40 years. It lasted this long, things don't last today. You get that going on." – Sales & Design, WA*

- **Job and home stability** affects VSHP uptake as well. Some populations are extremely transient. For these people, they do not plan or foresee them staying in the same home for a long enough time to invest in a VSHP. They may not receive substantial savings

before they move out of the home as the savings accrue over time. On the other hand, those who see themselves in their home for an extended time (e.g., more than 20 years) will be likely to see a return on investment, and as such, will be more inclined to install a VSHP.

- **Life-stage** is another factor to consider. Depending on what stage someone is in may influence if they want to invest in a VSHP. For example, if someone is near end-of-life, they will not install a piece of equipment that will last longer than their lifespan; they won't see any return on investment. If a homeowner is young or about to start a family, he or she may want something that will not only last long, but also keep them and their future family comfortable throughout the equipment's lifespan.

Note: As we spoke only to contractors, further research is needed to better understand how demographics factor into consumer purchasing trends.

RO3: HVAC contractors who are, or are likely to be, early adopters of VSHPs, and their attributes

The research revealed that there is widespread adoption of VSHPs among HVAC contractors across the Northwest. The below charts represent data pulled from contractor's pre-interview questionnaires. They exhibit the estimated heat pump sales and installation currently, in five years, and by state.

Chart 1: Estimated heat pump sales and installations: Current (2021), n=30 (*Q: Please estimate the approximate proportion of sales and/or installations for each of the following types of heat pumps, in your business currently?)*

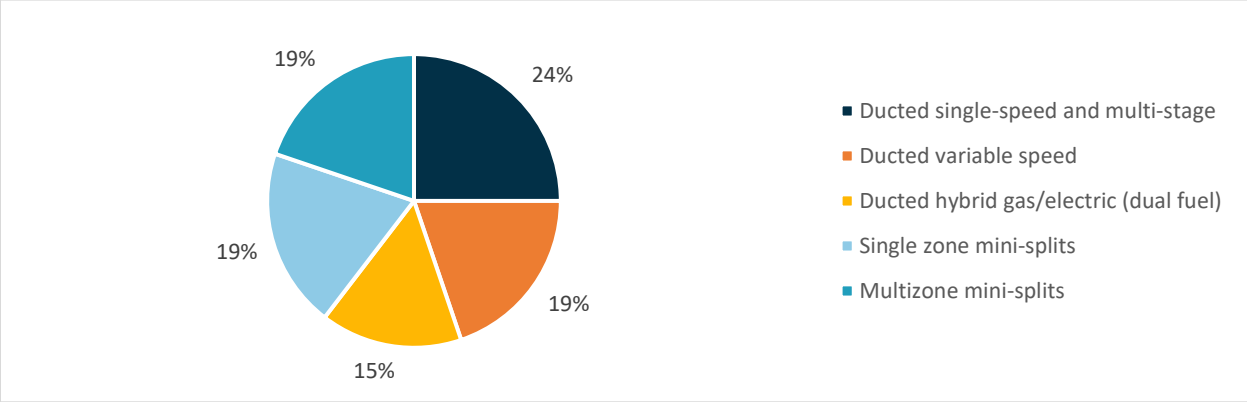


Chart 2: Estimated heat pump sales and installations: Current (2021) and Future (2026) – ALL SEGMENTS, n=30 (*Q: Thinking ahead to 5 years from now, how much do you expect the proportion of sales and/or installations for each of the following types of heat pumps in your business to be?)*

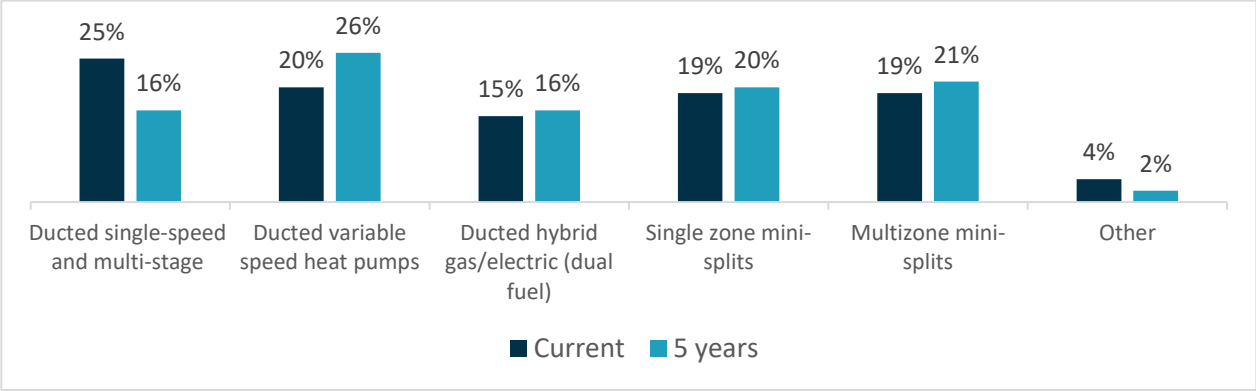
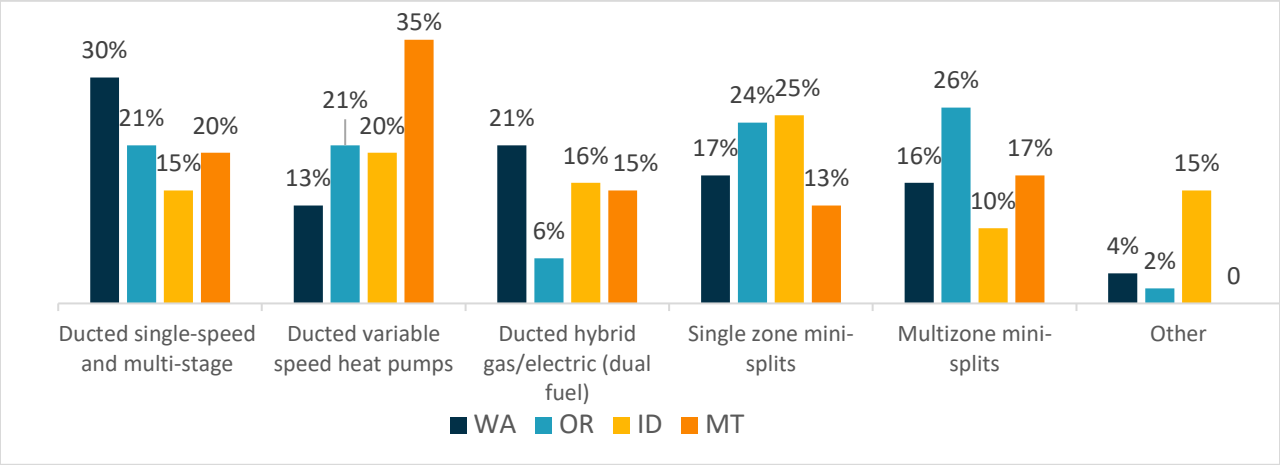


Chart 3: Current estimated heat pump sales and installations by state. Sample numbers per state are as follows: WA n=12, OR n=12, ID n=2, MT n=3 (*Q: Please estimate the approximate proportion of sales and/or installations for each of the following types of heat pumps, in your business currently?)*



Note: Additional information about the current and anticipated heat pump landscape can be found in Appendix A.

VSHP adoption already is widespread among HVAC contractors

Among the sample of contractors who were interviewed, who stemmed from a variety of business sizes (small, medium, and large) and from more than 20 urban and rural counties in all four states, all were adopters and supporters of VSHPs. The HVAC industry is by now well past the point of early adoption, if not late adoption, as all HVAC contractors are 'sold' on VSHPs and their advantages and are more frequently recommending VSHPs to their customers when the circumstances are right. However, contractor adoption rates may not equate to VSHP sale figures since customers do not purchase VSHPs at the same rate that contractors are recommending them.

Indeed, it is still important for the circumstances to be right for VSHPs to be granted a position in a contractors' proposal. Not all homeowners can have or want to have a ducted system. But in situations where a ducted system is the goal, VSHPs are typically classified as a 'best' option in a 'good, better, best' offering, indicating they are still perceived as a top-of-the-line, premium choice. Hence, while VSHPs are now a solid player in the market, and they now come at varying price points, they are not yet the standard go-to for homeowners (although they are projected to be in a few years from now).

Given how far ahead the market is with VSHP adoption, NEEA's focus could be on identifying contractor attributes that may lead to more frequent recommendations and sales of VSHPs, versus adoption of VSHPs. However, based on the interviews with contractors, there were very few factors that signaled a greater or lower propensity to sell VSHPs. One potential factor was

location-based, specifically, HVAC businesses in more affluent areas, with a surrounding customer base comprising young families looking to invest in their homes for the longer-term. However, even then, contractors emphasized that customers' final choices can be unpredictable, and it is unwise to judge a book by its cover. For example, contractors noted they have sold expensive equipment to residents of manufactured homes, and some of the cheapest heating systems to residents of mansions.

Another potential attribute was HVAC businesses who sell more ductless heating systems than ducted. At least two contractors interviewed indicated that they prefer ductless systems and wish to sell more ductless systems to their customers because they consider them to be "the future" of heating, even despite the benefits they see in VSHPs. However, these businesses still sell VSHPs under the right customer circumstances and avoiding engagement efforts with these businesses would be unwise given the need to ensure they, too, continue offering energy-efficient ducted options to customers.

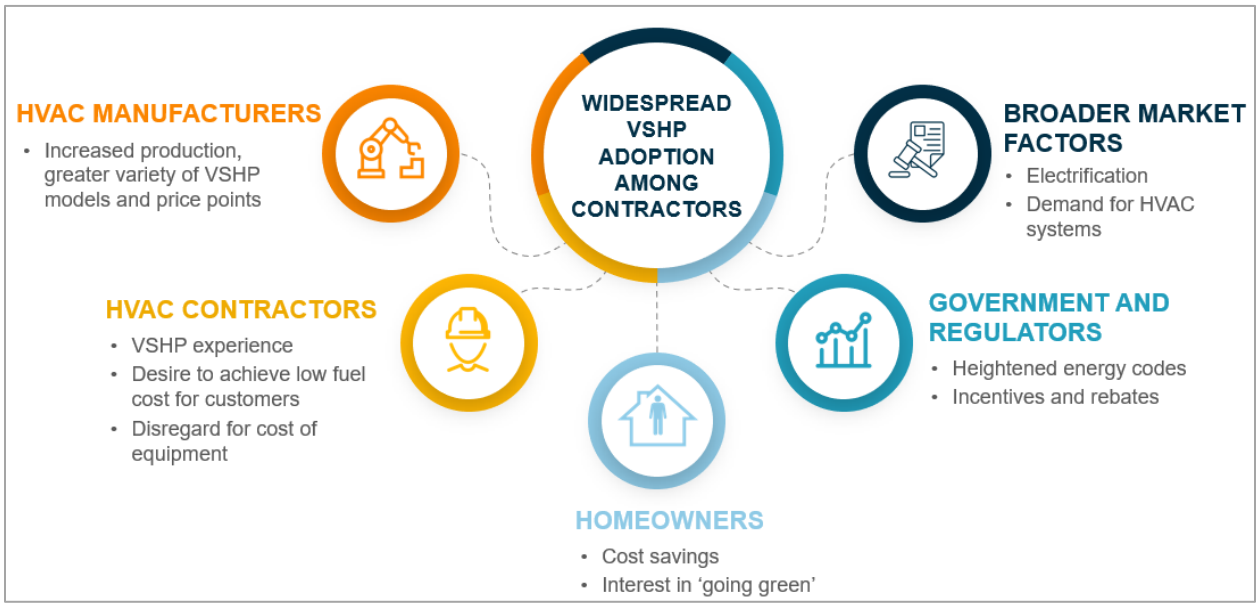
Given this, we recommend NEEA avoids prioritization of HVAC contractors in any future engagement efforts, as all HVAC contractors and businesses should be included and considered as targets.

There are various factors helping to drive widespread adoption of VSHPs among contractors

A combination of several factors has created a 'perfect storm' of conditions for VSHP sales to increase over the past several years, and for HVAC contractors to recommend VSHPs more frequently. These involve:

- **HVAC manufacturers'** increased production of VSHPs, in a wider range of models and price points
- **HVAC contractors'** exposure and experience with VSHPs over the years
- **HVAC contractors'** priorities around helping their customers obtain a high-quality product, at a lower fuel cost
- **Homeowner** interest in long-term cost-savings, and for some, 'going green'
- Heightened energy codes and incentives at the **government and regulator** level
- **Broader market factors** such as electrification and growing demand for HVAC systems

Figure 9: A 'perfect storm' of conditions has enabled widespread adoption of VSHPs among HVAC contractors in the Northwest



Understanding the context around these factors will help to predict where the market will go next. This section provides a detailed look into each of these market forces and how they have created the perfect conditions for VSHPs to successfully gain market entry over the past few years.

HVAC MANUFACTURERS' INFLUENCE ON CONTRACTOR UPTAKE OF VSHPs

Advancing VSHP technology

Contractors interviewed explained that in the last decade there has been significant advancement in heat pump technology, resulting in a broader range of energy efficient heat pumps with improved efficiency capabilities. Manufacturers have focused their efforts on improving and maximizing the efficiency of heating systems, versus major upgrades in system functionality, making it easier for contractors to keep up with the installation and servicing needs of newer models. According to contractors, the technological upgrades in efficiency capabilities consist of the use of variable-speed motors, improved compressor speeds and advances in refrigerant composition.

While 10 years ago, modern, energy efficient heat pumps like VSHPs were harder to come by, the proliferation of these systems into the market has helped to drive interest and awareness (both for consumers and HVAC contractors). Contractors say they have become more exposed to and better versed in the specific energy- and cost-saving advantages of these systems compared to traditional single-stage or multi-stage heat pumps, as well as what systems like VSHPs can achieve in terms of comfort and control for the homeowner. Homeowners are now

more frequently introduced to these products during the sales process, thus driving greater awareness and understanding.

As technological advancement continues, contractors anticipated that interest and uptake in more energy efficient heat pumps will increase, despite cost likely remaining a limiting factor.

HVAC CONTRACTORS' BEHAVIORS AND DRIVERS

VSHP training for contractors

Most contractors are completing training about VSHPs as technology advances and more products come to market. In many cases these trainings are required and facilitated by manufacturers as a prerequisite to sell their equipment. For example, to be a Mitsubishi Diamond Dealer you must have completed all their trainings. VSHPs trainings tend to be part of broader heat pump training that are offered. These trainings serve to make sure contractors have the skills and expertise to be selling and installing a manufacturer's equipment.

Manufacturers tend to offer entry level training, and continuing education if contractors wish to learn more. There is typically new training offered when new models and technologies are added to a product line. For the manufacturers, these trainings ensure contractors are correctly installing equipment, preventing a reputation of unreliability that is a byproduct of incorrect installations.

For contractors, training provides an opportunity to learn about new product offerings, new advancements, and different ways to position the product when selling to consumers. Many of the trainings offered are in-person and hands-on. They also offer more in-depth online training and exams for certifications.

In addition, some larger HVAC companies have their own in-house trainings that they offer to ensure technicians are adequately versed in the equipment they are installing. These companies may reach out to manufacturers for a factory technician to help facilitate these trainings.

Topics covered during training include:

- VSHP technology and functionality
- Features and benefits of VSHPs compared to other products like single and multi-stage heat pumps
- Installation techniques and how to properly install VSHPS
- Troubleshooting and repairing VSHPs

HVAC contractors prioritize product quality and long-term results for customers, over convenience or quick financial reward

Contractors explained that they are very customer-centric in their approaches to dealing with customers and are driven by the goal to provide best-in-class customer service and cater to the wants and needs of their customers. Virtually all contractors interviewed classified "meeting customer needs" as their biggest priority, not just for altruistic reasons, but also as a business strategy to maintain their reputation as a trusted source of advice, and to ensure customers are firmly satisfied with the outcome, even years down the line post-purchase. To achieve this, they invest substantial amount of time during the sales process to adequately understand their customers' overall situation, e.g., around lifestyles, heating preferences, beliefs, and rational and emotional drivers and barriers.

However, a closer look into contractors' prioritizations and goals revealed that they (consciously or subconsciously) also place a great deal of value on specific product attributes that will ensure their customers will be satisfied. During the interviews, contractors were exposed to a set of 10 product attributes and were asked to score each of these according to how important these are when making a product recommendation to their customers. This exercise revealed that priorities tend to be the same for sales and design technicians and installers, and that all HVAC contractors recommend products based on their ability to satisfy the customers' needs, but also their quality and ability to meet those needs for the long-term. As such, product attributes like "reliability," "serviceability" and ability to achieve "lower fuel cost" rose to the top, while factors that would benefit the contractor (e.g., "easy to sell," "easy to install," "recurring income from service and maintenance") fell to the bottom.

Of note was the importance of "readily available" which most contractors explained was an anomaly given the specific stock shortages and supply chain issues they faced in 2021.

Most important HP product attributes for contractors

The following charts depict the outcomes of this scoring exercise, and the similarities in outcomes between the two segments.

Chart 4: Most important HP product attributes for contractors *(Q: Please give the criteria a score out of 5, where 5 is "most impactful to your recommendation" and 0 is "not at all impactful to your recommendation")*

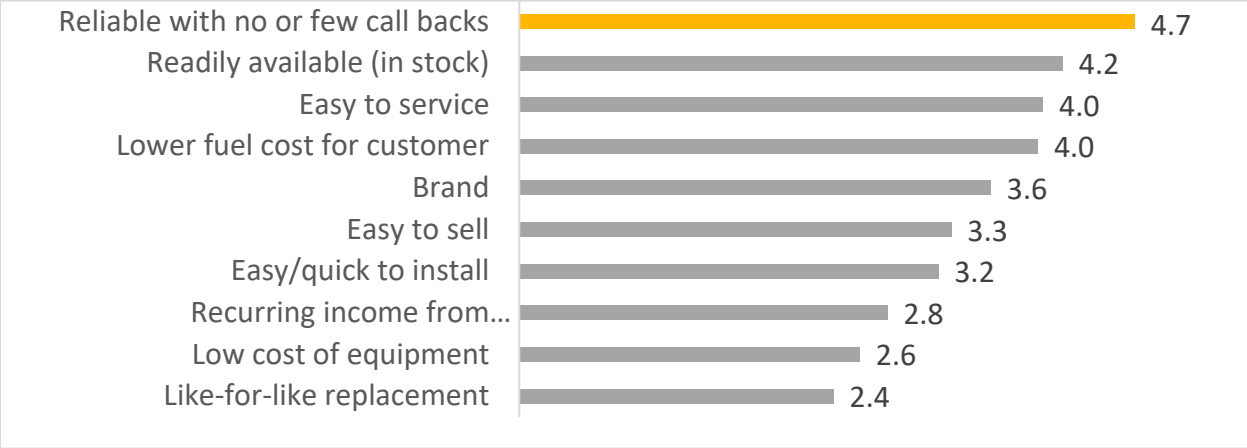
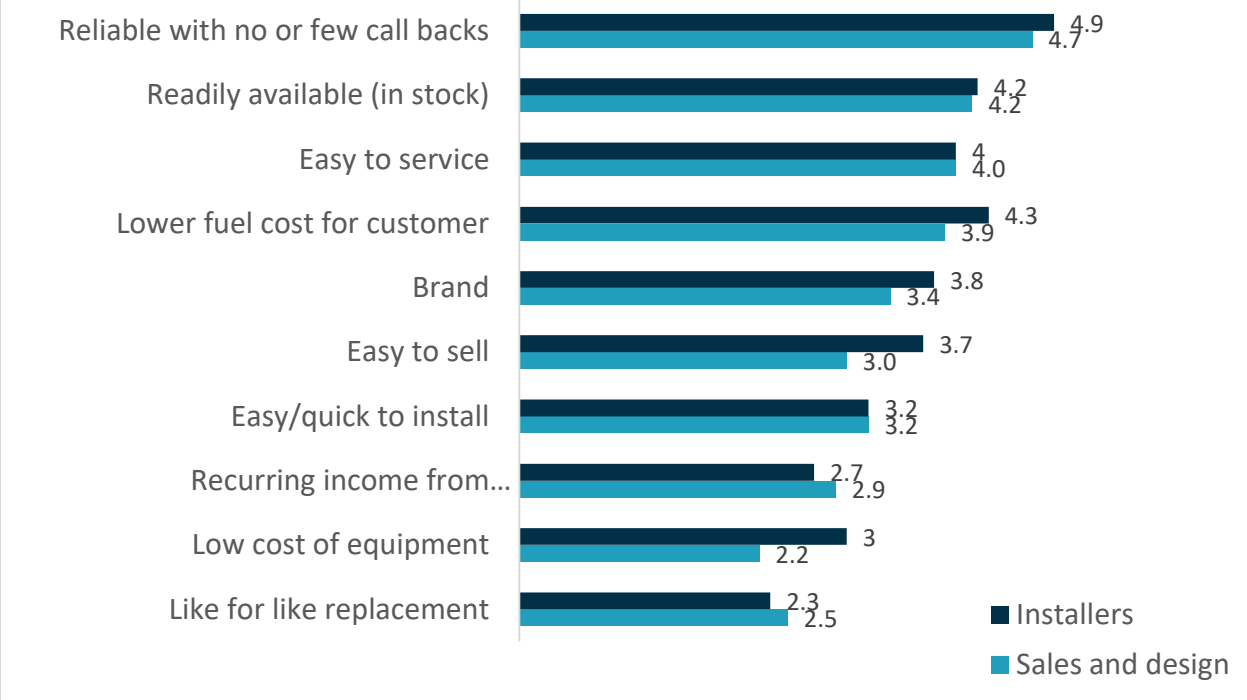


Chart 5: Most important HP product attributes for contractors stratified by interview segment *(Q: Please give the criteria a score out of 5, where 5 is "most impactful to your recommendation" and 0 is "not at all impactful to your recommendation")*



The information that follows provides a detailed deep-dive into reactions toward each product attribute, in order of highest average importance.

1st ranked criterion

Product reliability	As explained previously, contractors care most about system reliability for various customer- and business-related reasons, listed here in order of importance and number of mentions: • Company reputation: Reliable products reflect positively on the company's expertise, credibility, and trustworthiness • Personal reputation: Reliable products reflect positively on the salesperson; no salesperson wants to be known for selling a product that is not quality • Customer satisfaction (long-term): The more reliable a product, the fewer issues a customer will have with it over the course of their ownership. The less issues, the more satisfied a customer. • Repeat business: Satisfied customers are more likely to reconnect with the company for repeat business based on their positive experiences • Customer recommendations/Word of mouth customers: Satisfied customers are more inclined to recommend the HVAC company and/or spread positive reviews, which ultimately leads to more customers • Prevention of unnecessary callback costs: Systems that need frequent repairs not only negatively impact the company's credibility (e.g., perception that they may sell faulty equipment), but also cause general frustration for both the homeowner and the installer. It inconveniences the homeowner as their comfort is affected and costs money for repair, and it inconveniences the HVAC company to send a team out for a small job.

"When we're installing a system, we want it to be running good for many, many years. We look at it from a long-term solution." – Installation, WA

"It all lends to reputation, my reputation, company's reputation, product reputation. Nobody makes money on callbacks, homeowners or company, because it costs everybody a lot of time off work." – Installation, WA

2nd ranked criterion

Readily available	Given supply shortages, stock availability has become a critical factor in contractor's product recommendations. Many customers want/need service as soon as possible, especially in the context of repairs in which homeowners cannot wait months for product to become available. NOTE: This factor was an anomaly in 2021 due to supply chain issues and would not normally be a key factor in contractors' recommendations.

"Right now that's the biggest issue we are dealing with. As of today, I have over 90 jobs that are sold that we're waiting on equipment." – Sales & Design, WA

"That's a hot button right now. If you asked me that question a year and a half ago, I would have put that as low importance… Now it's a bigger deal." – Sales & Design, OR

3rd ranked criterion

Easy to service	Serviceability is important to save contractors' time and hassle and save customers' money. Servicing equipment is inevitable, and simplicity can make the experience better for both the contractor and the homeowner. If a heating system is easy to service, it means the process is quick and less cumbersome; there are no complex issues that arise and contractors do not need extensive training. It reflects positively on a company when issues seem easy to fix and allows for contractors to service more units in a single day. A few sales and design technicians said serviceability is more important to them in terms of making a sale than the actual maintenance aspect; sales and design technicians are not doing any service or maintenance on the system themselves.

"We don't want to put things in that are going to be a nightmare for our guys to try to deal with down the road. Because at the end of the day, that truly costs more to the customer. Any time it takes longer to do something it just costs money." – Sales & Design, WA

"We don't make money on service calls… Our goal is to not service stuff." – Sales & Design, OR

4th ranked criterion

Lower fuel cost for customer	Lower fuel cost is important to many contractors since savings is a highly influencing factor when making a sale. Customers want to save money, and contractors want to save money for their customers. Lower fuel costs help customers budget for both the short and long term. It also can help validate the upfront cost of equipment, especially for higher end units. Lower fuel costs can ultimately push customers towards a technology switch and towards a more efficient unit.

"I want to save everybody money because I want to be recommended. I want to be referred." – Installation, WA

5th ranked criterion

Brand	Equipment brand was considered moderately important to contractors. Brand names typically carry more weight for the contractors than the customers. While some large brand names like Carrier or Trane foster credibility, customers do not have enough familiarity or awareness with the options and trust their contractors' choices. HVAC contractors usually have a small selection of brands they work with. Some have established relationships with equipment brands and evaluate the value of a brand based on two key criteria: product quality and manufacturer support. Firstly, they evaluate brands based on product quality, insinuating that those certain brands (typically well-known brands) can equate to quality performance. Secondly, contractors appreciate brands that are responsive with helpful customer service, including helping troubleshoot issues that arise and assisting in ordering parts when needed. It is also important that manufacturers offer training for their products. However, other contractors are less brand loyal and are confident that the equipment they install is of high quality.

"I don't think brands is as important as performance. To be honest with you." – Sales & Design, OR

6th ranked criterion

Easy to sell	While not considered one of the most important factors, being easy to sell is an appealing factor when choosing an HVAC system because there are little to no perceived downsides. Being easy to sell is typically a product of the equipment's features and brand recognition; the better the features or more well-known a brand name, the easier to sell the product. This creates a win-win situation for contractors - offering a quality product with limited objections from the customer. Sales and design technicians noted that this is particularly appealing as they are often working on a commission-based income; the easier it is to sell, the easier and more

	secure the commission. On the other hand, a couple of sales and design contractors argued that nothing is an "easy sell." Every sale takes work and requires customer education.

> *"The more complex the subject, the better we can explain it, the better we can separate ourselves from our competitors because our competitors tend to put themselves in a box and if something's better for the client, they might not sell it because they think it's going to be too complex for the customer to understand." – Sales & Design, WA*

7th ranked criterion

Easy or quick to install	Overall, contractors felt more neutrally toward the system being easy or quick to install. While being difficult or time-intensive to install would be inconvenient, the functionality of the HVAC system and the investment trumps the installation complexity. Still, having a system to be quick and easy to install offers some advantages. For customers, a quick install means less burden and life disruption and lower install labor cost (less time). For contractors, a quick install means less training or expertise needed, a greater likelihood of a correct install, and being able to complete more projects and, in turn, make more money in a given time period.

8th ranked criterion

Recurring income from service and maintenance	Contractors felt somewhat indifferent towards recurring income from service and maintenance. It was not a large decision criterion when recommending an HVAC system. Income from routine service and preventative maintenance (e.g., filter cleaning) is welcomed and encouraged; it ensures the system is getting the appropriate care needed to optimize the function and longevity, and it is also a way for companies to continue the customer relationship between large sales. However, income from issues or systems breaking is actively avoided, despite the money the callbacks may bring. Income generated from repairs reflects poorly on the company and the product in which they sold. Interestingly, contractors voiced a disconnect between how their companies value income from recurring service and maintenance versus how the contractors themselves value it. Many companies are departmentalized, with installation and sales/design contractors not making money on service or maintenance. It is the service technicians that push maintenance plans. So, while recurring income from service and maintenance benefits the company at large, it is not a main income source or a significant incentive to sell a certain type of system.

> *"Might be more important for the company. For me, I don't get paid for service. I only get paid when I sell." – Sales & Design, OR*

9th ranked criterion

Low cost of equipment	Low cost of equipment was not a major consideration for HVAC contractors given they have variety of price points they offer and prefer not working with "cheap" products. However, low cost of equipment may be a factor for customers, which may limit the options a contractor can offer their customer. Price differences between a VSHP and single-speed or multi-stage heat pumps can range from a few hundred to several thousands of dollars, which for many homeowners is cost-prohibitive.

> *"We mark up the equipment so the cheaper I can get it, the better for my customer. But you also don't want to underspend. You don't want to buy cheap equipment that won't be supported." – Sales & Design, OR*

10th ranked criterion

Like for like replacement	A like-for-like replacement is typically less important to contractors. While some said working with what is already in the home can make sense for certain projects, it does not limit what type of system a contractor recommends for the replacement. Most are not intimidated by selling and installing a different system than what is currently in a home.

> *"It all boils down to what the consumer is looking for now, not what they know." – Installation, WA*

> *"When I go out and do an A/C bid, I always talk to them about a heat pump. However, it does matter what they have in their home. If they have a single stage furnace, it won't be efficient with a VSHP. It needs to be engineered and matched up correctly." – Sales & Design, WA*

HOMEOWNER INFLUENCES ON CONTRACTOR UPTAKE OF VSHPs

Homeowner awareness and interest in energy efficiency

Homeowner interest in energy efficient HVAC systems has been increasing over the years, driven mainly by awareness-raising efforts from all sectors (i.e., media, government, private sector, and community) to reduce carbon footprints, "go green," and opt for energy efficient equipment and products for their homes.

Contractors noted a modest rise in homeowner awareness of heat pumps, specifically, including what they are, but that there was still substantial lack of understanding of the value they can provide to consumers in terms of comfort and long-term cost savings.

> *"The other thing we're running into is a lot of people want to go supposedly green and using electric and getting off gas. So, we've had a lot of those phone calls as well." – Sales & Design, OR*

GOVERNMENT AND REGULATOR INFLUENCES ON CONTRACTOR UPTAKE OF VSHPS

Incentives from government and regulators

Contractors explained that some utility companies and NGOs are further promoting energy efficiency by offering customers incentives to purchase energy efficient heating systems. In other cases, heat pump manufacturers are offering rebates to customers if they opt for higher-end, energy efficient equipment (e.g., Carrier's "Cool Cash" program). These incentives and rebates subsidize customers' investments and drive uptake of energy efficient heating systems in the Northwest.

However, several contractors and technicians noted several shortcomings with incentives. Firstly, there is still substantial lack of awareness about incentive programs for energy-efficient products like VSHPs. There is also confusion around how rebates work, with many homeowners lacking clarity or understanding about how to use the rebates, or if they are a candidate for a rebate in their given situation. Additionally, some contractors insisted that incentive payments need to increase substantially as energy prices rise.

> *"I also wish we had better incentives. We have two utilities here that offer almost $2,000 for those systems. And coupled with the small federal tax credit, that mitigates almost all the cost difference, except a couple thousand dollars." – Sales & Design, OR*

New energy codes

In the state of Washington, energy codes have been successful at driving higher uptake of energy efficient heating systems, including VSHPs. New energy codes are being passed every few years determining the use of energy efficient heating systems that meet a minimum HSPF (Heating Seasonal Performance Factor) score, to qualify for credits and a permit. A certain number of credits is required to build a home.

These energy codes have been pushing for the increased use of electric vs. gas heating and are making it increasingly difficult for new construction homes to use gas as a heating source. However, while energy codes have propelled forward momentum in the uptake of VSHPs, they have also created a shift away from ducted systems due to the many issues that ducts can create (e.g., duct leakage, energy loss, etc.).

> *"Washington state has a pretty intensive energy code that they've been passing. About every two to three years, they pass new energy codes at some point. I had a [greater] percentage of VSHPs just because of the energy codes. [They] are going to [require] you have a much more efficient heat pump." – Sales & Design, WA*

BROADER MARKET FACTORS AND THEIR INFLUENCE ON CONTRACTOR UPTAKE OF VSHPS

Electrification

Contractors signaled that the "wave" of electrification (the process of transitioning from gas to electricity) is coming to the Northwest, and with it will come a rise in homeowners switching their gas furnaces over to electric heat pumps. Manufacturers are playing a significant role in this as they work to increasingly invest resources to produce high efficiency electric products. In support of this, several manufacturers have produced electric replacement units that are the same shape and size as residential gas furnaces, for an easier replacement to a new electric only air handler furnace.

Many contractors believe gas-fueled heating systems will eventually become phased out, as gas furnaces break down or reach the end of their life expectancy and are replaced with electric heating systems.

Supply chain issues

With disruptions to the global supply chain in 2021, the HVAC market in the Northwest has been significantly impacted. At the time of writing, all interviewed HVAC companies are experiencing delays with getting their HVAC orders in, sometimes up to 3-4 months. This has resulted in the postponement of many installation projects in residential homes, reduced heat pump sales over the last few months, and in some cases, customers who are unwilling to wait for a heating system are opting for what's available and may switch for ductless systems. Additionally, stock shortages have caused some HVAC companies to make the decision to carry additional brands as a precaution.

> *"We are having major problems getting parts and getting anything. That goes all the way from hot water tanks through everything." – Sales & Design, WA*

COVID-19 Impact

As many residents have been spending more time at home due to COVID-19, some contractors have noticed a subtle shift in homeowner interest in higher-end heating systems (e.g., VSHPs) that offer added comfort and low noise.

Recommendations

This research identified a range of opportunities for NEEA's residential HVAC program teams to consider for potential, future interventions with residential HVAC contractors (as well as homeowners). There are opportunities to exert influence across multiple areas to minimize existing barriers, boost current drivers, and implement new initiatives to further drive VSHP uptake and help to transform the residential HVAC market in the Northwest.

Recommendations are described below, alongside their respective research objective and key insight.

RO1: Characterize current sales, design, and installation practices of residential HVAC contractors for central/ducted HVAC systems, including VSHPs.

Key insight: Sales and design technicians work separately from the installation department, and have the greatest amount of influence on the overall process

Recommendations:

- Engage with sales and design technicians as a primary target. Leverage the valuable inroads they make with customers through their conversational and relationship-building efforts.
- Empower the sales and design technicians to be more proactive in their sales approach. Provide the guidance and leadership that customers desire within a transaction, while attaining a greater influence over the customer decision.
- Consider equipping sales and design technicians with talking points on VSHPs based on different customer profiles and their specific informational needs (consider a homeowner segmentation to achieve this).

Key insight: HVAC contractors are highly customer-centric in their sales approach

Recommendation:

- Keep in mind that sales and design technicians avoid being pushy with customers, so any efforts to engage with them must be tactful and considerate of this. Any tools and resources about VSHPs offered to contractors should be designed in a way that is helpful to contractors, enabling them to be proactive, but not forceful.

Key insight: VSHPs are typically offered as a "best," premium option

Recommendation:

- Consider equipping contractors with objection-handling resources for the sales and design technicians to override any concerns about choosing the "best" option.

- Advocate for the VSHP be positioned as a mid-tier, “better” option, creating the psychological appeal of VSHPs being a safer, more conservative choice than the highest-end option.

Key insight: Installing VSHPs is a standard process and almost the same process as other heat pump types

Recommendations:

- When communicating with or educating contractors about VSHP installation, focus on the aspects of the process that are unique to VSHPs, such as initialization and set-up.

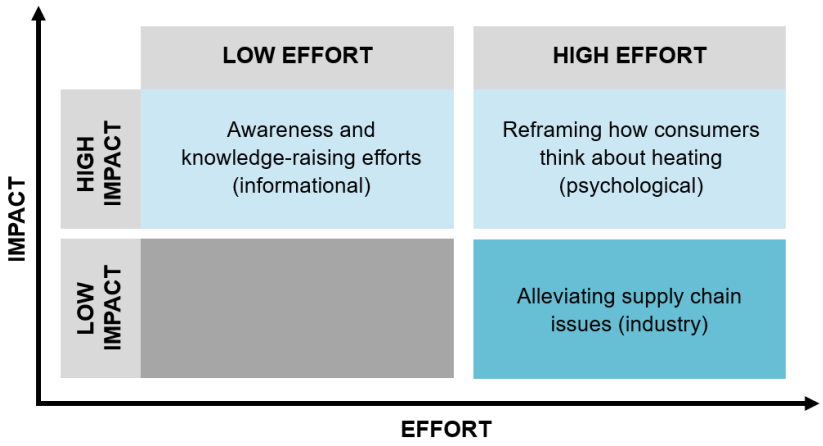
RO2: Determine any barriers or drivers for VSHP adoption.

Key insight: VSHP growth is encumbered mainly by cost and awareness, but consumer psychology and broader industry factors also play a role

Recommendations:

- The market landscape is fluid and ever evolving. Continue research efforts to understand the dynamics around existing barriers to identify ways to facilitate movement toward higher VSHP uptake.
- In the short term, strive for high impact, lower effort initiatives (see Figure 10), such as information raising efforts to close the knowledge gap among homeowners about VSHPs, and help drive awareness and understanding about available rebates and how they work.
- In the longer-term, consider marketing initiatives aimed at reframing how consumers think about home heating and energy efficient solutions. For example, help them to perceive their home heating systems as more than just a basic necessity, but instead as an important lifestyle investment, like their cars.

Figure 10: Consider a framework such as an action-priority matrix to plan for short-term and long-term engagement efforts



Key insight: Cost strongly dictates sales and purchase behaviors

Recommendations:

- Educate homeowners that there are many different types of VSHPs on the market today that come at different price points. Encourage homeowners to shop around and compare pricing.

Key insight: Financial assistance programs support uptake but can be hard to access

Recommendations:

- Develop communications initiatives aimed at demystifying the range of financial assistance available and how to access them.
- Consider creating a go-to online resource detailing all current incentives and rebates available to customers with qualifying criteria.
- Support contractors with information and tools to help them apply for rebates on behalf of their customers.

Key insight: Homeowners lack awareness and understanding of VSHPs

Recommendations:

- Educate homeowners about VSHPs and how they work (e.g., via online resources, hard-copy resources, media campaign). Ensure educational resources are easily accessible and user-friendly and that information is in plain language that cuts through and clearly conveys the advantages of VSHPs.
- Empower homeowners to make more informed choices. For example, consider providing a list of questions to ask their HVAC contractors, and include the associated benefits of asking those questions (e.g., "Top 10 Things to Ask Your HVAC Contractor When Considering a Heat Pump").

Key insight: There is a potential need for more VSHP training for HVAC contractors

Recommendations:

- Strengthen sales and design technicians' knowledge of VSHPs with more detailed information about ideal application and correct sizing in different situations. Equip contractors (particularly sales and design technicians) with the latest knowledge available on energy savings from VSHPs.

Key insight: Homeowners think about their heating needs in basic terms

Recommendations:

- Consider educational initiatives to help homeowners realize the cost-savings of VSHPs over the long-term. Consider creating or driving attention to an online savings tool for homeowners to estimate energy savings through VSHPs. This tool should include a

rebate calculator to estimate how much homeowners will save after incentives and rebates.

Key insight: Technology can be intimidating to some (usually older) homeowners

- Work to counter the belief that more technology means more complications and therefore difficulty. Provide contractors with talking points that connect the technology aspects of the VSHP with ease and simplicity of use. Emphasize that the technology makes things easier for the customers, and that it is the technology that makes the system more reliable, adaptable and less time consuming when troubleshooting errors.

RO3: Identify HVAC contractors who are or are likely to be early adopters of VSHPs, and their attributes.

Key insight: There is already widespread adoption of VSHPs among HVAC contractors across the Northwest.

Recommendations:

- Potential future targeted engagement efforts should avoid prioritization and encompass all HVAC businesses.

Appendix A. Current heat pump landscape

Current heat pump landscape

Data gathered through the questionnaire and subsequent follow-up interview questions revealed a substantial amount of insight into the current landscape of heat pump sales and uptake across the Northwest. The information collected offered a valuable snapshot of the types of heat pumps that are most commonly sold, how this has changed in recent years, and how contractors anticipate heat pump sales will evolve in the future.

Heat pump sales by state

Most common heat pumps by state

According to contractors' questionnaire responses, heat pump sales were fairly evenly distributed across the different heat pump types. In particular, sales of VSHPs, have been increasing over the years, and this trend is expected to continue, with many predicting sales will soon overtake sales for traditional single-speed and multi-stage heat pumps.

Notable differences by state

Washington contractors estimated that they currently sell the highest portion of current SSHP heat pumps (30%, see Chart 3) compared to the other regions, and at the same expects the largest decrease over 5 years (17%), noting the market shift towards more energy efficient systems.

Compared to other regions, **Oregon contractors** estimated less use of hybrid systems (6%, see Chart 3) and greater use of multi-zone heat pumps (26%, see Chart 3).

Montana and Idaho contractors reported a couple of differences, as well. However, these findings are preliminary due to small sample sizes of n=3 and n=2, respectively.

Montana contractors estimated the largest portion of VSHP sales (35%, see Chart 3) as rural areas are cold and gas is more expensive than areas like Seattle and Portland.

Idaho was the only region that estimated a small decrease in VSHP over the next 5 years (20% to 18%), often because they accounted for the largest increase in mini-split systems (both single-zone and multi-zone).

Reported trends by heat pump type

This section details the current dynamics, attitudes, and trends for each heat pump type, according to the contractors interviewed in this research.

Single-speed and multi-stage heat pumps

In terms of ducted heat pumps, HVAC contractors' questionnaire responses revealed **single-speed and multi-stage are sold somewhat more often than variable speed heat pumps** because of lower upfront costs and adequate efficiency. Single and multi-stage heat pumps are the introductory and mid-level heat pumps respectively. They provide moderate energy efficiency, which somewhat minimizes operational costs and environmental impact.

During interviews, HVAC contractors explained these heat pumps are a good choice for homeowners who are new to the heat pump technology and may not be ready for the highest end unit (i.e., VSHP). Depending on the needs of a house, the single or multi-stage heat pumps can do an adequate job considering the price point they are at. HVAC contractors felt these heat pumps are also an excellent choice for those who are currently on propane, especially in rural areas where propane delivery is expensive and timely. However, a single or multi-stage heat pump may not reduce energy costs so a gas furnace may be cheaper.

According to HVAC contractors, single and multi-stage heat pumps do not pose many drawbacks in moderate climates. However, because of the nature of the technology, the colder it is outside, the more energy the heat pump needs to heat the home. This becomes especially apparent in the less efficient single-speed units. If the climate is cold enough, it becomes inefficient to use such a heat pump, and it would be cheaper for the homeowner to run a gas furnace. As a result, homeowners may opt for a gas furnace or a VSHP, which perform better in colder climates.

In their questionnaire responses, HVAC contractors estimated their sales of different types of heat pump systems currently and in five years. They expect the sale of single stage and multi-state heat pumps to decrease due to the prevalence of more efficient systems (i.e., VSHPs, mini-splits) becoming more widely available. The inefficiencies of these heat pumps in certain climates will make them obsolete as heat pump technology moves forward.

> *"Why we install more [SSHP] is because the economy and cost, customers budget. People don't have the money to buy the best system out there." – Sales & Design, MT*

Ducted variable speed heat pumps

HVAC contractors said sales of VSHPs have been increasing modestly but steadily over the years, and they expect this trend to continue. Many predicted VSHP sales will soon overtake

sales for traditional single-speed and multi-stage heat pump (26%, see Chart 2). This growth is being driven by several economic, legislative, and societal market forces, namely: Advancing technology and manufacturers' efforts to produce a greater variety of VSHP models than in the past, recommendations by HVAC sales technicians, heightened energy codes and initiatives aimed at promoting the switch to energy efficient heating systems, incentives and rebates to aid affordability, and customer awareness and interest in the benefits of VSHPs.

HVAC contractors reported that ducted VSHPs are chosen when within budget for a higher efficiency product. They are typically recommended and chosen for homeowners who want a the most efficient heating system and/or something better for the environment, beyond what their single and multi-stage counterparts can offer. VSHPs can provide a greater level of comfort to homeowners through more stable temperatures in the home and lower noise levels when the system is running. Contractors believe they are a good choice for large multi-level homes that would otherwise be expensive to keep warm.

VSHPs do not have higher error rates than other heat pumps, and there is consensus among contractors that they are among the most energy efficient ducted heating solution available today. The only disadvantage contractors noted about VSHPs is the upfront cost. The cost of VSHPs remains a barrier even with the incentives and rebates available to homeowners. The energy cost savings of a heat pump are not always apparent upfront, and the need for immediate gratification from such an expensive purchase pushes homeowners away. Not all homeowners are willing to wait years for a return on investment, and not every homeowner will receive a return of investment in a unit's lifetime. This cost barrier ultimately pushes homeowners to opt for less efficient systems, such as the traditional single and multi-stage heat pumps.

> *"I think the only pushback we really get about using the variable speed heat pumps is really coming from someone who just their budget doesn't really give us room to work within." – Sales & design, OR*

> *"We do get some snow and freezing temperatures, but the newer variable speed heat pumps work pretty well in our area for most of the time." – Sales & Design, ID*

Hybrid or dual fuel systems

Overall, contractors do not expect the sales of hybrid or dual fuel heat pumps to increase much in the coming years. According to their questionnaires, they estimated sales would be about the same in five years and explained that is because more efficient technology (i.e., VSHPs) will become more widely available and more affordable over time.

Contractors estimated a small proportion of customers are pairing a **VSHP with a gas furnace**. These customers are typically those who can afford the higher expense, and support owning energy efficient equipment in their homes (e.g., owning a Prius or Tesla).

Hybrid or dual fuel systems are installed to leverage the price of natural gas – optimizing cost efficiency for back-up heating. Like the term "hybrid" has become a buzz word in the context of cars, it has for heat pumps. The term "hybrid" carries a positive connotation as homeowners relate it to energy. In the words of one HVAC contractor, homeowners who opt for a hybrid system are homeowners who are looking for the "best of both worlds." Contractors explained these homeowners are reluctant to stop using natural gas altogether because of its price and efficiency at cold temperatures. However, these homeowners may be environmentally conscious or want a system that both heats and cools their home. So, adding a heat pump or replacing their A/C with a HP is a compromise. In this scenario, homeowners can use the gas furnace as the back-up heat source for when it becomes too cold for the heat pump to run efficiently, but also use the HP to cool their home in the summer.

HVAC contractors described how hybrid systems provide a level of comfort above HPs in that temperature does not impact its performance; their home will always be warm. If homeowners believe that a heat pump is not adequate to heat their home in their climate, the gas furnace adds a level of comfort and security that a heat pump alone cannot provide. Having two heat sources also means if one heat source fails, there is back-up.

HVAC contractors praised hybrid systems as highly energy efficient. When the temperature goes below a certain point, heat pumps must work harder to maintain the temperature in the home. As the temperature continues to go down, the heat pump must use more electricity or back-up electric heat strips. However, with a hybrid system, the customer can save money by having the furnace heat the home when it is extremely cold outside. This ultimately saves homeowners money in the event the heat pumps begin to be more costly to run. Therefore, some people switch from gas to electric depending on the season. In the colder winter months, it can be cheaper to run the furnace, and in fall months, the heat pump can be the more efficient way to heat your home. In other cases, homeowners who opt for a hybrid heating system when they want to pair their furnace with a humidifier.

While many contractors recognize the advantages of a hybrid system, some steer away from recommending these to their customers due to cost, as they are ineligible for tax credits. Both the gas companies and electricity companies (and NGOs) do not offer rebates to homeowners

> *"The reason why we don't push the hybrid, which I believe honestly everybody should have a hybrid in their home for two sources of heat, is the energy tax credits for homeowners. The gas company is not going to give you a tax credit for installing a heat pump and the electric company is not going to give you a rebate for installing a gas furnace, they want one or the other." – Installation, OR*

for hybrid systems. Hybrid systems also require more explanation/education given that the equipment has different ways they can be used.

Mini-splits or Ductless Heat Pumps

While overall estimations showed that mini-split sales were predicted to increase only slightly over the next five years (see Chart 2), some contractors voiced expectations that ductless heat pump sales will exponentially rise. These contractors considered mini-splits to be "the future" of heat pumps.

The advantages of a mini-split system, according to the sampled HVAC contractors, include ease of installation, reliability in cold temperatures, and greater zonal control over the temperature in the home, meaning the most frequented areas can be consistently comfortable. HVAC contractors noted that since mini-splits are also capable of running on variable speed inverters, they can have similar energy efficiencies when compared to a ducted VSHP.

Another significant advantage brought up by HVAC contractors is not needing ductwork. If a home does not have any ductwork, it would be extremely costly to create the ductwork needed for a system. For those with existing ductwork, a mini-split can eliminate any potential duct inadequacies (e.g., air loss), which is appealing since contractors cite that almost every home requires minor ductwork improvement. In instances when existing ductwork is in poor condition, the cost of major duct repairs may outweigh energy savings from ducted heat pumps.

> *"The mini-split groups are typically first-time home buyers. People that don't have any ducted systems are looking for something a little more cost-effective than trying to cut ducting into all parts of the house. So, the mini-split options typically are for those that don't have ducting, not always, but most of them." – Installation, WA*

> *"You have no duct work, which means you will have no air loss because most typical ducted systems, no matter how good they're built, you have a three to 5% duct loss. So you blow a hundred percent of the air and only 95% of the air actually gets to its destination, because you have some leakage. So, these eliminate that issue, and their efficiency is very great." – Sales & Design, OR*

Perceived drawbacks of the ductless system include less control of the whole house, despite greater control over certain zones. It could be costly to install an indoor unit in every room, so homeowners are left to choose which zones are most important.

HVAC contractors explained the customers who are most likely to opt for a ductless system like the mini-split will be homeowners either without ductwork, or who have ductwork that is in

poor condition. They may also be attracted to getting the high efficiency ratings at a more affordable price point compared to that of a traditional ducted system. However, the mini-split is not a good fit for the homeowner who wants their whole house heated and cooled unitarily.

Appendix B. Recruitment screener

Screener

583-04 Residential HVAC and VSHP Journey

Final (October 1, 2021)

Name:

_____

_____

Phone:

_____

_____

Email Address:

_____

__

Interview Time / Date:

_____

METHODOLOGY

- 50 minutes to 1 hour of pre-work to include a Survey Monkey questionnaire and submitting video and pictures
- 60-min Qualitative Telephone Depth Interviews qual TDIs using an online platform (Civicom)

KEY RECRUITING CRITERIA

- Must work for a residential HVAC contractor who sells, designs, and installs HVAC systems in Single-Family residential homes
- Must be either involved in sales, design, or installation
  - For smaller firms, participant can be involved in all aspects
- Aim for ¼ of participants to have experience with Variable Speed Heat Pumps in residences
- Ideally majority to be working on a current HVAC/Heat Pump project (whether selling, designing, or installing)
- Be willing to complete both phases of research, Pre-work and 60-minute interview

SEGMENTS

Criteria	Respondent type	Oregon	Washington	Idaho	Montana	Total
Geographic spread across: • **Washington** • **Oregon** • **Montana** • **Idaho**	**Those involved in sales and design**	3	3	2	2	10
	Those involved in installation of heat pumps	5	5	4	4	18
						TOTAL:

INTRODUCTION: Hello, I'm _____ calling from Lieberman Research, a marketing research company. We are conducting a study about HVAC installations and are looking to speak to those who are involved in the sales and design and/or installation of HVAC systems. Are you the best person to talk to about the sales, design and/or installation of HVAC systems?

If yes, Continue; If No: Who would be the right person? Is that person available?

If needed, reintroduce yourself and begin:

Hello, I'm _____ calling from Lieberman Research, a marketing research company. We are conducting a study about HVAC installations and are looking to speak to those who are involved in the sales and design and/or installation of HVAC Systems.

May I ask you a few questions to see if this study is of interest to you? To thank you for your time, we are offering an honorarium of **$725.00** (IF NEEDED: Please be assured this call does not involve sales of any kind. The information gathered will remain confidential and be used for research purposes only.)

Q1. Please tell us the state(s) in which you work.

_____

SEE QUOTA, MUST BE FROM WASHINGTON, OREGON, IDAHO, OR MONTANA

Q2a. Is your company an HVAC contractor?

1	Yes		**CONTINUE**
2	No		**TERMINATE**
3	Don't know/Not sure		

Q2b. Which of the following does your HVAC company do?

1	HVAC Installations/Replacements		**MUST SELECT TO CONTINUE**
2	HVAC Repairs		
3	HVAC Maintenance		

MUST SELECT HVAC INSTALLATIONS TO CONTINUE

Q2c. In what types of buildings do you install HVAC Systems? Check all that apply.

1	Manufactured Homes	
2	Single-family homes	**MUST SELECT TO CONTINUE**
3	Multifamily buildings such as apartment buildings or condos, or senior or assisted living	
4	Commercial facilities	
5	Don't know/Not sure	**TERMINATE**

Q2d. Thinking about the installations/replacements you do in Residential, Single-family homes, approximately what percentage are for **new constructions**, versus to **existing homes**?

1	New Construction	**XX%**
2	Existing Homes	**XX%**
3	Other (Please Specify: _____)	**XX%**
4	Don't know/Not sure	**TERMINATE**

MAX 6 PARTICIPANTS WHO HAVE MAJORITY PERCENTAGE NEW CONSTRUCTION. THE REST TO HAVE MAJORITY PERCENTAGE EXISTING HOMES.

MAJORITY % TO MEAN 60% OR MORE IN EITHER CATEGORY.
FOR NEW CONSTRUCITON MAJORITY, MUST STILL DO AT LEAST 10% IN EXISTING HOMES

Q3a. What is your exact title?

_____**[RECORD VERBATIM]**

LOOKING FOR JOB TITLES INVOLVED IN SALES, DESIGN, INSTALLATION, JOB MANAGER, CONTRACTOR, GENERAL MANAGER AND/OR OWNER,

Q3b. Thinking about your **current role** at your company what percentage of time do you **personally** and **directly** spend on each of the following...?

a) % of time involved in sales of central HVAC Systems	**XX%**
b) % of time involved in design of central HVAC Systems	**XX%**
c) % of time involved in installation of central HVAC Systems	**XX%**

d) Other (Please Specify: _____) **XX%**

MUST ADD UP TO 100%

CHECK QUOTA TABLE. THE ROLE WITH THE MOST PERCENTAGE OF TIME WILL QUALIFY FOR THAT ROLE. IF EQUAL ACROSS MULTIPLE ROLES, PARTICIPANT QUALIFES FOR BOTH ROLES

Q3c. For **how long** have you been active in your current role?

_____years / months

TERMINATE IF LESS THAN 1 YEAR; RECRUIT A MIX IF POSSIBLE

Q4a. Thinking about your residential business, which **types of products** does your company sell, design, and install? *Select all that apply.*

1. Central heating systems with or without cooling (e.g., furnaces or heat pumps)	
2. Central air conditioning systems	
3. Ductless heating or cooling systems (e.g., mini splits, room heating/cooling, etc.)	
4. Combination ducted and ductless heating or cooling systems	
5. Combination space and water heating systems	
6. Other type of product (Please specify: _____)	**HOLD AND ASK LIEBERMAN IF SAY ANOTHER PRODUCT**

MUST SELECT CODE 1, 2 OR 4 TO CONTINUE. ONLY ALLOW A FEW WHO SELECT CODE 2 ONLY

Q4b. Thinking specifically about installations/replacements (not repairs or maintenance) which of these products does

your company currently have active or upcoming installation/replacement jobs for? *Select all that apply* ***[ONLY INCLUDE OPTIONS THEY SELECTED IN Q4A]***

1. Central heating systems with or without cooling (e.g., furnaces or heat pumps)	
2. Central air conditioning systems	
3. Ductless heating or cooling systems (e.g., mini splits, room heating/cooling, etc.)	
4. Combination ducted and ductless heating or cooling systems	
5. Combination space and water heating systems	
6. Other type of product (Please specify: _____)	**HOLD AND ASK LIEBERMAN IF SAY ANOTHER PRODUCT**

HOLD IF DON'T SELECT ANY, OR ONLY SELECT 3 OR 5

Q5a. Thinking about your residential business, which type of **heat pumps** does your company sell, design, and install? *Select all that apply.*

a) Ducted single-speed and multi-stage heat pumps	**CONTINUE**
b) Ducted variable speed heat pumps (AKA variable capacity heat pumps and inverter-driven heat pumps)	**CONTINUE**
c) Ducted hybrid gas/electric or dual fuel heat pumps (like an electric heat pump combined with a gas furnace)	**CONTINUE**
d) Single zone mini-splits (AKA ductless heat pumps)	**TERMINATE IF ONLY SELECT**
e) Multizone mini-split (more than one indoor unit)	
f) Other (Please Specify: _____)	

AIM FOR AT LEAST 7 OF PARTICIPANTS TO SELECT B

Q5b. Again, thinking specifically about installations/replacements (not repairs or maintenance) which of these **heat pumps** does your company currently have active or upcoming installation/replacement jobs for? *Select all that apply* ***[ONLY INCLUDE OPTIONS THEY SELECTED IN Q5A]***

a) Ducted single-speed and multi-stage heat pumps	**CONTINUE**
b) Ducted variable speed heat pumps (AKA variable capacity heat pumps and inverter-driven heat pumps)	**CONTINUE**
c) Ducted hybrid gas/electric or dual fuel heat pumps (like an electric heat pump combined with a gas furnace)	**CONTINUE**
d) Single zone mini-splits (AKA ductless heat pumps)	**TERMINATE IF ONLY SELECT**
e) Multizone mini-split (more than one indoor unit)	
f) Other (Please Specify: _____)	

Q5c. Thinking about the heat pumps your company offers, which do you personally have experience in selling, designing and/or installing? *Select all that apply.* ***[ONLY INCLUDE OPTIONS THEY SELECTED IN Q5A]***

a) Ducted single-speed and multi-stage heat pumps
b) Ducted variable speed heat pumps (AKA variable capacity heat pumps and inverter-driven heat pumps)
c) Ducted hybrid gas/electric or dual fuel heat pumps (like an electric

	heat pump combined with a gas furnace)
d)	Single zone mini-splits (AKA ductless heat pumps)
e)	Multizone mini-split (more than one indoor unit)
Other (Please Specify: _____)	**TERMINATE**

AIM FOR AT LEAST 7 OF PARTICIPANTS TO SELECT B

TECHNOLOGY REQUIREMENT [ASK ALL]

. For this interview, **you will be required to use a desktop computer or full-sized laptop with webcam**. A smartphone, Chromebook, or tablet screen will not suffice. Will you have access to both a telephone and a full-size computer (with webcam) at the same time at the location where we will contact you for the interview?

1	Yes	**CONTINUE**
2	No	**HOLD – (PHONE ONLY)**

RECRUITER NOTE: PRIORITIZE ELIGIBLE RESPONDENTS WHO HAVE WEBCAM ACCESS

We are inviting a select group of people like you to participate in a pre-interview assignment and then participate in a 60-minute online interview about HVAC installation.

Your participation in this research and receipt of the honoraria will require you to complete an assignment at your home or place of work, prior to the interview. This assignment is mandatory.

An overview of the assignment elements is below:

- Short questionnaire
  - We would ask you to complete and return a short questionnaire. The survey will be sent to you via

Survey Monkey and can be completed over your phone or computer.
    - Estimated time to complete: Max 20 minutes.
- Photos and videos
    - We will ask you to send to use videos and photos (taken with your smartphone) of the key steps of a typical sales, design and/or installation process for residential heat pumps.
    - Estimated time to complete: 30 minutes

Important note: More detailed and clear instructions will be provided to you. This assignment will be designed to be very easy and quick for you to complete.

To compensate for the assignment and 1-hour interview, you will receive **$725.**

Would you be interested in taking part in both parts of this research: pre-interview assignment and follow-up interview?

Yes ( ) **CONTINUE**

No ( ) **TERMINATE**

Do you agree to complete the pre-interview assignments and return them 48 hours prior to the start of your scheduled interview?

Yes ( ) **CONTINUE**

No ( ) **TERMINATE**

Are you available between XX and XX to participate and complete in the pre-work?

Yes ( ) **CONTINUE**

No ( ) **TERMINATE**

Are you available between XX and XX to complete the follow-up interview?

Yes ( ) **CONTINUE**

No ( ) **TERMINATE**

We are excited that you will be participating! You will receive instructions for the pre-interview assignment shortly. For the follow-up interview, you will receive a confirmation / reminder the day before the interview. We are counting on your participation. If you should have an emergency, be sure to contact us at (phone number) because we will need to find a replacement

Thank you, we look forward to speaking with you on (DATE) _____at (TIME) _____.

PLEASE REMIND ALL RESPONDENTS

- You will also be using a telephone, ideally a landline, to call via a toll-free number for the discussion
- You will be contacted by an operator from Civicom before your scheduled interview to perform a technology check and review the process for logging in to the platform.

Appendix C. Questionnaire for Sales & Design technicians

Questionnaire A: Sales and Design

Thank you for taking part in this research study about residential central HVAC systems. We greatly appreciate your time to complete this survey before your scheduled interview. This should take no more than 20 minutes. Please complete it as accurately as possible.

1. **What is your first name and last initial? (Ex. John S.)**
   Note: Please do not provide last names for confidentiality purposes.

2. **In which state do you work?**
   - o Washington
   - o Oregon
   - o Montana
   - o Idaho

3. **What is your job title? _____**

4. **In a few sentences, how would you describe your role and responsibilities?**

5. **In what counties are most of your HVAC system installs and/or service visits located?**
   [ANSWER: COUNTY, STATE]

6. **Approximately what proportion of your business income from residential central HVAC systems would you say stems from service or maintenance vs. from installation/replacements?**

Service/maintenance	%
installation/replacements	%

7. **Approximately what proportion of your installations are for new homes vs. to existing homes?**

Sales and/or installations to new homes	%
Sales and/or installations to existing homes	%

8. **Please estimate the approximate proportion of sales and/or installations for each of the following types of heat pumps, in your business <u>CURRENTLY</u>:**

a. Ducted single-speed and multi-stage heat pumps	
b. Ducted variable speed heat pumps (AKA variable capacity heat pumps and inverter-driven heat pumps)	
c. Ducted hybrid gas/electric or dual fuel heat pumps (like an electric heat pump combined with a gas furnace)	
d. Single zone mini-splits (AKA ductless heat pumps)	
e. Multizone mini-split (more than one indoor unit)	
f. Other (Please specify: _____)	

9. **If "other," what type of system or systems is it?**

   _____

10. **Thinking ahead to 5 years from now, how much do you expect the proportion of sales and/or installations for each of the following types of heat pumps in your business to be?**

a. Ducted single-speed and multistage heat pumps

b. Ducted variable speed heat pumps (AKA variable capacity heat pumps and inverter-driven heat pumps)	
c. Ducted hybrid gas/electric or dual fuel heat pumps (like an electric heat pump combined with a gas furnace)	
d. Single zone mini-splits (AKA ductless heat pumps)	
e. Multizone mini-split (more than one indoor unit)	
f. Other (Please specify: _____)	

11. **If "other," what type of system or systems is it?**

    _____

12. **When you begin a project to sell/design a central HVAC system for a new residential client, what is the most important information you need to know to make the sale successful? Please state all information that matters most.**

_____

13. **What are the key steps in the *sales/design* process of central HVAC systems? Please list the key steps in a typical or active residential project, from initial customer phone call through to signing and scheduling, and provide a brief overview of what takes place at each stage.** *[e.g., What is happening? Who is involved? What is your*

goal? Where does this take place? What is frustrating you at this stage?]

Note: *We are not experts in this field so are looking to you, the contractor, to inform us about this important process. Where does the process start? What comes next? What is on your mind at that moment? Please be as specific as possible.*

Appendix D. Questionnaire for Installers

Questionnaire B: Installation

Thank you for taking part in this research study about residential central HVAC systems. We greatly appreciate your time to complete this survey before your scheduled interview. This should take no more than 20 minutes. Please complete it as accurately as possible.

14. **What is your first name and last initial? (Ex. John S.)**
    Note: Please do not provide last names for confidentiality purposes.

15. **In which state do you work?**
    - o Washington
    - o Oregon
    - o Montana
    - o Idaho

16. **What is your job title? _____**

17. **In a few sentences, how would you describe your role and responsibilities?**

18. **In what counties are most of your HVAC system installs and/or service visits located?**

    [ANSWER: COUNTY, STATE]

19. **Approximately what proportion of your business income from residential central HVAC systems would you say stems from service or maintenance vs. from installation/replacements?**

Service/maintenance	%
installation/replacements	%

20. **Approximately what proportion of your installations are for new homes vs. to existing homes?**

Sales and/or installations to new homes	%
Sales and/or installations to existing homes	%

21. **Please estimate the approximate proportion of sales and/or installations for each of the following types of heat pumps, in your business <u>CURRENTLY</u>:**

g. Ducted single-speed and multi-stage heat pumps	
h. Ducted variable speed heat pumps (AKA variable capacity heat pumps and inverter-driven heat pumps)	
i. Ducted hybrid gas/electric or dual fuel heat pumps (like an electric heat pump combined with a gas furnace)	
j. Single zone mini-splits (AKA ductless heat pumps)	
k. Multizone mini-split (more than one indoor unit)	
l. Other	

22. **If "other," what type of system or systems is it? _____**

23. **Thinking ahead to 5 years from now, how much do you expect the proportion of sales and/or installations for each of the following types of heat pumps in your business to be?**

a. Ducted single-speed and multi-stage heat pumps

b. Ducted variable speed heat pumps (AKA variable capacity heat pumps and inverter-driven heat pumps)	
c. Ducted hybrid gas/electric or dual fuel heat pumps (like an electric heat pump combined with a gas furnace)	
d. Single zone mini-splits (AKA ductless heat pumps)	
e. Multizone mini-split (more than one indoor unit)	
f. Other	

24. **If "other," what type of system or systems is it?**
_____

25. **When you begin a project to install a central HVAC system for a new residential client, what is the most important information you need to know to make the installation successful? Please state all information that matters most.**

_____

26. **What are the key steps in the *installation* process of a central HVAC system? Please list the key steps, from preparation through to any post-installation steps, in a typical or active residential project and provide a brief overview of what takes place at each stage.** *[e.g., What is*

happening? Who is involved? What is your goal? Where does this take place? What is frustrating you at this stage?]

Note: *We are not experts in this field so are looking to you, the contractor, to inform us about this important process. Where does the process start? What comes next? What is on your mind at that moment? Please be as specific as possible.*

Appendix E. Discussion guide

Discussion Guide

NEEA HVAC JOURNEY QUAL RESEARCH

Discussion Guide for Video TDIs with Residential HVAC Contractors

60-minutes

10.11.2021

DISCUSSION FLOW

I.	Moderator Introductions	2 mins
II.	About you, your role and organization/business	3 mins
III.	Re-cap on current business practices (from pre-work questionnaire)	5 mins
IV.	Core values and priorities	10 mins
V.	Drivers and barriers to VSHP uptake	10 mins
VI.	The sales/design/install process in action	30 mins
VII.	Wrap up and close	

I. Moderator Introductions **2 mins**

- Hello, my name is Michelle. I am an independent researcher moderator. I work for a research company called Lieberman, specializing in market research.
- I do not work for the company who has asked me to interview you today, and I did not create any of the materials I may be sharing with you – so because I'm independent, I hope you will free and comfortable expressing your honest perspectives with me. **There are no right or wrong answers today, you're the expert – I'm here to learn from you!**
- This conversation is being **audio and video recorded**, and I do have a few colleagues listening in – both from my independent research team and the sponsoring company. This is all for note-taking purposes only, and the recordings will be kept solely for research purposes.
- Please know that your **responses are confidential** and will not be associated with you by name. Everything we learn from these interviews is reported in summary form, with no links whatsoever to the individuals who took part. The only people who will have access to this confidential information will be **those involved in this research project**.
- You already know from the screening interview and pre-interview activities that, for this study, we are speaking to **people who are involved in the sales, design and/or installation process of central HVAC systems in residential homes.** The goal is to gain a deeper understanding of what

these processes look like in action. Because I do not work in your industry, I may ask you to explain or clarify certain things to me as we go along.

- I also want to thank you for completing the **pre-interview activities** (questionnaire, photos/videos). Everything you shared was very helpful, and I have some follow-up questions that I'll be asking you today.
- This discussion should last **60-minutes.** I do have a lot of questions for you, so I will sometimes try to **keep up the pace** to make sure we get through everything and we finish on time for you.
- Do you have any questions at all? Ok let's get started!

II. About you, your role and organization — 3 mins

1. Firstly, I'd like to learn a little about yourself. Without sharing identifying information and just speaking generally, can you please tell me:
    - Your first name only (no last names)
    - Which state, and county in that state, you work in
    - Your specific role and responsibilities at work

III. Re-cap on current business practices (from pre-work questionnaire) — 5 mins

Objectives of this section: To re-cap and seek clarification on contractors' questionnaire responses. This section should be quick as most questions should be pre-answered, but some elaboration may be desired.

Thanks again for completing the questionnaire before the interview today. I'd like to re-cap on a few of your answers:

[Moderator will probe/seek clarification on the contractors' responses to the below questions as needed.]

2. Thinking about your work to install **central HVAC systems** in a typical residential project, **approximately what proportion of your time** is spent on sales, vs. design, vs. installation? [If needed, cross-check with screening answers]
    - Do you work solo or in a team?
    - How often/when are subcontractors involved?
    - Who focuses on which aspects of the sales, design and/or install process?
        i. To what extent is there collaboration between you? [Gather overview only, then deep-dive during process exercise]

3. **<u>For those who install heat pumps (not just furnaces)</u>** And, approximately what proportion of your heat pump installs are for **new homes, vs. to existing homes?**
    i. Why is this the case? [Listen for: If customer-led, code related, intentional business strategy, other]

4. **Let's re-cap on the different types of heat pumps** your organization sells and installs for residential homes, and the estimated share of sales/installations for each type currently.
    i. [If not covered] How would you divide up the pie? Even if you make your best guess.

m. Ducted single-speed and multi-stage heat pumps	%
n. Ducted variable speed heat pumps (AKA variable capacity heat pumps and inverter-driven heat pumps)	%
o. Ducted hybrid gas/electric or dual fuel heat pumps (like an electric heat pump combined with a gas furnace)	%
p. Single zone mini-splits (AKA ductless heat pumps)	%
q. Multizone mini-split (more than one indoor unit)	%
r. Other (Please specify: _____)	%

[Probe fully on the breakdown]

- Why does the **breakdown** look like this? Why are some more commonplace to sell and install in residential homes over the others?
- **For ducted Variable Speed Heat Pumps**: Why are sales at this level currently?
    i. If expected increase: Why do you say this?
- **For multizone mini-splits:** What indoor equipment have you paired with an inverter-driven outdoor unit? In what situations are heat pump + air handler combinations a good solution?

IV. Core values and priorities — 10 mins

Objectives of this section: To gain a rich understanding of the contractor's ingoing mindset, core values, and priorities when selling/designing and/or installing residential central HVAC systems. A combination of unaided and aided exercises, coupled with deep and strategic probing, will seek to unearth any conscious or subconscious factors that impact on contractors' choices and behaviors.

5. **Automatic writing exercise:** Unaided exercise to understand contactor's deeper values and priorities

Now I'd like to understand more about what the process of [sales/design/install] of central HVAC systems in residential homes looks like in reality. The first thing I'd like to ask you to do is a **short writing exercise.** I'm going to ask you a question, and I'll give you 1 minute for you to write down your immediate thoughts. Don't think it through too much. Please be totally honest, and just let any thoughts that come to your mind flow onto the page.

I'll ask you to take yourself back to a situation where you're dealing with a new client who wants to [select/ buy/install] a central HVAC system in their home. Think about who they are, as well as what you hope to achieve.

Think about this scenario for a moment: **"When I first deal with a new client who is looking to [select/buy/ install] a central HVAC system for their home, my first thoughts and priorities are….".**

Now finish this sentence, writing down all your thoughts for 1 minute.

[Moderator times 1-minute]

Great. Thank you for that. Please can you read for me what you wrote?

- What is most important to you when dealing with a new residential heat pump project? What is your number one priority? Why?
- What are your other goals and priorities? Why?
- How might this vary from project to project, customer to customer?

[Probe fully to understand contractor's mental decision and evaluation process, goals, values, priorities, biases, etc. – whether they lean more toward consciously or subconsciously seeking economic reward, logistical advantages, time investment, customer needs and satisfaction, etc.]

6. **"Quick flash" Scoring:** Aided exercise to understand the extent to which key criteria impact on contractors' choices and behaviors.

I'm now going to share some criteria we came up with, which **may or may not impact on the selection of heat pumps for your residential customers**. I'd like to go through each, one by one, and please tell me how impactful each criterion is to you personally, out of 5 (where 5 is most impactful, and 1 is not at all impactful). I want you to really think about **what really matters to ***you*, *not* to your team or company** – but **what is it that ***you*** genuinely care most about.**

We'll be going through each quickly, so please tell me the score that automatically comes up for you.

[Criteria will be exposed on screen for ~3 seconds each, one by one. Order will be rotated for each interview]

Easy to sell to the customer

Low cost of equipment

Reliable with no or few call backs

Readily available (in stock)

Easy/quick to install

Easy to service

Recurring service income

Lower fuel costs for customer

Matching the customer's existing HVAC system

Equipment brand

- **For the top 3 scoring:** Why are these factors most important to you?
- **For the medium scoring:** Why are these factors less important to you?
- **For any low scoring:** Why are these factors not important to you?

[Probe fully to understand relative importance of each criterion to the contractor, all reasons behind this, triangulating with outcomes of the writing exercise as relevant, to gain a full picture of the contractor's core values and priorities, and the drivers of these]

7. **HOMEOWNER NEEDS:** [If not yet covered] Let's talk a little about the homeowners needs and values when it comes to the selection and purchase of central HVAC systems for their homes. To what extent do they play a role in your recommendations and approach?
   - Which homeowner priorities or values do you **most** care about meeting?
   - Which of their priorities **matter less**? Why?
   - Are there any situations in which a homeowner's desires/values **are misaligned** with yours, and, if so, how do you manage this? How does this affect the decision-making process?
   - If you were to paint the picture of **the ideal homeowner** for central/ducted HVAC projects, what would they be like? What attributes would they have? What attributes would their home have?

V. Drivers and barriers to VSHP uptake — 10 mins

Objectives of this section:

- **To address RO2:** Determine any barriers or drivers for VSHP adoption, including current practice alignment with NEEA's current understanding of best practices for VSHPs.
- **To address RO3:** Identify HVAC contractors who are or are likely to be early adopters of VSHPs, and their attributes.
- **Note:** This section is intended to come before the process discussion as their pre-work is likely to cover different types of products.

I'd like to circle back to discussing variable speed heat pumps (VSHPs, also known as inverter-driven heat pumps) in particular.

8. **If they do sell VSHPs:**
   - [Lower priority] For **how many years** has your current organization been selling VSHPs?
   - What made you/your organization decide to add them as a product offering? What was the "**trigger**"?

- In your mind, what are the **key benefits and/or drawbacks** of VSHPs for your company? For your customers? [Formulate list]
- [If not yet covered] What are some **common errors** or problems you have seen with VSHPs?
- In what **kinds of situations** would you/wouldn't you **recommend a VSHP** to a customer? Why?
    i. What is the **ideal homeowner** for a VSHP? What attributes would the ideal homeowner have?
    ii. What is the **ideal house** type for VSHPs?
    iii. What **types of existing equipment/equipment** upgrades might impact your VSHP recommendation?
- **How often** do you sell VSHPs? How easily do they sell?
- How often are you selling or being asked to install **VSHPs paired with gas furnaces (dual fuel)**?
    i. What's the ideal application of this type of system?
- In your mind, **what, if anything, would lead to greater volume of sales of VSHPs?**
    i. What are the **key factors holding back more sales** of VSHPs?
    [Probe fully to understand all barriers to selling VSHPs and begin identifying opportunities to overcome these]
- [For **anyone** who sells **any type of HP**:] Have you ever had any **training on VSHPs**? What specifically was the training focused on?
    i. Probe: VSHP sales, **sizing** and/or **installation** and/or **controls**, including 3rd party thermostats

9. **If they don't sell VSHPs:**

- Are you **familiar with VSHPs**? (If familiar) In your opinion, what are the advantages or drawbacks?
- For what reasons do you/your company opt for **single or two-speed solutions** more frequently?
    i. When are **other options (non-VSHP options) a better choice** for the customer? Better choice for the company? Better choice for the installer?
    ii. What advantages do **single or two-speed heat pumps** have over VSHPs, in your opinion?
    iii. How often are you selling or being asked to install heat pumps with gas furnaces?
        - What's the ideal application of this type of system?
- What are the **main reasons you do not sell** VSHPs? [Probe fully to understand all barriers to selling VSHPs and begin identifying opportunities to overcome these]
- What are your thoughts on **potentially adding VSHPs** as a product offering in your business in the future? What would you need to see/know for this to happen? What would it take?

VI. The sales/design/install process in action — 30 mins

Objectives of this section:

- To address RO1: Characterize current sales, design, and installation practices of residential HVAC contractors for central/ducted HVAC systems (including VSHPs)
- **Note:** Questions in this section will be tailored based on the contractor's pre-work submissions (photos/videos). Relevant pre-work materials will be exposed on the screen as a visual aid.

I'd now like to switch gears and talk about the steps involved in the [sales / design/ install] of residential heat pumps in more detail, so I can understand what the process looks like in action. For this part of the conversation, we may refer to the pre-work you shared with us.

SALES & DESIGN PROCESS [ONLY FOR SALES & DESIGN SEGMENT]

10. **SALES PROCESS:** Tell me what happens when a new customer comes to you seeking a quote or information to install a new HVAC system in their home. What is the **step-by-step process**?
    - ☐ From having dealt with a range of **different customer types**, are you ever able to **infer a customer's wants or needs** by certain characteristics they may have?
        i. What **kinds of inferences** might you make, based on what types of attributes?
    - ☐ [Lower priority] How **informed** are customers about types of HPs available?
    - ☐ What are customers' **biggest questions** and needs the first time you speak with them?
    - ☐ Before making a purchase decision, what do you think are they **evaluating in their minds**? What are triggers for the purchase?
    - ☐ [Lower priority] What is the **usual amount of time** between initial consultation touchpoint and their decision to purchase?

11. **DESIGN PROCESS:** I'd now like to understand how you make your design decisions for new or replacement central HVAC systems in residential homes. What are all the factors you consider?

    [Bring up pre-work responses to the screen as a visual aid]

    - ☐ Which of these are most important? Why?
    - ☐ Which are less important? Why?

    [If not mentioned, listen for/Probe:]

    - ☐ Home layout
    - ☐ Installation site selection
    - ☐ Technical considerations
    - ☐ Customer needs or preferences

- Available inventory
- Trust in brands/products
- Business/profit needs
- Existing systems
- Existing ducts
- Ventilation or Indoor Air Quality needs

- [If not yet covered] What are your **typical steps** in the design process? [Listen for/probe: Detailed heat loss calculation**,** modification to duct system]
- Do you **separate the design portion from the sales portion**? Who is responsible for what? (E.g., Job manager, vs. salesperson)

12. **PRODUCT SELECTION:** How do you typically go about selecting a HVAC product/system for a particular house? What does the selection process involve?
    - To what extent do **brands** play a role for you? Which ones do you lean more toward, if at all? Why?
    - Do you tend to lean toward **particular models**? Which ones, and why? Under which circumstances?
    - [Lower priority] To what extent does the **energy efficiency** of the system play a role for you? In what situations does this matter more, or less? Why?
    - [Lower priority] How do you go about deciding what **type of fuel** to use? [Probe/listen for: If existing is gas, do they stick with gas?]
    - **"Good, better, best" list:** To help me understand how these products differ for you, let's separate them out as good, better or best:
        i. **GOOD:** Which models or brands are at one end of the scale, "good" and do the job, but you don't consider these to be better or best?
        ii. **BETTER:** Which would you say fall somewhere in between? Why?
        iii. **BEST:** Which models or brands would you say are "best"? What makes these best? (Listen for/probe around criteria like performance or cost or particular features)
    - In your opinion, how does **performance** differ for one stage vs. two stage vs. variable speed heat pumps?

13. **SIZING PROCESS OVERVIEW:** Let's now talk about how you would typically size HVAC equipment, including heat pumps for a typical residential project? Please talk me through the process, **step by step**.

[Use pre-work submissions as needed, and probe on key parts of the process/areas of particular interest]

- What are all the **key factors** you consider in sizing? [Compile list]
- Which of these factors are **most important**, and why?
- Which are **less important**?
- Which are easier to do, versus harder? Why?
- (if time allows) Which sizing aspects are most likely to be **done incorrectly?** What is the impact if done incorrectly?

[If not mentioned, probe: Size of the house, window types, condition of the ducts, cold/hot weather temperatures]

- Do you use any **software or service** to help you with sizing? What is the name of it? How do you use it? In what ways does it help you?

Note: The following questions are intended as a deep-dive to gain more detail into specific sizing practices. For contractors' pre-work that relate to VSHPs, we will seek to ascertain the extent to which current practices align with NEEA's 5-Star System guidelines.

14. **DUCTS:** Do you ever **evaluate the existing ducts** in a home? In what types of situations? Please walk me through what you do regarding ducts.
    - What do you do to **evaluate existing duct conditions**?
    - How often do you evaluate **duct leakage**?
    - What do you do to **evaluate return air ducting**?
    - [Lower priority] In a simple **'push/pull' simple replacement job**, are the ducts usually evaluated? Why/why not?
    - How does ductwork affect your **proposed bid/design**?
        i. How much duct leakage do you assume?
        ii. How does ductwork affect your equipment choice?
        iii. How often do you recommend duct sealing and insulation is done when a system is replaced?
        iv. In what situations do you seek to improve/modify ducts, versus not?
    - What is the process of **improving or modifying** them, if at all? (Listen for: duct location in an unconditioned space, duct insulation, leakiness/sealing)
    - Do you ever get **subcontractors** to help with the existing ducts? Under which circumstances?
    - In situations where you must **modify or fix existing ducts**, how does that impact on the overall project timeline, if at all? Or on other aspects of the project?
    - Are there ever any **customer barriers** to duct improvements that you face? (E.g., cost?) How do you deal with those?

15. **BACK-UP HEAT:** We are interested in understanding your approach to using backup heat with heat pumps. Of special interest is how you may use electric resistance heating differently depending on the type of heat pump or situation.
    - **What type of backup heat** do you most commonly use with Heat Pumps (HP)s?
        i. How do you **size backup** heating systems?
        ii. For VSHPs specifically, do you ever install them **without backup heat**? Why?
    - **For electric backup (strip heat) systems only:**
        i. What is your **typical design** for backup heat?
        ii. Do you employ a **lockout temperature** above which backup heat is not used?
            1. What lockout temperature do you use?
            2. How does this differ depending on the type of heat pump (VSHP, single stage)?
        iii. What do you **tell customers** about backup heat (if anything)?

16. **CONTROLS:**
    - **Which thermostats** do you use with heat pumps? Why these types? If more than one type, in what situations do you recommend each?
    - [Lower priority] **Do customers ever make requests** about the types of thermostats they want or are interested in? Which ones?
    - [Lower priority] Do you ever use **different thermostats** for heat pumps vs. for other systems?
    - How often do you use **"third party" integrations** that can control multiple systems?

17. **EXISTING HEATING SYSTEMS:** What do you usually do with the **existing heating systems** in a home?
    - When you're going into a house that previously had electric baseboard systems, what do you typically do with them? Remove or keep?
    - What if they are **central** heating systems? Remove or Keep? [Note: Typically removed]
    - What if they are **ductless?** [Note: Typically keep]
    - [If system is kept in the house] How, if at all, is it then integrated with the new system? (Probe for: leaving electric resistance heaters in place, using an **existing gas furnace**)

INSTALLATION PROCESS [ONLY FOR INSTALLATION SEGMENT]

Now I'd like for you to walk me through a typical installation process, step by step. We can refer to the example you documented in your pre-work, or a recent installation you did.

Note: Questions here will be tailored based on the contractor's pre-interview responses covering the steps in the process, but would include the following:

18. **PREPARATION**

- What do you typically do to **prepare**?
- What do you **tell the homeowner** about what to expect?

19. **GOING TO THE HOME**

- How big is **the crew**, how does this vary by size of home/size of system? [Note: This process may be referred to as "Push/pull"]
- What are the **types of conversations** you have with the homeowners? (E.g., Introductions, explanations, what to expect)
- What **equipment** do you take with you?

20. **SIZING /EVALUATION**

- Do you take any additional **sizing/evaluation steps** immediately prior to installation? What might this involve?

21. **HOUSE/CONSTRUCTION FACTORS**

- Do you ever face **unexpected issues or pain points** regarding the house's existing construction? What types of issues?
- Do you ever arrive on site for the install and find the system designed and **bid would not be sufficient** due to over or under sizing? (If yes) How did you fix that issue?

22. **INSTALLATION**

- Walk me through the key steps of the **actual installation**. What are all the things you do, step by step?

  [Probe/listen for:]

- Prepare the site/place down covering
- Removal of the old system (if central system)
    i. [If remove] What do you do with them? Re-sell?
- Install the physical components of the inside and outside units
- Needed electrical work
- Install the thermostat
- Install the line-set
- Evacuation and charge
    i. **How long does typically take**? How do you assure you have the complete evacuation of the line-set? (Listen for: using a vacuum to clear it out)
    ii. Charging a system: How do you determine the needed **amount of refrigerant** for the system?

- Clean up
- Paperwork, photos, or any documentation

23. **QUALITY CONTROL:** Tell me about any **quality control** steps you typically take. What do they involve?
    - What about long-term quality control?
    - To what extent do you or your company keep track of quality control issues? Which ones? What do you do with that information? What kinds of **equipment commissioning tools** do you use (Listen for/Probe: A checklist, connected diagnostics like Fieldpiece and Measure Quick, using the equipment set up sequence, checking fault codes, etc.)? How valuable are these tools to you?

24. **Post-INSTALLATION CUSTOMER CONVERSATION**
    - After the install, what, if anything, do you **talk about with the homeowner** about the system?
    - Is there anything you **educate the homeowner about**? What are the key things you explain to them? [Listen for: Filter cleaning, filter changing, night-time set-backs, continuous fan operation]
    - For heat pumps: What specifically do you tell the homeowner about how the system will operate?
        i. What, if anything, do you tell them about maintenance needs for the outdoor unit?
    - How often do you offer or recommend a **maintenance service package**?

NOTE: For each key step and specific areas of interest, we will probe to understand:

- How the criteria they value most (discussed in section IV) impact on the different stages of the process
- Extent to which the process is "typical" or how it differs for other models of HVACs/Heat pumps, especially VSHPs
- Pain points and troubles they run into, how often they happen, what they do to mitigate and resolve the issues
- Factors that make the process easier and simpler

25. **FOR VSHPs (if installation process did not cover VSHPs):** Thinking about VSHPs again, in what ways does the installation process differ to the example you just shared with me?

[Probe fully to identify all barriers and the context around these]

VII. WRAP UP AND CLOSE

That's all the questions I have for you today. Thank you so much for participating in this research!