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Dual Fuel and Gas Heat Pump Market Research

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Table of Contents

Table of Tables

Table of Figures

Acronyms Used Throughout This Report

DFHP = Dual Fuel Heat Pump

GHP = Gas Heat Pump (for residential or commercial applications)

DFRTU = Dual Fuel Roof Top Unit

RO = Research Objective

IDI = In-Depth-Interview

HVAC Contractor SB = Small Business (< 10 employees)

HVAC Contractor LB = Large Business (> 10 employees)

Commercial Buyer SB = Small Business (< 100 employees)

Commercial Buyer LB = Medium and Large Business grouped into one cell (MB = > 100 employees, LB = > 500 employees)

1. Executive Summary

The Northwest Energy Efficiency Alliance (NEEA) and its Natural Gas Team are studying four emerging HVAC technologies to determine which, if any, of these technologies to further investigate for market transformation or other types of energy efficiency programs in their four-state region (with emphasis on Oregon and Washington).

NEEA seeks to gain deep insight into Residential Buyer, Commercial Buyer and HVAC Contractor perceptions and any experience regarding each of the technologies. Findings from the study will complement ongoing NEEA product research to assess product performance and readiness for Northwest markets. The four technologies of interest are:

Technologies for **residential applications** specifically to replace gas furnaces:

1. **Dual fuel heat pumps (DFHPs)** – defined for the purpose of this report as an air source heat pump combined with a gas furnace.
2. **Gas heat pumps (GHPs)**

Technologies for **commercial applications**:

3. **Gas heat pumps for space and/or water heating**
4. **Dual fuel rooftop units (RTUs)**

The main body of this report is organized by technology so readers can easily pinpoint findings specific to each type of HVAC system.

For each of the four HVAC technologies, this study had three primary research questions:

Research Question 1: What are the value propositions for buyers and HVAC contractors which are most relevant and effective?

Research Question 2: What are the possible target markets?

Research Question 3: What are the barriers to adoption?

Specifically for residential DFHPs and GHPs, this study had the following questions:

Research Question 4: What are the drivers for current residential dual fuel HVAC purchases?

Research Question 5: What are residential and HVAC contractor attitudes toward natural gas as a home heating fuel source for GHPs?

This study employed a mixed-method approach comprising a preliminary desktop research phase, which included interviews with NEEA staff, conducted between November 28th and December 2nd, 2022. The next phase comprised interviews with 56 HVAC contractors and residential and commercial buyers conducted between December 29th, 2022, and February 28th, 2023.

In the qualitative interviews, eight residential buyers have experience with dual fuel heat pumps and one with gas heat pumps. Three commercial buyers have experience with dual fuel RTUs and three with gas heat pumps. Among HVAC Contactors, five have residential market experience selling/installing dual fuel heat pump and three with residential gas heat pumps. Ten have commercial market experience with dual fuel RTUs and two with commercial gas heat pumps. A total of 42 respondents are located in

Northwest (with nine located in Idaho and Montana); and five from outside the region (two in Canada and three in Utah).

1.1 Key Findings and Insights

Market demand exists for all four technologies, but dual fuel has an edge over gas heat pumps.

Market demand exists for both dual fuel and gas heat pump technologies in the residential and commercial sectors. However, there is a stronger opportunity for dual fuel technology.

Cooling capability and decarbonization are important value propositions.

Throughout the Northwest there is a growing desire for cooling capability (especially among the residential sector) and growing social interest in carbon footprint reduction. These two factors combined drive interest in dual fuel technology given its hybrid fueling approach as compared to being strictly gas-fired.

Efficiency, capacity in cold weather, and value for service delivered are consistently valued.

There are value proposition commonalities that exist across the four technologies. Energy efficiency and carbon footprint reduction are both considered important and can be satisfied by any of the technologies. What separates the technologies from the buyer perspective are the ability of dual fuel technology to provide cooling - a highly desired attribute in the Northwest. Also valued is high capacity and the ability to deliver hot water vis-à-vis gas heat pump technology.

Buyer segment HVAC needs differ.

Residential and commercial buyer HVAC needs and purchase decisions are driven by different requirements. Residential buyers are driven by the desire for a continued level of comfort in the home and to reduce HVAC fuel costs. Many also express concerns over the environment so they are conscious of the carbon footprint associated with an HVAC technology.

Commercial buyers are heavily driven by total cost and realizing an improved return on investment – encompassing upfront costs, maintenance, and reduced HVAC operating costs. Comfort also plays a role with these buyers as an improper climate within a commercial property can impact productivity. Carbon footprint reduction for many, while important, is often secondary to cost. Conversely, there are those (particularly in Washington state) whose purchase decisions weigh heavily on the amount of decarbonization an HVAC system delivers.

Residential buyers are neutral toward natural gas, whereas commercial buyers prefer it.

Overall natural gas is perceived by almost all as being more efficient than electric. In terms of preference, the majority of residential buyers are neutral toward natural gas, with only sub-groups of younger (under 40) and more affluent ($75K +) individuals being anti-natural gas, and older and less affluent buyers being pro-natural gas.

A summary of the four technology value propositions and barriers to adoption are presented in Table 1 and are discussed within the body of this document.

Table 1. Summary of dual fuel and gas heat pump technologies value propositions and barriers to adoption by technology and segment

	Residential Buyers	
	Dual Fuel Heat Pump	**Gas Heat Pump (residential application)**
Value Proposition	1. Energy efficiency resulting in lower fuel costs. 2. Heating and cooling comfort from one system resulting in continuous comfort. 3. Reduced carbon footprint.	1. Energy efficiency resulting in lower fuel costs. 2. Reduced carbon footprint.
Barriers to Adoption (from higher to lower concern)	1. Lack of awareness – won't proactively seek out technology 2. Buyers assume newer HVAC technology will incur higher upfront costs. 3. Some buyers express concern over hybrid system reliability. 4. Some buyers express concern over the physical footprint of a DFHP. 5. Unanticipated additional installation costs resulting from the need for electrical panel upgrades.	1. Lack of cooling capability 2. Perception better suited for cold climates. 3. Negative perception of natural gas for some. 4. Concern over space requirements (physical footprint). 5. Need demonstrated proof of significantly improved energy efficiency and fuel cost savings over existing gas furnace.
	Commercial Buyers	
	Dual Fuel RTU	**Gas Heat Pump (commercial application)**
Value Proposition	1. Total lower cost of ownership and improved ROI. 2. Space conditioning - continued comfort within the commercial property. 3. Carbon footprint reduction.	1. Greater energy efficiency and higher capacity – enhanced comfort and lower operating costs. 2. Ability to deliver both hot water and space conditioning – simplicity and cost savings can be recognized. 3. Carbon footprint reduction – may help to move some less open to using natural gas technology toward utilizing GHPs.
Barriers to Adoption (from higher to lower concern)	1. Potential upfront cost and installation. 2. Unfamiliarity with product performance. 3. Concern about hybrid system effectiveness. 4. Concern over system durability and maintenance requirements. 5. Concern over system physical footprint and weight.	1. Concern over total cost of ownership (TOC) - needs to offer functional benefits at a lower TOC. 2. Concern over gas heat pump reliability/durability. 3. Unknown maintenance and repair frequency and associated cost. 4. Does not offer cooling capability. 5. Preference to replace like with like technology.

Table 2. Summary of dual fuel and gas heat pump technologies value propositions and barriers to adoption by technology and segment (cont.)

	HVAC Contractors			
	Dual Fuel HVAC (residential)	**Gas Heat Pump (residential)**	**Dual Fuel RTU (commercial)**	**Gas Heat Pump (commercial)**
Value Proposition	1. Provides heating and cooling from a single HVAC system - no need for a separate A/C unit. 2. No need for electric back-up heating installation. 3. Can reduce the carbon footprint.	1. Improved energy efficiency over a gas furnace. 2. Delivery of high-capacity heat. 3. Fuel flexibility offering expanded market opportunity. 4. Ease of use vis-a-vis smart controls. 5. Buyer can continue to utilize natural gas and reduce emissions.	1. Increased energy efficiency over existing RTUs – can result in reduced HVAC operating costs. 2. Carbon footprint reduction.	1. Greater energy efficiency and higher capacity – enhanced occupant comfort and lower operating costs. 2. Ability to deliver both hot water and space conditioning – simplicity and reduced operating costs can be recognized. 3. Carbon footprint reduction – can help to meet carbon neutral codes or goals.
Barriers to Adoption **(from higher to lower concern)**	1. Unfamiliarity or unfavorable prior installation experience. 2. Residential buyers who have access to natural gas but are not connected – could add too much cost for the buyer. 3. Resistance to newer technology among older residential buyers (65+) 4. A residential buyer may not stay in their home long enough to recognize energy efficiencies.	1. Need proof of energy efficiency and performance compared to gas furnace. 2. Potential impact of carbon neutral codes. 3. Use of ammonia as refrigerant in GHP. 4. Residential buyers not already connected to natural gas.	1. Need proof of reliability & durability. 2. Potential supply chain issues 3. Limited knowledge of product & insufficient training. 4. Potential for no available rebates/tax credits to help offset cost. 5. Concern over natural gas restrictions. 6. Uncertainty about energy efficiency. 7. Concern that installation can incur even higher costs.	1. Reliability and durability of the system – need proof of superiority to gas furnace. 2. Potential supply chain issues – product, parts and support. 3. Carbon neutral codes in Northwest. 4. Commercial buyer unwillingness to add natural gas to buildings. 5. Unless asked for, HVAC contractors often engage in little consultative selling with commercial buyers (except for commercial property managers. 6. Concern over refrigerant utilized.

1.2 Recommendations

1.2.1 Addressing Barriers to Adoption and Exploiting Value Propositions

There are a number of barriers that exist for all four technologies that need to be addressed in order to improve the acceptance of these products in the marketplace. Some of these barriers are common across technologies and some are specific to each of the technologies themselves. The recommendations below address these barriers and offer suggested courses of action.

Addressing common barriers across all four technologies

Cost, proof of reliability and durability, energy efficiency and resultant fuel cost savings are all barriers that will need to be addressed across all of the technologies and markets in order to facilitate adoption.

1. ***Buyers focus on price, therefore the cost of the technology needs to be justified by clearly demonstrating not just the physical, but the financial benefits.***

Work with partners to promote to buyers the ability to save on fuel costs and demonstrate through development of head-to-head HVAC technology comparisons, case studies and end-user testimonials. Encourage utilities to help increase awareness of dual fuel and gas heat pump technologies and offer customers tax credits and rebates; while also encouraging manufacturers and distributors to extend buyers different credit/financing options to help offset upfront costs.

2. ***Build greater awareness and confidence in the technologies among buyers and sellers.***

Work with HVAC contractors and manufacturers to facilitate site visits or establish small pilot programs to help build their confidence with dual fuel and gas heat pump technologies. Also consider the development of short informational videos. Additionally, encourage manufacturers to create attractive extended warranties to further build contractor confidence. The development of dual fuel and gas heat pump technology certification programs should also be encouraged among distributor and manufacturing partners.

3. ***Work with partners to actively address any concerns or hesitation regarding the use of natural gas and extoll carbon footprint reduction provided by the technologies.***

Encourage partners to promote how both dual fuel and gas heat pump technologies can help to reduce carbon footprint and how these fit with a growing buyer demand for decarbonization and to be able to meet new carbon neutral goals. Also keep partners up to date on current carbon neutral codes in their respective markets.

4. ***Address any buyer apprehension about reliability of dual fuel and gas heat pump technologies***

Buyers will be apprehensive toward what they perceive as newer technology and they need to be reassured that dual fuel and gas heat pump technology is as, if not more dependable than current HVAC technology. Concerns about maintenance requirements also need to be addressed, especially among commercial buyers as they have a heightened concern in this area.

Residential Dual Fuel Heat Pump Recommendations

1. *Promote heating and cooling capability from a single HVAC system.*

Encourage partners to heavily promote DFHP ability to provide continuous heating and cooling comfort from a single system, meeting the growing need of cooling capability among buyers in the Northwest and eliminating the need for a separate A/C system.

2. *Promote fuel cost savings.*

Encourage contractors and utilities to emphasize in their promotions how DFHPs can save residential buyers in fuel costs. Provide head-to-head comparisons to competitive technologies. Also emphasize the technology as a means of meeting today's modern residential HVAC needs – these buyers expect newer technology will always provide improvements.

3. *Accurately convey spacing requirements for DFHPs.*

Encourage partners to provide physical footprint requirements for DFHP which will help residential buyers more easily assess if they have room to install the technology.

Gas Heat Pumps (Residential and Commercial)

1. *Promote lower HVAC operating costs.*

Encourage partners to educate buyers on how GHPs utilize less natural gas which will serve to recognize lower HVAC operating costs and help to counteract any hesitancy among those who may be uncertain about wanting to use natural gas as a home heating source.

Exercise caution using the phrase 'high capacity' among residential buyers when associating with heat as most buyers associate this as meaning that GHP technology is best suited primarily for those in very cold climates only.

2. *Address how and in what geographies technology can meet carbon neutral codes.*

Work with partners to develop means of assuring technology can meet stricter decarbonization mandates and building regulations.

3. *Promote the ability to deliver heat and hot water from a single HVAC system.*

Discuss with partners and strongly consider as a key aspect to promote to buyers. The ability to also provide hot water will generate appeal to both commercial and residential buyers, and for some of the latter can compensate for the GHP's lack of cooling capability.

4. *Emphasize fuel flexibility when promoting GHP technology.*

This will have particular appeal among contractors as it expands their potential market opportunity beyond just those who utilize natural gas.

Commercial Dual Fuel RTU Recommendations

1. ***Promote an improved return on investment among commercial buyers and selling partners.***

Work with partners to develop case studies or white papers that illustrate how DFRTUs can lower total cost of ownership – highlight how energy efficiency can reduce HVAC operating costs and the lack of need to install a back-up resistance element for the indoor unit further helps reduce total cost of ownership. This will also help to support the contractor sales pitch.

2. ***Work with commercial buyers and contractors to increase awareness of the continued level of comfort offered by DFRTU technology.***

Encourage partners to educate and promote how DFRTUs maintain a comfortable temperature within a commercial workspace, no matter the outside temperature; which helps to support worker productivity.

3. ***Work with partners to address concerns over reliability and durability of hybrid technology as well as product footprint and weight.***

Support the development of informational literature and/or videos to reinforce the reliability of hybrid technology to alleviate buyer concerns of system wide failure among commercial buyers. Also provide detailed information on product size and weight specifications to address commonly requested information by commercial buyers.

2 Introduction, Research Questions and Methodology

Introduction

The Northwest Energy Alliance (NEEA) and its Natural Gas Team are evaluating four emerging HVAC technologies to determine which, if any of these technologies to further investigate for market transformation or other types of energy efficiency programs in their four-state region (with emphasis on Oregon and Washington).

NEEA seeks to gain deep insight into Residential/Commercial Buyers and HVAC contractor perceptions and any experience regarding each of the technologies. Findings from the study will complement ongoing NEEA product research to assess product performance and readiness for Northwest markets.

The four technologies of interest are:

Technologies for residential applications specifically to replace gas furnaces:

1. Dual fuel HVAC (DFHPs)
2. Gas heat pumps (GHPs)

Technologies for commercial applications:

3. Gas heat pumps for space and/or water heating
4. Dual fuel rooftop units (RTUs)

The main body of this report is organized by technology so readers can easily pinpoint findings for each of the four HVAC systems. Overall conclusions and recommendations follow the four findings sections.

Research Questions

For each of the four HVAC technologies, this study had three primary research questions:

Research Question 1: What are the value propositions for buyers and HVAC contractors which are most relevant and effective?

Research Question 2: What are the possible target markets?

Research Question 3: What are the barriers to adoption?

Specifically for residential DFHPs and GHPs, this study had the following questions:

Research Question 4: What are the drivers for current residential dual fuel HVAC purchases?

Research Question 5: What are residential and HVAC contractor attitudes toward natural gas as a home heating fuel source for GHPs?

Methodology

Desktop Research

Lieberman Research received several documents from NEEA for review purposes. In addition to these documents, Lieberman conducted n=4 stakeholder interviews occurring between November 28th and December 2nd 2022, and conducted an online search to find supplemental information to support this review.

Lieberman Research reviewed all documents, qualitative interview findings, and documents located via online searches to identify major barriers of the four HVAC technologies. The team also reviewed the documents to gain an overall market perspective.

All information was collated, synthesized, and then summarized by specific technology and both the Buyer and HVAC Contractor perspective.

Recruitment for In-depth Interviews (IDIs)

Sample Target Quotas

Lieberman and NEEA established quotas for all three primary segments and their subsegments. Business size for the commercial segment is defined as 1) Small businesses – having 1 – 99 employees and 2) Medium/Large business – having more than 100 total employees.

Table 3. Sample target quotas

Segment	Rural (n)	Urban (n)	Total IDIs (n)
Residential Buyers			
Dual fuel heat pump owners	3	5	**8**
Recent HVAC purchasers	3	5	**8**
HVAC purchase intenders	4	5	**9**
Sub-total	***10***	***15***	***25***
Commercial Buyers			
Small businesses	1	2	**3**
Medium/large businesses	4	8	**12**
Sub-total	***5***	***10***	***15***
HVAC Contractors			
Small business HVAC contractors (< 10 employees)	4	1	**5**
Large business HVAC contractors (> 10 employees)	4	7	**11**
Sub-total	***8***	***8***	***16***
Total # of IDIs			**56**

In-depth Interviews

56 interviews were conducted with residential buyers, commercial buyers, and HVAC contractors. Interviews were 60-minutes in length and were conducted over Discuss.IO, an interactive web-enabled platform. The research teams from NEEA and Lieberman Research were able to view the interviews in real-time and communicate with the moderator and each other through the available chat feature of the platform. Interviews were conducted between December 29th, 2022, and February 28th, 2023.

Table 4. Interviews by respondent location

State/Province	Residential Buyers	Commercial Buyers	HVAC Contractors	Total Respondents
Washington	19	6	3	28
Oregon	3	3	8	14
Idaho	1	3	1	5
Montana	0	1	3	4
Utah	1	2	0	3
British Columbia	0	0	1	1
Toronto, Canada	1	0	0	1
Total	**25**	**15**	**16**	**56**

Residential Buyers were recruited based on the following:

- Respondents reside within Oregon, Washington, Montana and Idaho (per heating zone map). The majority (maximum approximately 75%) of respondents are to be from Oregon, Washington, and Idaho. For Residential Gas Heat Pump respondents, also include Utah and Canada (as per NEEA's request, given the very low incidence of residential gas heat pumps in the region).
- A mix of gender and race.
- A mix of ages with the minimum qualifying age being 21.
- Qualified respondents must be the person in his/her home responsible or influential in the decision-making process regarding selection and purchase of an HVAC system.
- All must have experience with gas furnaces (their current or prior home was heated by a gas furnace within the last 2 years).
- A mix of annual household incomes. Residential Buyer annual household income ranges recruited:
    - 12% are $35-$50K;
    - 28% $50-$75K;
    - 36% $75-$100K;
    - 20% $100-$150K; and
    - 4% $150K or higher.
- Equal urban vs. rural representation.

Three residential segments were also recruited, and quotas were established:

1. Consumers who have a dual fuel heat pump at home. (Target quota n=8.)
2. Consumers who recently purchased a home HVAC system within the last 12 months. (Target quota n=8.)
3. Consumers who intend to purchase a home HVAC system within the next 12 months. (Target quota n=9.)

Commercial buyers were recruited based on the following:

- Respondents are located in Oregon, Washington, Montana & Idaho. The majority (75% or more) of respondents are from Oregon and Washington.
- Qualified respondents are the business owner/key decision makers/senior individuals responsible for the selection and purchase of HVAC systems for their commercial properties.
- All have experience with gas furnaces (e.g., their current or former commercial building is heated with gas).
- All are able to speak to HVAC system technologies, and knowledgeable in one type of commercial property (e.g., retail).
- Equal urban and rural representation.

Two sub-segments by business size and urbanicity were recruited for the commercial buyers segment, and quotas were established:

1. Small businesses (<100 employees). (Target quota n = 6.)
2. Medium businesses (100 – 999 employees) and large business (>1,000 employees). (Target quota n = 12.)

HVAC contractors were recruited based on the following:

- Located in Oregon, Washington. Lieberman was given permission by NEEA to include contractors from other regions of the country (Montana, Idaho and Utah) as well as Canada, if these totaled less than half of the sample size.
- All were recruited from within heating zones one through three.
- Qualified respondents are all from organizations that are active sellers/designers/installers of residential and/or commercial HVAC systems (not industrial systems), with ~50/50 split of residential to commercial.
- Qualified respondents are senior/experienced individuals responsible for customer accounts (mix of sales and installation) – minimum 5 years' experience in sales and/or installation.
- Recruitment targeted equal urban and rural representation.

Two sub-segments of HVAC contractors were recruited, and quotas were established:

1. Smaller HVAC contractors (< 10 employees). (Target quota n = 8.)
2. Larger HVAC contractors (> 10 employees). (Target quota n = 8.)

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., including the desktop research). During the analysis, the research team applied a specific focus on uncovering similarities and differences in attitudes and behavior by segments (i.e., residential buyers, commercial buyers, and HVAC contractors), geographic regions, residential buyer age, range of household income, and firm size.

Capturing Aided and Unaided Respondent Reactions to HVAC Technologies

Reactions to the four HVAC technologies were primarily derived through exposure to prepared stimuli given the high level of unawareness of the technologies among study respondents. (The exception to this is existing residential dual fuel HVAC owners. They were specifically targeted and recruited for their experience with this technology.) A three-step process was utilized in our approach:

1. First a slide with the name of the technology to gauge awareness and familiarity was presented to each respondent.
2. This was followed by a slide with a simple explanation of how the technology works to capture reactions and perceived positives and negatives of the technology.
3. Lastly, an aided list of potential advantages was presented to each respondent to determine if that prompted additional thoughts or change in perceptions.

We analyzed both the unaided and aided reactions to determine the drivers, barriers, value propositions of the four HVAC technologies among the different groups of research respondents.

Study Limitations

Due to the qualitative approach and small sample size, the findings from this research offer directional guidance only. Findings in this research are reliant on respondent experiences and opinions. The primary data source for this study is the qualitative interviews; all findings are thus derived from interviewees' perceptions and perspectives.

3 Residential Buyer HVAC Market

3.1 Residential Buyer Market Summary and Trends

3.1.1 Residential Buyer HVAC Needs

1. HVAC technology is considered essential – in-home comfort is a core HVAC need.

Residential buyers consider their HVAC system to be an integral aspect of their home as it keeps the home comfortable. They define comfort as an even, relaxing, and even cozy temperature throughout their living space. It is one of the primary needs these buyers are seeking to satisfy when searching for a new HVAC system.

> *"Comfort is important to me…comfort means that your indoor temperature stays close to constant, it doesn't get too cold or too warm."* (Residential Buyer – Recently Purchased HVAC System, Urban Canada)

2. Carbon footprint reduction is important but not necessarily a purchase driver.

Both the qualitative interviews and our literature review confirm many (but not all) residential buyers believe it is important to lower their carbon footprint. Some perceive carbon footprint reduction to be a secondary need behind their comfort (and for some, behind cost savings).

> *"Reducing the carbon footprint is important for me and going forward it will influence the type of (HVAC) system I will purchase." (Residential Buyer – Recent HVAC Purchaser, Rural OR)*

> *"Being able to reduce my carbon footprint is definitely important to me. It's not the top consideration. But if technology is green and is good for climate change and has less pollution, those are all pluses. And if I were looking at similarly priced systems and one was more green, I would definitely choose that one even if it were, say $1,000 more. I'd pay a little bit more knowing that over 10 years it was helping to reduce the carbon footprint." (Residential Buyer – HVAC Purchase Intender, Urban WA)*

3. Energy efficiency (reducing fuel cost savings) is becoming increasingly important.

Residential buyers desire an HVAC system that will perform more efficiently than what they have currently installed and reduce their fuel costs in the long run – regardless of household income level. When it comes time to replace their existing system, many are hoping for a more energy efficient system – which they expect from any new HVAC technology. Energy efficiency is a primary driver of a new HVAC purchase, provided the upfront and installation cost can be justified by the residential buyer's budget and the amount of fuel savings they can expect to realize.

> *"I really would like to have a system that is more efficient…something that would lower my fuel bills."* (Residential Buyer – HVAC Purchase Intender, Urban WA)

"I was looking for something that would offer me greater efficiency and cost savings. I tried to balance the cost of the new system and what the fuel was costing me and how much I end up saving in total on my new replacement unit." (Residential Buyer - Recently HVAC Purchaser, Rural OR)

4. The desire for HVAC cooling capability is increasing in the Northwest.

Almost all of the residential buyers regardless of geographic location indicate a growing desire for cooling capability in their HVAC system. In particular, those located in Northwest have witnessed an increasing number of hotter summers than in past years. These hotter summers are leading more buyers to seek out cooling solutions to add to their homes. It is not uncommon to hear residential buyers indicate they will not even consider a new HVAC technology if it does not offer cooling capability.

"I want an HVAC unit that will give me both heating and cooling. The increase in warm weather here in Washington state is like…we have never had weather this warm. If my system could do both heating and cooling it would solve the problem of these warmer summers." (Residential Buyer – HVAC Purchase Intender, Urban WA)

"I want a unit to provide heating, but especially cooling…right now air conditioning is a super high priority because in summer it's so hot and sleeping can be difficult. It would be terrific if I could have [an HVAC System] that can give me heat and cooling." (Residential Buyer – HVAC Purchase Intender, Urban WA)

"Being able for my system to also cool is important…we definitely need cooling, it's getting warmer here." (Residential Buyer - Recent HVAC Purchaser, Urban OR)

3.1.2 Desired Improvements in Residential HVAC Systems

1. Current systems are not perceived as energy efficient enough to meet current needs.

Residential buyers desire a more energy efficient HVAC system that allows them to utilize less fuel and ultimately save on their monthly energy spend.

"I wish it would give me even distribution of the heat into each room…for it to be more cost efficient…save me money every month." (Residential Buyer – HVAC Purchase Intender, Rural WA)

"When you're getting a furnace system, it's a major thing, and so I want to get a good quality product and something that is efficient…will reduce my energy costs… we have to be really careful with our money." (Residential Buyer – DFHP Owner, Urban WA)

2. Buyers want a more consistent indoor temperature without having to think about it.

Residential buyers frequently remark their current system does not keep them as comfortable as they would like. It lacks sufficient heating or cooling during hot and cold spikes. Some also express that their

existing system does not keep the whole house at a consistent temperature, with rooms experiencing hot or cold spots. This tends to cause a high level of dissatisfaction with their current 'older' system. They want to set the desired temperature and not have to think about their HVAC system again.

"My current system does not provide me with even heating throughout the house…I would like something that can heat the home evenly…keep me more comfortable." (Residential Buyer – HVAC Purchase Intender, Rural WA.

"I wanted to be able to set my temperature, have it stay at that temperature... I didn't want to hear it. I didn't want to have to be making changes all the time to it. I just wanted it to be very consistent. I didn't want to have to worry about it." (Residential Buyer – DFHP Owner, Rural Idaho)

3. System noise is a commonly heard complaint among many residential buyers.

Almost all residential buyers would like to have a quieter HVAC system. While they claim to have gotten used to noisy HVAC systems, they do take the time to point it out as an annoyance – suggesting it is more of an issue than they claim it to be.

"One of the main issues I had with my older heating system is that it was noisy…you could hear not only in the basement, but up here in this room, too." (Residential Buyer - DFHP Owner, Urban WA)

When I moved into my home, we had an older heating system…a gas furnace…it worked well but it wasn't very efficient…and it was noisy. I wanted to get a newer, more efficient and much quieter system." (Residential Buyer, DFHP Owner, Urban WA)

4. Residential buyers want an HVAC technology that requires less maintenance.

Residential buyers don't want to be concerned over maintenance issues with their HVAC system. They don't want to have to call an HVAC contractor multiple times a year to keep their unit maintained. They want to be able to forget about their unit and have it be as maintenance-free as possible.

"What is really important to me is that it requires less maintenance." (Residential Buyer, HVAC Purchase Intender, Urban Washington)

"I want a system that costs less to maintain…that is easy to maintain, easy to clean…that I can maintain myself." (Residential Buyer – HVAC Purchase Intender, Urban WA)

3.1.3 Residential Buyer HVAC System Purchase Drivers

1. Residential buyers typically wait until they have to replace their current system.

Residential Buyers tend to not replace their existing HVAC system until it reaches the end of its lifecycle or requires a repair that results in a sizeable expenditure. While the mindset to exchange like for like technology exists (primarily among older and lower income households (under <$50K), many expect

newer HVAC technology will provide improved energy efficiency and a higher level of space conditioning capability. This is a result of being 'trained' to expect improvements in each next generation of technology.

"Our last system was old and it finally broke and we decided to have it serviced…and the guy said it would probably be $500 to fix it with no guarantees on how long it would work after that. He said it's already outlived its life. It wasn't very efficient so I didn't want to get the same thing again so I started looking at newer technology…electric heat pumps …I'm very happy with it but it's not as efficient as I would like in the colder weather." (Residential Buyer – Recent HVAC Purchaser, Urban, WA)

2. Awareness of heat pumps is increasing among residential buyers.

While not all are knowledgeable, awareness and interest in heat pump technology is increasing because of what buyers are seeing and hearing in the media and from what they may be told by others they know and trust (family, friends, neighbors). It is the promise of increased energy efficiency and fuel cost savings that is primarily capturing their interest.

"I have a dual fuel heat pump and it was a sound investment. If you can foot the big bill in the beginning, down the line you will end up saving money." (Residential Buyer – DFHP Owner, Urban WA)

"Heat pumps are getting popular now. It's what I am in the market for." (Residential Buyer – HVAC Purchase Intender, Urban WA)

"Heat pumps are modern, more efficient and better for the environment." (Residential Buyer – DFHP Owner, Urban WA)

3. Upfront costs, reliability/durability, and incentives may influence the HVAC purchase decision.

Upfront costs are always a consideration for the majority of buyers and can easily turn them away from an option unless significant energy efficiency is demonstrated and/or rebates/incentives are offered to help offset a higher upfront cost. Incentives are not as important among higher income households (over $100K), but they still can have an impact on their purchase decision if they are evaluating fairly similar options.

The reliability and durability of whatever HVAC technology buyers choose is also an important consideration. It is considered a large and important expenditure and buyers do not want to make a mistake that could reduce or negatively impact the comfort level of their home or incur greater maintenance expenditures.

"I'm price conscious…so price is important. I had an old gas furnace and replaced it with another. It was reliable and the price was right. That was 20 years ago…so looking for something new now…they have this advanced technology available but I don't know…I know the gas furnace is reliable, and if the brand name is good, and the price is right that works for me." (Residential Buyer – HVAC Purchase Intender, Urban WA)

"We chose our system because it offered what we were looking for and the upfront costs were reasonable and a lot less than other choices…especially with the rebates that were offered as part of the purchase. This also influenced my decision." (Residential Buyer – DFHP Owner, Urban WA)

3.1.4 Residential Buyer Attitudes Toward Natural Gas and Decarbonization

1. Natural gas is considered more efficient than electric by most residential buyers.

No matter what a buyer's home heating fuel preference may be, most believe that natural gas is a more efficient home heating fuel source as it is perceived to heat more rapidly and efficiently than electric. Additionally, the gas supply is perceived as being more stable than electric grid. It also has a long and proven track record, and it is readily available to most residential buyers.

"Natural gas is much more efficient than electric or any other heating fuel source." (Residential Buyer – HVAC Purchase Intender, Urban WA)

"Natural gas is more efficient than electric because you get more BTUs burning gas than you do with a kilowatt of electricity." (Residential Buyer – Recent HVAC Purchaser, Rural OR)

2. When it comes to preference, residential buyers are neutral toward natural gas whereas HVAC contractors prefer it over electric.

Most residential buyers tend to be neither strong pro- nor anti-natural gas, but there are some exceptions. The minority who are anti-natural gas are a sub-group of younger individuals (under age 40) found more prominently in the states of WA and to an extent OR. They perceive natural gas as being not good for the environment and also prefer alternative fuel sources such as electric, wind or solar. They are also very focused on reducing their carbon footprint and this can impact their choice of HVAC technology.

"I believe electric is more efficient and better for the environment than gas. I am very concerned about the environment so the size of the carbon footprint will absolutely influence my choice of HVAC system." (Residential Buyer – DFHP Owner, Urban WA)

At the same time, there is a minority at the other extreme, typically 60 years of age or older and of lower household income (under $50K) who have a strong preference for natural gas as a home heating source. These individuals tend to be most concerned about energy efficiency and saving money as opposed to reducing their carbon footprint.

"I consider gas to be more efficient and affordable. I am a long-time user of natural gas and have no desire to switch an alternate home heating fuel source." (Residential Buyer – HVAC Purchase Intender, Rural WA)

"I don't consider carbon footprint at all…I just don't believe in global warming. Cost is a more important consideration for me...you know, I'm dead set against what they're trying to do, windmills and all that. None of that is going to work." (Residential Buyer – HVAC Purchase Intender, Urban WA)

The majority of residential buyers perceive carbon footprint reduction as something they should attempt to do, but they won't necessarily be driven to select a specific HVAC technology because of it. However, if a specific technology they are interested in helps to reduce their carbon footprint, this is perceived as a valuable benefit.

"I am certainly concerned about reducing carbon footprint but I'm not willing to sacrifice gas for a less efficient HVAC system. However, if a non-gas HVAC system offered the same capabilities of what I want but offered a greater reduction of the carbon footprint, I would opt for the non-gas operated system." (Residential Buyer – HVAC Purchase Intender, Urban WA)

4 Dual Fuel Heat Pump Technology

4.1 Residential Buyer DFHP Pump Value Propositions

Based on feedback from residential buyers regarding dual fuel heat pump technology, the key value propositions center around three main areas:

1. **Energy efficiency (specifically, fuel cost savings).**
2. **Heating and cooling comfort from one system.**
3. **Carbon footprint reduction.**

These three value propositions are described below:

1. Energy efficiency.

While many residential buyers do not completely understand DFHP technology, they do show some comprehension as to how and when the technology alternates between electric and gas. By using less natural gas to heat and cool their home overall, many buyers anticipate they will save on the long-term operating costs of their system. The concept itself appeals to most except buyers who completely reject the use of natural gas.

"I don't know much about dual fuel heat pumps but from what I can see, I like the cost efficiency. It switches back and forth to maximize your comfort and energy efficiency. It's trying to save you money. So that stands out as a big positive to me." (Residential Buyer – HVAC Purchase Intender, Urban WA)

"The biggest advantage is that it uses less gas than a normal furnace …so I should be able to save money." (Residential Buyer – (Recent HVAC Purchaser, Urban WA)

"I like everything I have read. It is energy efficient…in cold temperatures it will use gas and in warm weather will use electric…so I should be able to save money on my energy bill…that's good." (Residential Buyer - HVAC Purchase Intender, Urban WA)

2. Heating and cooling comfort from one single system.

DFHP technology provides both heating and cooling from a single system, meeting residential buyers' increasing desire for cooling technology and potentially reducing their total expenditures by eliminating the need for a separate A/C. These buyers also expect they can more easily control their living space with one system, offering them a 'set and forget' scenario which they find very appealing.

"It provides both heating and cooling from the same unit...that's the most important thing to me." (Residential Buyer – HVAC Purchase Intender, Urban WA)

"I chose to purchase a dual fuel heat pump specifically because I wanted the additional ability to cool without having to buy a separate A/C." (Residential Buyer – DFHP Owner, Urban WA)

"I like that it also provides cooling…that is an advantage…and it switches automatically so I don't have to worry about it." (Residential Buyer – Recent HVAC Purchaser, Rural OR)

3. Reduced carbon footprint.

Most residential buyers feel positive about themselves if they are able to do something good for the environment. Reducing HVAC emissions is a goal of some residential buyers, particularly among those under 40, while many others perceive this more of a valuable attribute of the technology, and an important selling point that captures their attention.

"The fact that it is going to be better for the environment, that it will reduce your carbon footprint is a big plus…that is pretty cool…I may not purchase a dual fuel heat pump for that reason alone, but it is a good benefit." (Residential Buyer – HVAC Purchase Intender, Urban WA)

"Being able to reduce my carbon footprint is a very important thing to me and it was a big factor in my decision to purchase a dual fuel heat pump." (Residential Buyer – DFHP Owner, Urban WA)

4.2 HVAC Contractor DFHP Pump Value Propositions

Based on feedback from HVAC contractor respondents the key value propositions for DFHPs center around three main areas:

1. **Provides heating and cooling from a single HVAC system - no need for separate A/C unit.**
2. **No need for electric back-up heating installation.**
3. **Can reduce carbon footprint.**

These three value propositions are described below:

1. Provides heating and cooling from a single HVAC system - no need for separate AC/Unit.

Many residential buyers exhibit cost sensitivity, particularly those with household incomes under $50K. By providing both heating and cooling from a single HVAC system, it reduces the buyers total cash expenditure and makes it an easier sell for the contractor. Additionally, it allows for continual comfort without the need for the buyer to operate two different HVAC systems.

"One of the advantages is that you don't need to install a separate AC/unit, this (DFHP) provides both heating and cooling." (HVAC Contractor - LB Urban WA)

"It offers heating and cooling and that is an advantage. We get both seasons here….it gets cold here in certain months and then it can get hot, 80, 90 degrees." (HVAC Contractor – LB, Urban, MT)

2. No need for electric back-up installation.

HVAC contractors perceive DFHPs as a more efficient alternative to the electric backup heating needed for electric heat pumps by comparing their efficiency to that of electric backup heating. They see this as

benefiting the residential buyer by replacing inefficient electric resistance heat with the gas furnace on cold days when the heat pump cannot run as efficiently.

> *"I think the big bullet point here is cost savings. You are eliminating the backup electric resistance element from the indoor unit for low operating costs, and you are going to use less gas, so you're going to save money."* (HVAC Contractor – SB, Rural OR)

3. Can reduce carbon footprint.

This is a prerequisite need for some but not all residential buyers. However, contractors claim that if it is mentioned as a benefit of the DFHP, it will be perceived by the buyer as a value-added extra which helps to increase the appeal of the technology.

> *"You are putting less gas into the environment, so you are reducing your carbon footprint. When you talk about reducing carbon footprint with most people, it's one of those things that makes them feel a little better about buying it…it's a selling point, maybe not a critical decision maker but it is a selling point."* (HVAC Contractor - SB, Urban OR)

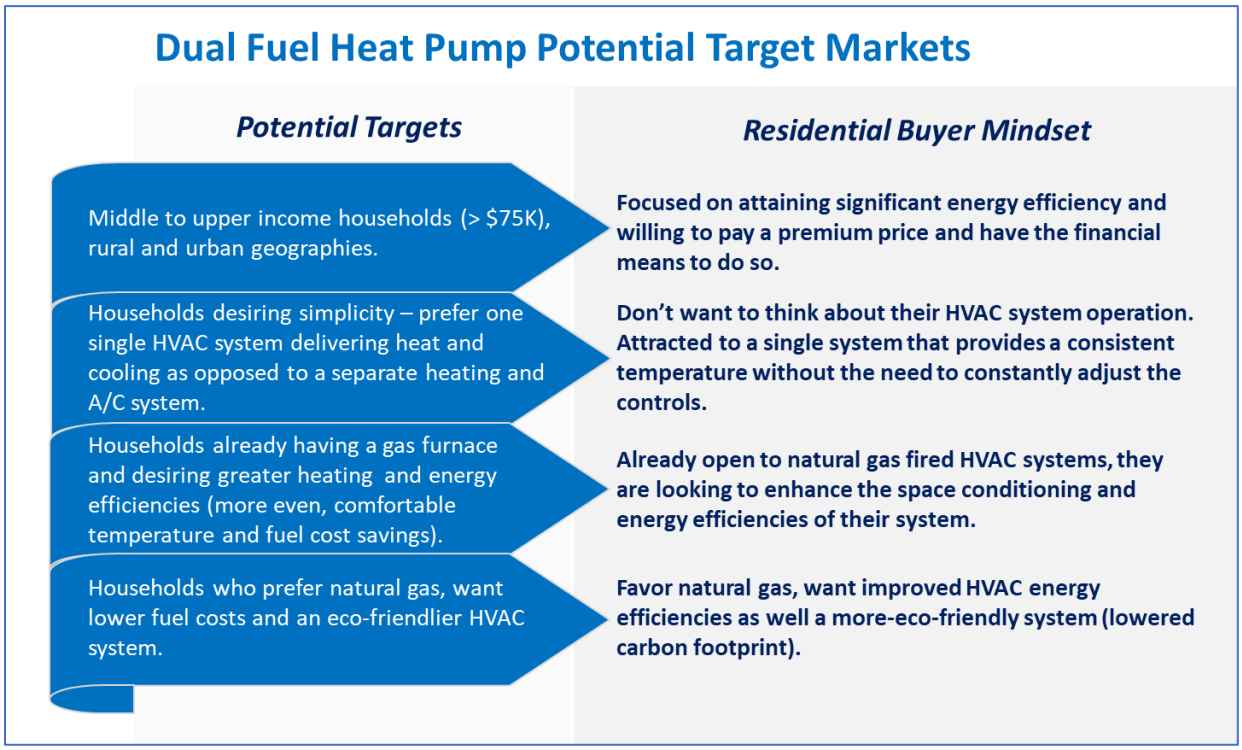
HVAC contractors also find value in DFHPs in geographies where residential buyers have access to propane but not natural gas. In these (often rural) areas it is expensive for residential buyers to heat their home in the winter. With the addition of a heat pump, a buyer can save on their propane costs by using the furnace less often.

> *"You do have two different energy sources for heat, so that's an advantage. If any time anybody ever wants a propane gas furnace, definitely we want to put a heat pump with it, because propane is extremely expensive to heat with, this is a case where you definitely would like to use electricity as much as possible to heat."* (HVAC Contractor - SB, Urban OR)

4.3 Dual Fuel Heat Pump Potential Target Markets

Potential target markets for DFHP are residential buyers who are open to natural gas and are seeking an eco-friendlier single space conditioning solution. The majority of residential buyers also assume dual fuel heat pumps will come with a premium price as they expect all new technology to be higher priced than older technology. Those with household incomes over $75K indicate a higher propensity to spend more (15-20%) on DFHP technology provided they can recognize a significant improvement in fuel savings over currently available HVAC technology alternatives. Our qualitative and literary research findings indicate the opportunity for this technology exists in both urban are rural geographies. Potential target markets for Dual Fuel Heat Pumps are illustrated in Figure 1 below.

Figure 1. Potential target markets for DFHP



4.4 Residential Buyer DFHP Barriers to Adoption

Seventeen of the residential buyers in the qualitative research do not own a DFHP. These respondents were exposed to stimuli (see Appendix B) and probed regarding their perceptions (both positive and negative) regarding this technology. The primary barriers expressed by these individuals toward DFHP technology are provided below, listed in order from more significant to less significant. Note, the order is subjective based upon a small number of interviews.

1. The majority of residential buyers lack awareness of dual fuel heat pumps.

One of the most frequently expressed barriers to DFHP adoption from the buyer side is a general lack of HVAC awareness. Many express they know very little about most HVAC technology and rely heavily on their HVAC contractor for advice and recommendations, as opposed to being proactive and seeking solutions on their own. If the contractor is unaware or unconvinced of the benefits of DFHPs, it won't be mentioned to the buyer.

> *"I haven't heard of a dual fuel pump before. I know about gas furnaces because I have one but I don't know much about other types…I go by whatever the technicians tell me to help me select one. They know way more than most people about how they work. Because I don't know."* (Residential Buyer – HVAC Purchase Intender, Urban WA)

2. *Residential buyers expect a DFHP will come at a premium price.*

Residential buyers have been conditioned to expect higher costs to be associated with newer technology. Those in this qualitative research perceive a DFHP will carry a premium cost over currently available alternative HVAC options.

> *"I imagine this is expensive because it is new technology, and I think new technology is always expensive."* (Residential Buyer – HVAC Purchase Intender, Urban WA)

> *"I like it but I worry about that it will be really expensive because it's the furnace and the heat pump together."* (Residential Buyer – HVAC Purchase Intender, Urban WA)

Households with incomes over $75K indicate a higher propensity to spend a premium, however the technology needs to demonstrate significant energy cost savings over the lifetime of the product to justify the purchase. Some show hesitancy to adopt any new technology until it has proven itself in the marketplace before they will consider adopting.

> *"I would need to know specific details before I would consider buying this…how efficient is it, what are the actual cost savings that I can expect to see?"* (Residential Buyer – HVAC Purchase Intender, Urban WA)

3. *Some buyers express concern over hybrid system reliability.*

Some of the residential buyers in this research voice concern over the reliability of an all-in-one HVAC system (i.e., heating and cooling). While the concept is appealing, they wonder how prone the system will to be failure and if it does fail, if they lose both their heating and cooling ability. Additionally, these buyers question how long it will take to repair and how costly repairs may be.

> *"Since it is a two-in-one system, I have some concern that the electric and gas component properly communicate with each other…how reliable is it really?"* (Residential Buyer – HVAC Purchase Intender, Urban WA)

> *"What is the quality like? How reliable is it? Will both the gas and electric components of the dual fuel heat pump be high quality or will one part function well and the other part be just so-so*?" (Residential Buyer – HVAC Purchase Intender, Urban WA)

> *"What happens if the system fails? Do I lose both my heating and cooling?"* (Residential Buyer - HVAC Purchase Intender, Urban WA)

4. *Some buyers express concerns over the physical footprint of a DFHP.*

When interviewing residential buyers who do not own a DFHP, the research team provided a description and images of DFHP systems for them to react to. These respondents perceive the system to be much larger than their current system. Since it is essentially two systems in one, they assume it will be larger

than a conventional HVAC system. Some residential buyers became concerned they would not have the space for a DFHP.

"I am wondering about how big the outdoor and indoor unit is. Like it says, there is an outdo or unit but the rest is indoors. Well, how big is that and where is it going to go? Will I even have the space for it?" (Residential Buyer – HVAC Purchase intender, Urban WA)

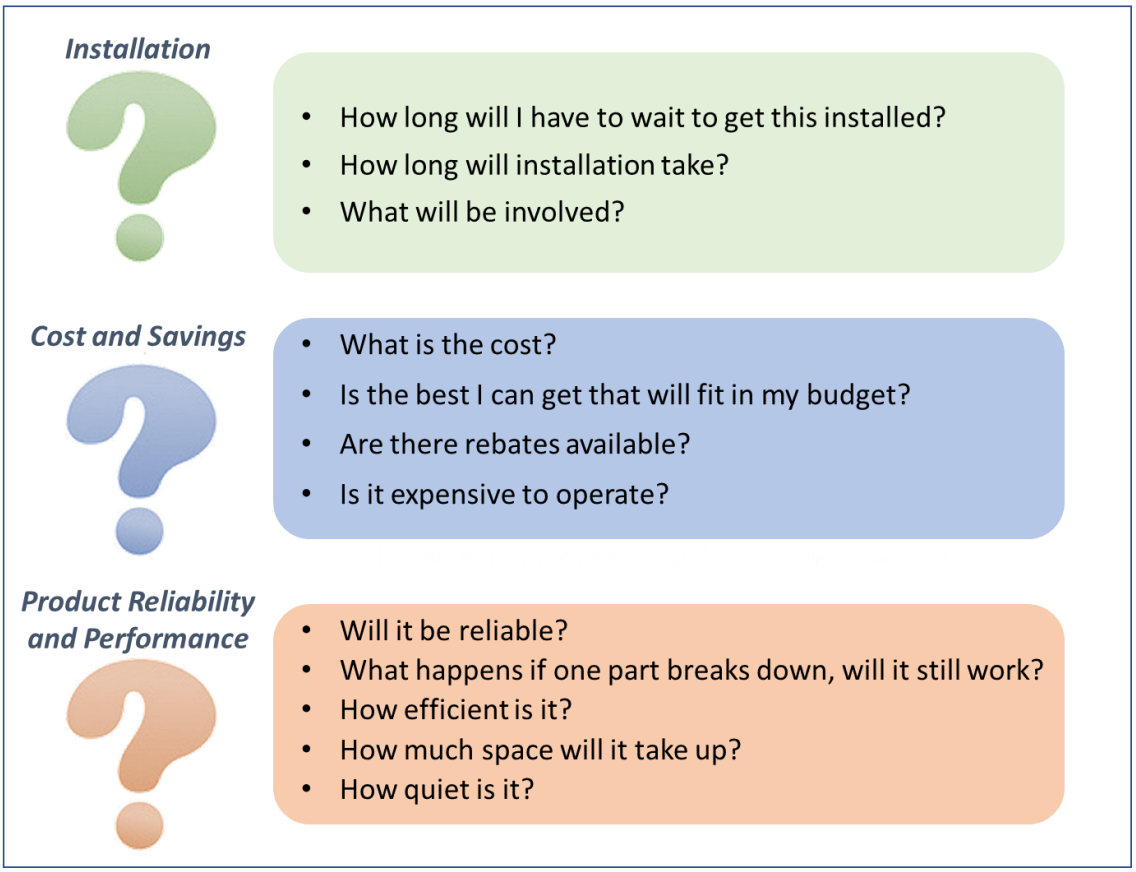
"I need both an outdoor and an indoor unit….so how big are they? I have space limitations indoors and outdoors so that could be a problem for me." (Residential Buyer – HVAC Purchase intender, Urban WA)

5. Unanticipated additional installation costs resulting from needed upgrades.

This barrier was initially uncovered during the literature search but presented itself in the qualitative research among a few existing DFHP owners. The typical non-DFHP owning residential buyers in the qualitative research did not take into consideration any additional installation cost that may be required. However, there were a few instances mentioned among existing DFHP owners who were unpleasantly surprised by the additional installation expense (i.e.; upgrades to electric service panels, duct work). In retrospect, they are still pleased with their decision to install their DFHP, but they wish they knew and understood right from the beginning that there may be additional installation costs required.

"It took much longer than I thought it would to have installed…and I had to spend more because we needed additional ductwork done." (Residential Buyer – DFHP Owner, Urban WA)

Figure 2. Key questions residential buyers ask about dual fuel heat pumps



***Note**: Residential Buyers ask many of these same questions related to Gas Heat Pump technology.*

4.5 HVAC Contractor DFHP Barriers to Adoption

1. Unfavorable prior installation experience.

There were two HVAC contractors (in rural locations) who claim to have had some negative experience with DFHPs and as a result prefer not to recommend them to their customers. Their primary issue is the belief that adding an electric heat pump to a gas furnace lowers the efficiency of the electric heat pump and the system overall. The perception among these contractors is that it would be more efficient to use an all-electric system, either just installing a heat pump, or pairing it with an electric furnace.

A second issue expressed by these contractors was they are difficult for the homeowner to control (e.g.; problems with setting an acceptable switchover point).

"I don't recommend dual fuel heat pumps for customers. I do have some commercial [small businesses] and homes that have dual fuel heat pumps and we work on them, but I will not sell them. In my opinion they lack efficiency and are difficult to control." (HVAC Contractor – SB, Rural OR)

"I find dual fuel heat pumps to be less user friendly…we get more call backs for these… if it gets iced over I get a service call and then have to explain how to manually switch over to the gas furnace and it's an extra step for us. Typically, I will only sell a dual fuel heat pump to customers who request it. I don't recommend them. Most customers don't want to think about their heating system once it is installed and dual fuel heat pumps will require service and continued education." (HVAC Contractor – SB, Urban OR).

2. Residential buyers who have access to natural gas but are not connected.

Some contractors commented that installing a natural gas line can be expensive to the buyer and can possibly raise the upfront cost of a DFHP out of their budget in addition to extending the length of time for installation.

3. Resistance to newer technology among older residential buyers.

A few of the contractors expressed that in their experience, older (e.g., 65+) buyers tend to be resistant to newer technologies and prefer to stick with what they know and have experience with. DFHPs could be a difficult sell to these individuals.

"I have younger and older customers and typically the older ones, like 65 and older are closed-minded and resistant to newer technology, and those of lower income level as well." (HVAC Contractor – LB, Urban MT).

4. A residential buyer may not stay in their home long enough to recognize fuel savings.

Some interviewed contractors claim some homeowners may be hesitant to install newer HVAC technology (especially if it has a premium price) if they do not plan to stay in their home long enough to save much money on fuel costs.

"If a customer is not expecting to stay on their property if they will only be there for a few years, they won't be there long enough to realize the benefits and they won't spend the money for this (DFHP)." (HVAC Contractor – LB, Urban MT)

Some residential buyers also perceive installing a DFHP as something that can increase the value of their home.

4.6 Current DFHP Owner Drivers of Adoption

Lieberman specifically recruited current DFHP owners for this study. A total of eight were recruited and interviewed regarding their experience. Half of these respondents were in urban locations and half in rural locations. The majority of these owners have household income between $75K and $100K with two having in excess of $100K. Only three of these individuals have a household income of between $50 -$75K and are all located in a rural geography. All but two are located in Washington state (the other two in Idaho and Utah).

These DFHP owners were typically introduced to this technology either by their HVAC Contractor or word-of-mouth recommendations from those they know and trust. The majority also indicated they were proactive in going online and further researching this technology before deciding to make the purchase.

Their decision to purchase their DFHP was driven primarily by four primary wants and needs.

1. Year-round comfort.

Many of the DFHP owners claimed to have installed the system because they wanted to experience maximum comfort year-round. These DFHP owners express that now even on the coldest days their house remains at a comfortable temperature. They appreciate that the system automatically switches from electric to gas without their intervention, and most tend not to notice when the system changes over. While a small minority of DFHP owners expressed some dissatisfaction with the initial set switchover point (which was easily rectified by their HVAC contractor), most expressed no dissatisfaction.

"I'm very satisfied with it. It is very responsive and easy to control. It keeps the house at a constant comfortable temperature, and I don't have to mess with it." (Residential Buyer – DFHP Owner, Urban WA)

2. Greater energy efficiency and cost savings.

All of these DFHP owners wanted an HVAC system that would be more energy efficient than what they already had in place or had in a previous home (in the case of DFHP owners in newly constructed homes). Every one of the DFHP owners indicated a reduction in their energy costs after system installation and have a high level of satisfaction with their purchase.

"I would absolutely recommend the dual fuel heat pump system to others – I have had really good luck with it…it works well and it saves me money …my electric bill is only like $30/$40 per month now." (Residential Buyer – DFHP Owner, Urban WA)

3. Cooling capability.

Many of the interviewed DFHP owners indicated they made the purchase because of its additional ability to provide their home with cooling capability (as opposed to installing a separate A/C system). A couple of residential buyers also pointed to the greater incidence of smoke from forest fires in the warmer weather and the need to keep their windows closed. They appreciated the cooling capability and the healthier indoor environment provided by their DFHP on those particular days.

"When we moved in, we had an old gas furnace and we wanted to replace that. Then the A/C died, so I wanted to get something that would provide both heat and cooling…we've had some big heat waves out here so the cooling is important…I also wanted something that is better for the environment and reduces my carbon footprint. The dual fuel heat pump offered me this." (Residential Buyer – DFHP Owner, Urban WA).

4. Reduction of carbon footprint.

All of the DFHP owners express concern over the environment and found the reduced carbon footprint of their DFHP to be a valuable attribute which also contributed as a driver of their purchase decision.

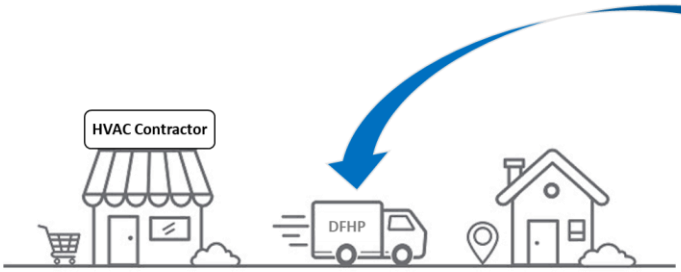
"I am very conscious of the environment, so the fact that a dual fuel heat pump helps to lower my carbon footprint was an important criteria [sic] in my purchase decision." (Residential Buyer- DFHP Owner, Urban WA)

Figure *3. Drivers of current DFHP sales*

Current dual fuel heat pump sales driven by desire for a single space conditioning system, improved energy efficiency and carbon footprint reduction.

Current Drivers of Dual Fuel Heat Pumps

- Current residential Buyer DFHP awareness and interest being driven by HVAC contractors' recommendations, online research, or word-of-mouth recommendations from those they know. These buyers tend to be more proactive in seeking out information.
- These buyers are equally likely to be in urban and rural locations and are more likely to have annual household incomes in excess of $75K.
- Incentives in terms of rebates also appear to play a role, especially among those who are not financially well-off (less than $75K annual household income).



- **Ability to deliver even, year-round comfort (heating and cooling from a single system)**
- **Ability to deliver greater energy efficiency**
- **Perceived to be better for the environment**

5 Gas Heat Pump Technology (residential application)

5.1 Residential Buyer GHP Value Propositions

Based on feedback from residential buyers' reactions to the GHP stimuli (including one who has a GHP installed in his home), their key value propositions for this technology center around two primary areas:

1. **Improved energy efficiency over a gas furnace.**
2. **Can continue to use natural gas while realizing a reduced carbon footprint.**

The research team also ascertained a third, lesser value proposition:

3. **Ability to provide both heat and hot water with a single HVAC system.**

This value proposition emerged during a small number of residential buyer interviews when NEEA staff asked the interviewer to inquire about water heating as a possible capability of a GHP (e.g., a combi system).

These three value propositions are described below:

1. Energy efficiency is the most important aspect of the value proposition.

The number one goal of residential buyers in the qualitative research is to realize enhanced HVAC energy efficiency (e.g.; reduced fuel costs). They will evaluate the total cost of a GHP versus the potential fuel savings over the lifetime of the product to help them decide if it is worth risking a technology that is new to them. They also want to realize any energy efficiencies well in advance of the end of the product lifecycle.

"Energy efficiency is the key advantage… and it uses less gas than natural furnace…so that will help me to save money." (Residential Buyer – HVAC Purchase Intender, Urban WA)

"It offers high energy efficiency and high capacity in cold climates, so it will lower my fuel costs and keep me warm…these are a big plus." (Residential Buyer – Recent HVAC Purchaser, Rural OR)

2. Carbon footprint reduction adds to the appeal of GHPs.

Residential buyers are impressed when exposed to stimuli claiming GHP technology can reduce the carbon footprint between 30-50% and perceive this as a significant technological advantage. Whether a buyer is specifically focused on carbon footprint reduction or not, it is a welcomed and valued attribute of the value proposition, regardless of age, income level or geographic location.

"The reduction of the carbon footprint is a big, big benefit of this as well." (HVAC Purchase Intender, Urban WA)

"I think that the gas heat pump can lower your carbon footprint is an important…that's probably the most important thing for me." (Residential Buyer - HVAC Purchase Intender, Urban WA)

3. Ability to provide both heat and hot water from a single HVAC solution.

As noted above, NEEA staff observing a few of the residential buyer interviews asked the interviewer to provide an additional piece of information about GHPs: they can be used to heat both space and water. When this was mentioned, interest in GHP technology increased significantly. Residential buyers perceive the end result as being lower operating cost and HVAC efficiency as they can combine heating and hot water into one system. A few even express this can potentially overshadow the GHP's lack of cooling capability.

"If this could provide me with heat and hot water, that definitely would increase my interest." (Residential Buyer – Recent HVAC Purchaser, Rural OR)

"If the gas heat pump could provide hot water as well, that could possibly make up for its lack of cooling." (Residential Buyer – HVAC Purchase Intender, Urban WA)

5.2 HVAC Contractor GHP Value Propositions

When exposed to the GHP stimuli during their interview, most HVAC contractors express interest in the technology and want to learn more about it. There are four main GHP value propositions for GHP among HVAC contractors, plus a fifth related to the possible addition of hot water capacity to the system (a combi system) .

1. **Improved energy efficiency over a gas furnace.**
2. **Fuel flexibility offering expanded market opportunity.**
3. **Ease of use vis-a-vis smart controls**
4. **Can continue to utilize natural gas and reduce emissions.**
5. **Delivery of high-capacity heat in addition to hot water from a single HVAC system.**

These five HVAC contractor value propositions are described below:

1. Improved energy efficiency over a gas furnace.

This is considered a key value proposition to residential buyers as it addresses their key need – the reduction of fuel costs which can help make the HVAC contractor sales pitch an easier one, especially if specific attractive cost reductions can be conveyed to the residential buyer.

"The big advantage to me is that it is more energy efficient, more fuel efficient and has high capacity…that means it can operate at colder temperatures. That would be a big selling point for people." (HVAC Contractor – SB, Rural, OR)

"The high fuel efficiency catches my attention…that will lower customers' fuel bill…I think that a lot of residential customers may be interested in this type of HVAC system." (HVAC Contractor – SB, Rural OR)

2. ***Fuel flexibility offers the HVAC contractor a greater target market opportunity.***

Contractors consider this a valuable attribute because it provides an additional selling point to residential buyers by accommodating a wider range of potential customers based on what fuel source they have available (i.e.; natural gas, propane, biofuels or hydrogen blend). This increases the HVAC contractor sales opportunity for GHP technology.

"Fuel flexibility is a big selling point…I can recommend this to customers whether they use propane, natural gas, hydrogen, blends, or even biofuels." (HVAC Contractor – LB, Urban MT)

"Fuel flexibility is an advantage…it's a big positive." (HVAC Contractor – LB, Urban WA)

3. ***Ease of control/smart controls.***

Some HVAC contractors find smart controls appealing as they can make it easier for customers to control their HVAC system. These contractors often get tied up answering customer questions on how to control the system post-installation and this takes time away from their other business activities and is frustrating for their customers. They also report that some of their younger residential customers (40 and younger) favor smart controls.

4. ***Buyers can continue to use natural gas while realizing reduced carbon footprint.***

HVAC contractors echo residential buyer sentiment on carbon footprint reduction – for most this is a positive selling attribute of GHPs, even if their primary focus of the buyer is not on decarbonization.

"It allows you to use gas and reduce your carbon footprint. That's a selling point." (HVAC Contractor – SB, Rural OR)

This offers a lower carbon footprint …this could change the mind of people who have mixed feelings about using natural gas…but you'd have to probably be able to show them something like you're taking this many cars off the road or something like that in order to sway them. Because I do think people in Washington more and more have a bad taste in their mouth about natural gas." (HVAC Contractor – LB, Urban WA)

5. ***Delivery of high-capacity heat in addition to hot water from a single HVAC system.***

HVAC Contractors value the high capacity of GHP in the colder weather as it is perceived as an improvement over electric heat pump. Similar to interviews with residential buyers, during HVAC contractor interviews, NEEA staff occasionally requested the interviewer ask for impressions of a GHP that could heat water as well as space. When mentioned, contractors also perceive the ability to offer heat and hot water from a single HVAC system as something they believe will appeal to many residential buyers. However, it does bring up many installation and cost-related questions.

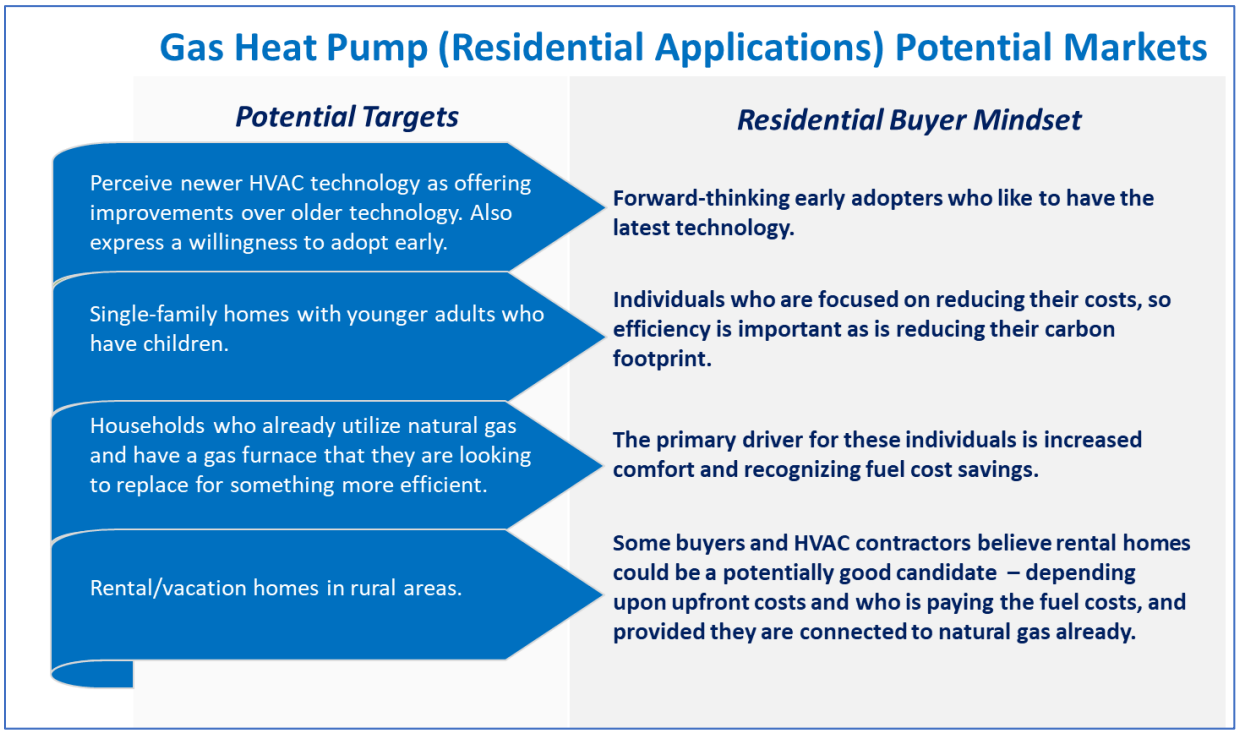
High efficiency with high capacity and can provide hot water…that's firing on all cylinders. That's what we're looking for." (HVAC Contractor - LB, Urban OR)

5.3 Gas Heat Pump Potential Target Markets

Conversations with residential buyers and HVAC contractors identified several potential target markets for residential GHP technology. The common denominator among these potential market opportunities is that they are all perceived to be mid-to-higher-income households. This is due to the perception that the upfront cost for GHPs will be expensive.

The potential residential target market for GHP technology is an early adopter type of individual who prefers to utilize natural gas and is driven to find an HVAC solution that will offer substantial energy efficiency over his/her gas furnace and prefers a solution that will reduce his/her carbon footprint. Potential target market opportunities are illustrated in Figure 4 below.

Figure 4. GHP (residential application) potential target markets and mindset



5.4 Residential Buyer GHP Barriers to Adoption

During interviews, residential buyers were exposed to DFHP and GHP stimuli in a rotating order. Whether a respondent was first exposed to DFHP or GHP stimuli, many cited GHP's lack of cooling capability as a significant barrier to adoption. Other primary barriers identified include the perception that it does not suit buyer needs based on their geographic climate, or due to its reliance on natural gas as a fuel source. The barriers are listed below in order from more significant to less significant. Note, the order is based upon a small number of interviews.

1. ***GHPs lack cooling capability.***

A majority of residential buyers in the qualitative research indicate the GHPs' lack of cooling functionality is an immediate reason to reject the technology. The increasing periods of warmer weather in the Northwest are driving buyers to seek out a single heating and cooling solution. For these individuals, improved energy efficiency alone is not enough to generate significant interest, especially if they had been previously exposed to dual fuel technology.

"Not offering cooling capability is a big detractor for me…this doesn't meet my needs." (Residential Buyer – DFHP Owner, Urban WA)

"The biggest negative to me is that it doesn't offer cooling." (Residential Buyer – HVAC Purchase Intender, Urban WA)

2. GHP are perceived as best utilized in very cold climates.

Initial qualitative stimuli stressed GHP 'high capacity in cold climates' which resulted in most perceiving GHPs as being more suitable to very cold geographies such as Canada or Alaska. When stimuli were revised to stress that a 'GHP gas heat pump can keep a home comfortable even on the coldest days of the year,' most residential buyers continued to perceive the technology as better suited for very cold geographies. They believe that in the Northwest they tend to have a milder climate so many had difficulty recognizing the value of the GHP, aside from improved energy efficiency and reduced carbon footprint.

"High capacity in cold climates doesn't benefit me that much. It does not get cold here. This would probably do well in Canada or Alaska." (Residential Buyer – HVAC Purchase Intender, Urban WA)

"High capacity makes me think this is for where it is really cold…not here." (Residential Buyer HVAC Purchase Intender, Urban WA)

"This really doesn't fit my needs…high capacity in colder weather… I'm in the western half of the state, so it's relatively mild-here." (Residential Buyer – Recent HVAC Purchaser, Rural OR)

3. Some residential buyers want to discontinue their use of natural gas.

There are some residential buyers (more notably under 40 years old and in residing within an urban location in WA) who want to move away from utilizing natural gas as a home fuel heating source due to environmental concerns. These individuals prefer to utilize what they perceive as more eco-friendly alternative fuel sources such as electricity, solar, and/or wind power.

"It seems pretty good except for the natural gas part. I want to move away from using natural gas." (Residential Buyer – HVAC Purchase Intender, Urban WA)

"This relies fully on natural gas which is a big negative for me." (Residential Buyer – DFHP Owner, Urban WA)

"I'm trying to steer away from natural gas and move into electric pumps and stuff. Our whole house is trying to move over to electric. And so natural gas is something I want to get rid of, not something I want." (Residential Buyer, HVAC Purchase Intender, Urban WA)

4. Concerns over GHP physical footprint.

The stimuli included an image of a GHP, but no measurements or other indications of the size of the system. Residential buyers mentioned they couldn't tell how large the system would be. They assume since it comprises an indoor and outdoor component, it may be large. Buyers living in smaller homes, having limited space between their property line and their or their neighbor's home, or living in a Home Owner's Association community with strict guidelines as to what can be installed outside their homes express more frequent concern over physical footprint (and potential system noise).

"It seems like it might be too big for my home. I live in a small house…and there is an inside and outside piece to this…I don't know if it could fit." (Residential Buyer – HVAC Purchase Intender, Urban WA)

"How much space will this take up? I don't have a lot of room in my home…and if it did and I was on top of it, would it be noisy?" (Residential Buyer – HVAC Purchase Intender, Urban WA)

5. Uncertainty over how much more efficient GHPs are compared to a gas furnace.

Residential buyers want to see a head-to-head comparison so they can justify a GHP purchase. They want to know if a GHP will generate as much or more heat than their gas furnace and exactly how much fuel cost savings they can expect to recognize.

"It says high fuel efficiency but it doesn't give any numbers. It says it uses less natural gas than a gas furnace…so give me numbers. These are all general statements. I need to see direct comparisons." (Residential Buyer – HVAC Purchase Intender, Urban WA)

5.5 HVAC Contractors Barriers to GHP Adoption

HVAC Contractors perceive value in offering GHP technology to their residential customers. While they do identify some barriers to adoption, they are more likely to raise questions than specific barriers. Contractors identified four primary barriers to adoption:

1. Need proof of energy efficiency and performance compared to a gas furnace.

Before a contractor will recommend the product to a residential buyer, they need to be assured of its energy efficiency and how well it performs compared to a gas furnace. Much of their business comes from client recommendations and they cannot afford to have their image tarnished by an unhappy customer.

"Gas heat pumps seem like a good idea but I need to know more about them. What is [sic] the efficiency ratings and how do they compare to a gas furnace? I need to see comparisons, field results." (HVAC Contractor – LB, Rural WA).

2. Potential impact of carbon neutral codes.

Some contractors, predominantly located in Washington State, believe that existing and potential new carbon neutral codes in the state can impact the viability of the GHP. There are also some contractors who believe this will be more of an issue in urban as opposed to rural Washington. Many are watching changing codes and are not certain yet as to what the full impact will be on GHP, causing many to say they will take a 'wait and see' approach before they wholeheartedly embrace the technology.

"In certain states we are having different issues with adding more natural gas appliances if you already don't have a natural gas appliance... So a lot of [residential buyers] are going straight to electric versus gas. This could be an issue for gas heat pumps." (HVAC Contractor – LB, Urban OR)

"In Washington state there is a broad push to go with electrical power as a primary means of energy use. A system like this is more likely to face future restriction or changes in code than say a pure electric system. And that's specific to Washington state, I can only speak on behalf of that." (HVAC Contractor – LB, Urban WA)

3. Use of ammonia as refrigerant in GHP.

The GHP stimuli shown to HVAC contractors specified the use of a natural refrigerant. A few asked what the refrigerant was; when told it was ammonia, a few expressed hesitation to embrace the technology citing safety concerns. An additional few of the respondents were told the refrigerant was ammonia without them asking and most shared a similar response.

"We get asked questions about the use of ammonia as a refrigerant. Some people have safety concerns. A few years back there was an accident where three people died from an ammonia leak in an ice arena, and this is not a single, one-off event. This has happened two or three times over the last few decades. It's perceived as a dangerous refrigerant. We had a gas heat pump pilot project cancelled because the client found out the refrigerant being used was ammonia." (HVAC Contractor – LB, Urban British Columbia)

One respondent indicated the greater concern to him is not whether ammonia is the refrigerant, but that the industry needs to decide upon a standard refrigerant to be used and until that happens, he would be hesitant to adopt GHP technology.

There are different refrigerants being used out there…there is carbon dioxide, there's ammonia, there's propane. Some people are using propane as refrigerant, which again, is a very good refrigerant, but it is hazardous to operate. So I'm waiting first for the market to really figure out what the new refrigerant is going to be." (HVAC Contractor- LB, Rural OR)

4. ***Residential buyers who are not already connected to natural gas.***

Similar to the concern that was mentioned with DFHP technology, contractors express that installing a natural gas line can push the upfront cost and required installation time outside the budgetary and acceptable installation window for some residential buyers.

Key Questions and Needs Contractors Have Regarding Residential GHPs

1. ***HVAC contractors need to know more about the technology and support - supply chain availability, support and training is critical.***

Aside from the aforementioned barriers to adoption, contractors are very interested in GHP technology and can envision adding it to their product portfolio. First, contractors want to be assured of product and parts availability vis-à-vis the supply chain. These contractors also have much to learn about the technology and how/who would support them before they would adopt and actively promote GHP technology to their customers and prospects. They also require that customer support and training needs be made available through the manufacturer. The quality of support is important, and the provider needs to be knowledgeable and available.

> *"I'd want some hands on experience first…I want to know that they were manufactured properly, and that they would have parts for repairing when they break down. My main concern is not where it comes from…my concern is parts and, and availability for the customer, support."* (HVAC Contractor – LB, Urban ID)

A few contractors mentioned certification programs related to GHP would be considered a plus and would help them to be perceived as an expert in GHP technology among their customers/potential customers. Contractors want to be assured of product and parts availability vis-à-vis the supply chain.

> *"It would be great to have a certification program. If you're going to stand by reliability and warranty as well as reputation, having a certification program after a base training, advanced training and so forth. Those things always look really good …it makes your company stand out from your competitors."* (HVAC Contractor - SB, Rural MT)

2. ***HVAC contractors want 'proof of concept' before they offer GHPs to their customers.***

Contractors want reassurance that GHP technology will deliver on its promises, and they want to have hands-on experience. In addition to technical specifications and manuals, they are interested in reading case histories and residential testimonials. Print and video formats were both mentioned.

> *"Case studies and testimonials are important both for me and for my customers. They help me and my customers better understand practical cases with the technology…certainly helps with the sales pitch."* (HVAC Contractor – LB, Urban MT)

3. ***Some HVAC contractors want to experience the technology first-hand.***

A subset of HVAC contractors want to see a GHP system in operation before they fully embrace the technology. Some would like to do a site visit where they can see a GHP in operation and talk to an actual user to gauge their firsthand experience. A few indicate they prefer to conduct a small pilot program first as it would provide them actual experience with installation and maintenance. Others express they have a very close relationship with their distributor, through which they receive all of their training and support. If their distributor supports or endorses a certain technology, these contractors claim they are more likely to adopt it without having to have hands-on experience.

"I want to see these units in person at wherever they're stored instead of just seeing it on a computer…I want to be able to do a site visit to wherever they are going to install the system. I don't need to run pilot programs though, those are not necessary for me." (HVAC Contractor – LB, Urban MT)

"We would have to run a small pilot program first to see for ourselves if we want to be offering this technology to our customers." (HVAC Contractor – SB, Rural OR)

6 Commercial Buyer HVAC Market

6.1 Commercial Buyer Market Summary and Trends

6.1.1 Commercial Buyer HVAC Needs

1. Commercial buyers are very focused on HVAC system cost, efficiency, and comfort.

Interviewed commercial buyers focused on HVAC solutions that deliver a lower total cost of ownership and achieve a balance of efficiency and reduced HVAC operational costs. How efficient a system is at delivering space conditioning throughout their commercial space and maintaining a suitable temperature for the occupants is also a key consideration. The comfort of their employees (or leasers of their property) is of prime importance, as insufficient comfort level is perceived to have a negative impact on worker productivity.

"Cost is a critical issue...upfront cost as well as total cost of ownership of the system are the key evaluation criteria for a new HVAC system. I also look at warranty and speed to delivery. Energy efficiency is important too… how quickly will it heat or cool an entire building is important because people will complain if they are not comfortable and it impacts their productivity. There is also a cost to this, how efficient does the system use the fuel source to move the heat or cooling through the building." (Commercial Buyer - LB, Rural MT)

However, buyers with smaller commercial establishments (e.g., mom and pop establishments) behave more like residential buyers and focus more heavily on the upfront costs.

2. Carbon footprint reduction importance varies among commercial buyers.

Some commercial buyers are intentionally moving toward HVAC technologies that will reduce their carbon footprint, whether driven by internal or external mandates. However, for others this is not necessarily a high priority, but rather a benefit.

The desire to actively reduce the carbon footprint is observed primarily among HVAC commercial system decision-makers under 40 years of age, and businesses that are tech-focused (existing and newer start-up businesses). It is also noticeable among those who are building new properties where they are being mandated by local/state officials to install more efficient HVAC systems (i.e., Washington State).

Property investors can push toward a building's use of HVAC technology that reduces the carbon footprint of the property. Discussions with property management buyers in both Washington and Oregon mentioned several such instances.

Many commercial buyers (especially in Washington and Oregon) are watching closely as more carbon neutral codes are coming online and expect that in time, decarbonization will become more of a necessity than a 'nice to have' when choosing an HVAC system.

"Business owners are starting to think about it [decarbonization] more and more… from an everyday people perspective, it is still new for them…. but they are starting to think about it more… they think

about the rebates and tax credits they get for these types of purchases…I think this influences some people." (Commercial Buyer - LB, Rural MT)

3. HVAC system reliability and reduced maintenance is a critical need.

Interviewed commercial buyers talk about how system breakdowns and frequent maintenance translates into additional cost and unhappy building occupants, and result in additional loss in revenue and reputation. Any commercial HVAC system they consider will need to demonstrate reliability, low maintenance, and come with a robust warranty for parts and service. Those in colder or warmer climates also express the need for a system to function properly in both weather extremes.

"Ease of maintenance is one of my key evaluation criteria for a new HVAC system. Also warranty and speed to delivery and installation." (Commercial Buyer – LB, Urban ID)

"These Commercial Buyers want dependability and something that is durable and maintenance free…downtime means money and problems." (HVAC Contractor - LB, Urban WA)

4. Occupant comfort is an important consideration.

Commercial buyers define 'comfort' as establishing a pleasing workplace environment where the occupants are happy with the working temperature, and it does not hinder their job performance. Commercial buyers and particularly commercial property managers express the importance of this, as a dissatisfied tenant will tie up the property manager with complaints, may not recommend them to other businesses, and may not renew a lease.

"If the employees are not comfortable, they're not going to be productive and then the people that are leasing out the space, they're going to be upset and it's going to snowball into a big nightmare for me." (Commercial Buyer - Commercial Property Manager, LB, Urban ID)

"When you have offices that have larger office spaces with a lot of human beings working in like call centers or office space, that's really where everything has to be right to make them comfortable to be productive throughout the day. So those are the most sensitive, the offices." (HVAC Contractor - LB, Urban WA)

6.1.2 Commercial Buyer Approach and Drivers of New HVAC System Purchase

1. Replacing a failing HVAC system or a need for greater capacity is driving commercial purchases (in addition to new construction).

Commercial buyers do not seek out a new HVAC system for their property unless their current system needs to be replaced or they are constructing a new building. Since they are heavily focused on cost and have budgets to work within, they take an 'if it is not broken, then don't fix it/change it approach.' When a need does arise, how the commercial buyer approaches the purchase appears to vary by the situation.

2. Business size, type, and location play a role in HVAC technology selection.

Smaller businesses take a different approach to the HVAC purchase decision than larger commercial businesses and commercial property managers. Much of this is related to their level of knowledge of HVAC technology, which in general is lower among smaller businesses.

Smaller commercial business owners behave more like residential buyers. They will conduct some basic online research and ask business associates for advice but end up relying heavily on the HVAC Contractor for recommendations. Upfront cost is foremost on their minds.

"We are a small non-profit. So mostly, I do general internet searching because I feel like I want to make sure that I make the right decision and feeling like it's all new to me…I don't know much about HVAC systems… I want to make sure that I'm doing the right thing. And definitely cost is the big concern for me. So, because it's new, I feel when I look at information online there's a lot of different opinions, different sources of information and so, I'm not sure which sources to trust…so I turn to my contractor a lot for guidance." (Commercial Buyer – MB, Urban WA)

Larger-sized businesses and particularly commercial property managers are much more aware of HVAC technology and actively seek out information on their own. Commercial property managers in particular tend to read HVAC trade magazines and articles, attend trade shows, and speak regularly with HVAC manufacturer representatives. They frequently know what technology they want when they reach out to an HVAC contractor.

"I like to learn about new HVAC technologies and brands because that's my job to select them for our properties. I do that all day. I read product catalogs, I go and see things at conventions and trade shows, read different magazines and things like that. I watch different videos. I speak with manufacturer reps. So, for me it's exciting. I like to get information on different innovative [HVAC] products." (Commercial Buyer – Property Management, LB, Urban ID)

Architects or key business stakeholders in a commercial property also can influence what technology is to be utilized in a specific property, particularly where new construction is concerned. Most HVAC contractors in this research indicate they tend to oblige and bid on what is asked for, though some will also offer alternative solutions if they believe it will better serve their client, even if it is a more expensive option.

"For us a lot of times most of the commercial customers come to HVAC contractor with an idea of what they want to install – already decided by the building architect. I always try to upsell a better system that is a premium if I believe the client will benefit, but it is always a tougher sell because they already have pretty much decided on what they want." (HVAC Contractor - LB, Urban OR)

3. Rebates and tax credits can influence the commercial HVAC decision.

The ability to receive rebates, tax credits, and certain certifications that allow a business to expand into new markets can have influence on which HVAC technology commercial buyers decide upon for their property (i.e., meeting emissions guidelines and receiving a specific business rating).

"We do take rebates and tax credits into account for these types of purchases…this can absolutely have influence on our purchase decision." (Commercial Buyer - LB, Rural MT)

4. Time to installation matters to commercial buyers.

The time required to install a replacement/retrofit for their HVAC system plays a role in the commercial buyer purchase decision process. Typically, these buyers cannot afford to wait an extended period of time in this circumstance.

"Commercial customers are focused on price…but they are also focused on the reputation of the product and the company providing the service and installation and how quickly installation can be done." (HVAC Contractor – SB, Rural OR)

6.1.3 Commercial Buyer Desired Improvements in Current HVAC Systems

1. Commercial buyers want to see more reliable HVAC systems which require less maintenance.

The interviewed commercial buyers would like to see improvements in the reliability of their commercial HVAC systems. The most frequently mentioned complaint of existing HVAC systems is that they require too much maintenance which results in system down time and additional expenditures.

"Commercial buyers want high quality and low maintenance. They don't want to schedule service calls…They want dependability, and something that is maintenance free." (HVAC Contractor – SB, Rural MT)

2. More fuel-efficient HVAC technology that results in fuel cost savings

The other area of improvement commercial buyers would like to see in HVAC technology is greater fuel efficiency which would result in lower costs – a key area of focus among all commercial buyers.

"At the end of the day we want to see high energy efficiency and lower fuel costs." (Commercial Buyer - LB, Rural MT)

6.1.4 Fuel Source Perceptions and Preferences

1. The majority of commercial buyers prefer natural gas and find it more effective than electric.

Most interviewed commercial buyers have a long history of utilizing natural gas to fuel their HVAC systems. They find it to be efficient, reliable, and relatively inexpensive (depending upon geographic region). There are some buyers who have had experience with electricity as their fuel source but claim it was not as effective as natural gas – it doesn't heat as fast, and it doesn't provide the same level of comfort that natural gas-powered systems do.

> *"It [natural gas] is what we use and it's cost-effective, efficient, and delivers high-quality heat. I have a positive opinion toward it. Electric is a less expensive option than gas, but it doesn't deliver as high-quality heat."* (Commercial Buyer - MB, Urban WA)

> *"Natural gas is abundant, already in place and a lot of HVAC technology for the longest time has utilized gas. It's easily transported…while it is not the cleanest type of fuel, it is cleaner than other types of fossil fuels [oil]. It does produce pollution and there is room for improvement, but I still prefer it."* (HVAC Contractor - LB, Rural MT)

2. A minority of commercial buyers who prefer an alternative to natural gas do exist.

While the majority of commercial buyers prefer natural gas, a small subset primarily located in urban areas of Washington is interested in reducing (but not necessarily eliminating) their usage of natural gas at their commercial property. This is both for cost reduction and meeting carbon neutral codes or goals. These individuals tend to be considering electric heat pumps even though they do not necessarily perceive them to be as effective as gas-fueled heating systems.

> *"There is some negative to these new codes but there is also a lot of positive…it's certainly going to make buildings much more expensive but there is a payback…For the first time in my career I am regularly able to talk to customers about making choices that will pay off over the long run…I'm not sure what will happen to electric prices over time, but if they stay relatively stable, then the building owners will see a better payback over time by moving to electric."* (Commercial Buyer - Property Management, LB, Urban, WA)

6.1.5 Decarbonization in the Commercial Sector

1. Decarbonization is a goal for some, but not all commercial buyers.

Many of the commercial buyers are not driven to reduce their carbon footprint but do consider it a positive attribute if an HVAC system provides a smaller carbon footprint. However, more 'tech-focused' businesses and businesses with leaders under 40 years old are more aware of decarbonization and tend to prioritize it more. While most are yet to begin working towards significant decarbonization goals driven by carbon neutral codes, there is evidence that new building codes in WA and OR are beginning to exert influence on the purchase decision process.

The general perception among many of these commercial buyers and HVAC contractors is that requirements to meet specific decarbonization goals will increase over the next several years. They are carefully watching the changes in regulations and what that will mean for what types of HVAC systems they will need to acquire for their commercial operations.

Washington State-based commercial buyers and HVAC contractors are starting to prepare themselves for a move towards selecting HVAC technologies offering greater efficiencies and reduction of carbon footprint. More progressive companies (e.g., mid-size tech firms, tech start-ups, and some food processing companies) are described by HVAC Contractors as being early movers and tend to be more focused on efficiency and decarbonization as part of their strategic initiatives.

"I personally want to be socially responsible and reduce our carbon footprint, but we have to be realistic. The most important factors are upfront cost and efficiency [operating costs]. Reducing our carbon footprint is a bonus." (Commercial Buyer - MB, Urban WA)

"We are seeing that some commercial customers are driven to meet certain carbon footprint reduction goals, so for them, this plays a strong role in their preference in their HVAC system decision. The majority of the work we do for commercial companies is for electric HVAC systems." (HVAC Contractor - SB, Rural OR)

2. ***Manufacturer promotion of efficiency and decarbonization is beginning to impact commercial buyer perception.***

Discussions with primarily Washington State-based commercial and HVAC contractor interviewees indicate the way that HVAC manufacturers are promoting their products does seem to have an impact on commercial buyer and HVAC contractor perceptions. Touting product efficiency and the benefit of carbon footprint reduction does seem to be making these buyers consider these factors more.

3. ***Commercial property managers are focused on decarbonization.***

Interviewed commercial property managers are cognizant of decarbonization, especially when it comes to new construction. However, it is not usually a primary HVAC purchase decision driver. In only about 1-in-10 scenarios with new construction does decarbonization tend to be a requirement (unless it is in a specific region (Seattle) where specific building codes are in place to address this issue).

These property managers are not particularly interested in turning away from natural gas, but rather they are more actively looking for HVAC systems that help to reduce the carbon footprint of their commercial properties. They are more open to different HVAC system options; keeping in mind that overall, they need to be efficient and deliver lower total cost of ownership first and foremost, especially if they are responsible for the costs.

"We do think about decarbonization [when exploring new HVAC systems]. We work with a lot of new build designs with architects. So being eco-friendly and environmentally conscious is always on our list. That is something that we always take into consideration. It's nice to have, it kind of like puts the shine on it. It's kind of the icing on the cake but not the cake. It helps to make a more attractive package when we're working with an architect saying that we're going, we found something that's eco-

friendly…but that's only in about 10% of the situations where we see this need arise." (Commercial Buyer - Property Management, LB, Urban ID)

4. Decarbonization does not appear to be a big concern for 'Passive Houses.'

One particular interviewee who works at a large Energy Services Company (ESCO) commented that when it comes to Passive Houses (buildings created to rigorous energy efficient design standards so that they maintain an almost constant temperature), decarbonization does not play a role in the building design. The focus is on energy performance/efficiency only. In a location such as Seattle, the reliance is on electric heat pumps given restrictions on the usage of natural gas.

"When it comes to Passive Houses, all that matters is energy performance only, they do not care about eco friendliness. Since we are in Seattle we will only focus on the most efficient systems and those will be electrical heat pump and A/C, electrical water heaters and PRV systems because we cannot use natural gas." (Commercial Buyer [ESCO] - LB, Urban WA)

7 Dual Fuel RTU Technology

7.1 Dual Fuel RTU Value Propositions

Based on feedback from commercial buyer reaction to DFRTU stimuli, the key value propositions center around three primary main areas:

1. **Improved return on investment (ROI).**
2. **Comfort within the commercial property.**
3. **Can reduce carbon footprint.**

These three value propositions are described below:

1. Improved ROI.

Upon exposure to qualitative stimuli, commercial buyers perceive the DFRTU as offering superior system effectiveness and a more favorable return on investment over the life of the technology. This perception is driven by the stated energy efficiency of the hybrid system as well as lack of need for a back-up electric resistance element. An HVAC system that can provide the desired level of functionality and reduce total cost of ownership will be highly favored by commercial buyers.

> *"The key selling point [of DFRTUs] for me is that it offers high energy efficiency, and my operating costs would be much less than with a traditional gas furnace."* (Commercial Buyer – Property Manager, LB, Rural MT)

2. Comfort within the commercial property.

Comfort is an important value proposition by commercial buyers since they claim productivity is negatively impacted if the comfort level is not maintained in a commercial workspace. Among those buyers who lease their commercial properties, any complaints they receive are costly in terms of initiating repairs and have a negative impact on their reputation as leasers. Pair this with fuel cost savings and it captures the commercial buyers' attention.

> *"Continued comfort is really important…they have to get that right because I have seen that fail before…continued comfort is important to the occupants of the building."* (Commercial Buyer - LB, Urban OR)

3. Can reduce carbon footprint.

This is relevant for some but not all commercial buyers. Those who are driven to meet carbon neutral goals, whether internally or externally driven, find this an attractive value proposition. For commercial buyers not focused on decarbonization, it serves as a selling point for the technology, but is perceived more as a benefit as opposed to a critical attribute of DFRTU technology.

7.2 DFRTU Potential Target Markets

Commercial buyers and HVAC contractors share similar perceptions regarding the identity of potential target market(s) for DFRTUs. Target businesses can range in size but have specific attributes that they share - all potential target markets will be seeking to recognize reduced fuel costs and lower overall total cost of ownership. They also include commercial buyers who desire to provide their property/properties with continued space conditioning while realizing less required maintenance and a lower carbon footprint. These can be retrofits or new construction.

The most receptive commercial buyer to DFRTU technology will be eco-minded commercial property owners, those who are managed by younger decision makers (under 45), and those whose commercial property is located in areas where decarbonization is top of mind (whether being imposed by internal or external forces). Figure 5 below provides a summary of potential target markets for DFRTUs (according to interviews and the literature search).

Figure 5. Potential commercial target markets for DFRTU technology

Smaller – Mid-Size Spaces/Commercial Properties	Larger Spaces / Commercial Properties	Buyer Mindset
Small-to-mid-size startup firms heavily focused on decarbonization. Smaller-sized commercial operations focused on reducing total cost of HVAC system ownership. Smaller-sized buildings and split commercial/residential properties with storefronts on the ground floor and apartments on the upper floor. Smaller-to-mid-size buildings located in rural environments where the electric grid may be unsteady/unreliable. Mid-size buildings where temperature control is critical (e.g.; gymnasiums, medical facilities, food preparation facilities and warehouses with attached offices).	Larger multi-residential living spaces (e.g.; assisted living facilities, stacked apartments, etc.) with high density of people, a larger building, and a large number of individual rooms.	Commercial buyers who are driven primarily by cost; cost-efficiencies and ROI are important considerations. Commercial buyers focused on decarbonization goals (internal or external). Commercial buyers replacing existing system or initiating a new-build and are responsible for paying the associated HVAC system fuel and maintenance costs.

"So, we have two sources of energy and have two units in one…if you have a big enough building like a warehouse or large corporate office, this [DFRTU] could be the most cost-effective option over the long run." (Commercial Buyer - Property Manager, LB, Rural MT)

"I think mid-sized buildings where comfort is critical such as gymnasiums and medical facilities would be candidates for this type of technology (DFRTU). The buyers in these properties tend to have a more forward-thinking mentality and like to utilize more modern equipment all around." (HVAC Contractor - LB, Urban MT)

"The code that is going to be adopted by the state of Washington will allow kitchens to utilize natural gas, but they have to have the infrastructure in place to completely switch to electric power...so with

this (DFRTU) you already have the (electric) heat pump installed…I can also envision this as an interim step as we have to electrify things and also a solution where there is an unreliable electric grid…like in remote, rural locations." (Commercial Buyer - LB, Urban WA)

7.3 Commercial Buyer Barriers to DFRTU Adoption

Overall, the perceived key barriers to DFRTU technology among commercial buyers are potential high upfront costs and unknowns such as system efficiencies, system effectiveness, and durability. The barriers are listed in order from more significant to less significant. Note, the order is subjective based upon a small number of interviews.

1. ***Potential upfront cost and installation.***

Commercial buyers are very focused on cost, and this will play heavily in their HVAC purchase decision. The perception among many interviewed commercial buyers is that any new HVAC technology will come with a premium cost. If DRFTU technology does not deliver a lower total cost of ownership, recognized by significant savings in operating costs, these buyers will be less inclined to consider this option.

Commercial buyers representing smaller businesses (i.e., mom and pop stores) will be most sensitive to costs, as will older commercial buyers (65+) and those who are looking to install in older buildings.

"Installation might be complex and more costly. Because you are using a furnace that has duct work but also an electric heat pump. There is no A/C, so there may be a limited amount of people who can do this type of installation." (Commercial Buyer, LB, Rural MT)

2. ***Unknown performance track record - system durability and maintenance requirements.***

Interviewees unfamiliar with the technology tend to be hesitant to adopt any HVAC technology unless it has proven itself in the marketplace. These commercial buyers express concern over how well DFRTU technology will hold up when exposed to the elements and how much maintenance will be required for a hybrid system. This information was missing from the stimuli but frequently asked for by respondents in the qualitative research.

"Some of the technologies that we are going to be forced to use are not well established, so I think we are going to be putting some products in our customers' buildings that don't have the reliability of natural gas products… They don't have the run time or proven track record in the US and at the scale we are using them…and I have reservations about them." (Commercial Buyer, LB, Urban WA)

"I am guessing it has more parts to it and it's got to have a more sophisticated software system to allow for the switching around between using the gas furnace and the electric heat pump. I wonder how reliable it will be and what kind of maintenance will it require? If it's more money, and it's going to create more problems for my tenant, then it's not a good sell for me." (Commercial Buyer – Property Manager, LB, Urban WA)

3. ***Concern over hybrid system effectiveness.***

While comfortable with the natural gas aspect of the DRFTU, a few of the commercial buyers expressed concern over whether the electric heat pump component will be effective enough at generating a sufficient level of space conditioning. These individuals had no prior electric heat pump experience.

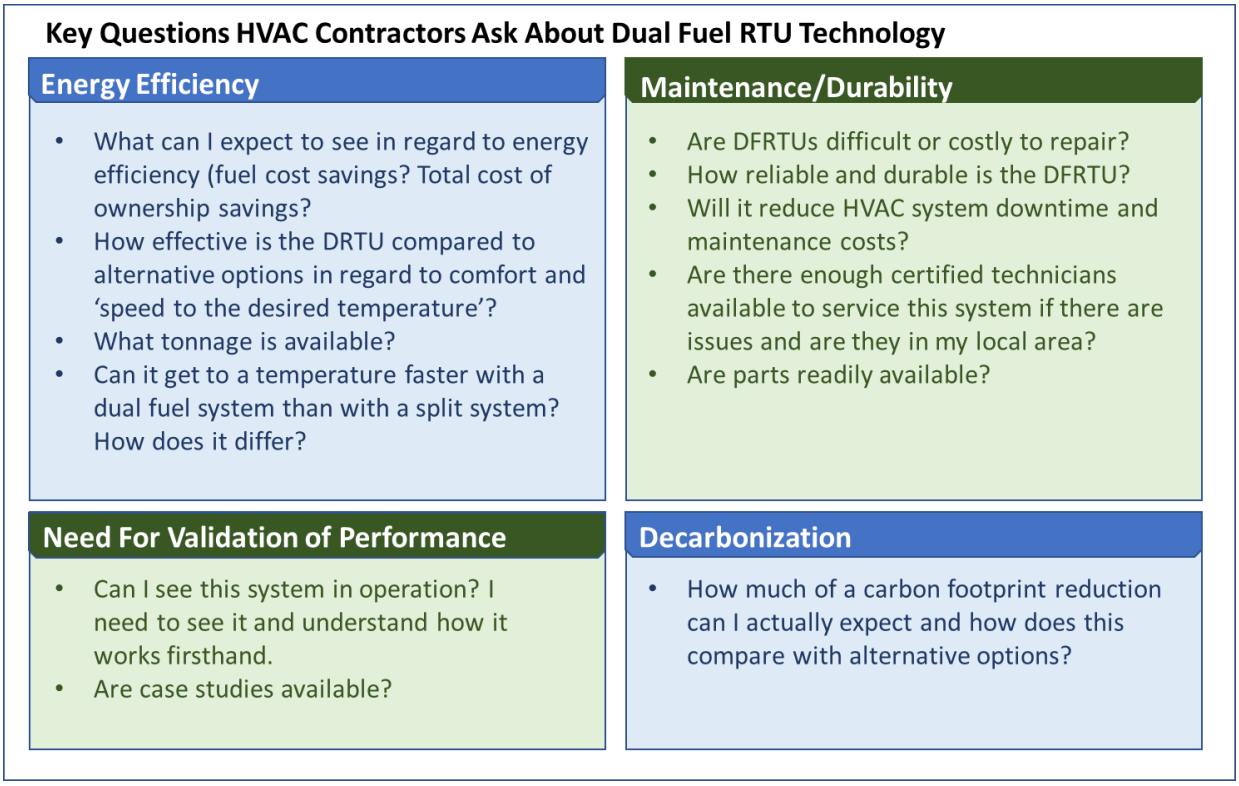
"I have no experience with these, but since it's a single integrated unit, I'm concerned there may be a higher chance for a single point of failure…which can shut the entire system down." (Commercial Buyer, MB, Urban WA)

4. Concern over system physical footprint and weight.

Some of the interviewed commercial buyers (and HVAC contractors) are concerned over the physical footprint of a DFRTU. Not knowing much about the technology, they are worried that a DFRTU may be larger than what they typically work with, so they want to know more about how much space the device will require and what specifically is different regarding installation. They also want to know how much the unit will weigh. Some perceive it may be heavier than current RTUs due to its hybrid design.

"There is more information I need…I need to know the weight, I need to know about vibration noise, and amount of space it requires." (Commercial Buyer, LB, Urban WA).

Figure 6. Key questions commercial buyers ask about DFRTUs



7.4 HVAC Contractor Barriers to DFRTU Adoption

HVAC contractors unfamiliar with the technology share some of the barriers to adoption that commercial buyers do. Among the HVAC contractors interviewed in the qualitative research, the most frequently cited concern was the reliability and durability of DFRTU technology.

1. ***Reliability and durability of the hybrid RTU***

A number of HVAC contractors in the research who are less familiar with DFRTU technology express concern that the hybrid RTU may be prone to a single point of failure which could shut the system down.

> *"In my opinion, the biggest objection [to DFRTUs] is customer lack of understanding and a fear that a 'dual fuel' system may break down because now they are dealing with two units that are tied together…they envision greater potential for problems and are hesitant to utilize a system where if one part fails, the entire system goes down."* (HVAC Contractor, LB, Urban MT)

2. ***Concern over natural gas restrictions.***

Primarily mentioned by contractors in Washington, this can restrict market opportunity for the HVAC contractors, particularly in more urban areas.

> *"With the changes that are taking place in Washington, I would say that the more rural a project is, the more likely our perception is that they can and should utilize gas. And the more urban they are, there's a higher percentage that gas won't be much of an option."* (HVAC Contractor, LB, Rural WA, WA)

3. ***Potential supply chain issues – product, parts, and support.***

HVAC Contractors in the qualitative research currently selling or installing DRFTUs do not claim to be experiencing any supply chain issues related to this technology at this point in time (although during the COVID-19 pandemic they did). Those less familiar with the technology voice their concerns over potential supply chain issues. They want to be assured of product availability, parts and service and support before they will adopt the technology.

> *"Logistics is a huge concern. If we say a unit will be delivered on a certain day and if that expectation is not met, I have a problem. The supply chain is super important. I need to know I can have access to OEM parts. I need to be assured there is a good warranty to back this [DFRTU] up, and we need to be able to have access to training."* (HVAC Contractor, SB, Rural OR).

4. ***Potential for no available rebates/tax credits to help offset cost.***

This arose in the literature search and was mentioned a few times during interviews. If there is a premium to be charged for DFRTUs, buyers would be looking for potential rebates/tax credits. HVAC contractors express that the availability of these credits and rebates can vary by geography and

technology. Some HVAC contractors express the ability to provide DFRTU incentives would help to make the sale easier.

5. ***Technology efficiencies must prove superior to alternative HVAC options.***

While DFRTU technology interests those who are unfamiliar with it, they have a lot of questions that require answers before they will consider recommending the technology. Many claim they will take a 'wait and see' approach before embracing the technology. Others would like to have a site visit, while others would prefer a small pilot program so they can get hands-on experience and judge if this is a technology they want to include in their HVAC product portfolio. Some believe dual fuel systems to be not as efficient as traditional gas systems and that they are more difficult to control.

8 Commercial Gas Heat Pump

8.1 Gas Heat Pump Value Propositions

Upon exposure to gas heat pump technology stimuli, feedback from both commercial buyers and HVAC contractors suggests the key value propositions center around three primary areas:

1. **Greater energy efficiency and higher capacity.**
2. **Ability to deliver both hot water and space conditioning.**
3. **Carbon footprint reduction.**

These three value propositions are described below:

1. Greater energy efficiency and higher capacity.

Commercial buyers in the qualitative research need assurance that GHPs can provide sufficient heating comfort on colder days as it can impact worker productivity. The higher capacity in colder weather offered by Gas Heat Pumps coupled with its less use of natural gas than a conventional furnace represents lower HVAC operating costs, which buyers find very appealing.

"We were planning a new construction and we were collaborating with the investors and architects. They wanted (an HVAC system) that was very energy efficient with high capacity, so we did a comparative analysis of our options. We chose the gas heat pump because of its higher efficiency and capacity." (Commercial Buyer – Property Manager, LB, Urban, ID)

2. Ability to deliver both hot water and space heating.

The commercial GHP technology NEEA is studying can heat water, space, or both. This was explicitly mentioned in the stimuli provided to interviewees, so all interviewees asked about commercial GHPs in this study were informed of this capacity. A single HVAC system that provides both hot water and heating is perceived positively among commercial buyers. They perceive this can potentially lower their HVAC operating costs. However, it does bring into mind questions over plumbing and any other expenses which may be incurred during installation. Still, the delivery of hot water is an appealing and important value proposition.

The fact that it doesn't have cooling may be an impediment…but the ability to offer heat and hot water is a very positive aspect…I see that as a good utilization." (Commercial Buyer, SB, Rural ID)

3. Carbon footprint reduction.

Many commercial buyers and HVAC contractors react positively to the ability to continue to use natural gas and be able to reduce their carbon footprint. Reduced carbon footprint plays a somewhat stronger level of importance with commercial GHP technology compared to DFRTUs since this technology relies strictly on natural gas. Offering a reduction in carbon footprint may help to move some who may be on

the fence over using natural gas (due to environmental reasons) and makes them feel more comfortable with this type of solution.

"Gas heat pumps can reduce gas usage up to 50%...that is really impressive…and it reduces the carbon footprint…that goes hand in hand with using less fuel… Carbon footprint reduction is very important to us in our buildings, so this is really good." (Commercial Buyer – Property Manager, LB, Urban WA)

8.2 Gas Heat Pump Potential Target Markets

Commercial GHPs may best serve small to mid-sized commercial properties owned by those who prefer using natural gas. Figure 7 below summarizes the potential commercial target markets for gas heat pump technology.

Figure 7. Potential target markets for gas heat pump technology

8.3 Commercial Buyer Gas Heat Pump Barriers to Adoption

During interviews, commercial buyers were presented stimuli with an overview about GHPs to gauge their perceptions toward the technology. The text below outlines the primary barriers to commercial gas heat pump adoption. The barriers are listed in order from more significant to less significant. Note, the order is subjective based upon a small number of interviews.

1. Concern over total cost of ownership.

GHPs need to demonstrate equal or higher energy efficiency and a significantly lower total cost of ownership over alternate options in order to be considered by commercial buyers.

> *"I see high efficiency, high capacity which is great, but that makes me think this will be costly. There's a numbers aspect to all this as well. You have the upfront costs, but over the long run I won't break even on this cost versus going with something like a conventional furnace."* (Commercial Buyer, MB, Urban OR)

2. Concern over gas heat pump reliability/durability.

Since commercial buyers perceive GHPs as a new technology, they are unsure of how durable the product will be and need to be assured they can depend upon it. They also need to know realistically what to expect in terms of product life expectancy. Many of the commercial buyers are hesitant and prefer to wait and see how GHPs will fare in the marketplace before they adopt. Additionally, some have expressed the perception that heat pump maintenance/repairs are higher in the long run than a more traditional HVAC system alternative.

> *"What I am really looking for is reliability. The issue is when you have a unit that provides heat and hot water and it stops working, then everything stops working. I don't want it to be an all or nothing situation."* (Commercial Buyer- Property Manager, LB, Rural ID)

3. Higher maintenance costs.

A significant concern expressed by commercial buyers relates to how much maintenance gas heat pump technology will require. Ideally, they want to realize less maintenance with whatever technology they acquire. This means less downtime and less maintenance expenditure. Given their lack of experience with this technology, they are unsure of how much maintenance it will really require.

> *"What does maintenance look like in terms of operating costs? Maintenance costs are typically higher for heat pumps."* (Commercial Buyer, MB, Urban OR)

> *"In my understanding, over the long run, maintenance repair costs for heat pumps are usually higher than a traditional furnace."* (Commercial Buyer - Property Manager, LB, Urban OR)

4. Does not offer cooling capability.

Some commercial buyers expressed a lower level of interest in gas heat pump technology because it only provides heating. This would require a separate cooling system for the property and some buyers are hesitant to do this as it means additional cost.

"It doesn't offer cooling. That means we would need a separate system for cooling…I would feel less inclined to want to do that." (Commercial Buyer, MB, Urban WA)

5. Carbon neutral codes in Northwest.

Carbon neutral codes cause some commercial buyers (most prominently noticed among buyers located in urban areas of Washington) to hesitate to embrace gas heat pump technology. Some others will wait to see if code exceptions are made that will not prevent this technology from being used in certain industries or geographic regions.

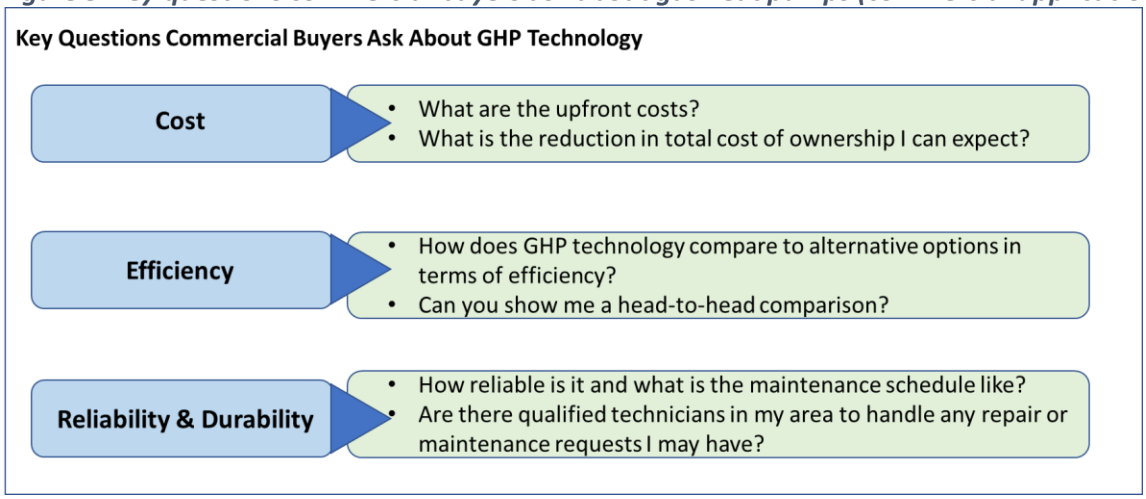
"I am in Seattle, so in our local market, natural gas will be ruled out due to the carbon neutral codes. The west coast of the US is where the progressive codes begin. There will be codes added this summer to restrict the use of natural gas…any new buildings will not be able to put in natural gas. It's just a thing and we will have to deal with it. This is a very expensive thing to put on our customers, the buildings will cost more, but it's what we have to do. I see these codes moving eastward." (Commercial Buyer – Property Manager, LB, Urban WA)

"I think there may be exceptions made to the carbon neutral codes…if the manufacturers are good at doing lobbying to get exceptions to the codes, we may be able to use this more…we'll have to wait and see." (Commercial Buyer, LB, Urban, WA.)

6. Preference to replace like with like technology.

The literature review indicated that commercial buyers tend to replace 'like technology' with 'like technology.' While no interviewee stated this directly, some expressed that unless there is a problem (e.g., poor performance or high operating cost), many of the commercial buyers tend to stick with the technology they have in place/are familiar with.

Figure 8. Key questions commercial buyers ask about gas heat pumps (commercial application)



8.4 HVAC Contractor Gas Heat Pump Barriers to Adoption

HVAC contractors unfamiliar with the technology share some of the barriers to adoption that commercial buyers do such as concerns over reliability, durability, and for some in Washington – carbon neutral codes. Three additional lesser barriers were cited by HVAC contractors and are discussed below.

1. ***Commercial buyer unwillingness to add natural gas to a building that's not already utilizing it.***

Some HVAC contractors in the qualitative research believe that commercial buyers that do not have gas lines available in their building would incur too much cost to bring natural gas in, including costs flowing from interruption to the commercial property's operation.

> *"If a customer is not already using natural gas, it may be hard to get them to switch."* (HVAC Contractor, SB, Urban OR).

2. ***Unless asked for by the buyer, the contractor may not have the opportunity to offer the technology.***

A number of interviewed HVAC contractors often engage in little consultative selling with commercial buyers (except for commercial property managers). In these situations, the buyer comes to them and asks for a bid on a specific pre-determined HVAC solution. Unless the buyer asks for a gas heat pump, the contractor has little opportunity to offer the option.

> *"There are times when the customer comes to us and they already know what they want. We just provide them with a bid. If they don't ask for say a gas heat pump, then we would not bring it up."* (HVAC Contractor, SB Rural OR)

3. ***Concern over refrigerant utilized.***

While only expressed by a small number of HVAC contractors, it should be noted that there was some safety concern over the use of ammonia as the natural coolant in gas heat pump technology.

> *"There's been a lot of backlash on the use of ammonia, even though it's a very, very, very good refrigerant."* (HVAC Contractor, SB Urban, BC)

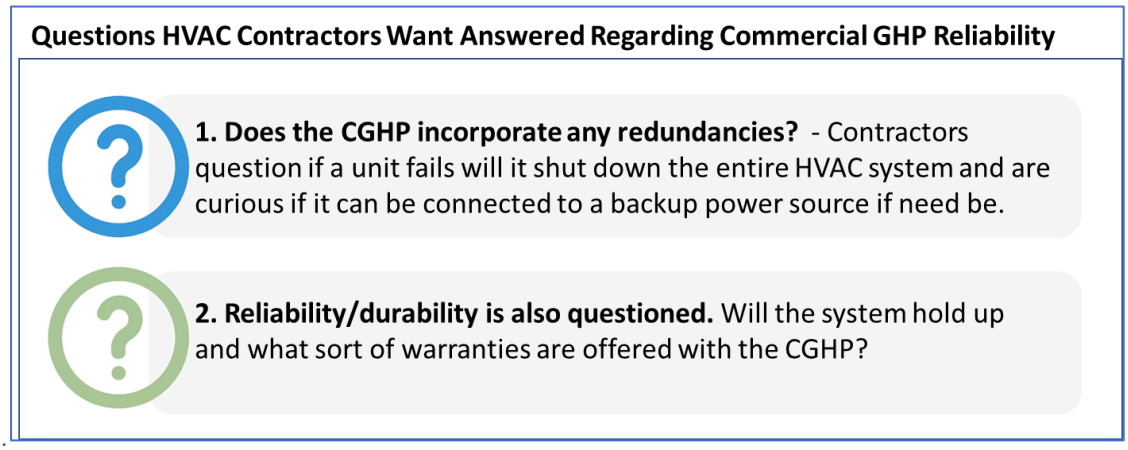
4. ***Brand considered important, but not critical.***

Commercial buyers and HVAC contractors believe that a well-known brand conveys reliability and quality. However, they also acknowledge when newer advanced technologies enter the market they may come from lesser-known brands. These lesser-known brands are not rejected, but rather if the technology is found appealing, they will undergo more scrutiny to assess the viability, performance, reliability, and cost savings that can be achieved by adopting this technology.

> *"I wouldn't be uncomfortable if a Gas Heat Pump was only available from an unknown brand. I probably would not adopt it early, but I would like to run a pilot program to see it in operation first*

before any decision was made to include it our offerings. It would need to prove its efficiency and cost savings and to come with a good product warranty…and good technical support and training." (HVAC Contractor, SB, Rural OR)

Figure 9. Key questions HVAC contractors ask about gas heat pump reliability.



"It's an integrated unit that solves several issues at once but the flip side of this is if it is truly integrated and if one part of the system fails, does it allow for the system to continue to function as normal or does one single failure result in the entire shutdown? So that's a big question that I want to know." (HVAC Contractor - SB, Rural MT)

9 Conclusions, Recommendations and Next Steps

9.1 Conclusions

Market demand for both dual fuel and gas heat pump technology exists based on results of this qualitative and literature research. Gas heat pump technology's lack of cooling capability puts it at a competitive disadvantage compared to dual fuel technology, but both show promise among segments of the residential and commercial markets.

There are a number of barriers that exist for all four technologies that need to be addressed in order to improve the acceptance of these products in the marketplace. Some of these barriers are common across technologies and some are specific to each of the technologies themselves. The recommendations below address these barriers and suggested courses of action.

9.2 Recommendations

9.2.1 Addressing common barriers across all four technologies

Cost, proof of reliability and durability, uncertain energy efficiency and resultant fuel cost savings are all barriers that will need to be addressed across all of the technologies and markets in order to facilitate adoption.

1. Clearly demonstrate the financial benefits of the technologies.

a) Work with partners to promote the ability of buyers to save on fuel costs resulting from greater energy efficiency. Develop and provide buyers with head-to-head comparisons with primary competing HVAC technologies.

b) Work with contractors and utilities to create case studies and testimonials supporting product satisfaction and realized fuel cost savings. These will need to be tailored for different markets, industries, and business size.

c) Work with utilities to help generate awareness of the technologies and encourage them to offer rebates or tax credits to bring down the price of purchase. This will serve to function as an added incentive to buyers to adopt the technologies.

d) Encourage contractors and manufacturers to extend credit to buyers to ease their acquisition of the technology.

2. Build greater awareness and confidence in the technologies among buyers and sellers.

a) Work with HVAC contractors and manufacturers to facilitate site visits or be able to start small pilot programs to offer contractors the ability to experience the technologies firsthand. This will build contractor confidence and experience with these products. Also consider the development of short videos that extoll the cost, energy and environmental benefits.

b) Encourage distributors and manufacturers to develop dual fuel and gas heat pump technology certification programs. In addition to training, this will provide contractors with a competitive edge and build confidence among buyers that a newer HVAC technology will be installed and maintained by a certified technician.

c) Work with HVAC Contractors, manufacturers and distributors to create attractive enhanced/extended warranties on the technologies to help address any buyer or contractor concerns of reliability/durability.

d) Encourage partners to provide technology specification sheets to buyers that clearly illustrate product reliability, durability and required maintenance in specific rather than general terms (e.g., product life expectancy, periods and type of maintenance required, availability of parts and qualified service).

3. Work with partners to actively address any concerns or hesitation regarding the use of natural gas and extoll carbon footprint reduction provided by the technologies.

a) Encourage partners to promote that both dual fuel and gas heat pump technology utilize less natural gas than gas furnaces and can help to reduce their carbon footprint. Show how this technology fits within a growing demand for decarbonization and how it can meet carbon neural codes.

b) Keep HVAC contractors up to date on carbon neutral codes and changes that may impact them in their market. Not all contractors claim to be up to date on changes in the market, which creates confusion on their part. This will help them properly position and recommend dual fuel and gas heat pump technology to their prospects.

4. Address any buyer apprehension about reliability of dual fuel and gas heat pump technologies.

a) Work with partners to develop testimonials emphasizing reliability of the technology and encourage offering of extended warranties to further ease buyer concern.

9.2.2 Residential Dual Fuel Heat Pump Recommendations

1. Promote heating and cooling capability from a single HVAC system.

Encourage partners to heavily promote DFHP ability to provide continuous heating and cooling comfort from a single system, meeting the growing need of cooling capability among buyers in the Northwest and eliminating the need for a separate A/C system.

2. Promote fuel cost savings.

Encourage contractors and utilities to emphasize in their promotions how DFHPs can save residential buyers in fuel costs. Provide head-to-head comparisons to competitive technologies. Also emphasize the technology as a means of meeting today's modern residential HVAC needs – these buyers expect newer technology will always provide improvements.

3. Accurately convey spacing requirements for DFHPs.

Encourage partners to provide physical footprint requirements for DFHP which will help residential buyers more easily assess if they have room to install the technology.

9.2.3 Gas Heat Pumps (Residential and Commercial)

1. Promote lower HVAC operating costs.

Encourage partners to educate buyers on how GHPs utilize less natural gas which will serve to recognize lower HVAC operating costs and help to counteract any hesitancy among those who may be uncertain about wanting to use natural gas as a home heating source.

Exercise caution using phrase 'high capacity' among residential buyers when associating with heat as most buyers associate this as meaning that GHP technology is best suited primarily for those in very cold climates only.

2. Address how and in what geographies technology can meet carbon neutral codes.

Work with partners to develop means of assuring technology can meet stricter decarbonization mandates and building regulations.

3. Promote the ability to deliver heat and hot water from a single HVAC system.

Discuss with partners and strongly consider as a key aspect to promote to buyers. The ability to also provide hot water will generate appeal to both commercial and residential buyers, and for some of the latter can compensate for the GHP's lack of cooling capability.

4. Emphasize fuel flexibility when promoting GHP technology.

This will have particular appeal among contractors as it expands their potential market opportunity beyond just those who utilize natural gas.

9.2.4 Commercial Dual Fuel RTU Recommendations

1. Promote an improved return on investment among commercial buyers and selling partners.

Work with partners to develop case studies or white papers that illustrate how DFRTUs can lower total cost of ownership – highlight how energy efficiency can reduce HVAC operating costs and the lack of need to install a back-up resistance element for the indoor unit further helps reduce total cost of ownership. This will also help to support the contractor sales pitch.

2. Work with commercial buyers and contractors to increase awareness of the continued level of comfort offered by DFRTU technology.

Encourage partners to educate and promote how DFRTUs maintain a comfortable temperature within a commercial workspace, no matter the outside temperature; which helps to support worker productivity.

3. Work with partners to address concerns over reliability and durability of hybrid technology as well as product footprint and weight.

Support the development of informational literature and/or videos to reinforce the reliability of hybrid technology to alleviate buyer concerns of system wide failure among commercial buyers. Also provide detailed information on product size and weight specifications to address commonly requested information by commercial buyers.

9.3 Areas to Investigate in the Future

While this research revealed residential and commercial perspectives toward Dual Fuel and Gas heat Pump technologies, results are based on a small sample and are therefore directional.

NEEA may want to consider a study to quantify and size the market opportunity for the technologies among the residential and commercial sectors more definitively. This deeper dive into residential and commercial perspectives could examine how changing environmental regulations targeted at natural gas may impact buyer and seller recommendations of Dual Fuel and Gas Heat Pump technologies in the near and mid-term. NEEA also may want to consider exploring how these changing regulations may impact the acceptance of these technologies in other U.S. regions in order to understand potential upstream influences on their regional programs.

Appendix A: Residential Buyer Discussion Guides

NEEA Dual Fuel and Gas Heat Pump Research: RESIDENTIAL BUYERS

60 minutes

BACKGROUND:

This guide focuses on The RESIDENTIAL BUYERS/POTENTIAL BUYERS of Dual Fuel Heat Pumps and HVAC systems (specifically **dual fuel heat pumps** and **gas heat pumps**). NEEA wants to gain a deep understanding of which, if any, of these RESIDENTIAL technologies is promising enough to further investigate for market transformation or other types of energy efficiency programs in their four-state region (with emphasis on Oregon and Washington). Findings from the study will complement ongoing NEEA product research to assess product performance and readiness for Northwest markets.

KEY OVERALL RESEARCH OBJECTIVES FOR THE TWO RESIDENTIAL TECHNOLOGIES:

- What are the value propositions for buyers (consumers)?
- What are the possible target markets?
- What are the barriers to adoption?
- For **residential dual fuel heat pumps** - What drives actual dual fuel HVAC purchases?
- For **residential gas heat pumps** - What are consumer attitudes about natural gas as a home heating fuel source?

METHODOLOGY:

A total of n=25, 60-minute web-enabled TDIs conducted among Residential Buyers:

- ~N=8 **"Dual Fuel HP Owners":** Consumers who have a Dual Fuel Heat Pump installed in their home
- ~N=8 **"Recent HVAC Purchasers":** Consumers who have purchased an HVAC system within the past 12 months
- ~N=9 **"HVAC Purchase Intenders":** Consumers who plan to purchase an HVAC system within the next 12 months.

DISCUSSION FLOW:

- Moderator introductions 5 mins
- About you & perceptions toward heating/cooling systems 15 mins
- Decision-making around new heating/cooling system 8 mins
- Aided Perceptions toward Gas HPs and Dual Fuel HPs 30 mins
- Wrap up 2 mins

Introduction (5 min)

Standard Introduction. Moderator welcomes respondent, introduces self and topic of discussion, emphasizes **not trying to sell you anything** or influence your opinion in any way. For research purposes only.

Topic to be conveyed to respondent: Today we are going to discuss your attitudes, opinions, and any experiences you may have regarding the heating/cooling systems you have installed in your home or considering purchasing. We'll cover topics such as what kind of heating/cooling needs do you have and are most important to you, what you like/don't like about the system you have, what ideally you would like to have and why, etc. I also want to show you some technologies for home heating/cooling and get your honest opinions and feelings about them.

- Session being recorded
- No right or wrong answers, only looking for you honest opinion, moderator has no stake in outcome
- Answers are confidential, reporting in aggregate
- Professional moderator – no right or wrong answers, no stake in outcome

About You & Perceptions Toward Heating/Cooling Systems (15 min)

*(**Objectives**: Understand the consumer, their levels of awareness and perceptions toward HVAC systems, Identify type of type of technology in the home (or is planning to be installed within next 12 months); how selection is made and what influences selection)*

About the consumer, awareness and general perceptions of heating/cooling systems

1. Please tell me a little bit about you. Where you live, who is in your household - what type of home do you currently have? Any idea of the approximate square footage?
    - Did you have this home built or did you move into a pre-existing home?
    - Where did you live previously?
    - How would you describe the area you live in (e.g. urban, rural)?
    - How long have you lived in your current home?
    - Would you describe your home as single family or a multi-family building?
    - Do you own your home, or do you rent?
2. **System 1, Automatic Reaction Exercise:** I'd like to start off with a quick exercise. I'm going to display some words on the screen and I'd like for you to come up with as many words or ideas that come to mind for you. This is a timed activity – I'll give you 10 seconds to come up with as many words as you can. Please don't filter your thoughts, and you can say anything at all!

(Moderator exposes the words: "Home heating and cooling system", "Natural Gas Heating", and "Heat Pump" on screen, rotated)

(Moderator probes fully to understand reason behind responses for each of the terms, particularly probing around any potential negative reactions or concerns)

3. What are some of the different types of heating systems you are aware of?
    - Can you tell me how they work? How are they different?
    - How did you come to learn about these different heating systems?
    - Are there any particular heating systems that you have a more positive opinion toward than others? Why?

Understanding the technology in their home

4. To clarify, I understand that you… *[Ask based on segment to verify segment]:*
    - **FOR RECENT HVAC PURCHASERS: …** Have recently purchased a new HVAC system, is this correct?
    - **FOR HVAC PURCHASE INTENDERS:** …Are planning to purchase a new HVAC system, is this correct?
    - **FOR DUAL FUEL HP OWNERS: …**Currently own a dual fuel heat pump, is this correct?
5. **FOR RECENT HVAC PURCHASERS:** As you know, in this conversation I want to learn about the new heating and cooling system you chose to buy for your home, but firstly I want to learn about your **previous** heating/cooling system. What kind of system was it?
    - How long did you have this system?
    - How satisfied were you with this system? What makes you say that?
    - Is there anything that you were not satisfied with?
    - What would you say was the primary benefit of this system?
    - Is this what made you decide to purchase the system? If not, what was it that drove you to make the decision to purchase?
    - What, if anything, would you have wanted to see improved in the system you had? *[if not mentioned, probe: operating cost, type of fuel, efficiency, decarbonization, one unit to provide heating and cooling).*

    FOR HVAC PURCHASE INTENDERS: As you know, in this conversation I want to learn about the heating and cooling system you are choosing to buy for your home, but firstly I want to learn about your **current** heating/cooling system. What kind of system is it?
    - How long have you had this system?

- How satisfied have you been with this system? What makes you say that?
- Is there anything that you are not satisfied with?
- What would you say was the primary benefit of this system?
- Is this what made you decide to purchase the system? If not, what was it that drove you to make the decision to purchase?
- What, if anything, would you have wanted to see improved with this system? *[if not mentioned, probe: operating cost, type of fuel, efficiency, decarbonization, one unit to provide heating and cooling).*

FOR DUAL FUEL HP OWNERS: Before I ask you about the heating/cooling system you have now, I want to know a bit about what you had previously. What kind of system was it?

- How long did you have this system?
- How satisfied were you with this system? What makes you say that?
- Is there anything that you were not satisfied with?
- What would you say was the primary benefit of this system?
- Is this what made you decide to purchase the system? If not, what was it that drove you to make the decision to purchase?
- What, if anything, would you have wanted to see improved in the system you had? *[if not mentioned, probe: operating cost, type of fuel, efficiency, decarbonization, one unit to provide heating and cooling).*

Thank you for sharing that with me. Now, I want to learn about your current heating system which I understand is a dual fuel heat pump.

- How long have you had this system?
- How satisfied have you been with this system? What makes you say that?
- Is there anything you are dissatisfied with?
- What, if anything, would you want to see improved with this system? *[if not mentioned, probe: operating cost, type of fuel, efficiency, decarbonization, one unit to provide heating and cooling).*
- What is the most important thing you want to see improved? What makes that most important improvement you want?

6. When you think about what you most want and need from your home heating and cooling system, what is most important to you? Why? *[Probe for rational and emotional benefits] (NOTE: If Comfort or Comfortable is mentioned, probe on what that means to the respondent)*

- Of all of these, what are the most important things for your heating / cooling system to 'get right'? What makes you say that?
- Have these wants and needs evolved over the last few years for you? If so, how? What, if anything, has impacted this? *(Probe/ listen for: Changes in geographic location, lifestyle, work from home, income, interest in efficiency)*

7. To help me understand how you think about your home heating / cooling system, I'd like to think about it in terms of a creative analogy. Please complete this sentence for me: Choosing the right heating/cooling solution for my home is like…..
    - What makes you say that?
    - How does choosing a heating/cooling solution for your home compare to choosing any other type of technology for your home or lifestyle? Why?
8. Let's talk a little about fuel sources. Firstly, and this is not a knowledge test,
    - As far as you're aware, what types of fuel sources are available in your area? *(E.g., Natural gas, electricity)*
    - In your personal opinion, what is more efficient – *electric or natural gas? What makes you say that?*
    - *(If decarbonization not mentioned, ask)* Have you ever heard of decarbonization/ carbon footprint? What does this mean to you?
        a. How do you feel about decarbonization? How important is decarbonization/ reducing the carbon footprint to you, if at all? Why?
        b. Just before you told me about your preference for electric or natural gas as a fuel source – based on what you just mentioned about reducing the carbon footprint, does your preference for fuel type change? What makes you say that?

Decision-making around new heating/cooling system (8 min)

*(**Objectives**: <u>Unaided</u> exploration of how residential buyers evaluated their decision for their new heating/cooling system, unaided exploration of value propositions for buyers, identification of barriers to adoption, and drivers of dual fuel HVACs)*

Note: We will spend longer on the below questions for <u>Dual Fuel HP Owners</u>

9. Now I'd like to learn about how you are choosing / how you chose your new heating/cooling system / dual fuel heat pump.

    When you were **shopping around** for a heating/cooling system, what were/are the key criteria or attributes about the system you were looking for? Why? *[Moderator to type*

up list of attributes/ criteria on screen. Refer back to previous list of value drivers if needed]

- Were there any factors or specific circumstances that relate to the specific needs of your home? Your area? If so, what?

10. What kinds of systems were you considering? Why?

FOR DUAL FUEL HP OWNERS ASK ALL QUESTIONS – FOR RECENT HVAC PURCHASES ASK QUESTIONS # 11 – 14 ONLY THEN SKIP TO NEXT SECTION:

11. How much did you know about this system before you purchased it?
    - Do you understand how the system works now?
    - Did you have any pre-existing opinions of this system before you purchased it?
12. Why did you end up choosing this specific system?
    - What were the top attributes about this system that led you to purchase it?
    - Why did you choose this particular fuel source for this new system? What do you see as the pros and cons (if any)? *(If not mentioned, probe on cost/cost savings, efficiency, decarbonization, influence or importance of incentives/rebates, importance of financing options)*
    - To what extent did the need or desire for cooling play a role in your decision?
13. How much did the system cost? How did you feel about this price?
    - How if at all did the system cost play a role in your decision?
    - Do you believe the system was worth the price? *(Probe for efficiency, attitudes on return of investment)*
14. To what extent were you ever aware of any rebates or tax credits available to help you purchase the system?
    - *(If yes)* What incentives were you aware of?
        a. How did you find out about these incentives?
        b. How, if at all, did this play a role in your decision to purchase?
        c. How was the experience for you in securing the incentives? *(Probe on potential complexity or hurdles)*
15. Now that you have the system installed, to what extent is it performing based on your expectations? Are you using it for just heating, just cooling or both? (**FOR EACH USAGE SCENARIO MENTIONED, ASK THE FOLLOWING**)
    - Anywhere it excelled?

- Anywhere is fell short of your expectations? Please elaborate.
- Was there anything that surprised you about this system? If so, what?

16. Would you recommend this system to your friends and/or family? Why/ Why not?
    - Who would you most likely recommend this system to?
    - Who might not be a good candidate for a dual fuel HP system like this? Why? *(Probe/listen for: Type of home, affordability)*
17. What has your experience been like with controlling the system? E.g., using the thermostat)
    - Do you notice a difference between when the heat pump is on and when the furnace is on? *(Probe/ listen for: Any pain points when it switches from HP to furnace)*

AIDED Perceptions Toward Gas HPs and Dual Fuel HPs (30 mins)

I now want to show you some information about two different types of heating/cooling systems. I am curious to know what you think of them, what do you see as being some of the potential benefits to these systems, what you think might be some of the potential drawbacks, and your general opinions about them.

GAS HEAT PUMP CONCEPT EXPOSURE

Let's start off with residential? **Gas Heat Pumps.** Firstly, have you ever heard of this type of heating system before?

(MODERATOR SHOW STIMULI OF RESIDENTIAL GAS HEAT PUMPs)

18. This is not available in the US yet. Here is some information about it. Please read over this and let me know when you're done, and I'll ask you some questions.
    - Based on what you just read, what are your initial thoughts
    - How well do you think this product can meet your needs? What makes you say that?
        a. (If respondent says 'not for them' ask)- What makes you say that?
        b. (If respondent says 'not cold enough here')- Please explain to me what that means?
    - Do you see any potential disadvantages or drawbacks? If so, what are they? What makes you say that? *(Listen for/ probe: Willingness to use natural gas, ammonia as a refrigerant)*
    - What, if any, questions or concerns do you have regarding a system like this?

19. To what extent do you think a system like this would be suitable for your home? Why/ why not?
    - Thinking about your specific wants and needs we discussed earlier, to what extent do you feel a system like this would be suitable for **you**? Why/why not?
20. If you were in the market to upgrade the system in your home – how likely would you be to consider this type of technology? What makes you say that? (*Probe for specific rationale*)
    - What would you need to know / what might be needed to encourage you to consider a system like this for your home? Why?
    - How much influence would the HVAC salesman/contractor have on your purchase decision? What makes you say that?
21. Who do you think would be the ideal candidate for a system like this? Why?
22. Now I want to show you some potential advantages of this system, to get your thoughts.

(MODERATOR SHOW STIMULI OF POTENTIAL ADVANTAGES OF GAS HEAT PUMPs)

23. Now that you've read this, what do you think about this system? Do you feel any differently about this system?
24. How much does the cost effectiveness of a system like this matter to you? In your opinion, what is the real benefit, if any to you?
    - To what extent might you be willing to pay more for this system than a gas furnace? Why?
    - To what extent might you be willing to pay more for this system than an electric heat pump? Why?
    - What if a gas heat pump system could also heat your water? Would that add any interest or value to you?

DUAL FUEL HEAT PUMP CONCEPT EXPOSURE (ASK ONLY OF THOSE WHO DO NOT OWN A Dual Fuel HEAT PUMP)

Ok great. Now I'd like to talk about Dual Fuel Heat Pumps.

Firstly, have you ever heard of this type of heating system before?

(MODERATOR SHOW STIMULI OF DUAL FUEL HEAT PUMPS)

25. Here is some information about dual fuel heat pumps. Please read over this and let me know when you're done, and I'll ask you some questions.
    - What do you think about this type of heating/cooling system?

- Do you understand how this works? (clarify to respondent that it pairs an electric heat pump with a gas furnace and alternates between the two fuel sources to maximize comfort and efficiency.)
- How well do you think this system can meet your needs? What makes you say that?
- Do you see any potential disadvantages or drawbacks? If so, what are they? What makes you say that?
- What, if any, questions or concerns do you have regarding a system like this?
- If you were to use this system, do you envision using the heat pump primarily for heating, cooling, or both?

26. To what extent do you think a system like this would be suitable for your home? Why/ why not?
    - Thinking about your specific wants and needs we discussed earlier, to what extent do you feel a system like this would be suitable for **you**? Why/why not?
27. If you were in the market to upgrade the system in your home – how likely would you be to consider this type of technology? What makes you say that? (*Probe for specific rationale*)
    - What would you need to know / what might be needed to encourage you to consider a system like this for your home? Why?
    - How much influence would the HVAC salesman/contractor have on your purchase decision? What makes you say that?
    - Who do you think would be the ideal candidate for a system like this? Why?

Now I want to show you some potential advantages of this system, to get your thoughts.

(MODERATOR SHOW STIMULI OF POTENTIAL ADVANTAGES OF DUAL FUEL HEAT PUMPS)

- Now that you've read this, what are your perceptions of this system? Do you feel any differently about this system?
- How much does the efficiency of a system like this matter to you?
- - What if anything do you perceive as being the primary benefit of this system?
- To what extent might you be willing to pay more for this system than a gas furnace and A/C? Why?

Wrap Up (2 min)

Check with research team to see if there are additional questions

28. Ask any additional probes, then thank and dismiss respondent.

Appendix B. Commercial Buyer Discussion Guide

NEEA Dual Fuel and Gas Heat Pump Research: COMMERCIAL BUYERS

60 minutes

BACKGROUND:

This guide focuses on The COMMERCIAL BUYERS of central gas fueled heating and cooling systems for commercial properties (with a specific focus on Gas Heat pump for space conditioning (heating & cooling) and/or water heating and Dual fuel rooftop units (RTUs/ ERTUs). NEEA wants to gain a deep understanding of which, if any, of these COMMERCIAL technologies is promising enough to further investigate for market transformation or other types of energy efficiency programs in their four-state region (with emphasis on Oregon and Washington). Findings from the study will complement ongoing NEEA product research to assess product performance and readiness for Northwest markets.

KEY OVERALL RESEARCH OBJECTIVES FOR THE TWO COMMERCIAL TECHNOLOGIES:

- What are the value propositions for buyers (commercial)?
- What are the possible target markets?
- What are the barriers to adoption?

METHODOLOGY:

A total of n=18, 60-minute web-enabled TDIs conducted among Commercial Buyers:

- N=6 who classify as Small Businesses (< 100 employees)
- N=12 who classify as Medium/Large Businesses (> 500 employees)
- Urban and Rural mix will be represented within each segment.

DISCUSSION FLOW:

• Moderator introductions	5 mins
• Needs and Perceptions Toward Commercial Heating/Cooling Systems	12 mins
• Decision-making Around New Commercial heating/cooling system	12 mins
• Perceptions Toward Commercial Dual Fuel RTUs & Gas Heat Pumps	30 mins
• Wrap up	1 min

Introduction (5 min)

Standard Introduction. Moderator welcomes respondent, introduces self and topic of discussion, emphasizes not trying to sell anything or influence your opinion in any way. For research purposes only.

Topic to be conveyed to respondent: Today we are going to discuss your attitudes, opinions and any experiences you may have regarding the heating/cooling systems you have installed in your commercial properties or considering are purchasing. We'll cover topics such as what kind of heating/cooling needs do you have and are most important to you, what you like/don't like about the system you have, what ideally you would like to have and why, how this may be different if you reside in that specific commercial property or not, etc. I also want to show you some technologies for commercial heating/cooling and get your honest opinions and feelings about them.

- Session being recorded
- No right or wrong answers, only looking for you honest opinion, moderator has no stake in outcome
- Answers are confidential, reporting in aggregate
- Professional moderator – no right or wrong answers, no stake in outcome

Needs and Perceptions Toward Commercial Heating/Cooling Systems (12 min)

*(**Objectives**: Identify type of chosen technology for the commercial property; how selection is made and what influences selection)*

1. Please tell me a little bit about you and the organization you work at/for.
    - Where are you located? Is this an urban/suburban or rural area?
    - How large is your company in terms of total full-time employees?
2. I want to learn a little about the commercial property you occupy/manage. How would you describe it in size? Is it a large building, medium, small sized - what is the approximate square footage?
    - (**NOTE TO MODERATOR: IF MULTIPLE PROPERTIES ARE BEING MANAGED ASK THE NEXT 3 QUESTIONS (a, b and c) AS APPROPRIATE TO NARROW DISCUSSION TO FOCUS ON ONE PROPERTY**):
    - a) Are any of the properties a small-to-mid size building– say 25,000 square feet or less? (**INSTRUCTION: IF ONE PROPERTY FITS THE DESCRIPTION, FOCUS ON THAT PROPERTY . IF MULTIPLE PROPERTIES FIT THE DESCRIPTION, ASK QUESTION 'b'**)
    - b) Are any of these properties a warehouse (or if a food service ask if one of those buildings is for food preparation?) (**INSTRUCTION: IF ONE PROPERTY FITS**

THE DESCRIPTION, FOCUS ON THAT PROPERTY. IF MULTIPLE PROPERTIES FIT THE DESCRIPTION, ASK QUESTION 'c')

- c) If you had to pick **ONE OF THOSE PROPERTIES**, which one would require the most attention to ensure the right HVAC system was installed? (**INSTRUCTION: FOCUS DISCUSSION ON THAT PROPERTY AND CONTINUE**).
- What type of commercial property would you describe it as?

  (Listen for: hotel, warehouse, retail store, food service, office buildings, warehouse)

- Who occupies this commercial property? (e.g., Students, office workers, families)

  (Moderator to probe if they use/occupy the commercial property themselves)

- If you know it, can you tell me the approximate occupant density (number of full-time employees per square foot) at this property?
- If applicable based on property type: What are the operating hours of this property?
- How long have you been at this location (or managing this location)?
- How would you describe the area your commercial property is located (e.g., urban, rural), if different from where you are normally based?

3. During our conversation we will be exploring your thoughts and decisions around purchasing commercial heating / cooling systems. What is your specific role when it comes to recommending or purchasing commercial heating or cooling systems for your commercial property?
   - Are others involved in the decision-making process? If so, who and what is their role?
4. **System 1, Automatic Reaction Exercise:** I'd like to try a quick exercise with you to understand your thoughts around different types of heating/cooling systems. I'm going to display a word on the screen, and I'd like for you to come up with as many words or ideas that come to mind for you. This is a timed activity – I'll give you 10 seconds to come up with as many words as you can. Please don't filter your thoughts, and you can say anything at all!

   (Moderator exposes the words: "Commercial heating and cooling system", "Natural Gas Heating", "Heat Pump" on screen.)

   (Moderator probes fully to understand reason behind responses)

5. What are some of the different types of heating systems you are aware of?
   - Can you tell me how they work? How are they different?
   - How did you come to learn about these different heating systems?

- Are there any particular heating systems that you have a more positive opinion toward than others? Why?

Understanding the technology in their commercial property

6. I now want to learn about what kind of system you currently have in place at your commercial property. What kind of system is it? (Moderator to note if they currently have a dual fuel RTU or commercial Gas Heat Pump)
    - If you're aware, how many tons of heating and cooling does your system provide?
    - How long have you had this system?
    - How satisfied have you been with this system? What makes you say that?
    - Is there anything that you were not satisfied with?
    - What would you say was the primary benefit of this system?
    - Is this what made you decide to purchase the system? If not, what was it that drove you to make the decision to purchase?
    - **Ask as relevant** – Do you have similar HVAC systems in place across your other sites? Why or why not? IF not, what do you rely on in other locations and why that particular HVAC system?
    - What, if anything, would you like to see improved in the system you have? *[if not mentioned, probe: operating cost, type of fuel, efficiency, decarbonization, one unit to provide heating and cooling, ease of maintenance).*
7. When you think about what you NEED the most from your commercial property's heating and cooling system, what would that be? Why? *[Moderator capture full list. Probe for rational and emotional benefits]*
    - Of all of these, what are the most important for your heating / cooling system to 'get right'? What makes you say that?
    - How have your heating and cooling needs evolved in the last few years, if at all? What, if anything, has impacted this?
    - *Ask if not a resident on property:* Do you think your thoughts would be different if you occupied the property yourself?
8. To help me understand how you think about your commercial heating/cooling systems, I'd like to think about it in terms of a creative analogy. Please complete this sentence for me: Choosing the right heating/cooling system for my commercial property is like….
    - What makes you say that?

- How does choosing a heating/cooling system for your commercial property compare to choosing any other type of commercial technology you may need on-premises at your location? Why?

9. Let's talk a little about fuel sources. Firstly, and this is not a knowledge test,
    - As far as you're aware, what types of fuel sources are available in your area? *(E.g., Natural gas, electricity)*
    - *In your personal opinion, what is more efficient – electric or natural gas? What makes you say that*
    - *(If decarbonization not mentioned, ask)* Have you ever heard of decarbonization/ carbon footprint? What does this mean to you?
        a. How do you feel about decarbonization/reducing your carbon footprint? How important is decarbonization/ reducing the carbon footprint to you, if at all? Why?
        b. Do you have decarbonization goals? If so, what is driving those goals (e.g. personal preference, company mandate, local/state mandates, certification, credits, etc.)?
        c. Just before you told me about your preference for electric or natural gas as a fuel source – based on what you just mentioned about reducing the carbon footprint, does your preference for fuel type change? What makes you say that?

Decision-Making Around New Heating/Cooling System (12 min)

(*Objectives: <u>Unaided</u> exploration of how commercial buyers evaluated their decision for their new heating/cooling system, unaided exploration of value propositions for buyers, identification of barriers to adoption)*

10. I understand that you are currently considering upgrading or changing your commercial heating/cooling system. Why is that?
    - What is your current system missing or lacking that makes you want to upgrade or replace it? (*If not mentioned probe on local/state regulations, green energy mandates)*
11. I'd like to learn about how you will choose your new heating/cooling system. When you are **shopping around** for a heating/cooling system, what are the key criteria or attributes you are looking for? Why? *[Moderator to type up list of attributes/ criteria on screen. Refer back and compare to previous list of value drivers if needed. Probe on any differences to previous list]*

- Are there any factors or specific circumstances that relate to the specific needs of your commercial property? Your area? If so, what? *(Probe if needed: Incentives/financing options, meeting energy efficient goals, legislation, building codes, comfort)*

    a. Do newer local/state codes have any impact on your decision? If so what type of impact?

12. What kind(s) of system(s) are you considering? Why?

13. How, if at all, does cost play a role in your decision?

- Would you be willing to pay more for a new system if it provided reduced energy costs?

14. Are you aware of any rebates or tax credits that may help you purchase a new system?

- (If yes) what incentives are you aware of?
- How, if it all, will this play a role in your future purchase decision?

Perceptions Toward Commercial Dual Fuel RTUs & Gas Heat Pumps (30 min)

I now want to show you some information about two different types of heating/cooling systems. I am curious to know what you think of them, what do you see as being some of the potential benefits and/or potential drawbacks, and your general opinions about them.

(PROCEDURAL NOTE: DUAL FUEL RTU OWNERS TO BE ASKED PROBES BELOW BUT NOT TAKEN THOUGH STIMULI EXERCISE FOR DF RTU. ONLY NON-OWNERS OF DUAL FUEL RTU TO BE TAKEN THROUGH DF RTU STIMULI AND ASKED ASSOCIATED PROBES)

DUAL FUEL RTU CONCEPT EXPOSURE

(ASK ONLY IF CURRENTLY OWNS DUAL FUEL RTU): I understand you currently own a dual fuel RTU is that correct?

15. How much did you know about this system before you purchased it?

- Do you understand how the system works now?
- Did you have any pre-existing opinions of this system before you purchased it?

16. Why did you end up choosing this specific system?

- What were the top attributes about this system that led you to purchase it?
- Why did you choose this particular fuel source for this new system? What do you see as the pros and cons (if any)? *(If not mentioned, probe on cost/cost savings,*

efficiency, decarbonization, influence or importance of incentives/rebates, importance of financing options)

17. How much did the system cost? How did you feel about this price?
    - How if at all did the system cost play a role in your decision?
    - Do you believe the system was worth the price? *(Probe for efficiency, attitudes on return of investment)*
18. To what extent were you ever aware of any rebates or tax credits available to help you purchase the system?
    - *(If yes)* What incentives were you aware of?
        a. How did you find out about these incentives?
        b. How, if at all, did this play a role in your decision to purchase?
        c. How was the experience for you in securing the incentives? *(Probe on potential complexity or hurdles)*
19. To what extent is it performing based on your expectations? (**FOR EACH USAGE SCENARIO MENTIONED, ASK THE FOLLOWING**)
    - Anywhere it excelled?
    - Anywhere is fell short of your expectations? Please elaborate.
    - Was there anything that surprised you about this system? If so, what?

CURRENT DUAL FUEL RTU OWNER SKIPS TO NEXT TECHNOLOGY (e.g. GAS HEAT PUMP)

(TO BE ASKED ONLY OF THOSE WHO DO NOT HAVE DUAL FUEL RTU): Let's start off with **Dual Fuel RTUs, also known as Hybrid RTUs or Gas/Electric RTUs.** Firstly, have you ever heard of this type of heating system before? If so, how would you describe it to me?

I want to show you a quick description of this technology…

(MODERATOR SHOW STIMULI OF DUAL FUEL RTUs)

20. Here is some information about Dual Fuel RTUs. Please read over this and let me know when you're done, and I'll ask you some questions.
    - What do you think about of this type of heating/cooling system?
    - How well do you think this system can meet your needs? What makes you say that?
    - Do you see any potential disadvantages or drawbacks? If so, what are they? What makes you say that?
    - What, if any, questions or concerns do you have regarding a system like this?

- Based on what you see here, what, if any, questions do you have regarding a system like this?
- If you were to use this system, do you envision using the heat pump primarily for heating, cooling, or both?

21. To what extent do you think a system like this would be suitable for your commercial property? Why/ why not? (Moderator to probe on each property if multiple)
    - If multiple: Are there properties this system, would be a good fit for? Why is that?
    - If multiple: Are there properties where this system would be a poor fit for? What is that?
    - If not suitable – ask what would it take for you to embrace this technology? What would be needed? (PROBE)
22. Ok. Let's imagine you are in the market to upgrade the system in your commercial property, and you come across a technology like this. What are the first thoughts or questions that spring to mind?
    - What would you most want to know to help you decide whether this would be a suitable technology for your property?
    - What other information would you need about the system?
    - What could prevent you from considering this technology for your commercial property? *(List out all factors)*
        a. Which of these are the most important or influential? Why?
        b. Which are the least important to you? Why?
23. Overall, how likely would you be to consider this type of technology for your commercial property? What makes you say that? *(Probe for specific rationale)*

Now I want to show you some potential advantages of this system, to get your thoughts.

(MODERATOR SHOW STIMULI OF POTENTIAL ADVANTAGES OF DUAL FUEL RTUs)

24. Now that you've read this, what are your perceptions of this system? Do you feel any differently about this system?
    - How much does the efficiency of a system like this matter to you?
    - What if anything do you perceive as being the primary benefit of this system?
    - To what extent might you be willing to pay more for this system than a standard RTU? Why?

(PROCEDURAL NOTE: COMMERCIAL GAS HEAT PUMP OWENERS TO BE ASKED PROBES BELOW BUT NOT TAKEN THOUGH STIMULI EXERCISE FOR GHP. ONLY NON-OWNERS OF GAS HEAT PUMP TO BE TAKEN THROUGH GHP STIMULI AND ASKED ASSOCIATED PROBES)

COMMERCIAL GAS HEAT PUMP FOR SPACE AND/OR WATER HEATING CONCEPT EXPOSURE

(ASK ONLY IF CURRENTLY OWNS A COMMERCIAL GAS HEAT PUMP): I understand you currently own a commercial gas heat pump is that correct?

25. How much did you know about this system before you purchased it?
    - Do you understand how the system works now?
    - Did you have any pre-existing opinions of this system before you purchased it?
26. Why did you end up choosing this specific system?
    - What were the top attributes about this system that led you to purchase it?
    - Why did you choose this particular fuel source for this new system? What do you see as the pros and cons (if any)? *(If not mentioned, probe on cost/cost savings, efficiency, decarbonization, influence or importance of incentives/rebates, importance of financing options)*
27. How much did the system cost? How did you feel about this price?
    - How if at all did the system cost play a role in your decision?
    - Do you believe the system was worth the price? *(Probe for efficiency, attitudes on return of investment)*
28. To what extent were you ever aware of any rebates or tax credits available to help you purchase the system?
    - *(If yes)* What incentives were you aware of?
        a. How did you find out about these incentives?
        b. How, if at all, did this play a role in your decision to purchase?
        c. How was the experience for you in securing the incentives? *(Probe on potential complexity or hurdles)*
29. To what extent is it performing based on your expectations? (**FOR EACH USAGE SCENARIO MENTIONED, ASK THE FOLLOWING**)
    - Anywhere it excelled?
    - Anywhere is fell short of your expectations? Please elaborate.
    - Is there anything that surprised you about this system? If so, what?

- Based on your actual experience with this type of technology, what if anything, would you like to see improved or added to the system in order to increase your satisfaction?

(CURRENT OWNERS OF DUAL FUEL RTU COMMERCIAL GAS HEAT PUMP SKIP TO WRAP UP SECTION):

(ASK ONLY IF RESPONDENT DOES NOT OWN A COMMERCIAL GAS HEAT PUMP) Ok great. Now I'd like to talk about commercial gas heat pumps for space and water heating.

Firstly, have you ever heard of this type of heating system before?

(MODERATOR SHOW STIMULI OF COMMERCIAL GAS HEAT PUMPs)

30. Here is some information about commercial gas heat pumps. Please read over this and let me know when you're done, and I'll ask you some questions.
    - What do you think about of this type of heating/cooling system?
    - How well do you think this system can meet your needs? What makes you say that?
    - Do you see any potential disadvantages or drawbacks? If so, what are they? What makes you say that?
    - What, if any, questions or concerns do you have regarding a system like this?
    - Based on what you see here, what, if any, questions do you have regarding a system like this?
31. To what extent do you think a system like this would be suitable for your commercial property/properties? Why/ why not? (Moderator to probe on each property)
    - If multiple properties owned ask: Are there properties this system, would be a good fit for? Why is that?
    - If multiple properties owned ask: Are there properties where this system would be a poor fit for? What is that?
32. Ok. Let's imagine again you are in the market to upgrade the system in your commercial property, and you come across a technology like this. What are the first thoughts or questions that spring to mind?
    - What would you most want to know to help you decide whether this would be a suitable technology for your property?
    - What kind of information would help to make you consider this technology for your commercial property?

- What are the types of factors that could prevent you from considering this technology for your commercial property? *(List out all factors)*
    a. Which of these are the most important or influential? Why?
    b. Which are less important to you? Why?

33. Overall, how likely would you be to consider this type of technology for your commercial property? What makes you say that? *(Probe for specific rationale)*
34. Given that this is a relatively new available technology, what would your reaction be if I told you, it was being manufactured by only one or two unknown brands?
    - Would you be comfortable or uncomfortable offering this product to your commercial customers knowing that? Why?

    What would you need in order for your to feel comfortable selling this to your commercial customers? (*Probe for specific needs -e.g., warranty, etc*.)

(MODERATOR SHOW STIMULI OF POTENTIAL ADVANTAGES OF GAS HEAT PUMPS)

35. Now that you've read this, what are your perceptions of this system? Do you feel any differently about this system?
    - How much does the efficiency of a system like this matter to you?
    - What if anything do you perceive as being the primary benefit of this system?
    - To what extent might you be willing to pay more for this system than a standard RTU? Why?

Wrap Up (2 min)

Check with research team to see if there are additional questions

36. Ask any additional probes, thank and close

Appendix C. HVAC Contractor Discussion Guide

NEEA Dual Fuel and Gas Heat Pump Research: HVAC CONTRACTOR

60 minutes

BACKGROUND:

This guide focuses on HVAC CONTRACTORS and their perceptions and experience with HVAC Systems and thoughts (as well as usage if any) with of the four targeted Heat Pump technologies.

OBJECTIVES:

NEEA wants to gain a deep understanding of which, if any, of these RESIDENTIAL & COMMERCIAL technologies (From an HVAC Contractor perspective) are promising enough to further investigate for market transformation or other types of energy efficiency programs in their four-state region (with emphasis on Oregon and Washington). Findings from the study will complement ongoing NEEA product research to assess product performance and readiness for Northwest markets.

KEY OVERALL RESEARCH OBJECTIVES FOR THE FOUR COMMERCIAL TECHNOLOGIES:

- What are the value propositions for buyers?
- What are the possible target markets?
- What are the barriers to adoption?
- For residential dual fuel heat pumps - What drives actual dual fuel HVAC purchases?
- For residential gas heat pumps - What are consumer attitudes about natural gas as a home heating fuel source?

METHODOLOGY:

- A total of n=16, 60-minute web-enabled TDIs conducted among HVAC Contractors who sell, design and install HVAC systems in residential and commercial properties (approximate *even mix residential and commercial, across rural and urban locations*).
    - **N = 8 Smaller HVAC contractors (< 10 employees)**
    - **N = 8 Larger HVAC Contractors (>10 employees)**

DISCUSSION FLOW:

• Moderator introductions	5 mins
• HVAC Contractor Background	8 mins
• Key Differences Between Residential and Commercial Customers	10 mins
• HVAC Contractor Perceptions Toward Commercial HVAC Systems	18 mins
• HVAC Contractor Perceptions Toward Residential HVAC Systems	18 mins
• Wrap up	1 min

Introduction (5 min)

Standard Introduction. Moderator welcomes respondent, introduces self and topic of discussion, emphasizes not trying to sell anything or influence your opinion in any way. For research purposes only.

Topic to be conveyed to respondent: Today we are going to discuss your attitudes, opinions and any experiences you may have regarding HVAC systems that you currently sell, design and install and service for your residential and commercial customers. I am particularly interested what you consider to be the value propositions of these systems, the key purchase/adoption barriers from both a customer perspective as well as your own business perspective. I'll also be showing you some newer technologies that you may or may not have some experience with and I want to get your perceptions on those as well….and if you have any actual experience, we'll touch on that as well.

- Session being recorded
- No right or wrong answers, only looking for you honest opinion, moderator has no stake in outcome
- Answers are confidential, reporting in aggregate
- Professional moderator – no right or wrong answers, no stake in outcome

HVAC Contractor Background (8 min)

1. Please tell me a little bit about your role and your organization.
    - Where are you are you located? Are you located in a rural or suburban/urban area?
    - How large is your company in terms of total full-time employees? How many total employees are at your current location?
2. Which brand(s) of HVAC systems do you sell to you customers?
3. Thinking about your customer base, what is the approximate mix of residential vs. commercial customers?
    - Approximately what percent of your customers are in rural vs. suburban/ urban areas?
4. I'd like to understand a little more about your specific role and responsibilities. What is your role within your company – what functions to you primarily perform?
    - How long have you been in this role?
    - In this role, how much time would you say you spend on the following (best guess is fine)?

Sales of Central HVAC systems	- %
Design of Central HVAC systems	- %
Installation of Central HVAC systems	- %
Maintenance of Central HVAC systems	- %
Other (describe) Central HVAC systems	- %

- What specific types of HVAC systems does your company sell, design and/or install? (*If not mentioned ask if they also include Residential Dual Fuel Heat Pumps and/or Commercial Dual Fuel RTUs/ERTUs*)

5. **System 1, Automatic Reaction Exercise:** I'd like to do a quick exercise with you to understand your perceptions toward different types of heating/cooling systems. I'm going to display some terms on the screen, and I'd like for you to come up with as many words or ideas that come to mind for you. This is a timed activity – I'll give you 10 seconds to come up with as many words as you can for each. Please don't filter your thoughts, and you can say anything at all!

   (Moderator exposes the words one at a time on the screen (order will be rotated per each interview):
   - Natural Gas Heating for residential applications
   - Residential dual fuel heat pumps (gas furnaces with added ASHPs)
   - Residential gas heat pumps
   - Commercial dual fuel RTUs
   - Commercial gas heat pumps for space and/or water heating

   (Moderator probes fully to understand reason behind responses)

Key Differences Between Residential vs. Commercial Customers (10 min)

Just to clarify – do you sell and install HVAC systems for Residential Customers only, Commercial Customers Only or Both Residential and Commercial? (MODERATOR TO MAKE NOTE AND ASK ONLY APPROPRIATE PROBES WITHIN THIS SECTION – RESIDENTIAL ONLY, COMMERCIAL ONLY OR BOTH)

ASK ONLY IF RESPONDENT IS SELLING AND INSTALLING HVAC SYSTEMS FOR RESIDENTIAL CUSTOMERS: Residential HVAC System Perceptions and Barriers

6. I want to learn more about your perceptions toward different types of HVAC systems for your customers. But first, I want to get a sense of the different needs that your customers may have when it comes to choosing a heating/cooling system.

7. **Projective exercise:**

   Residential character "Jennifer"

   Let's imagine you have a residential customer come to you looking for a heating/cooling system for their home. To help me understand what a typical residential customer residing in a single-family home in your area might be looking for, I'm going to ask you a few questions about what they value/care about, and what criteria they typically use to make purchases.

   - Firstly, what would you say is most important to your residential customers when it comes to choosing a HVAC system for their home? Can you give me some specific examples of the things they ask for and why?
   - What fuel sources do they typically rely upon? Why?
     - To what extent would a typical residential customer like this be interested in natural gas as a home heating fuel source?
     - From your experience, what are residential customers' attitudes toward natural gas as a home heating fuel source?
   - To what extent, if at all, does geography/where they live play a role in their decision?
   - To what extent, if at all, does their income level play a role in their decision?
   - To what extent, if at all, is a typical residential customer interested in reducing their carbon footprint/clean energy, and does that play any role in their decision-making?
     - If focused on decarbonization – what specific goas are they seeking to realize and what is driving those goals?
       - How if at all does this differ by new construction versus retrofit?
   - How do you feel about selling / offering new kinds of HVAC technologies to a typical residential customer?

   ASK ONLY IF RESPONDENT IS SELLING AND INSTALLING HVAC SYSTEMS FOR COMMERCIAL CUSTOMERS Commercial character "Jacob"

   Now, let's imagine you have a commercial customer come to you looking for a heating/cooling system for their small-to mid-sized office building. To help me understand what a typical commercial customer in your area might be looking for, I'm going to ask you a few questions about what they value/care about, and what criteria they typically use to make purchases.

- Firstly, what would you say is most important to your commercial customers when it comes to choosing a HVAC system for their commercial property? - Can you give me some specific examples of the things they ask for and why?
- What fuel sources do they typically rely upon? Why?
- From your experience, what are commercial customers' attitudes toward natural gas as a commercial property heating fuel source?
- To what extent, if at all, is a typical commercial customer interested in reducing their carbon footprint/clean energy, and does that play any role in their decision-making?
    - If focused on decarbonization – what specific goas are they seeking to realize and what is driving those goals? (e.g. certification, specific city/state codes, etc.)
    - How if at all does this differ by new construction versus retrofit?
- To what extent, if at all, does geography/location of property play a role in their decision?
- To what extent, if at all, does property or business size play a role in their decision, if at all?
- To what extent, if at all, is a typical commercial customer interested in reducing their carbon footprint/clean energy, and does that play any role in their decision-making?
- How do you feel about selling / offering new kinds of HVAC technologies to a typical commercial customer?

Upselling the Commercial Customer (ask of all who have Commercial customers)

- (ask only as appropriate) How likely are you to recommend a more expensive but also more efficient HVAC system to your commercial clients?
    - Is there a price increase above your typical "better" option you comfortable pitching as a "best" option? For example, would you feel comfortable pitching a system that is 20% more expensive as long as it was efficient enough to have a decent payback for your customer? Why or why not?

Perceptions Toward Commercial HVAC Systems (18 min)

ONLY ASK THESE QUESTIONS IF RESPONDENT IS SELLING AND INSTALLING HVAC SYSTEMS FOR COMMERCIAL CUSTOMERS

I now want to talk about different types of HVAC systems. I want to first focus on two specific technologies for commercial applications.

Dual Fuel RTUs

[Moderator exposes first commercial technology on screen. E.g., "Dual Fuel RTUs". Order to be rotated for each interview]

Let's talk about Dual Fuel RTUs – these are also known as Hybrid RTUs and/or Gas/electric RTUs We talked about this one earlier, but I'm curious to learn a bit more about it from your perspective. Let me show you an example of this technology just as a reference (**Moderator shows the Daikin Applied Rebel series via the stimuli**). This is just an example of what we mean by Dual Fuel RTUs.

8. Firstly, do you currently sell this technology in your business?

   If yes:

   - How many of these units do you typically sell, in an average year? How does this compare with other similar types of technology? I.e., is it a lot more, or less than other types?
   - Who do you typically sell this technology to? Why this type of customer?
     a. Has this evolved or changed in any way in recent years?

   If no:

   - What are the main reasons why you are not selling this technology?

9. In your opinion, what would be/are the **advantages, if any,** of this technology for your commercial customers?
10. In your opinion, what would be/are **disadvantages, if any,** of this technology for your commercial customers?
    - What, if anything could help you overcome these perceived disadvantages?
      a. **(IF not mentioned probe**) Would you want to run a pilot program to help you become more familiar/confident with the system? If so, what would that pilot program look like (e.g.; would it be an installation at one of your customer sites, being able to view an already installed system at a commercial site, commercial customer testimonials, etc.)
      b. What do you hope to gain from running a pilot program? What is/are the key benefit(s) to you?

11. Thinking about all the advantages and drawbacks of this technology, what would you say is the best application/type of commercial property for a technology like this?
    - Who do you believe is the ideal commercial customer for this technology? *(Moderator to probe on attributes: new construction/existing property, retrofit/replacement, building type, buyer demographics, climate/heating zone/location, existing HVAC type)*
12. Under what scenario(s) would you NOT recommend or sell this system to a customer? What are the specific reason(s) you would not recommend?
13. Right now, how aware would you say commercial customers are of this technology? How would you describe the level of interest and uptake of this technology in your area? Why?
    - How do you see this evolving in the future? Might there be greater adoption in the future? Why / why not?
14. **(ASK OF ALL)** What, if anything, typically prevents/would prevent your commercial customers from choosing to buy this technology? Why?
    - Of all of these hurdles, which do you see as being the most significant? Why?
    - **What, if anything, might be needed to help overcome these hurdles?**
    - **(IF RESPONDENT NOT SELLING THIS TECHNOLOGY, SKIP TO QUESTION # 13)**
15. (**ASK ONLY IF RESPONDENT IS CURRENTLY SELLING THIS SYSTEM**) How do you describe this technology to your commercial customers? What makes / would make this technology an "easy sell"? Why?
    - How do you specially define 'an easy sell"? Why?
    - What do you see as being the key customer benefits of this technology when selling it to commercial customers?
16. Thinking about your business, what value does/would a technology like this bring?
17. **(ASK ONLY IF RESPONDENT IS SELLING THIS TECHNOLOGY)** Can you see any disadvantages to offering this technology to your commercial customers, from a business perspective? Why?
18. (**ASK ONLY IF RESPONDENT IS NOT SELLING THIS TECHNOLOGY**) Based on what you have reviewed and all we have discussed, can you envision any disadvantages to offering this technology to your commercial customers, from a business perspective? Why?

19. (**ASK ONLY IF RESPONDENT IS CURRENTLY SELLING THIS SYSTEM**)) What difficulties, if any, have you faced in integrating this technology into your business? *(Listen for/probe: e.g., challenges around installation, codes, like for like replacement preference, Occupant/Owner Split incentive, Supply Chain Issues, any reliability concerns/experiences)*

Commercial Gas Heat Pumps for Space and/or Water Heating

[Moderator exposes "Gas Heat Pumps for Space and/or Water Heating" slide on screen]

Okay great, now I would like to talk about **Gas Heat Pumps for Space Conditioning and/or Water Heating.**

[**Moderator exposes second commercial technology on screen. E.g., "Commercial Gas Heat Pumps". Order to be rotated for each interview**]

20. Let's talk about Commercial Gas Heat Pumps for Space Conditioning and/or Water Heating. – At present, these are currently available only through selective channels. We talked about this one earlier, but I'm curious to learn a bit more about it from your perspective. Firstly, do you currently sell this technology in your business?

    If yes:

    - How many of these units do you typically sell, in an average year? How does this compare with other similar types of technology? I.e., is it a lot more, or less than other types?
    - Who do you typically sell this technology to? Why this type of customer?
        a. Has this evolved or changed in any way in recent years?

    If no:

    - What are the main reasons why you are not selling this technology?

21. What are your thoughts around the flexibility of this technology?
    - What are your thoughts in regard to this technology being able to offer a single device that can condition commercial space as well as heat water? What makes you say that?
        a. Imagine if you were offering this product to your customers, would you or would you not promote this particular aspect of the technology? Why or why not?
        b. If not, would you focus on a particular aspect – space conditioning only? Hot water only? Why?

22. Given that this is a relatively new available technology, what would your reaction be if I told you, it was being manufactured by only one or two unknown brands?
    - Would you be comfortable or uncomfortable offering this product to your commercial customers knowing that? Why?
    - What would you need in order for you to feel comfortable selling this to your commercial customers? (*Probe for specific needs -e.g., warranty, etc*.)
23. Based on what have shown you, in your opinion, what would be/are the **advantages, if any,** of this technology for your commercial customers?
24. In your opinion, what would be/are the **disadvantages, if any,** of this technology for your commercial customers?
    - What, if anything could help you overcome these perceived disadvantages?
        a. **(IF not mentioned probe**) Would you want to run a pilot program to help you become more familiar/confident with the system? If so, what would that pilot program look like (e.g.; would it be an installation at one of your customer sites, being able to view an already installed system at a commercial site, commercial customer testimonials, etc.)
        b. What do you hope to gain from running a pilot program? What is/are the key benefit(s) to you?
25. Thinking about all the advantages and drawbacks of this technology, what would you say is the best application/type of commercial property for a technology like this?
    - Who do you believe is the ideal commercial customer for this technology? *(Moderator to probe on attributes: new construction/existing property, retrofit/replacement, building type, buyer demographics, climate/heating zone/location, existing HVAC type)*
26. Under what scenario(s) would you NOT recommend or sell this system to a customer? What are the specific reason(s) you would not recommend?
27. Right now, how aware would you say are commercial customers to this technology? How would you describe the level of interest and uptake of this technology in your area? Why?
    - How do you see this evolving in the future? Might there be greater adoption in the future? Why / why not?
28. (**ASK OF ALL**) What, if anything, typically/would prevent your commercial customers from choosing to buy this technology? Why?
    - Of all of these hurdles, which do you see as being the most significant? Why?
    - **<u>What, if anything, might be needed to help overcome these hurdles?</u>**

a. (**IF not mentioned probe**) Would you want to run a pilot program to help you become more familiar/confident with the system? If so, what would that pilot program look like (e.g.; would it be an installation at one of your customer sites, being able to view an already installed system at a commercial site, commercial customer testimonials, etc.)
b. What do you hope to gain from running a pilot program? What is/are the key benefit(s) to you?

- **(IF RESPONDENT IS NOT SELLING THIS TECHNOLOGY, SKIP TO QUESTION # 27)**

29. (**ASK ONLY IF RESPONDENT IS CURRENTLY SELLING THIS SYSTEM**) How do you describe this technology to your commercial customers? What makes / would make this technology an "easy sell"? Why?
    - How do you specially define 'an easy sell"? Why?
    - What do you see as being the key customer benefits of this technology when selling it to commercial customers?
30. Thinking about your business, what value does/would a technology like this bring?
31. Can you see any disadvantages to offering this technology to your commercial customers, from a business perspective? Why?
32. (**ASK ONLY IF RESPONDENT IS NOT SELLING THIS TECHNOLOGY**) Based on what you have reviewed and all we have discussed, can you see any disadvantages to offering this technology to your commercial customers, from a business perspective? Why?
33. (**ASK ONLY IF RESPONDENT IS CURRENTLY SELLING THIS SYSTEM**) What difficulties, if any, have you faced in integrating this technology into your business? *(Listen for/probe: e.g., challenges around installation, codes, like for like replacement preference, Occupant/Owner Split incentive, Supply Chain Issues, any reliability concerns/experiences)*

Perceptions toward Residential HVAC Systems (18 min)

ONLY ASK THESE QUESTIONS IF RESPONDENT IS SELLING AND INSTALLING HVAC SYSTEMS FOR RESIDENTIAL CUSTOMERS

I now want to talk about two specific **residential HVAC** technologies

Residential Dual Fuel Heat Pumps

[Moderator exposes first residential technology, e.g., "Residential Dual Fuel Heat Pumps" slide on screen. Order to be rotated for each interview]

34. Let's talk about Residential Dual Fuel Heat Pumps. We talked about this one earlier as well, but I'm curious to learn a bit more about it from your perspective. Firstly, do you currently sell this technology in your business?

    If yes:

    - How many residential dual fuel heat pumps do you typically sell, in an average year? How does this compare with other similar types of technology? I.e., is it a lot more, or less than other types?
        a. How do you refer to these systems – do you call them Dual Fuel Heat Pumps or something else?
    - Who do you typically sell this technology to? Why this type of customer?
        a. Has this evolved or changed in any way in recent years?
    - **(Ask for dual fuel HPs):** Why are these selling? What is driving these purchases?

    If no:

    - What are the main reasons why you are not selling this technology?
        a. How do you refer to these systems – do you call them Dual Fuel Heat Pumps or something else?

35. In your opinion, what would be/are the **advantages** of this technology for your residential customers?

36. In your opinion, what would be/are the **disadvantages** of this technology for your residential customers?

    - What, if anything could help you overcome these perceived disadvantages?
        a. **(IF not mentioned probe**) Would you want to run a pilot program to help you become more familiar/confident with the system? If so, what would that pilot program look like (e.g.; would it be an installation at one of your customer sites, being able to view an already installed system at a commercial site, commercial customer testimonials, etc.)
        b. What do you hope to gain from running a pilot program? What is/are the key benefit(s) to you?

37. Thinking about all the advantages and drawbacks of this technology, what would you say is the best residential application for this technology and what type(s) of residential dwellings? Why?

    - Who do you believe is the ideal residential customer for this technology? *(Moderator to probe on attributes: new construction/existing home, retrofit/replacement, building type, buyer demographics, existing HVAC type, climate/heating zone/location)*

38. Right now, how aware would you say residential customers are of this technology? How would you describe the level of interest and uptake of this technology in your area? Why?

    - How do you see this evolving in the future? Might there be greater adoption in the future? Why / why not?

(**IF RESPONDENT NOT SELLING THIS TECHNOLOGY SKIP TO QUESTION # 37**)

39. **(ASK ONLY IF RESPONDENT IS CURRENTLY SELLING THIS TECHNOLOGY)** What, if anything, typically prevents your residential customers from choosing to buy this technology? Why?

    - Of all of these hurdles, which do you see as being the most significant? Why?
    - **What, if anything, might be needed to help overcome these hurdles?**

40. (**ASK OF ALL IN THIS SECTION**) How much does/would fuel source impact a residential customer's decision or ability to purchase this specific system? Why?

    - We talked about this earlier, but how do you your typical residential customers feel about natural gas as a home fuel source? Why is that? *(Probe fully)*

    (IF NOT SELLING THIS TECHNOLOGY SKIP TO Question # 39)

41. **(ASK ONLY IF RESPONDENT IS CURRENTLY SELLING THIS TECHNOLOGY)** How do you describe this technology to your residential customers? What makes / would make this technology an "easy sell"? Why?

    - How do you specially define 'an easy sell"? Why?
    - What do you see as being the main value proposition / key customer benefits of this technology when selling it to residential customers?

42. Thinking about your business, what value does/would a technology like this bring?

    - Can you see any disadvantages to offering this technology to your residential customers, from a business perspective? Why?

43. **(ASK ONLY IF RESPONDENT IS CURRENTLY SELLING THIS TECHNOLOGY)**What difficulties, if any, have you faced in integrating this technology into your business? *(Listen for/probe: e.g., challenges around installation, codes, Supply chain issues, Low-income consumers/High-cost)*

Residential Gas Heat Pumps

[**Moderator exposes second residential technology on screen. E.g., "Residential Gas Heat Pumps". Order to be rotated for each interview**]

44. Let's talk about Residential Gas Heat Pumps – At present, these are not widely available in the United States, but may soon be. We talked about this one earlier, but I'm curious to learn a bit more about it from your perspective. Let me show you an example of this technology just as a reference (**Moderator shows the SMTI Gas Heat Pump prototype in field testing via the stimuli**). This is an example of what we mean by Residential Gas Heat pump .Firstly, do you currently sell this technology in your business?

    If yes:

    - How many of these units do you typically sell, in an average year? How does this compare with other similar types of technology? I.e., is it a lot more, or less than other types?
    - Who do you typically sell this technology to? Why this type of customer?
        a. Has this evolved or changed in any way in recent years?

    If no:

    - What are the main reasons why you are not selling this technology?

45. What are your thoughts around this technology?
    - What are your thoughts in regard to this replacing a traditional gas furnace?
        a. Imagine if you were offering this product to your customers, how would you promote it? Why?

46. Given that this will be a new technology In the United States when it becomes available, what would your reaction be if I told you it would be available from only one or two unknown brands?
    - Would you be comfortable or uncomfortable offering this product to your residential customers knowing that? Why?
    - What would you need in order for you to feel comfortable selling this to your residential customers? (*Probe for specific needs -e.g., warranty, etc.*)

47. Based on what have shown you, in your opinion, what would be/are the **advantages**, if any, of this technology for your residential customers?

48. In your opinion, what would be/are the **disadvantages, if any**, of this technology for your commercial customers?
    - What, if anything could help you overcome these perceived disadvantages?

a. **(IF not mentioned probe**) Would you want to run a pilot program to help you become more familiar/confident with the system? If so, what would that pilot program look like (e.g.; would it be an installation at one of your customer sites, being able to view an already installed system at a commercial site, commercial customer testimonials, etc.)
b. What do you hope to gain from running a pilot program? What is/are the key benefit(s) to you?

49. Thinking about all the advantages and drawbacks of this technology, what would you say is the best application/type of residential property for a technology like this?
    - Who do you believe is the ideal residential customer for this technology? *(Moderator to probe on attributes: new construction/existing property, retrofit/replacement, home type, buyer demographics, climate/heating zone/location, existing HVAC type)*
50. Under what scenario(s) would you NOT recommend or sell a Gas Heat Pump to a customer? What are the specific reason(s) you would not recommend?
51. Based on what you know about your residential customers, how open do you think they may be to this technology? What do you think their level of interest may be? Why?
    - How do you see the opportunity for this technology evolving in the future? Might there be greater adoption in the future? Why / why not?
    - **(IF RESPONDENT NOT SELLING THIS TECHNOLOGY, SKIP TO QUESTION # 51**)
52. (**ASK ONLY IF RESPONDENT IS CURRENTLY SELLING THIS SYSTEM**) What, if anything, typically prevents your residential customers from choosing to buy this technology? Why?
    - Of all of these hurdles, which do you see as being the most significant? Why?
    - What, if anything, might be needed to help overcome these hurdles?
53. (**ASK ONLY IF RESPONDENT IS CURRENTLY SELLING THIS SYSTEM**) How do you describe this technology to your residential customers? What makes / would make this technology an "easy sell"? Why?
    - How do you specially define 'an easy sell"? Why?
    - What do you see as being the key customer benefits of this technology when selling it to residential customers?
54. Thinking about your business, what value does/would a technology like this bring?
55. (**ASK ONLY IF CURRENTLY SELLING THIS TECHNOLOGY**) Can you see any disadvantages to offering this technology to your residential customers, from a business perspective? Why?

56. (**ASK ONLY IF RESPONDENT IS NOT SELLING THIS TECHNOLOGY**) Based on what you have reviewed and all we have discussed, can you envision any disadvantages to offering this technology to your commercial customers, from a business perspective? Why?

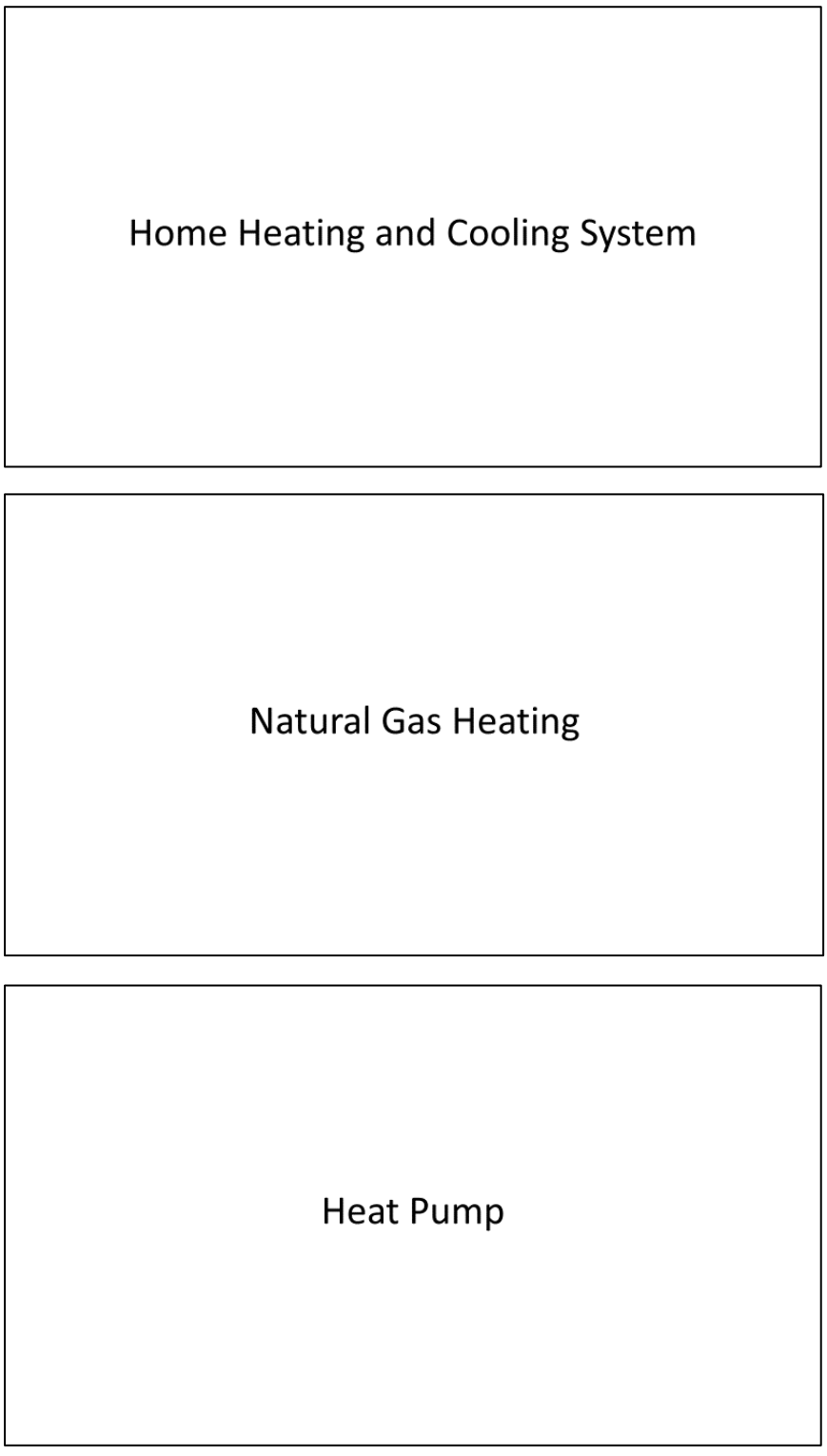
(**ASK ONLY IF RESPONDENT IS CURRENTLY SELLING THIS SYSTEM**) What difficulties, if any, have you faced in integrating this technology into your business? *(Listen for/probe: e.g., challenges around installation, codes, like for like replacement preference, Occupant/Owner Split incentive, Supply Chain Issues, any reliability concerns/experiences)*

Wrap Up (1 min)

Check to see if there are any additional questions and ask

57. Thank respondent and close

Appendix D. Residential Buyer Stimuli



Gas Heat Pumps

GHP1

Gas Heat Pumps

What is a gas heat pump?

- Residential gas heat pumps are a **new** type of heat pump powered by **natural gas**
- Gas heat pumps:
  - **Provide heat only (no cooling)**
  - Have very **high fuel efficiency**
  - Unlike some electric heat pumps**,** a **gas heat pump** can keep a home **comfortable** even on **the coldest days of the year**.
  - **Use less natural gas than a furnace**

Gas heat pump systems have **both indoor and outdoor** components to the system, and run on **natural gas**

GHP2

Potential Advantages of Gas Heat Pumps

- **No Need to Switch From Natural Gas:** Use heat pump technology without the cost and stress of switching from a natural gas system.
- **Fuel Flexibility**: Natural gas, propane, bio-fuels, hydrogen blend.
- **Can Reduce Carbon Footprint**: Reduces CO2 emission between 30-50%.
- **Wi-Fi and Bluetooth Communication Through an App or the Web.**
- **Life expectancy:** Meets current market technology.

Dual Fuel Heat Pumps

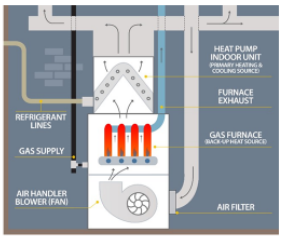
RDF1

Dual Fuel Heat Pump

What is a Dual Fuel Heat Pump?

- A HVAC system that pairs an **electric heat pump** with a **non-electric central heating source** (e.g., gas, propane, fuel oil)
- The **electric heat pump** operates in hot or mild temperatures (about 40°F and higher) and the **non-electric central heating source** operates in colder temperatures (about 39°F and below).
- The dual fuel heat pump **alternates or switches between the two fuel sources depending on the climate** to maximize comfort and efficiency.
  - When it is **HOT**, the heat pump cools your home by blowing cold air through your ducts, similar to an AC.
  - When it is **COLD**, the system works to heat your home by blowing hot air through your ducts.
- Dual fuel heat pumps have both an **outdoor and indoor component**.

Dual Fuel Heat Pump



Dual fuel heat pump systems supplement air from a heat pump with heat from natural gas.

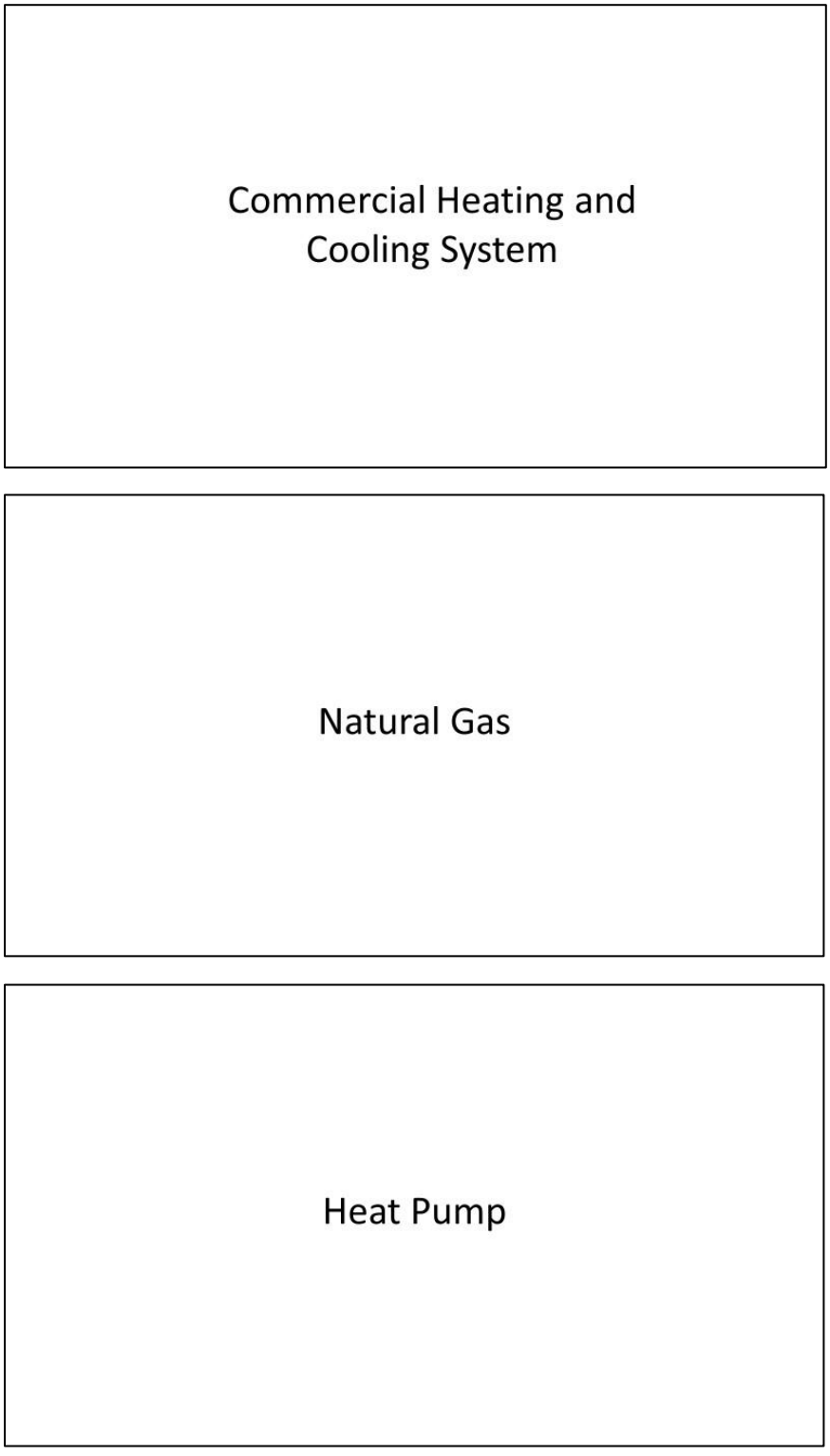
RDF2

Dual Fuel Heat Pump

Some Potential Advantages

- **Energy Efficient:** Combines the best of both electric and gas fueled heating systems and automatically changes between the heat pump and furnace based on the outside air temperature.
- **Continued Comfort**: The dual-nature of system ensures an adequate amount of heat when needed and will switch from electric to gas above certain outside air temperatures.
- **Cost Savings**: Eliminates the backup electric resistance element from the indoor unit for lower installation cost.
- **Flexibility:** Can perform multiple tasks like space heating and space cooling.
- **Can Potentially Reduce Carbon Footprint**: With a dual fuel system, you'll still only use your electric heat pump for the majority of the year, which means you'll burn less gas. However, this can vary by region.

Appendix E. Commercial Buyer Stimuli



Dual Fuel Rooftop Units (RTUs)

RTU1

Dual Fuel Rooftop Unit (RTU)

What is a Dual Fuel Rooftop Unit?

- HVAC Technology that combines a **gas furnace and an electric heat pump** instead of a traditional A/C.
- The heat pump can provide **heated OR cooled** air through a building's duct system.
- The furnace component will provide **heated air** through the building's duct system.

Daikin Rebel Dual Fuel RTU

RTU2

Dual Fuel Rooftop Unit (RTU)

Some Potential Advantages

- **Efficiency:** Combines the best of both electric and gas fueled heating systems.
- **Continued Comfort**: The dual-nature of system ensures an adequate amount of heat when needed and will switch from electric to gas above certain outside air temperatures.
- **Energy Efficient:** The electric heat pump provides an energy efficient source of heating and cooling.
- **Cost Savings**: Eliminates the backup electric resistance element from the indoor unit for lower operating cost.
- **Can Potentially Reduce Carbon Footprint**: With a dual fuel system, you'll still only use your electric heat pump for the majority of the year, which means you'll burn less gas. However, this can vary by region.

Commercial Gas Heat Pump

GHP1

Gas Heat Pump for Space Conditioning and/or Water Heating

What is a Commercial Gas heat pump (for space conditioning and/or and water heating)?

- Gas heat pumps are a new type of heat pump that is powered by **natural gas.**
- They allow you to have **high efficiency** with **high capacity and keep a commercial property comfortable** even on **the coldest days of the year**.
- The unit is capable of **heating your space, heating your water, or both**.
- The unit **uses less gas** than a **conventional furnace and boiler** for an equivalent energy demand.
- Gas heat pumps can **provide heat.**

VICOT Gas heat pump

GHP2

Gas Heat Pump for Space Conditioning and/or Water Heating

Some Potential Advantages

- **Energy Efficient:** Gas heat pumps can reduce your gas usage by up to 50%.
- **Comfort**: Gas heat pumps allow you to experience the same level of comfort you receive from an electric heat pump or gas furnace.
- **Cost Effective**: The reduced gas use allows for lower energy costs each month.
- **Can Reduce Carbon Footprint**: Reduce CO2 emission between 30-50%.
- **Natural Refrigerant:** (Global Warming Potential = 0).
- **Fuel Flexibility**: Natural gas, propane, bio-fuels, hydrogen blend.
- **Wi-Fi and Bluetooth Communication Through an App or the Web.**

Appendix F. HVAC Contractor Stimuli

Approximately how much time do you spend on the following:

Sales of Central HVAC Systems	%
Design of Central HVAC Systems	%
Installation of Central HVAC Systems	%
Maintenance of Central HVAC Systems	%
Other	%

Natural Gas Heating for residential applications

Residential dual fuel heat pumps (gas furnaces with added ASHPs)

Residential gas heat pumps

Commercial dual fuel RTUs

Commercial gas heat pumps for space and/or water heating

Your customers

What are their wants and needs when choosing a HVAC system?

"Jennifer"

"Jacob"

Commercial

Dual Fuel RTUs
(aka Hybrid RTUs or Gas/Electric RTUs)

RTU1

Commercial Dual Fuel Rooftop Unit (RTU)

- **What is a Dual Fuel Rooftop Unit?**
  - HVAC Technology that combines a **gas furnace and an electric heat pump** instead of a traditional A/C
  - The heat pump can provide **heated OR cooled** air through a building's duct system
  - The furnace component will provide **heated air** through the building's duct system

Daikin Dual Fuel RTU

RTU2

Commercial Dual Fuel Rooftop Unit (RTU)

Some Potential Advantages

- **Efficiency:** Combines the best of both electric and gas fueled heating systems.
- **No Need to Switch From Natural Gas**: The dual-nature of system ensures an adequate amount of heat when needed and will switch from electric to gas above certain outside air temperatures.
- **Energy Efficient:** The electric heat pump provides an energy efficient source of heating and cooling.
- **Cost Savings**: Eliminates the backup electric resistance element from the indoor unit for lower operation cost.
- **Can Reduce Carbon Footprint:** With a dual fuel system, you'll still only use your electric heat pump for the majority of the year, which means you'll burn less gas. However, this can vary by region.

Commercial

Commercial Gas Heat Pumps
(For Space and/or Water Heating)

GHP1

Commercial Gas Heat Pump for Space and/or Water Heating

What is a Commercial Gas heat pump (for space and/or water heating)?

- Gas heat pumps are a new type of heat pump that is powered by **natural gas.**
- They allow you to have high efficiency with high capacity in cold climates.
- The unit is capable of **heating your space, heating your water, or both**.
- The unit uses less gas than a conventional furnace and boiler for an equivalent energy demand.
- Gas heat pumps can **provide heat.**

Robur Gas Heat Pump

GHP2

Commercial Gas Heat Pump for Space and/or Water Heating

Some Potential Advantages

- **Energy Efficient:** Gas heat pumps can reduce your gas usage by up to 50%.
- **Comfort:** Gas heat pumps allow you to experience the same level of comfort you receive from an electric heat pump or gas furnace.
- **Cost Effective:** The reduced gas use allows for lower energy costs each month.
- **Can Reduce Carbon Footprint:** Reduce CO2 emission between 30-50%.
- **Natural Refrigerant** (Global Warming Potential = 0).
- **Fuel Flexibility:** Natural gas, propane, bio-fuels, hydrogen blend.
- **Wi-Fi and Bluetooth Communication Through an App or the Web.**

Residential

Dual Fuel Heat Pump

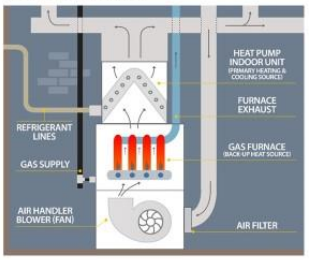
RDF1

Residential Dual Fuel Heat Pump

What is a Dual Fuel Heat Pump?

- An HVAC system that **combines a gas furnace and electric heat pump.**
- When the outdoor temperature gets too cold for the heat pump, the furnace turns on to heat the home instead.
- There is an outdoor compressor unit for the heat pump, but the rest of the equipment is indoors.

Dual Fuel Heat Pump



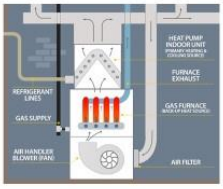
Dual fuel heat pump systems supplement air from a heat pump with heat from a natural gas or propane furnace.

RDF2

Residential Dual Fuel Heat Pump

- **System Configuration**
  - Gas (or other non-electric fuel) heat exchanger must be before (upstream of) the heat pump heat exchanger.
  - Gas is for back-up heating. There's no need for expensive electrical backup heating).
- **System Operation**
  - System to either run in only-heat pump mode or furnace mode.
  - **Changeover temperature**: the outdoor air temperature above which the system operates in heat pump mode, below which system operates in other fuel mode.
  - System would also **switch** from electric to gas (above outside air temperature changeover temperature) when demand exceeds HP capacity.

Dual Fuel Heat Pump



RDF3

Residential Dual Fuel Heat Pump

Some Potential Advantages

- **Energy Efficient:** Combines the best of both electric and gas fueled heating systems and automatically changes between the heat pump and furnace based on the outside air temperature.
- **Continued Comfort**: The dual-nature of system ensures an adequate amount of heat when needed and will switch from electric to gas above certain outside air temperatures.
- **Cost Savings**: Eliminates the backup resistant element from indoor coil unit for lower installation cost.
- **Flexibility:** Can perform multiple tasks such as space heating and space cooling.
- **Can Potentially Reduce Carbon Footprint**: With a dual fuel system, it utilizes the electric heat pump for the majority of the year, which means your customer will burn less gas. However, this can vary by region.

Residential

Gas Heat Pump

GHP1

Residential Gas Heat Pump

What is a Gas heat pump?

- Residential gas heat pumps are a new type of heat pump that is powered by natural gas.
- They allow you to have very high fuel efficiency with high capacity in cold climates.
- Gas heat pumps provide **heat.**
- Gas heat pumps use less natural gas than a furnace.
- Gas heat pump systems have both indoor and outdoor components to the system, and run on natural gas.

SMTI Gas Heat Pump

Residential Gas Heat Pump

GHP2

Some Potential Advantages

- **No Need to Switch From Natural Gas:** use heat pump technology without the cost and stress of switching from a natural gas system.
- **Fuel Flexibility:** natural gas, propane, bio-fuels, hydrogen blend.
- **Can Reduce Carbon Footprint:** reduces CO2 emission between 30-50%.
- **Wi-Fi and Bluetooth communication Through an App or the Web.**
- **Life expectancy:** Meets current market technology.

Appendix G. Recruitment Screeners

583-08 Dual Fuel and Gas Heat Pump Research

Revised 7 December 2022

Name: _____

Phone: _____

Email Address: _____

Interview Time / Date: _____

METHODOLOGY

- 60-min Qualitative Telephone Depth Interviews qual TDIs using an online platform, CIVICOM

KEY RECRUITING CRITERIA

- **Residential Buyers**
  - Recruit from Oregon, Washington, Montana & Idaho (per heating zone map) **Majority (maximum approximately 75%) of respondents to be recruited from Oregon, Washington, and Idaho. For Residential Gas Heat Pump respondents, we may extend recruiting to Canada**
  - Mix of gender, race, and income
  - Age minimum 21
  - Must be the person responsible or influential in the decision-making process regarding selection and purchase of an HVAC system
  - All must have experience with gas furnaces (as in, their current or prior home was heated by a gas furnace within the last 2 years)
  - Three residential segments:
    - Consumers who have a dual fuel heat pump at home
    - Consumers who recently purchased a home HVAC system within the last 12 months
    - Consumers who intend to purchase a home HVAC system within the next 12 months
  - Aim for equal weighting of urban vs. rural representation

Residential Buyers n=25			
Sub-Segment	Rural	Urban	Total
Have Dual Fuel Heat Pump	4	4	8
Have Purchased HVAC system w/in last 12 months	4	4	8
Plan to Purchase HVAC system w/in next 12 months	4	5	9
Total # of IDIs	12	13	25

- **Commercial Buyers**
  - Recruit from Oregon, Washington, Montana & Idaho (per heating zone map) **Majority (75% or more) of respondents to be recruited from Oregon and Washington – can extend to Idaho and Montana as needed. Please notify Lieberman immediately if we need to extend beyond that range.**
  - Business owner/key decision makers/senior individuals responsible for the selection and purchase of HVAC systems for their commercial properties.
  - Must have experience with gas furnaces (e.g., their current or former commercial building is heated with gas)
  - Must be able to speak to HVAC system technologies, and knowledgeable in one type of commercial property (e.g., retail)
  - Three sub-segments by business size and urbanicity
    - Small business (<100 employees)
    - Medium business (100 – 999 employees)
    - Large business (>1,000 employees)
  - Aim for equal urban and rural representation

Commercial Buyers n=18			
Sub-Segment	Rural	Urban	Total
Small Businesses	3	3	6
Medium - Large Businesses	6	6	12
Total # of IDIs	9	9	18

- **HVAC Contractors**

- Recruit from Oregon, Washington (per heating zone map) – **NOTE**: may also include contractors from other regions of the country and Canada, but these participants should be less than half of the total sample size
- All must be recruited from within specified target heating zones
- Must be from organizations that are active sellers/designers/installers of residential and/or commercial HVAC systems (not industrial systems), with ~50/50 split of residential to commercial.
- Senior/experienced individuals responsible for customer accounts (mix of sales and installation) – minimum 5 years' experience in sales and/or installation
- Two sub-segments
    - Smaller HVAC Contractors (< 10 employees)
    - Larger HVAC Contractors (> 10 employees)
- Aim for equal urban and rural representation

HVAC Contractors n=16			
Sub-Segment	Rural	Urban	Total
Smaller HVAC Contractors	4	4	8
Larger HVAC Contractors	4	4	8
Total # of IDIs	8	8	16

Residential Buyers Screener

INTRODUCTION: Hello, I'm _____ calling from Lieberman Research, a marketing research company. We are conducting a study about home heating and cooling systems. Are you the best person in your household to talk to about your heating and cooling system?

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 home heating and cooling systems and are looking to speak to someone in your household resident familiar with your heating and cooling system.

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 **XX [INSERT HONORARIUM AMOUNT - $100 for residential buyers, $125 for commercial buyers, and $250 for HVAC contractors].** (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.)

SEE HEAT MAP AND LIST OF ZIP CODES, EQUAL MIX OF RESPONDENTS FROM THE THREE HEATING Zones. MAJORITY (75% MUST BE FROM WASHINGTON AND OREGON, REMAINDER CAN BE FROM IDAHO, OR MONTANA IF NECESSARY)

Q1. Would you classify the area you live in as urban, suburban, or rural? (NOTE OK TO ASK BUT UTILIZE Respondent ZIP CODE TO CLASSIFY whether URBAN, RURAL or SUBURBAN)

1	Urban	**See Quotas**
2	Suburban	**CLASSIFY AS URBAN and SEE Quotas**
3	Rural	**See Quotas**

Q2. What type of home is your primary residence?

1	Single Family Home	
2	Multifamily buildings such as apartment buildings or condos, or senior or assisted living	**TERMINATE**
3	Other	**TERMINATE**

Q3. Do you heat your current home with Central natural gas ? If not, have you ever heated your home with Central natural gas? (**RECORD ANSWERS AND SEE Qualifiers**)

1	Current home heated with Central Natural Gas	
2	Previously heated home with Central Natural Gas	

IF Current home or previous home NOT heated by Central natural gas, THANK And TERMINATE

Q4a. Do you currently own one of the following heating technologies?

1	Dual Heat Fuel Pump (aka Hybrid heat pumps which are gas furnaces paired with electric heat pumps)	**SEE QUOTAS, CONTINUE TO Q5**
2	Gas Heat Pump (heat pumps powered by natural gas)	**NO QUOTA, CONTINUE TO Q5**
3	Don't Know	**TERMINATE**
4	None of the above	**CONTINUE TO Q4b**

Q4b. How likely are you to purchase a heating system for your property within the next 12 months or so? Please use a scale of 1-5 where '1' is 'Very Likely" and '5' is 'Not at all Likely'.

1	Very Likely	**SEE QOUTAS**
2	Likely	**SEE QOUTAS**
3	Somewhat Likely	**CONTINUE**
3	Not Very Likely	**CONTINUE**
4	Not at All Likely	**CONTINUE**

Q5. When was your heating system last replaced?

1	Within the last 12 months	**See Quotas**
2	More than 12 months ago	**See Quotas**
3	Don't Know	**TERMINATE**

IF Q4b is 3-4 and Q5 is More than 12 months ago TERMINATE UNLESS IN DUAL FUEL or GAS Heat PUMP group.

Q6. How involved were you/will you be with the selection and purchase or your planned selection and purchase?

1	I alone am responsible for making the selection and purchase decision	
2	I share joint responsibility for the selection and purchase decision	
3	I am not involved in the selection or purchase decision	**TERMINATE**

Just for classification purposes I'd like to ask you a few more questions…

Q8a. What is your age?

_____

TERMINATE AGE >21

Q8b. What is your race? You may select more than one.

a) White or Caucasian	
b) Hispanic, Latino, or Spanish	
c) Black or African American	
d) Native American or Alaska Native	
e) Middle Eastern or North African	
f) Asian Indian	
g) Chinese	
h) Vietnamese	
i) Filipino	
j) Korean	
k) Japanese	
l) Other Asian	
m) Native Hawaiian or Other Pacific Islander	
n) Other (**Please Specify**: _____)	

RECRUIT A MIX

Q8c. What is your annual household income?

1	Less than $15,000 per year		
2	$15,000 to less than $24,999		
3	$25,000 to less than $34,999		
4	$35,000 to less than $49,999		
5	$50,000 to less than $74,999		
6	$75,000 to less than $99,999		
7	$100,000 to less than $149,999		
8	$150,000 to less than $199,999		
9	$200,000 and over		

10	Don't know		
11	Prefer not to answer		

RECRUIT A MIX

Q8d. In which state do you reside?

_____

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 to participate in a 60-minute online interview about HVAC technologies.

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

Are you available to participate between [DATE] and [TIME]?

Yes ( ) **CONTINUE**

No ( ) **TERMINATE**

We are excited that you will be participating! You will receive a confirmation email and a reminder call,

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.

Commercial Buyers Screener

INTRODUCTION: Hello, I'm _____ calling from Lieberman Research, a marketing research company. We are conducting a study about heating and cooling systems for commercial properties. Are you the best person in your organization to talk to about the heating and cooling systems in your commercial properties?

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 gas heat pumps and dual rooftop units (also known as hybrid or gas/electric roof top units) and are looking to speak to the person in your company most familiar with the heating and cooling systems in your commercial properties.

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 **XX [INSERT HONORARIUM AMOUNT].** (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.)

SEE HEAT MAP, EQUAL MIX OF RESPONDENTS FROM THE THREE HEATING ZONES. MAJORITY (75% MUST BE FROM WASHINGTON AND OREGON, REMAINDER CAN BE FROM IDAHO, OR MONTANA IF NECESSARY

Q1. In what type(s) of commercial building(s) do you have or plan to install HVAC heating and cooling systems)? **Check all that apply**

1	Multifamily buildings such as apartment buildings or condos, or senior or assisted living	
2	Office Buildings	
3	Medical Centers	
4	Hotels/Motels	
5	Shopping Malls	
6	Retail Stores	
7	Schools	
8	Warehouse with Offices	
9	Other	**TERMINATE IF ONLY CHOSEN**
10	Don't Know	**TERMINATE**

Q2. What percentage of your commercial property(ies) would you estimate classifies as Urban or Rural?

1	Urban ____%	**See Quotas**
2	Rural _____%	**See Quotas**

Classify based on majority and SEE QOUTA

Q3. Approximately what percentage of these commercial properties are in the following states?

- Washington **(RECORD**) _____
- Oregon **(RECORD**) _____
- Idaho **(RECORD**) _____
- Montana **(RECORD**) _____

(**MUST BE PRIMARILY IN OREGON OR WASHINGTON – SEE QUOTAS**)

Q4. Do you heat your current commercial properties with central natural gas? If not, have you ever heated your commercial properties with central natural gas? (**RECORD ANSWERS AND SEE Qualifiers**)

1	Current commercial property heated with Central Natural Gas	
2	Previously heated commercial property with Central Natural Gas	

IF Current or previous commercial property NOT heated by central natural gas, THANK And TERMINATE

Q5. How involved are you with the selection purchase or your planned selection and purchase of an HVAC system for these commercial properties?

1	I alone am responsible for making the selection and purchase decision	
2	I share joint responsibility for the selection and purchase decision	
3	I am not involved in the selection or purchase decision	**TERMINATE**

Q6. How likely are you to purchase a commercial HVAC system for your property within the next 12 months? Use a scale of 1 – 5 where '1' is 'Very Likely' and '5' is 'Not at all Likely"

1	Very Likely	
2	Likely	
3	Somewhat Likely	**TERMINATE**
3	Not Very Likely	**TERMINATE**
4	Not at all Likely	**TERMINATE**

Just for classification purposes I'd like to ask you a few more questions…

Q7a. Is your business any of the following? ()

1	Veteran-owned	**Yes**	**No**
2	Small Business	**Yes**	**No**
3	Woman-owned	**Yes**	**No**
4	Minority-Owned	**Yes**	**No**

Q7b. How many full-time employees does your organization have in total?

1	1 – 99 employees (Small Business)	SEE QUOTAS
2	100 – 999 employees (Medium Business)	SEE QUOTAS
3	1,000 + employees (Large Business)	SEE QUOTAS

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 to participate in a 60-minute online interview about HVAC technologies.

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

Are you available to participate between [DATE] and [TIME]?

Yes ( ) **CONTINUE**

No ( ) **TERMINATE**

We are excited that you will be participating! You will receive a confirmation email and a reminder call, 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.

HVAC Contractors Screener

INTRODUCTION: Hello, I'm _____ calling from Lieberman Research, a marketing research company. We are conducting a study about heating and cooling systems and are looking to speak to those who are involved in the sales and installation of HVAC systems. Are you the best person in your company 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 heating and cooling systems and are looking to speak to person in your company who is involved in and can talk to the sales, 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 **XX [INSERT HONORARIUM AMOUNT].** (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 HEAT MAP, AT LEAST 51% OF TOTAL SAMPLE MUST BE FROM WASHINGTON and OREGON

Q2. Would you classify the area where your business is located as urban, suburban, or rural? **(IF RESPONDENT ZIP CODE INFORMATION AVAILABLE. USE THAT TO CLASSIFY RESPONDENT. YOU CAN STILL AS QUESTION AS A REFERENCE**)

1	Urban		**See Quotas**
2	Suburban		**CLASSIFY AS URBAN and See Quotas**
3	Rural		**See Quotas**

Q3. Is your company an HVAC contractor?

1	Yes		**CONTINUE**
2	No		**TERMINATE**

Just for classification purposes I'd like to ask …

Q4. Is your business any of the following? (record)

1	Veteran-owned	**Yes**	**No**
2	Small Business	**Yes**	**No**
3	Woman-owned	**Yes**	**No**
4	Minority-Owned	**Yes**	**No**

Q5. How many employees in total does your company have?

1	< 10 employees	**Classify as Small HVAC Contractor**
2	>10 employees	**Classify as Large HVAC Contractor**

Q6. Which of the following does your company do? (**CHECK ALL THAT APPLY**)

1	HVAC Installations/Replacements		**MUST SELECT TO CONTINUE**
2	HVAC Sales		**MUST SELECT TO CONTINUE**
3	HVAC System Design		**MUST SELECT TO CONTINUE**

4	HVAC Repairs		
5	HVAC Maintenance		

MUST SELECT HVAC INSTALLATIONS AND SALES IN Q6 TO CONTINUE

Q7. What percentage in each type of dwelling do you install HVAC Systems? **(Record Percentage)**.

1	Residential properties _____	
2	Commercial properties _____	
3	Industrial properties_____	**TERMINATE IF ONLY CHOSEN**
4	Don't know/Not sure _____	**TERMINATE**

CLASSIFY BY HIGHEST PERCENTAGE

RECRUIT 50/50 RESIDENTIAL AND COMMERCIAL PROPERTIES

Q8. For **how long** have you been active in your current role?

_____years / months

RECRUIT A MIX IF POSSIBLE

IF LESS THAN 1 YEAR Go to Q8A;

Q8A Thinking about your previous experience, how would you answer the same question?

_____years / months

If less than 1 year in Q8 and Q8A TERMINATE

Q9 Thinking about your **current role** at your company what percentage of time do you 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) % of time involved in Maintenance	**XX%**
e) % of time involved in **Other** of central HVAC Systems **(Record) ____**	**XX%**

MUST ADD UP TO 100%; RECRUIT A MIX IF POSSIBLE

Q10. Thinking about your business, which **types of products** does your company sell, design, and install? (**CHECK ALL THAT APPLY**).

1. Residential Dual Fuel Heat Pumps (AKA hybrid heat pumps which are gas furnaces paired with electric heat pumps)	**Record**
2. Commercial Dual Fuel Rooftop Units (RTUs) (AKA hybrid RTUs which are gas furnaces combined with electric heat pumps in the same unit)	**Record**
3. Other type of product (**Please specify**: _____)	**Record**

MUST SELECT AT LEAST TWO OF CODES 1, 2, 3 OR 4 TO CONTINUE.

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 to participate in a 60-minute online interview about HVAC technologies.

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

Are you available to participate between [DATE] and [TIME]?

Yes ( ) **CONTINUE**

No ( ) **TERMINATE**

We are excited that you will be participating! You will receive a confirmation email and a reminder call, 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 H. Detailed Recruitment Methodology

The following outlines our approach to recruitment and illustrates the steps taken with each market actor type.

1. Residential Buyers

A primary recruiter, Tallgrass, was brought on from the onset of the project to recruit residential buyers. Tallgrass recruited directly from their internal panel. Panel members were contacted by email as well as asked for referrals.

Recruitment was slow due to the holiday timing. Tallgrass incentives were increased from $100 to $125 to increase interest and show rates.

A supplement recruiter, Logit Group, was brought on once recruitment stalled. They matched the $125 incentive. Email outreach to internal panel for residential buyers, followed by a phone call.

We were able to fully recruit with two recruiters, Tallgrass (n = 21) and Logit Group (n = 3) and increased the incentive of $125.

Through a NEEA referral, Lieberman was also able to recruit n = 1 Gas Heat Pump owner located in Canada. The incentive paid was $125.

2. Commercial Buyers

A primary recruiter, Tallgrass, was brought on from the onset of the project to recruit Commercial Buyers. They conducted email outreach to their internal panel and asked for referrals. They also emailed service organizations and a small number of school districts in the target states. These efforts yielded n = 0 commercial buyer respondents. The incentive being offered was initially $125.

The research team contracted a supplement recruiter, Logit Group, once recruitment stalled. Logit Group conducted email outreach within their internal panel and LinkedIn searches for relevant job titles within the Fuel & Gas, HVAC, and related industries. In addition to owner, GM, VP of operations, these titles were targeted:

- Procurement Manager
- Purchasing Manager
- Supply Chain Manager
- Materials Manager
- Strategic Sourcing Manager
- Category Manager
- Vendor Manager
- Purchasing Agent
- Inventory Manager
- Senior Buyer

They increased the incentive for commercial buyers to $400. Logit Group recruited n=8 respondents, half of the sample size.

Another supplement recruiter, Techspert, was brought on once recruitment stalled a second time. Techspert recruited using AI technology targeting LinkedIn with the following key words:

- Building Owner
- Building Manager
- Facilities Manager
- Maintenance Manager
- Building Operator
- Property Owner
- Property Manager

They also searched for members of the Building Owners and Managers Association (BOMA); targeted senior individuals at hotels, retail stores, and schools among other industry areas; and searched for district staff within school districts of the target states. Techspert excluded the following domains in their AI technology outreach: utility companies, NEEA, and HVAC manufacturers. Techspert matched the $400 incentive.

When recruitment stalled again, Techspert added the following keywords to their AI search:

- Senior Property Manager
- Property Director
- Property Administrator
- Director of Facilities
- Facilities Coordinator
- Facilities Supervisor
- Maintenance Supervisor
- Maintenance Coordinator
- Head of Maintenance
- Building Supervisor

Techspert was able to recruit n=7 respondents.

3. HVAC Contractors

A primary recruiter, Schlesinger, was brought on from the onset of the project to recruit HVAC contractors using NEEA's list of contacts. Schlesinger recruited n=5 HVAC contractors from the list using email and phone outreach.

NEEA also provided Schlesinger with list of referrals from HVAC distributors and utilities. They emailed and conducted outreach by phone up to 3 attempts and were unsuccessful recruiting any HVAC contractors using this approach.

Lieberman followed up with referrals through email outreach. Was able to successfully recruit n=2 HVAC contractors.

When recruitment stalled, Schlesinger conducted email outreach within their internal panel. Only n=1 was recruited using this approach.

Schlesinger then programmed the screener as an online survey and provided Lieberman and NEEA with the link. NEEA provided the screening link to a utility company implementer, who in turn added the link to their quarterly email newsletter. The incentive was increased from $250 to $375 when the newsletter went out. Schlesinger reached out by phone to respondents who were fully screened and qualified via this link. N=5 were recruited using this method.

A supplement recruiter, Logit Group, was onboarded when recruitment efforts stalled. They conducted email outreach within their internal panel, followed by a phone call. They also searched on LinkedIn for relevant titles within the fuel & Gas, HVAC, and related industries. They were able to recruit n=3 HVAC contractors using these methods.