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Cold Climate Demonstration Installation & Water Heater Installer Focus Group Research

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TABLE OF CONTENTS

Tables

Figures

Executive Summary

NEEA wanted to understand adoption barriers and the magnitude of previously identified installation challenges, particularly among installers with little to no heat pump water heater (HPWH) experience and installers working in the cold-climate zones of the Northwest (where HPWH adoption has been much slower than the Northwest's warmer-climate zones). In addition, in advance of a possible new federal appliance standard that would require heat pump water heaters (HPWH) in most electric water heater replacement situations, NEEA wanted to understand how the market might respond to such a standard and identify ways to support the market, if such a standard were adopted.

To help explore these topics, NEEA contracted with ILLUME on two concurrent research streams: the Cold Climate Demonstration Installation (CCDI) and the Water Heater Installer Focus Group (WHIFG) studies. The following are the key takeaways from these research projects.

Previous research studies have highlighted ***well known market challenges, such as the labor shortage and increased costs of living, as underlying factors that shape installers' perceptions of newer technologies, including HPWHs*** (ILLUME 2019 and ILLUME 2020). These create constraints and challenges for installers personally and make installers concerned about how these challenges impact their customers. As a result, installers can be more cautious in recommending HPWHs (as well as any newer, more expensive technology) because it could create a financial burden for their customers and potentially make their jobs harder.

Until there are ***more design and size options readily available in supply houses***, market interveners should focus resources to increase HPWH adoption in ***straightforward retrofit applications***, specifically electric retrofits where the water heater is in a spacious area (e.g., crawlspace, garage, or basement) that is away from frequented living spaces. Otherwise, there is a risk that both installers and customers will have bad experiences with HPWHs which could harm adoption and prolong the market's transformation. And, ***even for straightforward retrofits, appropriately sized incentives are necessary*** to convince installers that the return-on-investment is worthwhile for their customers.

We encourage focusing more on straightforward HPWH installations because installers, even those with little or no prior HPWH installation experience, generally think these types of installations are ***"pretty much the same" as installing a traditional water heater***. In general, installers recognize that HPWHs can *technically* be installed in most homes, but there are certain situations where most installers do not think HPWHs are *realistically* feasible at this time, given the current product options and availability.

Market interveners should ensure that installers understand the types of installations that will be like installing a traditional water heater to manage expectations and avoid negative experiences. If market interveners push the message that HPWHs can get installed anywhere with the same ease as a traditional water heater, it could erode installers' trust in that information source as that message may conflict with their experiences.

As part of focusing on increased adoption in the more straightforward installations, market interveners, in collaboration with manufacturers, should use these easier installations to help ***educate installers***, including individuals who sell and/or scope projects, ***about which type of HPWH would work best in each situation*** (e.g., should they get a unit with top or side connections). In addition, easier installations can allow installers to ***learn about the key installation differences between HPWHs and regular water heaters in lower stress situations***, such as the power up process and ways to position HPWHs to maximize the compressor's performance.

To support this strategy throughout the Northwest, market interveners must ***ensure that suppliers in colder-climate zones readily stock a variety of HPWHs***. Currently, in places like Idaho and Montana, HPWHs are scarce and can take weeks (or months in select cases) to arrive at supply houses. This makes them ***unreliable solutions for most water heater replacements*** – emergency situations. It also means that to install a HPWH, installers must use whatever is available to them, which might include units with defects or a design that is not suitable for the space; this could create and/or enforce negative perceptions.

More HPWH design and size options are needed for HPWHs to be considered a solution for any household. With any water heater replacement there is a chance for installation challenges since houses can be quirky; however, challenges are more likely when installing a HPWH in a more confined space (e.g., closets or small mechanical rooms) and installers may not recommend HPWH to customers in these situations. In general, ***installers do not think relocating the water heater is a reasonable solution for space constraints.***

Market interveners should ***continue working with manufacturers to develop solutions for water heaters replacements in more confined spaces***. Aside from developing other form factors, this could include developing manufacturer-branded resources and trainings that teach installers how to ensure there is adequate air supply to the HPWH, such as ideas tested during the Amazing Shrinking Room experiment. When engaging installers with less experience solving the airflow needs for HPWHs, market interveners should be mindful of encouraging HPWHs installations in confined spaces at this time because, as the Amazing Shrinking Room experiment found, ***it will harm the HPWHs energy efficiency – the technology's main value proposition.***

While these studies and this report were designed to focus on the HPWH adoption barriers and installation challenges, ***positive insights, and opportunities for the HPWH market were uncovered*** through this work. For example, most ***installers are tenacious and excellent creative problem solvers***, which enables them to "get the job done" even when they are less experienced with a product, or the installation situation is difficult. We observed this during the CCDI research. Although most installers that participated in the CCDI study had little to no experience with HPWHs, ***all were successfully able to install the HPWH and all said they would, in the right situation, install a HPWH again***. This learning indicates that there is a path forward for broader HPWH adoption. Addressing or alleviating the adoption barriers and installation challenges outlined in this report could ease and/or accelerate movement down that path for broader HPWH adoption.

Introduction and Methods

Energy-efficient water heating is a focal point for market transformation because heating water accounts for 20% of home energy use in the United States.[1] There have been many market solutions that have attempted to address this issue for almost a decade, such as new products and standards requiring the manufacturing of more efficient appliances. Yet, the market has not seen the uptake of efficient appliances that was expected from these changes.

The Northwest Energy Efficiency Alliance (NEEA) has contributed to extensive market research into water heating. Specifically, their research seeks to understand the successes and failures in the water heater market. In 2019, NEEA hired ILLUME Advising ("ILLUME" or "we") to conduct exploratory research of more efficient residential gas HVAC and water heating equipment.[2] This work focused on understanding the day-to-day lives and challenges of installers and distributors that lead to difficulties adopting new technologies, for example. In 2020, ILLUME completed additional research around the uptake and installation of newer water heater technologies – specifically, for tankless water heaters and a near-commercialized gas heat pump water heater (GHPWH).[3] We identified that given installers' contexts and industry challenges (corroborated in our 2019 report), installers and distributors value new technologies that solves a problem for them (or their customers) and suits their busy, fast-paced schedules.

[1] U.S. Department of Energy. Water Heating. https://www.energy.gov/energysaver/water-heating

[2] ILLUME Advising. Natural Gas Water Heater and HVAC Installer Research Report. March 2019.

[3] ILLUME Advising. Gas Tankless Water Heater Combined Research Report. March 2020.

NEEA previously collaborated with the Cadeo Group to explore challenging HPWH installation scenarios in existing single-family homes.[4] The findings of this research were primarily informed by more experienced HPWH installers across the Northwest. Given the findings from Cadeo's research, NEEA wanted to understand the magnitude of the installation challenges identified, particularly among installers with little to no HPWH experience and installers working in the cold-climate zones of the Northwest (where HPWH adoption has been much slower than the Northwest's warmer-climate zones). In addition, in advance of a possible new federal appliance standard that would require heat pump water heaters (HPWH) in most electric water heater replacement situations, NEEA wanted to understand how the market might respond to such a standard and identify ways to support the market, if such a standard were implemented.

To help explore these topics, NEEA contracted with ILLUME on two concurrent qualitative research streams: the Cold Climate Demonstration Installation (CCDI) and the Water Heater Installer Focus Group (WHIFG) studies. We used ethnographic methods since NEEA already generally understood *what* the HPWH installation challenges were for installers and now wanted to more deeply explore *why* these challenges exist and *how*, if at all, installers overcome such barriers. The ethnographic approach provided rich insights into the experiences of installers that are not easily captured through other research methods. For example, we could observe the specific moments when subtle changes in mannerisms, tone, and approach indicated installers were getting tired and/or frustrated with the project (e.g., more sighing, elevated seriousness, and willingness to compromise precision for 'good enough'). The qualitative approach also allowed us to better understand installers themselves and their working conditions (e.g., we personally felt what it is like to crouch in a dark, cold crawlspace for several hours, or go up and down steep basement steps over 50 times, or drive 1.5 hours home in dark, icy, snowy conditions after standing for eight hours).

The findings of these two research studies are consolidated in this report because they are closely interrelated. For example, installation challenges we saw in the field (CCDI) are barriers that other installers mentioned in the focus group study (WHIFG), and larger structural challenges that focus group members mentioned (e.g., availability, demand) are present in the installations we saw (CCDI). We use the 'typical' HPWH installation journey we observed while in the field to organize this report. Within the installation journey, we highlight the challenges specific to HPWH installations, challenges that are common with any water heater installation, and then we discuss how pain points within the installation journey and the market context can shape the perceptions that installers have of HPWHs. Finally, we discuss the possible implications of advancing an appliance standard that would eventually require HPWH as the baseline technology for most residential electric water heater installations. Our research focused on the installer perspective and water heater retrofits in the cold-climate zones of the Northwest.

Research Objectives

The primary objectives of this research were to understand HPWH adoption barriers and the magnitude of previously identified installation challenges, inform the development of effective market interventions that advance the transformation of the electric water heating retrofit market, as well as identify support that market actors may need to comply with any future changes to water heating appliance standards.

[4] Cadeo Group. Heat Pump Water Heater Market Research: Challenging Installations Scenarios. April 2023.

This work focused on water heater installers, but also included interviews with residents who recently installed a HPWH. Table 1 lists the research objectives and which research activities inform them.

Table 1. Objectives by Research Activity

Research Objective	Observational Research	Customer Interviews	Installer Focus Groups & Interviews
Understand the context of water heater installers in the Northwest, including any variation across states.	✓		✓
Understand installer's perceptions of HPWH and identify underlying reasons for reluctance toward the product.	✓		✓
Observe and describe the types of difficult installations that installers face in real time.	✓		
Identify the solutions and problem-solving methods that installers use during installations.	✓		
Observe installer-customer interactions related to a HPWH installation.	✓	✓	
Understand installer satisfaction with HPWH installations.	✓		
Describe customer satisfaction with the installation and operation of HPWHs.		✓	
Understand how the market might be impacted by a new federal standard that would require HPWHs for nearly all electric water heater installations.			✓

Completed Research Activities

In this report, we summarize findings from two concurrent research streams: the CCDI and WHIFG studies.[5] Between the two studies, we spoke to 38 installers and 10 homeowners. Table 2 shows who we spoke to in each state by research project.

Table 2. Summary of Installers Engaged Across Both Research Activities

State	Installers From CCDI	Installers From WHIFG	Total
Idaho	N/A	5	5
Montana	17	3	20
Oregon	N/A	3	3
Washington	N/A	10	10
	17*	21	38

*This is inclusive of all the installers we spoke with during these installations. Seven installations we observed involved two people.

Cold Climate Demonstration Installation (CCDI)

ILLUME observed 10 HPWH installations in a cold-climate (areas identified as Zone 6 per International Energy Conservation Code guidelines (IECC)) to understand the magnitude of previously identified barriers for HPWH installations in these areas, as well as the solutions installers come up with to overcome the challenges. We also explored installer-customer interactions, customer satisfaction with the installation process, and overall customer satisfaction with their new HPWH after living with it for several weeks during colder weather months. All the HPWH installations we observed were in Montana (Table 3). We intentionally timed the installations for colder months to understand how cold weather might impact the HPWH installations, and whether the cold weather might impact residents' satisfaction with the HPWH.

All the installers we observed completed the HPWH installation (none gave up). We observed a variety of HPWH sizes installed, as well as the installation of at least two HPWHs from each of the three largest water heater manufacturers – AO Smith, Bradford White, and Rheem. Nine of the ten installations were completed by licensed journeyman plumbers.

[5] The findings of these two research studies are consolidated in this report because they are closely interrelated. For example: installation challenges we saw in the field (CCDI) are barriers that other installers mentioned in the focus group study (WHIFG), and larger structural challenges that focus group members mentioned (e.g., availability, demand) are present in the installations we saw (CCDI).

Of the nine companies we observed, eight offered HVAC and plumbing services, though two worked on hydronic heating systems and six did HVAC generally. Seven of the installers had never installed a HPWH before while the other three had some HPWH experience from several years ago because there was a rebate available.

Overall, the installers we observed had limited training on HPWHs prior to the installation—only two said they completed the online, self-paced training developed by Evergreen Consulting Group—the rest reviewed the specs and some noted watching a manufacturer produced YouTube video to get a sense for the installation process.

Table 3. Summary of HPWH Installations Observed

Time	City	No. Installations Observed	No. Installers	No. Homeowners	HPWHS Installed
October 2022	Kalispell	2	4	2	AO Smith, 80-gal (n=2)
	Missoula	3	5	3	AO Smith, 50-gal Bradford White, 50-gal State, 50-gal
January 2023	Bozeman	4	6	4	Bradford White, 80-gal Rheem, 50-gal Rheem, 80-gal Lochnivar, 50-gal
	Billings	1	2	1	AO Smith, 66-gal
TOTAL		10	17	10	

Our research partners at Evergreen Consulting Group recruited and scheduled the installations. We observed five installations in October 2022 and five installations in January 2023. We recorded each installation process with a GoPro camera. The cost of the equipment and installation labor were paid by NEEA. As part of our observations, we conducted on-site interviews with installers and homeowners.[6] We interviewed homeowners both during the installation and after they had lived with their HPWH for about six weeks.[7]

Water Heater Installer Focus Groups (WHIFG)

Currently, there are efforts to pass a federal standard requiring that all electric storage tanks larger than 45 gallons are effectively HPWHs. In 2015, a similar federal standard passed—the National Appliance and Energy Conservation Act (NAECA) Water Efficiency Standard—that required all electric storage tanks larger than 55 gallons effectively be a HPWH; however, HPWH installations have not increased as expected since this standard took effect. NEEA sought to understand why uptake of HPWHs had not increased as expected due to NAECA.

We completed three focus groups with installers to test installers' awareness of the 2015 NAECA standard and gather general reactions to a future standard update. We also completed five in-depth interviews (IDIs) with installers in cold-climate areas. We focused our recruitment of the IDIs in colder climates and less urban areas, as they were less represented in the three focus groups.[8] Appendix E: WHIFG Research Approach provides details about the ways this research evolved in response to new information. Table 4 outlines the characteristics of who we spoke with for this research stream.

Table 4. Characteristics of Installers We Spoke With

State	Total	Water Heater Installation Experience	HPWH Installation Experience	Company Size	Rurality
Idaho	5	More than 10 years (n=3)	Once or twice (n=4) A handful of times (n=1)	Between 5 and 20 employees (n=1) More than 20 employees (n=1)	More rural areas (n=3) Smaller urban areas (n=2)
Montana	3	5 to 10 years (n=1)	Once or twice (n=1)	Less than 5 employees (n=1)	Smaller urban areas (n=3)

[6] Installers received $500 for participating in the study, while homeowners received $50 for completing the on-site interview with us.

[7] Two homeowners were not home for the installation (and did not come home by the time it was complete) and one homeowner ended up being the owner of the plumbing company doing the installation. We completed all but one follow-up interview with homeowners. Homeowners received an additional $100 gift card for completing the follow-up interview.

[8] Each participant in a focus group or IDI received a $250 incentive for their time.

State	Total	Water Heater Installation Experience	HPWH Installation Experience	Company Size	Rurality
		More than 10 years (n=2)	Never installed (n=1) A handful of times (n=1)	More than 20 employees (n=2)	
Oregon	3	More than 10 years (n=3)	A handful of times (n=1) Many times (10+) (n=2)	Less than 5 employees (n=3)	More rural areas (n=1) Smaller urban areas (n=1) Larger urban areas (n=1)
Washington	10	2 to 5 years (n=1) More than 10 years (n=9)	Once or twice (n=2) A handful of times (n=4) Many times (10+) (n=4)	Less than 5 employees (n=2) Between 5 and 20 employees (n=4) More than 20 employees (n=3)	More rural areas (n=1) Smaller urban areas (n=2) Larger urban areas (n=6)

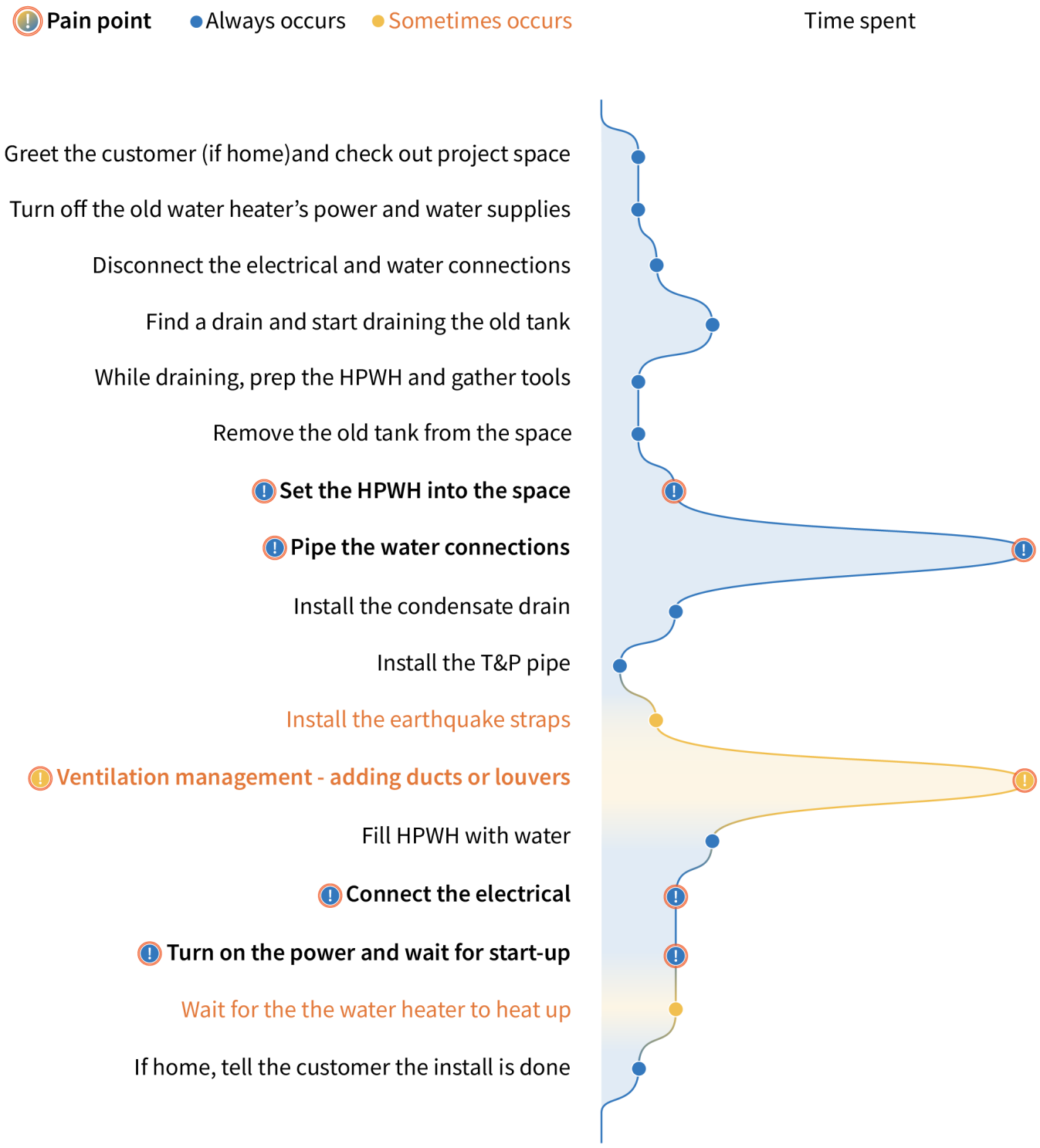
Findings

We organize the findings from these activities using a generalized HPWH installation journey. Within the installation journey, we highlight the challenges that are common with any water heater installation, challenges specific to HPWH installations, and then we discuss how pain points within the installation journey and the market context can shape the perceptions that installers have of HPWHs. Finally, we discuss the possible implications of advancing an appliance standard that would eventually require HPWH as the baseline technology for most residential electric water heater installations.

HPWH Challenges Along the Installation Journey

Figure 1 outlines a high-level HPWH journey map. Our intent is to show both the common pain points, as well as variations in the installation process compared to a standard tank. The x axis provides a sense of how long a given step typically took relative to other installation steps; this work is qualitative and therefore we did not assign specific time bands. Some of these steps occurred concurrently, especially in cases where there were two installers present. There are also steps that we did not observe, like project scoping, that happened before the day of the installation, or steps that the installer needed to complete another day once the supplies arrived – this most happened when ventilation modifications were needed. After the journey map, we describe steps in more detail that are specific to HPWH and/or are considered pain points.

Figure 1. HPWH Installation Journey Map



"Pretty much the same. It's all pretty standard. There wasn't very much re-piping to do on this one…if this thing fit through the door perfectly, it would have been just as easy as the rest of the water heaters usually are. Nothing wild on this as far as I can see. We'll see what happens when it fires up."

– Tom, a Montana installer

Setting the HPWH into place. Installers are no strangers to maneuvering water heaters through and into awkward spaces. However, since HPWHs are larger and heavier than a typical water heater, this already challenging step can become even more difficult. For example, one installation we observed, the HPWH was almost too wide to fit through the crawlspace access. During another installation, the installers had to remove the entire doorframe *and* cut an additional half inch off the wall to fit the HPWH into place. Even then, the closet was barely deep enough to hold the HPWH, so the unit's drain slightly protruded into the doorway. This also meant that the customer needed to pay someone to come out and install a new door, which adds cost to the installation overall.

Aside from physically getting the HPWH into a space, these units require a bit more thought as to how they are situated in the space than a traditional water heater. This is because HPWHs require more clearance on the side and top of the unit than a traditional water heater to 1) help with air flow and performance, and 2) enable servicing down the road. Installers generally understand that HPWHs require a space with proper airflow, but not that a certain clearance is needed around the tank. Of the seven installations we observed with smaller spaces or placing the HPWH against a wall, only one installer measured clearance to ensure they placed the HPWH according to the installation instructions.

Instead of situating the HPWH based on clearance needs, installers prioritized situating it so that:

1) The control panel was accessible
2) They could maximize recycling connections to existing piping/drains
3) Simply get the unit to fully fit in the space

To prepare for the HPWH installation, installers noted they primarily reviewed the manufacturer's spec sheet to confirm the dimensions and the parts lists to inform their supply house shopping list. In reviewing several manufacturer spec sheets, we observed that this information about clearance requirements was not included on the spec sheet, which might be why installers were generally not aware of this requirement. Instead, manufacturers tended to include this information on other documents, such as the lengthy installation manual that installers only looked at to power on the unit (more on this below).

Considerations for NEEA

NEEA will need to strike a balance between telling installers that the HPWH installation process is like installing a regular water heater and making sure they are aware of placement differences. To increase awareness of fit considerations, NEEA should work with manufacturers to include these requirements on the spec sheet so installers can factor it in when checking the HPWH's dimensions. Of note, Bradford White does have an installation checklist (separate from the spec sheet) with key information like the clearance needs and guidance about what to expect once the tank is powered on. Attaching something like this to the spec sheet could increase the chances of installers seeing the information before the installation.

Plumbing water lines and connecting the electrical. All water heater replacements require replumbing to connect the water lines, and electric resistance water heaters (ERWH) also require reconnecting the electrical line. These are usually relatively straightforward steps with traditional water heaters since these connections are typically located in the same place (the top of the unit) and tank dimensions are generally similar. However, as noted, HPWHs are noticeably taller and wider than an electric resistant water heater (ERWH), and most units have water and electric connections on the side of the unit. This means that, for some HPWH units, there is more replumbing involved and a chance that the existing electrical line is not long enough to reach the new connection spot. For example, we observed one installer spend several hours squeezing between the HPWH and a closet wall trying to plumb the water lines. It took so long because the water lines were on the opposite side of the HPWH, and the closet was narrow, so the tank took up most of the space. This meant that the installer had to run the water lines over the top of the unit to get them to reach the side connections. For this installation, having the connections on top of the tank would have made the installation significantly easier and shorter.

> *"I guess I'd say the only gripe I have about these heat pump water heaters is the **water connections are on the side instead of on top. So, the area you have to work in has to be a little bit bigger…A lot of these closets are smaller, and so a heat pump water heater isn't going to be feasible."***

However, there is also value in having HPWH designs with the water connections on the side because, in a space where height clearance is more of a concern than the width, there might not be enough space to easily make those connections on top of the unit. For example, we saw one installation in a crawlspace where the customer dug a "coffin" (i.e., a hole in the dirt) for the water heater so it could stand up in the crawlspace – digging coffins for water heaters is relatively common in eastern Montana. In this case, it was fortunate that the connections were on the side of the unit because it made it easier for the installers to complete the installation. In general, the installers we observed in Montana did not seem aware that they could choose between HPWHs with top and side connections, likely because the supply of HPWHs is so scarce there at this time that installers simply took what they could get.

Installers need more design options, and they need those options readily stocked. Installers need to 1) know there are options between HPWHs, 2) understand how to select these options for a job, and 3) know they can count on these options being readily stocked at their supply house. Aside from working with manufacturers to ensure there are a variety of design options for HPWHs, and working with suppliers to ensure those options are stocked, NEEA should also educate suppliers and installers (particularly those who scope projects) about when they might select a HPWH with top versus side connections. This could also become a set of questions that suppliers ask installers when they are placing a product order. For example, suppliers could provide this information to installers:

There are water and electric connection options—top of tank or side of tank—be sure to assess the dimensions of the space to determine which option will be easier.

- Spaces that do not have a lot of height clearance may need side connections since HPWHs are taller.
- Spaces that are narrow but have height clearances may need the top connections since HPWHs are wider.
- For HPWHs with water connections on the side, the electrical is also often on the opposite side of the tank. If you need a HPWH with side connections, check the length of the current electric line to ensure it can reach the side of the tank.

Running the condensate line. We hypothesized that running the condensate line could be a pain point during the installation. In general, installers did not sweat managing the condensate from the HPWH. For all the installations we observed, a drain was relatively close to the water heater or other plumbing was nearby that installers could tap into for draining the condensate. One installer pointed out that they are used to managing condensate from water heaters because it is a necessary step for any high-efficiency gas water heater installation. Installers shared that there are some unique homes where managing the condensate gets tricky but, among the installers we interacted with, these situations were outliers.

Ensuring the HPWH has the necessary airflow. In our observations, ensuring the HPWH has the necessary airflow tends to be the most challenging aspect of installing a HPWH. First, installing duct kits and louvers requires installers to perform tasks that are not necessarily in their wheelhouse; therefore, there is reluctance to place HPWHs where they may need to do this. Aside from their comfort-level with the task, these steps require more materials and cause the installation to take longer, thereby increasing project costs. Seven of the ten installations we observed required some kind of airflow adaptation. We observed ducting/louver installations during two HPWH installations. In both cases the installers spent at least one and a half to two hours installing the duct kit and/or placing louvers. While two installations scoped and installed airflow management options on the same day, five other projects needed airflow management and the installers planned to return another day to complete this step. Since it was planned for another day, we did not see this step completed because either the supplies were not in stock, or installers anticipated that they would not have enough time to do it the same day.

As identified in previous research, due to the labor shortage, installers tend to avoid products or situations that require multiple trips (or risk callbacks) as that is time they could spend on another project (ILLUME 2019 and ILLUME 2020). Addressing this challenge is very important for spurring broader adoption of HPWHs since the average installer will likely be reluctant to install a product that turns a water heater replacement—something that typically takes a half-day—into something that takes full-day or more.

Continue working with manufacturers to develop solutions for water heaters replacements in more confined spaces. Aside from developing other form factors, this could include developing manufacturer-branded resources and trainings that teach installers 1) when airflow management is necessary, and 2) how to ensure there is adequate air supply to the HPWH, such as ideas suggested during the Amazing Shrinking Room experiment.

Work with suppliers to ensure duct kits are readily available when installers pick up a HPWH. This could help installers avoid multiday water heater replacement projects since they would not need to wait for materials to arrive.

Interacting with the digital display once the unit has power. The only time that installers ever reviewed the HPWH's installation manual during the installation was when they turned on the unit's power. Installers seemed to expect the heat pump's fan to turn on immediately and did not want to leave the job site till they heard the fan turn on. Most installers became concerned when several minutes would pass and there was no sound from the fan, the display was flashing dotted lines, and the unit was unresponsive when they pushed buttons. There were a couple of installers who encountered the "HPO" code because the temperature of the ground or well water was colder than the manufacturer temperature setpoint for the heat pump to operate – likely the one element of cold-climate installations that differs from installations in warmer climates. One installer thought this was an error code signaling that something was wrong. Installers were able to find the answers they needed about the start-up process after reviewing the manual for several minutes. The manufacturer spec sheets do not currently include this information, which could explain why installers did not know what to expect with this step.

Although installers were ultimately able to figure out the start-up process (and will likely not get thrown by it during future installations), NEEA may want to collaborate with manufacturers to raise awareness with installers about what they should expect after flipping the power switch. This could improve installers' perception of installing HPWHs. It may help to include the following information on the spec sheet, so installers see it when checking the HPWH's dimensions:

1. After turning on the power, the unit will take about XX minutes to run diagnostics.
2. The heat pump fan might not kick on immediately.
3. If the incoming water is cold, the unit will use the electric elements to bring it up to temperature before using the heat pump for heating. This is the HPO code.

Overall, we never witnessed an installation where the installers gave up on the HPWH. Most challenges installers encountered were resolved by "muscling through it" (i.e., fitting pipes in tight spaces—there is no solution other than to continue working the problem for as long as it takes), calling for help, or employing creative problem-solving skills—like, placing a piece of chopped wood from the yard in front of the drain pan in order lift the HPWH into the pan.

Market-level HPWH Challenges

In addition to the challenges observed in the installation process, there are market-level challenges installers articulated across the research activities we conducted.

The HPWH has a place in the market, but currently they do not work for every household.

In general, installers recognize that the process for installing a HPWH is generally the same as installing an electric resistance water heater (ERWH). The differences and unique challenges primarily emerge when trying to install a HPWH in a confined space because HPWHs are larger than ERWH and require adequate airflow for operation. Accordingly, in households where the water heater is in a spacious area (e.g., not in a closet) the installation should be straightforward and not pose a unique challenge for the installer. And, even in these circumstances, there are other barriers to adoption, such as the availability of HPWHs, overall cost, and, depending on the location in the home, concerns about customer dissatisfaction with the noise and cold air. We outline these adoption barriers in the *Non-Installation Related Challenges for HPWH Adoption* section below.

"Yeah…the programming might take a little bit, but I don't think that stuff is very bad…explaining the modes with the customer might take a bit of time…but as far as the plumbing, it's almost exactly the same as a regular one."

– Ben, a Montana installer

Installers do not see the HPWH as a universal product.

Most of the installers we spoke with during the fieldwork and focus groups were not opposed to HPWHs, but they do not see HPWHs as a "one-size-fits-all" solution, particularly because of their size, noise, and cold air exhaust. Much of this is due to the location of existing water heaters in homes that must be considered during retrofit.

To maximize energy efficiency, in colder climate zones, the ideal location to install HPWHs is in the basement or interior of home (meaning bedroom closets, under stairs, etc.).[9] Homes in the western, coastal areas of Oregon and Washington can install HPWHs in garages. Based on the 2016 – 2017 RBSA, these ideal locations align fairly well with where water heaters are currently located throughout the Northwest – 41% of electric water heaters in the Northwest region are located in the main house, 30% are located in the basement, and 23% are in the garage. However, because of the added noise and cold air produced by HPWHs, customers may not be satisfied with a HPWH in some interior spaces.

"A garage [is probably the best place for HPWHs]. You gotta have a certain volume of air with these so a little closet doesn't necessary work."

– Tom, a Montana installer

[9] Source: Advanced Water Heating Initiative (AWHI), Residential Working Group meeting, March 18, 2023.

Therefore, locating HPWHs inside homes can feel risky for installers, especially in colder-climate zones. This concern may also extend to basements depending on how that space is used. As such, ***there are conflicts between balancing the ideal placement for the unit's energy efficiency, and placement in areas of the home that are ideal for the resident's experience and comfort.***

Table 5. Water Heater Location by State (From the 2016 – 2017 RBSA).

State	Water Heater Location			
	GARAGE	MAIN HOUSE	BASEMENT	CRAWLSPACE
Idaho	32%	25%	25%	2%
Montana	9%	33%	47%	11%
Oregon	41%	27%	26%	4%
Washington	38%	30%	25%	3%

Table 5 shows the breakdown of water heater locations by state. This distribution of water heater locations raises some potential issues for HPWH retrofits, especially in colder climates of the Northwest (e.g., Idaho and Montana) where 80% of water heaters in Montana and 50% in Idaho are in the main house and basement. Further details about where water heaters are in the main house and basement (e.g., how the basement is used, whether the water heater is within a closet in these spaces) would help determine the magnitude of potential adoption challenges for HPWHs in cold-climates.

We saw and heard about two major problems with installing the HPWH inside the home: 1) cold air exhaust and, 2) noise.

Cold air's chilling effect on HPWH adoption. Many installers in our focus groups from colder climates raised concerns about putting HPWHs in homes and basements, where the tank will be drawing warm air and exhausting cold air during winter months. In the field, most of the HPWH installations we observed did not duct cold air exhaust out of the home, and as a result most homeowners (n=6) acknowledged that they noticed a temperature drop in the space with the HPWH.

What this looks like: Terry, a Montana homeowner

Terry had his HPWH installed in a basement closet. His basement was finished and had bedrooms and a playroom for his kids. Terry told us during our follow-up interview that the biggest thing he dislikes about the HPWH is the cold air that pumps into the basement. He described it as having *"another AC down there"* and is looking into getting duct work done in warmer months for that reason. Terry also said that the cold air forced him to turn the HPWH into electric-resistance mode, thus preventing him from seeing the energy efficiency of the unit. Terry also expressed frustration with the unit because he had to go down to the unit every few days to flip it back to electric resistance only mode as it would automatically switch back to the hybrid mode.

In some instances, this was fine: the HPWH was in a crawlspace or a utility room that the homeowner does not visit often. However, there were some cases when homeowners told us that they were not fully prepared for the extent of the cold air produced from the HPWH, even though they recall discussing that feature with the installer beforehand.

Some installers in our focus groups noted that they were called back to jobs because they needed to install a duct kit since it was too cold for the customer without the kit installed.

Noise complaints are not just squeaky wheels. The other issue that installers have seen with HPWHs—particularly when they have been installed inside the home—is the noise that the HPWHs create. Installers in our focus groups and IDIs explained that they have had noise complaints from customers. At times, this led to callbacks to address the issue by installing sound boards, for example. As we know from previous findings about installers' lived experiences, they try to avoid callbacks at all costs. As a result, installers told us that they now avoid HPWHs installations in places like bedroom closets or interior closets near living spaces, which further limits the parameters of an 'acceptable' application for a HPWH.

During the follow-up cold-climate installation interviews, we asked residents about any changes they noticed since their HPWH was installed. Most homeowners (n=7) commented that they were surprised by how loud the unit is. One homeowner noted that her husband—who had been the driver to get the HPWH technology—was not prepared for the noise of the unit: *"It's louder than my husband thought it would be."*

Leaving known HPWH barriers unaddressed and pushing HPWH in all retrofit scenarios could have unintended CONSEQUENCES.

Two of HPWHs installations we observed were set to electric resistance only mode after customers expressed dissatisfaction with the cold air or noise. If set to electric resistance mode, HPWHs are designed to switch back to the hybrid mode after 72-hours. However, there is an override code which installers can get from the manufacturer that would allow the HPWH to stay in electric resistance mode indefinitely – effectively, eliminating the purpose of installing a HPWH in the first place. Although this is supposed to be a last resort, one installer we observed got the manufacturer override code for their customer rather than attempting to replace or repair the unit.

What this looks like: Jared, a Montana homeowner

Jared's HPWH was installed in a modest-sized closet below the stairs. The closet is between the master and guest bedrooms, and nearby the living room and kitchen space. During the installation, we heard the HPWH's fan was particularly loud, but the installers did not know why. The installers took a recording of the sound to send to the manufacturer.

During our follow-up interview, Jared said that the noise continued to bother Jared and his wife. He complained to the installers. There were no conversations about repairing or replacing the unit. Instead, the installers came back with the manufacturer's override code and permanently switched it into electric-resistance mode (they *"turned the fan off"*).

This "solution" was also mentioned during the focus groups – one installer recalled an installation where the customer was adamant that they install a HPWH, however, water heater location was too small for a HPWH's airflow needs and resulted in the installer setting the unit to electric resistance mode.

Though this feature has the potential to nullify any value of installing a HPWH, it also gives installers a piece of mind that if things do not work out that all they need to do is flip a switch and the electric resistance technology will provide hot water. ***In other words, attempting to restrict the use of this override feature (or eliminating it) may result in installers being more reticent to install HPWHs. Instead, resources would likely be better focused on resolving the reasons why installers might flip this switch.*** Installers are creative problem-solvers – if they need to bypass the heat pump, someone will figure it out. Further, manufacturers might be weary of restricting this feature because they likely understand that installers need assurances for their customer and that installers value manufacturers that save them time.

"We've been involved with a few heat pump water heater installations, and I think they're a great idea, especially in some of our mechanical rooms... there's a lot of mechanical rooms up here... They're great for that application but probably not so much in some of the other applications that we've come across, so. I think they're a great concept, and they've got a spot for 'em, it's just a matter of finding the right spot."

– Evan, a Montana installer

Again, the installers we spoke with thought there were some suitable locations for HPWHs. Installers in colder climates specifically thought that mechanical rooms (which are relatively common in their region) were ideal for HPWHs. Installers explained that mechanical rooms were typically larger than a closet space and could draw more air, and more importantly, they produced a lot of heat that would make a HPWH perform better than a cold space.

Customer feedback supports installers' concerns that noise and cold air from HPWH are not suitable for certain locations.

While customers were not the focus of this research, we did speak to most residents participating in the cold climate installation research directly after the installation and about a month following the installation. Because these residents got a HPWH in a non-typical situation—a non-emergency replacement situation and at no cost to them—we highlight customers' experience *using* the HPWH.

In general, the customers were satisfied with the HPWH's ability to deliver hot water and did not notice any issues when the weather got colder. Most indicated (n=7) that they did not have hot water shortages. There were two customers that said, on occasion, they experienced cold-water events (Table 6, in the Appendix D, describes installation characteristics and hot water supply experience).[10] One of the customers with some hot water supply issues received the same size HPWH as their previous water heater (50 gallons) and the installer did not use a mixing valve.

[10] We were unable to complete the follow-up interview with one customer, which is why this count does not total to 10 customers: seven did not have hot water shortages and two did report hot water shortages.

The installer set the HPWH to heat pump only mode initially and, once it was set to hybrid mode, all cold-water events stopped. The other customer noting cold water issues had a slightly larger HPWH than their previous ERWH (40 gallons to 50 gallons) and a mixing valve installed; our understanding is these occasional cold-water events have not been resolved.

Two customers were dissatisfied with the noise and cold air produced by the HPWH, primarily because of where they were located inside the home. Several homeowners who did not have those issues said they could see why they are not as affected by things such as the noise, the cold, etc., because their HPWHs were in places "*out of sight, out of mind*." They shared that, if the HPWH were in their homes (a hall or bedroom closet, for instance) rather than a utility room, they would likely be unhappy with their HPWH.

Until there are more design and size options readily available in supply houses, market interveners should focus resources to increase HPWH adoption in straightforward retrofit applications, specifically electric retrofits where the water heater is in a spacious area (e.g., crawlspace, garage, or basement) that is away from frequented living spaces. Otherwise, there is a risk that both installers and customers will have bad experiences with HPWHs which could harm adoption and prolong the market's transformation.

The 'electric resistance only mode' solution that installers are discovering should raise concerns for market actors whose main drive to transform the electric water heater market to HPWHs is their energy efficiency. In some ways, including the electric resistance only mode gives installers peace-of-mind because they know that, if the heat pump does not work well, the electric elements (something familiar) will ensure the customer has access to hot water – the main priority for installers and residents. However, this also means that if anything is not quite right with the HPWHs, especially if it is difficult for the installer to get a HPWH from their supply house, then the installers "solution" might be to bypass the heat pump setting all together, effectively defeating the purpose of installing a HPWH. Attempting to restrict the use of this override feature (or eliminating it) may not be wise. Instead, resources should focus on resolving the reasons why installers might flip this switch.

While HPWH technology is not new, its place in the market is nascent, especially in colder-climate zones of the Northwest, it is important that market interveners be mindful of presenting HPWHs as a nearly universal water heating solution. This message will erode market actors' trust in such information sources as that message may conflict with their experiences – the message might technically be true, but that is different than what is considered realistically feasible by installers.

Installers generally do not think relocating the tank is a realistic solution to HPWH installation challenges.

Relocation is *not* always an option. Our observations and conversations with installers throughout the Northwest do not support the idea from other research that "relocation is always an option" for installing a HPWH. When we asked this question to installers, most shook their heads "no" and smiled at the idea.

Even the installations we observed where the HPWH did not fit, and alterations needed to be made (removing the door, doorjamb, and 2x4s in the wall, etc.), the conversation with the homeowner never suggested that they could move the water heater to another spot.

Based on our research, moving a water heater from an interior closet to a different space is not considered a realistic retrofit solution by most installers, unless the household is undergoing major remodeling, or they are unconcerned about cost. Not only does changing the water heater's location substantially (i.e., doing more than just repositioning it within the same space) take more time and materials, thereby increasing the project cost, but it is also not a necessarily an easy task to complete during unplanned replacements when reestablishing the hot water supply is priority.

In our focus groups, one installer promoted the idea that relocation is an option for his customers. Most installers, however, thought about installation scenarios as the least-cost, most-reliable solution for their customers, and relocation did not align with those parameters. This distinction is important because it further limits the applications that most installers consider viable for a HPWH.

"If [the homeowner] wants to get in a hybrid, she's moving it. And it's quite a bit more expensive at that point…if this is an emergency situation, then she's going to be wanting to get something up and going, and get hot water right away, and that's going to be standard like-for-like…[to relocate], depends where the water pipes are [but it would] probably be three times the price of replacing like-for-like…if money is not a [concern], then it's an option."

– Shawn, a Washington installer

Some Installation Challenges Transcend Water Heater Technologies

While in the field, we observed that some installation challenges during retrofit projects are technology agnostic and related to the circumstances of the home, such as quirky construction or design, or DIY projects that are not done to code. Whenever installers come across something that is unsafe or noncompliant, they take the time to correct the issue. These challenges are not always obvious, can occur at random moments during the installation (usually after the old tank is removed), and are not exclusive to old homes. It is important to recognize and understand these types of technology agnostic challenges that installers encounter since it illustrates why some are reticent to try out newer products.

For example, during a HPWH installation we observed in a newer home in Bozeman, Montana, the installer spent around 30 minutes trying to find the wall stud to secure the earthquake straps for the tank (a step that typically takes a few minutes). The installer did not want to drill a bunch of random holes in his customer's wall so he tried using a stud finder, measuring out where the stud should be relative to other studs, and tapping on the wall to listen for sound differences but could not locate the stud. The installer eventually found the stud by tracing down where the electrical box was mounted and awkwardly positioning his drill at just the right angle around the water heater piping to catch the stud. It was potentially more difficult to locate because the HPWH's water connections were on the side of the unit (rather than the top like an ERWH) and the installer had to maneuver around those pipes, but the installer seemed to blame the house, not the HPWH.

Another example happened during a HPWH installation in Billings, Montana. The installation was in the basement of a mid- to late 20th century home and was just about to set the record for the fastest HPWH installation we observed during this study. Right around the three-hour mark for the installation, the team had finished filling the HPWH with water; they then turned on the power and sparks flew from the electrical plate on the tank. The installers immediately jumped into troubleshooting mode, reviewing the wire diagrams and connections. They were not sure what the issue was since all the connections looked correct and the same power source had been running the previous ERWH. The lead installer thought there was an issue with the grounding wire and an old water heater demand response (DR) box that the electricity ran through but wanted his electrician to check out the situation. Fortunately, the electrician was able to stop by the house the same day (about two hours after sparks flew) and confirmed that the installer did everything correctly and even accurately diagnosed the issue. The electrician simply had to bypass the out-of-use DR box and after that the HPWH turned on without any theatrics. In this case, there was something different about the way the HPWH interacted with the electrical supply compared to the previous ERWH, but the HPWH did not cause the issue, it just revealed it.

The installer was not surprised this happened because, as he explained, there are a lot of handy homeowners near Billings who attempt to do work they are not licensed to do, and this work is often not done to code. As a result, their company spends a decent amount of time working on "disaster remediation" projects to bring plumbing up to code following a catastrophic event.

Considerations for NEEA

To better understand the additive challenges that HPWHs introduce for installers, NEEA might consider conducting in-person observations of like-for-like water heater replacements.

Non-Installation Related Challenges for HPWH Adoption

A core part of this research was exploring the challenges that come up during a HPWH installation in cold-climates zones and how installers navigated these challenges. We found that factors that coincide with colder climates in the Northwest present ***more challenges to HPWH adoption than the cold itself***. In addition, these corollaries can exacerbate an already known challenge experienced by most installers regardless of geography: the shrinking workforce.

Confounding variables—not cold weather—are chilling HPWH adoption in cold-climate zones

Lower adoption of HPWHs in cold-climate zones is not necessarily due to the climate. Installers are accustomed to working in cold and snowy conditions, and water heaters are typically indoors or in conditioned spaces in these regions. However, corollaries with cold-climate areas in the Northwest, such as rurality, may be the cause of lower adoption. In the Northwest, the colder climate zones encapsulate the more rural and smaller urban areas of the Northwest, and they are further from coastal areas. Less density combined with bad weather can cause issues for installers that affect HPWH adoption in many ways, including supply, information dissemination, and commute time for a job.

"I talk to plumbers all over the country, mostly via Facebook, of course, now that we have that avenue – mainly to try to stay 'in the know,' if you will. And that's why the heat pumps didn't surprise me when they first hit – because I knew about them, before they came out here… You find a lot of stuff out… A lot more [technologies] will get in, like, Southern California, or the East Coast. Then we'll see it five, ten years later… it trickles up."

– Carter, a Montana installer

The reliably unreliable supply of HPWHs and manufacturer representatives in cold climates. During both the focus groups and fieldwork, we heard that the supply of HPWHs is typically unreliable in eastern parts of the Northwest, particularly Idaho and Montana – "*Finding [the HPWH] is the hard part. We found this one in Portland, I think…this was the only one that met the [household] need.*" Emergencies are typically like-for-like replacements. Limited and unreliable supply of a product can disqualify it as an option for emergency replacements, which account for most water heater replacement scenarios.

Without a reliable stock of HPWHs, installers will likely not consider offering HPWHs as options in emergencies since their goal is restoring hot water as quickly as possible; searching for a product and possibly waiting for it to arrive in town does not support that goal. As noted earlier, limited stock also means that installers might not have access to the right HPWH design, specifically they may not have a choice between top or side connections which can increase the difficulty of the installation.

We also heard from installers in colder-climate regions that manufacturer reps—an important source of information for installers (ILLUME 2019; ILLUME 2020)—do not frequently visit these areas to share updates or new technologies. This limits the educational opportunities for installers who work in colder-climate regions.

Workforce challenges are not going away and need earnest attention. This foundational industry challenge continues to disrupt the adoption of newer technologies and products. It creates strain for installers and leads to higher prices for their labor (on top of general inflation), which in turn makes it harder to sell more expensive, newer products to customers. In general, there must be a broad cultural shift away from devaluing trades and physical labor so that people *want* to work in trades. This shift could begin with rebuilding pipelines between high schools and vocational education programs rather than funneling folks to four-year college programs.

"Yeah, but in Missoula we have different supply houses that we buy stuff from. Usually, on a residential water heater, I'll go in, look at it, and make a list, and then start draining it. While it's draining, I'll get the material I need. By the time I get back, it's drained down and I can remove it and put the new one in."

– Tom, a Montana installer

Our research found that the context of water heater installers largely still aligns with findings reported in previous research conducted by ILLUME in 2018 and 2019. However, there are some aspects that have become more challenging for installers, such as supply chain, rising costs, and an increasingly competitive labor market. In the 2018 Installer research, ILLUME identified that finding qualified workers is a challenge for the industry and has implications for the broad adoption of newer technologies and installation projects, including challenges with attending non-mandated trainings, increasing job costs, stretched bandwidths, and prioritization of lower risk (and high return) jobs. This finding was then affirmed by the 2019 Water Heater Installer and New Technology Adoption research where market actors explained adopting newer technology, especially newer technology with a thin value proposition for customers and installers, adds installation risks and can increase costs to the customer because labor is scarce while jobs are plenty. *Predictable and straightforward installations (i.e., known products) allow installers to quickly cover more ground.*

During this research, we found that challenges around the workforce remain and, it seems, have gotten worse following the COVID-19 pandemic. This came up in nearly ***every conservation we had in the field***, and it was mentioned as one of ***the top challenges people were experiencing in every focus group***. Issues with retention, for example, led to staffing problems on jobs that created challenging HPWH installations.

Less density means fewer installers covering a lot of ground. While on a supply run with an installer who also does boiler work, the installer got the news that a company in the area was no longer going to service boilers because the company's "boiler guy" left. This was not necessarily welcome news, even though it meant the installer's company had less competition for these jobs, because it also meant they would have an even greater backlog of work as there was only one other company doing boiler work. The installer shared that, due to the worsening labor shortage within trades, there is an added pressure for those working in the field because making sure homes have heat in the Montana winter is a matter of safety, not luxury.

Also, in these areas of the Northwest, travel times to job sites can take can over an hour, thus making their time on the project that much longer. This becomes even more challenging if something unexpected occurs that requires a supply run. Delays in arrival and delays from supply runs can impact getting the customer hot water on the same day and can prevent installers from doing multiple jobs in a day. Although rush hour traffic in urban areas can also make travel times or supply runs long, there are fewer supply options in less dense areas. For example, one installer said that "*if the Ace Hardware in Polson doesn't have [the part], you have an hour trip to Kalispell or an hour and half trip to Missoula*," which pencils out to a $250 trip for a part. In contrast, more dense urban areas have more supply houses, big box stores, and hardware stores that give installers more options within a smaller geographic area. The same installer further illustrated the difference between more urban jobs versus the rural jobs explaining that, when they work within Missoula, they have more supply options and can quickly make supply runs while the old water heater is draining (when they would otherwise have little work to do onsite).

Plus, if any of the above issues arise on a job, getting help can be an issue in colder regions. We saw this during an installation in Big Sky, Montana. The installer, Jake, had to move an 80-gallon HPWH from the garage to a bedroom closet. The homeowner was not at home, cell service was poor, there was no landline, and it snowed for several hours that day. Jake tried calling his son (and business partner) several times to help him but, due to the poor cellphone service, he was unable to reach him. Jake had a dolly to move the tank but could not get it up the two steps leading from the garage to the main house. Ultimately, a member of the ILLUME research team ended helping Jake lift the tank up a few stairs so that he could complete the installation. Without this assistance, Jake would have either had to spend time driving to find a signal then wait for the help or wait for the customer to come home to help. Either way, this would have added hours, if not an additional day, to the installation.

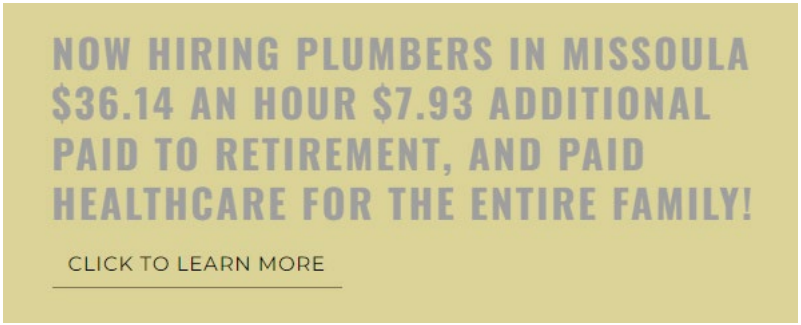
To better understand the additive HPWH-related challenges that rurality (rather than cold weather) introduces for installers, NEEA might consider conducting in-person observations of HPWH installations in more urban areas of Northwest, like Portland, Seattle, and Boise. Continue working with market actors, like manufacturers, to develop other HPWH designs that address installers' concerns related to the size, installation, and performance of HPWHs (and make sure installers support these solutions). In addition, continue working with suppliers to ensure that a variety of HPWHs are readily available in their warehouses.

Job, market, and weather conditions can consume installers' bandwidth. Added travel time to jobs and limited supply can exhaust installers in colder regions. In the winter, another level of fatigue is added when driving and installation conditions are poor. The reality is that trade work—while plentiful—can be difficult to live on in areas like Montana, with a skyrocketing cost of living. We heard from many of our Montana installers that affordable housing is a challenge for trade workers. Installers cannot afford to live in the cities that are being developed and where they are working. Some installers told us that they have coworkers whose families live across state lines in Idaho, but while they work in Montana, they live in trailers parked at the plumbing shop. Long commutes and time away from family can create stress and strain for installers, thereby limiting their bandwidth to learn about new products/technologies beyond what is required to maintain their license. In addition, anything above and beyond their licensing requirements might have to occur on their own dime and time as their typical workday is full of jobs.

When core job-related activities (commute and labor) can regularly take up to 12 hours a day, ***it is unreasonable to expect someone to do additional work-related tasks, like learning about new products or technologies*** such as the HPWH or take on new risks (like a new product) that might increase the frequency or duration of long workdays.

Companies are working hard to attract and retain workers. A plumbing firm we observed in Bozeman, Montana had their own program to incentivize new staff to join them. The company would help pay for their staff's education, and if they signed on with the company after their training is completed, the trainee does not have to reimburse the company. While driving around we saw that other companies took out billboard ads to recruit new workers. Another company placed the banner on their website to recruit plumbers.

Figure 2. For Hire Advertisement on Website



What this looks like: Drew

Drew is a journeyman plumber who primarily works in the greater Missoula region. Each leg of his daily commute is about 1.5 hours meaning, to get to the shop by 7am, he needs to leave his house around 5:30am. For the HPWH installation, he arrived at the job site around 8am and completed the HPWH installation about 9 hours later (this included one supply run and did not include installing the duct kit which still had not arrived at the supply house). Before heading home, he still needed to pack up the jobsite and swing by the shop. This likely meant that he did not get home to his family till around 7pm. A three-hour commute is exhausting, especially after a nine-hour day of physical labor. It also reduces the time Drew can spend and care for his family – for example, we heard him coordinating with the company scheduler because he needed to use a vacation day to take his kid to the dentist. Aside from these personal impacts, it also meant he did not have time or bandwidth for professional development or trainings beyond his required continuing education.

While these stories are not characteristic of *all* installers, they resonate with many. When thinking about the best actors to transform the water heater market, installers should not bear the weight of this alone. ***Installers are often the focus of market transformation but may not have their own basic needs met (e.g., housing), or struggle with the logistics of visiting family, long commutes, and exhaustion from long, intense days.*** New technologies are not the primary concern of these installers because they do not have the bandwidth for them. Reducing fundamental stressors for installers could mitigate the additive stressors that newer technologies, like HPWHs, might introduce or at least free up some bandwidth for installers to navigate these additional stressors more easily.

There was a relatively recent initiative in the state of Oregon to create licenses specifically for water heater installation that do not require a plumbing license. NEEA should explore this type of licensing and its expansion to other states in the Northwest. Having this job opportunity available could ease some labor pressure, while allowing industry entrants to earn money and pursue their plumbing license with experience.[11]

Given inflation, incoming tradesfolk might need additional support, especially those who were not born into the industry. For example, at the 2023 Hot Air and Hot Water Forum, PNNL presented on their workforce development pilot among disadvantaged communities, in which PNNL identified the following lessons:

1. Training organizations need consistent funding to self-sustain the training programs and keep costs down for trainees.
2. The courses must be flexible, and organizations need to provide trainees assistance to reduce attendance barriers, such as basic needs costs (housing, food, clothes), childcare, and commute costs.
3. Trainees may need GED education, refresher courses, and/or mentoring to successfully complete training.

The Lukewarm Value Proposition

When a product does not address a problem that either consumers and/or installers have recognized as needing a solution, the product lacks a compelling reason for purchasing it. The value proposition is even less if the product is also more expensive or creates new challenges. In the case of HPWHs, their energy efficiency is the main benefit. However, installation challenges in more confined spaces, possibility for customer comfort issues due to the noise and cold air, and the higher upfront equipment cost seem to outweigh the energy efficiency benefit. Furthermore, some lived experiences with HPWHs and perceptions of fuel prices, make some installers bring into question the "efficiency" of HPWHs.

[11] Note: Oregon's current rules do not allow licensed water heater installers to relocate water heaters (Source: State of Oregon Building Codes Division, October 1, 2020). Therefore, as further described in previous sections, the notion that relocation is always an option to install a HPWH would be at odds with this strategy to broaden the labor market.

For example, within the energy efficiency industry, the operational *energy* efficiency of a HPWH is the reason it is viewed as a good product. In contrast, "efficiency" is also important to installers and distributors, but in different contexts. To them, the most "efficient" product is one that does its job quickly, reliably, and effectively, is inexpensive and easy (i.e., cheap) to install, *and* operates efficiently.

Adoption challenges are common for newer technologies. Tankless water heaters (TWHs), for example, as we learned in our 2019 study, had difficulty with adoption because the installation is more involved than the traditional method and equipment. Often new technologies require modifications to the home (as we explain in later sections about HPWH design changes), which adds installation cost. In contrast, like-for-like tank replacements are easier; they swap without major changes. But when comparing HPWHs to TWHs, the value proposition for TWHs is clearer than HPWHs: a customer does not run out of hot water, it takes up less space, and possible water damage from leaks is minimal. The main value of HPWH is energy efficiency, and this efficiency is not always intuitive to the customer or the installer. This is why we still hear installers express concern about the HPWH "stealing" heat from their customer's heating system. We also heard comments from installers that indicated they are not totally convinced that HPWHs are as efficient as it is rated in all circumstances, which is true given the findings of the Amazing Shrinking Room study that found improper airflow for the HPWH will decrease the energy efficiency.

For installers, the questions about the value proposition become: What is the tipping point between *energy* efficiency gains and sacrifices to value proposition for customers and installers? Do the changes to the product and installation process (e.g., water inlets and outlets on the side rather than the top, size, noise, ducting) save enough energy to make it "worth it" to an installer? As we saw and heard in our research, when the HPWH is not "worth it," the alternative installers employ is to run the HPWH as electric resistance only, or more commonly, not installing the HPWH at all.

Efficiency for efficiency's sake is not a persuasive argument when it comes to broad market adoption.

Installers consider many factors when recommending products to customers. In the case of water heaters, we heard from installers in the field and the focus groups that they will ask customers about the context of the home: how many people live in the home, their age, the number of appliances attached to the heater (e.g., washers, showers, hot tubs), and the typical household hot water demand (i.e., is the hot water just for showering, or does the customer also run baths frequently?). In tandem with these factors, installers also mentioned that they tend to plan for the future of the household, as a water heater is not something that is replaced often. For example, if a family has young children, many installers said that they recommend larger tanks for when those children become teenagers and adults and use more water.

> *"There is a massive shortage of labor right now… what we really look for are things that save our contractors time and labor so that they can get more jobs done… We try not to promote products that are going to zap them of a lot of time… Anything that we're promoting should be efficient – meaning, have the least amount of impact on their labor pool and it should make life easier for them."*
>
> *– Distributor, Seattle, Washington (ILLUME, 2019)*

Beyond these household factors, installers also consider the logistics of the project. Installers want to save time and money spent on installations, and just as importantly, they wish to avoid callbacks to the customers' homes. This is corroborated in ILLUME's 2019 research, where time, money and reputation were the primary motivators for installer decisions. Installing unfamiliar (or seemingly unreliable) products has the potential to take more time to install and can lead to poor customer reviews if the product is not satisfactory. Poor experiences with an already limited value proposition can then make installers, as well as distributors, unwilling to offer a product again.

Cost continues to be a major hurdle in HPWH adoption. Due to the design of this research study, with customers getting a free HPWH, we did not gather the customers' perspective of HPWH costs. However, in 2021, ILLUME conducted customer research to support Lieberman Research's efforts to identify the optimal price range for HPWHs and key purchase decision factors (Lieberman, ILLUME 2021). The study found that the *ideal price point for the HPWH unit is $1,350,* with a max of $1,500 (note: this is for *equipment only* and does not consider installation labor costs), which is slightly lower, but generally aligned, with the cost of a 50-gallon HPWH from a retail store. However, larger HPWHs units sold at the same retail store come in about $1,000 over this ideal price point. The pricing research also showed that higher 'sticker' prices required higher rebates.

Being mindful of the expense is important due to broader market conditions – the Federal Reserve found that 32% of surveyed households do not have enough in savings to cover an expense more than $499 and another report found that 60% of consumers are living paycheck to paycheck in the United States.[12, 13] For context, the median HPWH project cost (including labor, materials/equipment, and permitting) reported by TECH Clean California is $6,155.[14] Appropriately sized instant rebates, rather than tax credits or rebates that can take 6-8 weeks to disburse, could help address this adoption barrier for customers, as well as no- or low-interest financing (though, financing might not be an option for households with high debt-to-income ratios or ineligible credit scores).

*"I mean, we have hydroelectric…It's cheap…They say [HPWHs are] efficient, but they're twice the price. So, what's your payoff? You save a little bit of electricity, but it costs you that much more to put it in… I think we have to really weigh the benefit versus the cost when it comes to these technologies, especially in a retrofit application… Just the fact that the unit itself is twice as much, let alone any modifications you have to make to the environment to make it work like it's supposed to, it just doesn't seem in anyone's really best interest…**We say 'keeping money aside' – well, you can't keep money aside, because it's a real factor. It's one of the biggest factors that a customer uses** when buying a piece of equipment like that, right?"*

– Shawn, a Washington installer

[12] United States Federal Reserve. Economic Well-Being of U.S. Households in 2022. May 2023.
[13] PYMTS. New Reality Check: The Paycheck-to-Paycheck report. February 2023.
[14] TECH Clean California. Cost Distribution: Heat Pump Water Heaters. July 2023.

Through the research activities, we learned that installers are sympathetic to customers' needs for hot water at a price they can afford now. Which is why installers view HPWHs as a product that requires upselling since they could install an ERWH for a fraction of the cost. Furthermore, some installers are skeptical of the payoff period for HPWHs since "*in the Pacific Northwest…electricity is cheap*," especially if they learn that their customer is not planning to stay in the home for more than a few years.

Many installers do not see HPWHs as having a tangible payoff. Thus, HPWHs are considered by many installers as an upsell to their customers and they are hesitant to recommend a HPWH as an option for replacement. During one of our focus groups, we asked installers "keeping money aside, what are the main challenges for HPWHs?" Framing the question this way frustrated some installers because ***cost is a real and core challenge for this technology*** that, from their perspective, cannot be dismissed or overlooked. If ERWH are removed as an option for most retrofit situations without addressing the cost barrier of HPWHs, it could have an impact that might feel like a form "premiumization" within the water heater market.[15]

Collaborate with funders who have HPWH rebate programs to understand the real project costs in the Northwest. If funders are not currently tracking this information, it could be helpful for them to start tracking it since this information could 1) empower homeowners with pricing information, 2) inform program designs and rebate levels, and 3) potentially provide insight for how project costs might vary depending on geography, tank size, and any other project data gathered.

Negative perceptions toward HPWHs are not necessarily from lack of education or education training on the equipment.

Negative perceptions of HPWHs arise when what people experience misaligns with what they are told. Over the course of our research, there were common misalignments we heard about HPWHs that challenged the value proposition that HPWHs were highly energy efficient (for more details see Appendix B).

The installers we spoke with generally agree that HPWHs are energy efficient. However, some of the installers have received complaints about cold air from their customers, which feed these ideas that HPWHs make *the home overall* less efficient. This perception makes sense since a person can feel the cold air coming out of the HPWH and the temperature drop in the room.

"We've done two or three [HPWH installations] since that first one where we had a bad taste in our mouth, because we were always trying to look for the perfect mechanical room generating a lot of heat that a heat pump could be utilized, take that heat and heat the water."

– Jeremy, a Montana installer

[15] New York Times. Is the Entire Economy Gentrifying?. March 2023.

Similarly, increasing the HPWH size or using a mixing value to accommodate recovery time also conflicts with some installers' definition of "energy efficiency." These solutions posit that storing and heating *more* water, or spending *more* energy to heat water is necessary with the HPWH to get the same amount of hot water, which to them, is inefficient and nonsensical (note: these perspectives were not exclusive to installers with limited HPWH training and education). The challenge in addressing these perspectives of HPWHs is getting installers and customers to believe something that is counter to what they feel or see (e.g., cold air and energy efficiency).

Revised Federal Appliance Standard Considerations

Instead of working around federal appliance standards, installers opt for inexpensive, readily available solutions to meet customers' hot water needs.

As we mentioned in our Research Background, Objectives, and Methodology, part of our research was meant to 'ground truth' the impact of the federal 2015 NAECA Standard and determine if installers' reluctance was the reason for minimal uptake in the market. The 2015 NAECA standard required higher energy efficiencies for almost all residential gas, electric, and oil water heaters manufactured in the United States.[16] For electric tank water heaters larger than 55 gallons, the required energy factors effectively required that a HPWH get installed. We learned that installers generally were less familiar with this portion of the standard but were somewhat familiar with the Standard because it made most other tank water heaters slightly larger due to insulation added to meet the new efficiency requirements.

Low awareness of the standard's push for HPWHs among installers indicates that they likely are not undermining the standard deliberately. Among the few installers we interacted with in Montana, familiarity with HPWHs was low and, accordingly, awareness that the 2015 NAECA standard effectively required HPWHs for large electric tank replacements was low. Installers noted trouble getting HPWHs from suppliers but did not express challenges getting traditional tank water heaters. Awareness of federal standards was also lower in other parts of the Northwest. Installers in Oregon and Washington seemed to think that any challenges in getting certain water heater products were due to stricter local and State codes/standards.

Other factors may have inadvertently kept traditional water heaters relevant in the market. Most (89%) electric resistance water heaters in the northwest are 50-gallons or smaller (2016 – 2017 RBSA 2019); therefore, the 2015 standard would not come into play during a typical like-for-like replacement in the Northwest. Installers could also continue to install any non-compliant tanks in stock somewhere after the Standard's effective date. In other words, the Standard may not be fully in effect yet due to low demand and available stock.

Other installation practices, such as installing mixing valves, can reduce the need for larger water heater tanks impacted by the federal standard. It is common for installers to put mixing valves on all their water heaters. Many stated that it was required by the plumbing code and noted that a mixing valve can increase hot water output by ~25-50% and ensure that a household will not run out of hot water. In addition, since water heaters generally got larger due to the 2015 Standard, if space is tight, installers can install a slightly smaller tank and a mixing valve to meet the households' hot water needs.

[16] Ruud Water Heaters. NAECA 2015 Regulations.

Accordingly, installers' low awareness and the limited impact, to date, of the NAECA 2015 standard may signal it has not served as a 'steppingstone' standard for the latest NAECA standard being considered.

At this time, a standard that requires HPWHs in most electric retrofit situations generally lacks the support of installers.

"I'd like for [the standard] to get implemented before it becomes a law, so our suppliers are able to stock up on set equipment. And each shop maybe is able to get this piece of equipment – even if they have to cut it up to see how it works, whatever, to learn about it hands-on before it's – make it not theory, before we have to do it."

– Eddie, a Washington installer

There are current efforts underway to update the NAECA standard. The proposed standard would require a water heater with an energy factor that only a HPWH can currently achieve in most electric retrofit scenarios (i.e., it would effectively require HPWHs in most electric retrofit situations). To gauge how installers might respond to such a standard, during our WHIFG research, we presented the key aspects of the proposed standard to installers. Specifically, we asked for their reactions if the following standard went into effect: all tanked, electric water heaters, 35 gallons or larger *and* taller than 36 inches, *must* be a HPWH or have an energy factor (UEF) of over 2.2 in medium draw patterns.

"There's not room in a lot of these houses to get two or three inches of more space to get the new water heater in there. A lot of homes don't have room for extra width or height. They're in closets under shelves and crawlspaces and basements that are barely big enough to stand up in. There's not room to go much bigger."

– Daniel, an Idaho installer

Overall, installers did not have positive initial reactions to the requirement presented to them.[17] Installers saw it as problematic, even the ones who were vocally supportive of HPWHs as technology. Installers did not say they would intentionally refuse to comply with the standard presented, they just did not think it was possible or realistic given the current cost barrier and installation limitations they associate with HPWHs. In other words, given the HPWH designs currently available on the market, most installers were not supportive of this type of standard and thought their customers could get harmed by the standard, as they will bear the cost for expensive "solutions" like relocation.

Considerations for NEEA

Continue working with market actors, like manufacturers, to develop other HPWH designs that address installers' concerns related to the size, installation, and performance of HPWHs (and make sure installers support these solutions). In addition, continue working with suppliers to ensure that a variety of HPWHs are readily available in their warehouses.

[17] This initial opposition is to be expected, especially since they had no heads up and little context. This is a good reminder that early and often engagement with installers about product and code changes is important because 1) it impacts them and they should have a say in such changes (i.e., co-create), and 2) it can help build broader buy-in.

Appendix

Appendix A: Summary of Considerations

Consideration #1: NEEA will need to strike a balance between telling installers that the HPWH installation process is like installing a regular water heater and making sure they are aware of placement differences. To increase awareness of fit considerations, NEEA should work with manufacturers to include these requirements on the spec sheet so installers can factor it in when checking the HPWH's dimensions. Of note, Bradford White does have an installation checklist (separate from the spec sheet) with key information like the clearance needs and guidance about what to expect once the tank is powered on. Attaching something like this to the spec sheet could increase the chances of installers seeing the information before the installation.

Consideration #2: Installers need more design options, and they need those options readily stocked. Installers need to 1) know there are options between HPWHs, 2) understand how to select these options for a job, and 3) know they can count on these options being readily stocked at their supply house. Aside from working with manufacturers to ensure there are a variety of design options for HPWHs, and working with suppliers to ensure those options are stocked, NEEA should also educate suppliers and installers (particularly those who scope projects) about when they might select a HPWH with top versus side connections. This could also become a set of questions that suppliers ask installers when they are placing a product order. For example, suppliers could provide this information to installers:

> There are water and electric connection options—top of tank or side of tank—be sure to assess the dimensions of the space to determine which option will be easier.
>
> a. Spaces that do not have a lot of height clearance may need side connections since HPWHs are taller.
>
> b. Spaces that are narrow but have height clearances may need the top connections since HPWHs are wider.
>
> c. For HPWHs with water connections on the side, the electrical is also often on the opposite side of the tank. If you need a HPWH with side connections, check the length of the current electric line to ensure it can reach the side of the tank.

Consideration #3: Continue working with manufacturers to develop solutions for water heater replacements in more confined spaces. Aside from developing other form factors, this could include developing manufacturer-branded resources and trainings that teach installers 1) when airflow management is necessary, and 2) how to ensure there is adequate air supply to the HPWH, such as ideas suggested during the Amazing Shrinking Room experiment. These solutions should be vetted by installers to gain buy-in and ensure the solutions are effective.

Work with suppliers to ensure duct kits are readily available when installers pick up a HPWH. This could help installers avoid multiday water heater replacement projects since they would not need to wait for materials to arrive.

Consideration #4: Although installers were ultimately able to figure out the start-up process (and will likely not get thrown by it during future installations), NEEA may want to collaborate with manufacturers to raise awareness with installers about what they should expect after flipping the power switch. This could improve installers' perception of installing HPWHs. It may help to include the following information on the spec sheet so installers see it when checking the HPWH's dimensions:

1. After turning on the power, the unit will take about XX minutes to run diagnostics.
2. The heat pump fan might not kick on immediately.
3. If the incoming water is cold, the unit will use the electric elements to bring it up to temperature before using the heat pump for heating. This is the HPO code.

Consideration #5: Until there are more design and size options readily available in supply houses, market interveners should focus resources to increase HPWH adoption in straightforward retrofit applications, specifically electric retrofits where the water heater is in a spacious area (e.g., crawlspace, garage, or basement) that is away from frequented living spaces. Otherwise, there is a risk that both installers and customers will have bad experiences with HPWHs which could harm adoption and prolong the market's transformation.

The 'electric resistance only mode' solution that installers are discovering should raise concerns for market actors whose main drive to transform the electric water heater market to HPWHs is their energy efficiency. In some ways, including the electric resistance only mode gives installers peace-of-mind because they know that, if the heat pump does not work well, the electric elements (something familiar) will ensure the customer has access to hot water – the main priority for installers and residents. However, this also means that if anything is not quite right with the HPWHs, especially if it is difficult for the installer to get a HPWH from their supply house, then the installers "solution" might be to bypass the heat pump setting all together, effectively defeating the purpose of installing a HPWH. Attempting to restrict the use of this override feature (or eliminating it) may not be wise. Instead, resources should focus on resolving the reasons why installers might flip this switch.

Since the HPWH market is still young, especially in colder-climate zones of the Northwest, it is important that market interveners be mindful of presenting HPWHs as a nearly universal water heating solution. This message will erode market actors' trust in such information sources as that message may conflict with their experiences – the message might technically be true, but that is different than what is considered realistically feasible by installers.

Consideration #6: To better understand the additive challenges that HPWHs introduce for installers, NEEA might consider conducting in-person observations of like-for-like water heater replacements.

Consideration #7: To better understand the additive HPWH-related challenges that rurality (rather than cold weather) introduces for installers, NEEA might consider conducting in-person observations of HPWH installations in more urban areas of Northwest, like Portland, Seattle, and Boise. Such research in places like Oregon or Washington could help NEEA understand the impacts of strategies, like a creating water installer license or more restrictive energy codes/standards, might have on HPWH installation challenges.

Consideration #8: While these stories are not characteristic of *all* installers, they resonate with many. When thinking about the best actors to transform the water heater market, installers should not bear the weight of this alone. ***Installers are often the focus of market transformation but may not have their own basic needs met (e.g., housing), or struggle with the logistics of visiting family, long commutes, and exhaustion from long, intense days.*** New technologies are not the primary concern of these installers because they do not have the bandwidth for them. Reducing fundamental stressors for installers could mitigate the additive stressors that newer technologies, like HPWHs, might introduce or at least free up some bandwidth for installers to navigate these additional stressors more easily.

There was a relatively recent initiative in the state of Oregon to create licenses specifically for water heater installation that do not require a plumbing license. NEEA should explore this type of licensing and its expansion to other states in the Northwest. Having this job opportunity available could ease some labor pressure, while allowing industry entrants to earn money and pursue their plumbing license with experience.[18]

Given inflation, incoming tradesfolk might need additional support, especially those who were not born into the industry. For example, at the 2023 Hot Air and Hot Water Forum, PNNL presented on their workforce development pilot among disadvantaged communities, in which PNNL identified the following lessons:

1. Training organizations need consistent funding to self-sustain the training programs and keep costs down for trainees.
2. The courses must be flexible, and organizations need to provide trainees assistance to reduce attendance barriers, such as basic needs costs (housing, food, clothes), childcare, and commute costs.
3. Trainees may need GED education, refresher courses, and/or mentoring to successfully complete training.

Considerations #9: Collaborate with funders who have HPWH rebate programs to understand the real project costs in the Northwest. If funders are not currently tracking this information, it could be helpful for them to start tracking it since this information could 1) empower homeowners with pricing information, 2) inform program designs and rebate levels, and 3) potentially provide insight for how project costs might vary depending on geography, tank size, and any other project data gathered.

Consideration #10: Provide installers with little to no HPWH experience with low-risk, straightforward HPWH installation opportunities to help gain market acceptance by demystifying the installation process.

Consideration #11: Continue working with market actors, like manufacturers, to develop other HPWH designs that address installers' concerns related to the size, installation, and performance of HPWHs (and make sure installers support these solutions). In addition, continue working with suppliers to ensure that a variety of HPWHs are readily available in their warehouses.

[18] Note: Oregon's current rules do not allow licensed water heater installers to relocate water heaters. Therefore, as further described in previous sections, the notion that relocation is always an option to install a HPWH would be at odds with this strategy to broaden the labor market.

Appendix B: Negative perceptions toward HPWHs are not necessarily from lack of education or education training on the equipment.

Negative perceptions of HPWHs arise when what people experience misaligns with what they are told. They arise regardless of the "truth," and are challenging to overcome. Over the course of our research, there were common misalignments we heard about HPWHs that challenged the value proposition that HPWHs were highly energy efficient: HPWHs are "stealing" warm air from the home, and HPWHs need to accommodate for recovery time by increasing the tank size or adding mixing valves.

The installers we spoke with generally understood the idea of using a heat pump to heat water and agree that it was an interesting (and energy efficient) concept. Many installers agreed that the HPWH was a good solution for warmer climates where warm air is plentiful. In cooler and cold climates, however, "stealing" heat from the home and dehumidifying air that might be intentionally humidified means that, from their perspective, the HPWH is making the household overall *less* efficient, even though the HPWH unit is more efficient than the ERWH.

Some of the installers explained that they received complaints about cold air from their customers, which feed these ideas that HPWHs make the home overall less efficient. It is understandable that there would be questions about energy savings for the winter and how the unit affects their customers' heating bills – a person can feel the cold air coming out of the HPWH and the temperature drop in the room.

> ***"We've done two or three [HPWH installations] since that first one where we had a bad taste in our mouth, because we were always trying to look for the perfect mechanical room generating a lot of heat that a heat pump could be utilized, take that heat and heat the water."***
>
> ***– Jeremy, a Montana installer***

As we saw in previous sections, an installer prioritizes the comfort and context of the household at a price that the customer can afford. The installer also looks to minimize the time and money spent on a project, with no callbacks or issues that would affect their reputation. Installers' doubts about the overall efficiency of the product in a customers' home combined with the other costs and uncertainties can make installers reticent to recommend a HPWH.

Similarly, increasing the HPWH size or using a mixing value to accommodate recovery time also conflicts with some installers' definition of "energy efficiency." These solutions posit that storing and heating *more* water, or spending *more* energy to heat water is necessary with the HPWH to get the same amount of hot water, which to them, is inefficient and nonsensical. These perspectives are not exclusive to installers with limited training and education on HPWHs as we also heard them from some of the installers who seemed to spend more time researching products and attending trainings than the average installers. The challenge in addressing these perspectives of HPWHs is getting installers and customers to believe something that is counter to what they feel or see (e.g., cold air and energy efficiency).

Appendix C: Opportunities to Change Perceptions of HPWHs

The greatest opportunity to change installers' perceptions (or misconceptions) about HPWHs is providing hands-on experience in real scenarios, yet many installers have not had many opportunities to work with them. In general, the HPWH market appears to be still in the early adopter stages, especially in rural, cold-climate areas. As mentioned in previous sections, MPER #6 found that Idaho and Montana made up 1% or less of the HPWH market share in the Northwest. MPER #6 also identified that most HPWH installations in the Northwest were happening in new construction situations and planned replacement scenarios.

Installers are reading the writing on the wall that HPWHs are likely here to stay. This is why several installers participated in the cold climate installations – to have a low-risk opportunity to learn more about the technology. Several installers explained that they are getting more calls for HPWHs, which they attributed in part to the IRA incentives. The CCDI research functioned like a test lab in certain ways: though there were some installers who had installed HPWHs before, many had little to no experience. While none necessarily became HPWH advocates after the one installation, they were open to the product in certain circumstances.

> ***"I think it's all just education… I really think it starts with getting a couple of contractors that believe in it, and they start educating homeowners, and you start seeing a shift that way. I mean, you get those calls all the time, right? Like, 'My neighbor just got a new heat pump or whatever, can you talk to me about this?' Especially right now, like I said, there seems to be push that I haven't seen in recent years in terms of people wanting to more go electric and away from fossil fuels. So, as they're researching about it, they're stumbling into heat pump options…"***
>
> ***– Jeremy, a Montana installer***

Some installers also noted that this opportunity helped them understand what they might do a bit differently next time (more discussed in a subsequent section). Providing these types of low-risk, real-life scenarios for a few installers and customers could help gain market acceptance, especially in more nascent markets, because it provides installers with hands-on field experience, and they can hear feedback directly from a real customer while mitigating the cost barrier.

Manufacturers are the go-to trusted messenger. We heard from installers that they predominantly look to manufacturers for relevant and reliable information for their day-to-day work. Related to this, there are other tangential sources they use for information, such as: sales representatives for the manufacturer, spec sheets online, and distributors and supply houses who installers think would know information on the products sold by the manufacturer. Other sources of information that were less common included: trade shows, trade ally groups, and utilities. These tended to be mentioned by installers and team members who were higher up in management (e.g., sales team members, business owners), and from larger companies. In general, installers want to know about new technologies and would like to see or test them out.

Installers are wary of messages from entities who they believe may be biased in promoting new technologies. For example, we discovered during our focus groups that installers have mixed opinions about NEEA, and that it is not a universally trusted resource, because at least one installer in this focus group thought that NEEA understates the limitations of HPWHs and may see NEEA as biased toward utility interests.

Appendix D: CCDI Installation Characteristics and Cold-Water Events

Table 6. Installation Characteristics and Cold-water Events

INSTALLATION	UPSIZE TANK?	MIXING VALVE?	COLD WATER EVENT?	LOCATION	PEOPLE IN HOME
A	No	Yes	No	Small, interior closet	Unsure – vacation home
B	Yes	No	No	Crawlspace	6
C	Yes	Yes	Yes	Large, unfinished basement	4
D	Yes	No	No	Small, interior closet	4
E	Yes	No	No	Large, unfinished basement	4
F	No	No	No	Large, unfinished basement	Unsure – rental property
G	No	No	Yes	Large, unfinished basement	2
H	No	Yes	No	Small, interior closet	4
I	Yes	Yes	No	Small, interior closet	2
J	No	Yes	No	Small, garage closet	3

Appendix E: WHIFG Research Approach

ILLUME planned to conduct six to eight focus groups with water heater installers to understand their perceptions of HPWHs, the magnitude of previously identified barriers for HPWH installations, as well as ways that installers might workaround such federal standards. This work was designed to help NEEA understand the long-term impacts of these installation barriers and inform future strategies to help water heaters installers comply with future codes and standards and advance the adoption of HPWHs. For these focus groups we targeted installers in colder climates and installers with limited HPWH experience; however, we also recruited some installers in warmer climate zones and with more experience installing HPWHs.

We began recruiting for these focus groups in January 2023 from a contact list of 929 installers throughout the Northwest region. The contacts were compiled from previous NEEA research efforts, lists provided by NEEA stakeholders, outreach by Evergreen Consulting, and web-scraping by ILLUME. We were successful in recruiting interested installers, but finding a time that worked with enough installers to hold a focus group was a challenge. In February 2023, after discussions with NEEA, we revised our research approach for the following reasons:

- ***Coordinating installer availability was challenging,*** particularly with installers in cold-climate areas. We proposed switching to in-depth interviews with installers, instead of focus groups, because that would allow us more flexibility in accommodating installers' busy schedules.
- Based on our findings from the CCDI project, we expressed concern that ***installers might be the wrong market actor to conduct research*** with since they generally seem unaware that they need to do something different to comply with the NAECA 2015 standard.
- Accordingly, since installers generally had low awareness of the NAECA 2015 standard, it indicated that ***installers are likely not deliberately working around the standard*** and stilting the adoption of HPWHs.
- Other factors, specifically the way the 2015 standard was written, may have ***inadvertently kept traditional water heaters relevant in the market***. For example, most (89%) electric resistance water heaters in the northwest are 50-gallons or smaller (2016-2017 RBSA 2019); therefore, the 2015 standard would not come into play a typical like-for-like replacement in the northwest. Installers could also continue to install any non-compliant tanks in stock after the Standard's effective date.

Appendix F: Installer Interview Guide

The research team will use the following guide for their post-installation discussion with installer(s).

Introduction

[Purpose of section: Gather basic business and their perceptions of HPWH]

1. To get started, please tell me a little bit about yourself and your company.
    a. How many people work for your company (office, technicians, installers, sales, etc.)? [PROBE FOR: company call center; incentives and training to sell products and/or services]
    b. How long have you been installing water heaters? What about HPWHs?
    c. Annually, about how many water heaters do you install? What portion of those are HPWHs?
    d. Has the number of HPWHs you are seeing in this area changed lately?
        i. [IF YES] How has it changed? Why do you think that is?

2. What do you think of HPWHs? What do you think of HPWHs as a product for homes in your area? [PROBE FOR: why HPWHs work or don't work; cold-climate concerns, typical water heater locations in homes, etc.]
    a. From whom would you seek further training on HPWHs (e.g., distributor, sales rep, peer, internet)? Why?

3. Based on your installation experience, would you ever recommend a HPWH as a *first* choice? Why do you say that? [PROBE FOR: cost concerns, functionality, value to the customer]

4. What portion of your water heater installations are planned versus emergency replacements?
    a. How, if at all, does this factor into the water heaters options you present to customers?
    b. All else constant, are you just as likely to recommend a HPWH in an emergency replacement situation as a planned replacement? Why or why not?
    c. How, if at all, does customer willingness to install a HPWH vary based on the replacement situation?
    d. How often, if at all, do you promote a water heater replacement while visiting the home for another project (e.g., replacing fixtures, servicing drains)? What type(s) of water heater do you promote in these situations? [IF NOT MENTIONED] Would you promote a HPWH? Why or why not?

Appendix G: Onsite Homeowner Interview Guide

Introduction

[Purpose of section: Learn a bit more about the household and home to contextualize decisions.]

1. Could you tell me a bit about yourself and your home?
    a. How many people live with you?
    b. How long have you been living in this home?
    c. How long do you expect to live into this home?
    d. How satisfied were you with your previous water heater? [PROBE FOR: satisfaction with recovery time and hot water delivery]
    e. Where was your previous water heater located?
    f. Where is the 'ideal' location for your water heater? Why? [PROBE FOR: awareness of the relationship between hot water delivery and location; space savings]

Motivations and Decision-Making

[Purpose of section: Understand the homeowner's motivations to install a heat pump water heater.]

Next, we would like to learn about why you chose to install a heat pump water heater.

2. Could you walk us through the steps you took to get to this point of installing a HPWH today? Starting with your decision to replace your water heater, to learning about HPWH, and how you ultimately chose the HPWH.
    a. Why did you replace your water heater?
    b. Was there anyone (aside from your installer) that you consulted throughout this process? If so, who? What did you talk about?
    c. How did you become aware of HPWHs?
    d. What did [installer name] say about HPWHs and your other water heater options?
    e. Why did you decide to go with a HPWH?
3. Were there any features/aspects of the HPWH that interested or were important to you? If so, what? **[PROBE: energy savings, bill savings, leak detection, warranty, etc.]**
4. What concerns, if any, did you have about HPWHs? How, if at all, were these concerns addressed/resolved and how?
    a. How do you think the HPWH will perform/operate differently than your previous water heater? Will it work better, worse, the same?

5. What information/resources, if any, helped you choose the HPWH over a regular water heater? How did you come across these resources? What, if anything, did you find helpful about these materials? **[PROBE: installer-provided resources and resources they found themselves]**

Installation Experience

[Purpose of section: Understand the participant experience with the HPWH installation process.]

Finally, we want to ask a few questions about your experience getting the HPWH installed.

6. We talked a bit about the steps you took to choose a HPWH. Now, could you describe the steps to complete the installation, including any prior visits from **[installer name]** to the visit today?
    a. Did [installer name] come or call by before today to plan and/or prep for the installation?
    b. How satisfied are you with the time it took to reach the installation day? Was this timeframe expected?
    c. How are you feeling about your new heater and why? **[PROBE FOR: excitement, concern, indifference, etc.]** Do you have any concerns with all the features do you think you will use them?
    d. If you could do anything different about your heater choice and or installation, what would it be?
7. From your perspective, how did the installation go today?
    a. Did anything unexpected happen? If so, what?
8. How satisfied are you with the time it took to complete the installation today? Was this timeframe expected?
9. [IF RELEVANT] During the installation we noticed… [PROBE: experiences with any aspects of the installation not already mentioned]**.**
10. [IF NOT OBSERVED] What information, if any, did [installer name] provide you about your new HPWH both before and after the installation? [PROBE: mode settings, maintenance, etc.]
11. Overall, how satisfied are you with this experience?

Appendix H: Follow-up Homeowner Interview Guide

Introduction

[Purpose of section: Understand if there have been other changes in the household to contextualize responses.]

1. Since our last conversation, have there been any major changes to your home or your household? If so, what has changed? **[PROBE for other upgrades, greater/fewer people living in the home, spending more/less time at home]**
2. **[IF NOT covered during the first interview]** What did [installer name] say about HPWHs and your other water heater options? Why did you decide to go with a HPWH?

Hot Water Usage

[Purpose of section: Understand if homeowners are using hot water differently since installing the HPWH.]

3. What are the main uses of hot water in your home?
4. Since installing your HPWH, have you noticed any differences in the ways you use hot water? If so, what changes have you noticed and what caused these changes?
5. Since installing your HPWH, have you noticed any differences in the amount of hot water you use? If so, how has the amount of hot water you use changed and why?
6. Since installing your HPWH, have you noticed any differences in the amount of time it takes for hot water to arrive? If so, how?

HPWH Experience

[Purpose of section: Understand their experience with the HPWH.]

7. When you decided to install a HPWH, what were your main expectations from it? How has it lived up to those expectations?
8. What is your level of satisfaction with your HPWH? Why?
9. What, if any changes, have you noticed in how your water heater works when the weather is colder outside? **[PROBE for water temperature, recovery time, cold air effluent into home]**
10. How, if at all, have you adapted to those changes?
    a. How, if at all, have those changes impacted your satisfaction with your HPWH?
11. What, if anything, do you like about your HPWH?
12. What, if anything, do you dislike about your HPWH?

13. Have you noticed any difference in how your HPWH works compared to your old system? If so, what difference have you noticed?
14. Have there been any challenges with the HPWH? If so, what, and how did you navigate those challenges?
15. Has your contractor made any follow-up visits since the installation? If so, what prompted the visit? [PROBE for maintenance and operating issues]
16. Have you noticed any other impacts or changes in your home since the HPWH was installed? If so, what?

Changes in Energy Savings

17. Now that it has been a few months since you've had your HPWH installed, have you noticed any changes in your energy bills?
18. What are your monthly energy bills like now—*after* the HPWH installation—compared to before? Was this what you were expecting? Why?
19. Have you noticed any changes in your energy consumption, compared to last year?

Appendix I: Water Heater Installer Focus Group Guide

Introductions, Challenges, and Resources (10 Minutes)

IN THIS SECTION, PARTICIPANTS WILL INTRODUCE THEMSELVES AND DISCUSS CURRENT BUSINESS CHALLENGES AND RESOURCES THEY RELY ON.

1. To start, we'll go around the group and share a bit about ourselves. Please take 30 seconds and tell us:
    a. Your name
    b. The company you work for
    c. Three main business challenges your company is experiencing. Related to business, what's keeping you up at night?
2. Could one or two of you briefly explain: How, if at all, these challenges you're experiencing impact water heater installations?
3. Thinking about all the plumbing work your company does, about what portion are water heater replacements? In other words, how much of your business centers on water heater replacements?
4. Where do you go to get your equipment and supplies for a water heater installs? How easy is it to get the equipment and supplies you need for a water heater install? Do you ever have issues getting a conventional tank water heater in your area? Has the availability changed recently?
    a. Thinking about conventional tanks, have you ever had any challenges getting certain sizes? If yes, which sizes and why?
    b. Have any of you noticed differences in availability for tankless and HPWHs compared to conventional tanks? [Listen for the terms participants use to describe the water heater types.]
    c. [IF DIFFERENT AVAILABILITY] Do any of you have a sense for why tankless and/or HPWHs are more/less available in your area compared to standard tanks? [PROBE FOR: PANDEMIC, SUPPLY CHAIN ISSUES, INFLATION, CLIMATE OF REGION, GEOGRAPHY (RURAL AREA)]
5. Switching gears slightly, please type into the chat box the three main resources you rely on for staying up to date on water heater-related topics? [REVIEW ENTRIES AND ASK ONE OR TWO PEOPLE THESE FOLLOW-UP QUESTIONS]
    a. Who produces these resources? [PROBE FOR: WEBSITE NAMES, MANUFACTURERS, OTHER PEOPLE IN THE INDUSTRY; RESOURCES USED TO STAY UP TO DATE ABOUT INDUSTRY OR EQUIPMENT CHANGES]
    b. What do you like about these resources? Why do you trust them?
    c. From these resources, what information do you focus on or use?
    d. Is there a resource you *wish* existed? If so, what is it and why do you want it?

Activity: Installation Conditions (20 Minutes)

THIS SECTION FOCUSES ON THE PROCESS CONTRACTORS NORMALLY TAKE WHEN INSTALLING A WATER HEATER, FROM SCOPING THE PROJECT TO INSTALLING THE WATER HEATER, AS WELL AS HOW THEY MAKE RECOMMENDATIONS.

Alright, these next few questions are focused on the process installing the water heater. **I'm going to present a couple of water heater replacement scenarios and give you all a few minutes to jot down how you would approach each project**, including what you would say to the customer, the type/size of water heater you would recommend, a rough estimate of the project cost, and whether there are any installation considerations. Please assume that the customers are in the area you typically serve. [PRESENT SCENARIOS (SHOW ON SCREEN) THEN ASK ONE OR TWO TO SHARE THEIR ANSWERS; ASK IF ANYONE HAS DIFFERENT RESPONSES]

- **JONAS:** Jonas and his family (five people total – two adults, three children between 8 and 16 years old) live in a home far from the town center and he wants his 19-year-old, 75-gallon water heater replaced. He's currently using propane to heat his home and water. The water heater lives in the basement, which the family mostly uses for laundry and storage. What do you do?
- **KAILYN:** It's late into January when Kailyn calls you for an emergency house visit. Her 50-gallon, 12-year-old electric resistance water heater is leaking from the seam between the wall and the top of the tank. She wants a replacement as soon as possible for herself and her three children and noted that she wants "green technology" and something that can keep up with their hot water demand. Kailyn's current water heater is in a garage closet, which comfortably holds the water heater but doesn't have much room to store other things. What do you do?

6. [IF TWH AND/OR HPWH ARE MENTIONED] Why would you recommend a tankless water heater or a HPWH in this scenario?
7. [IF TWH AND/OR HPWH ARE NOT MENTIONED] What would you need to see/hear to recommend a tankless water heater or a HPWH? Why *wouldn't* you offer a tankless water heater or HPWH? [If supply chain issues mentioned earlier, ask whether that impacts their recommendation of these.]

Thanks for stepping through this exercise with me. Thinking about water heater replacements in general…

8. **What, if any, situations do you recommend a tankless gas water heater to replace an electric storage tank? How often do these situations come up in your area?**
9. Can anyone think of a **situation where a smaller tank water heater, combined with some other technology or creative problem-solving**, could support a household with a hot water load that is greater than recommended for that size water heater? **How often do you use this type of solution in the area you work?**
    a. [IF YES] What circumstances would you do this and why? What value is there in doing this setup? What concerns, if any, do you have about this solution? What types of modifications are needed? What information is presented to the customer?

10. Can anyone think of a situation where they would install a commercial-grade water heater in someone's home and why? How common is this situation in the area you work?
    a. [IF YES] What situations would you do this and why? What value is there in doing this setup?

Changes to Codes and Standards (20 Minutes)

IN THIS SECTION, PARTICIPANTS WILL DISCUSS THE TYPES OF RESOURCES THAT INFORM THEM OF CODE CHANGES.

In this next section, we are going to talk a bit about changes to codes and standards. As a reminder, our findings will be anonymized, and no one here is evaluating your work; we are simply trying to understand the realities (challenges) water heater installers face.

11. To get us rolling, please type into the chat box how you stay up to date about code and standard changes? [PROBE FOR SPECIFIC TOOLS AND RESOURCES THEY CURRENTLY USE, WHY THEY USE THEM, AND HOW THEY USE THE INFORMATION THEY GET FROM THESE RESOURCES.]
12. Are there certain codes and standards you pay more attention to than others (e.g., local vs state vs federal vs plumbing code)? Why?
13. What do inspectors in your area look for with water heater installations?
    a. How often do you pull permits for water heater installs?
    b. How, if at all, does this impact the way you approach a water heater replacement? [PROBE FOR: EQUIPMENT RECOMMENDATIONS AND INSTALLATION STEPS]
14. Could someone share the last water heater-related code or standard change they remember in your region? Was this a federal, state, or local change?
    a. How did you learn about this code/standard change?
    b. What was your reaction to this code/standard change?
    c. How, if at all, did this code/standard impact the way you replaced water heaters?
    d. Is there anything that you think could have made transitioning to the new code/standard easier? If so, what? How would like to find out about upcoming changes?
15. [KEY QUESTION SET] In recent years, what changes, if any, have you noticed about the availability of conventional tank water heaters in your area (e.g., any particular brands, sizes)?

a. [IF LESS AVAILABILITY] **How have you coped with the more limited availability?**

b. How often do you install tanks 55 gallons or larger?

16. Do you recall the 2015 federal standard (**aka 2015 NAECA** (National Appliance Energy Conservation Act) **Water Heater Energy Efficiency Standard**) change that increased the minimum energy factor required for residential water heaters? A quick show of hands if you know about this standard.

[IF NO]

a. What do you think about this standard?

b. How, if at all, did these changes impact the way you replace water heaters?

c. **Why do you think this standard went unnoticed by you?**

[IF YES]

d. **Can one or two of you tell me, in your words, what this standard required?**

e. **How did you learn about this standard change?** What was your reaction to the change?

f. **How, if at all, did this standard impact your day-to-day? Around this time period, what changes, if any, did you notice about the tank water heaters available to you?**

g. How, if it all, did this change impact the way you replaced water heaters? What, if anything, did you do to comply with this standard?

h. How often do you install tank water heaters larger than 50 gallons?

i. **What, if anything, could have made this transition easier?**

j. [IF NO IMPACT] **Why do you think this standard did not change impact the type of tank water heaters you install?**

[IF NEEDED] Electric water heaters 55 gallons or larger need an efficiency rating of about 1.99. Gas water heaters 55 gallons or larger need an efficiency rating of at least a condensing tank water heater. All tanks smaller than 55 gallons needed additional insulation (making them taller and wider).

Proposed Federal Legislation (15 Minutes)

THIS SECTION FOCUSES ON HOW INSTALLERS MIGHT REACT TO THE PASSAGE OF THE PROPOSED FEDERAL STANDARD.

17. Next, I'm going to present a hypothetical new standard for electric water heaters. Essentially, this standard would require that all tanked electric water heaters, 35 gallons or larger, **and taller than 36" be a HPWH** (or have an energy factor (UEF) of over 2.2 in medium draw patterns).
    a. **In the chat box, type three words that convey your reaction to this standard.**
    b. How, if at all, would this standard impact the way you replaced water heaters?
    c. What, if anything, would you do to comply with this standard? Would you recommend your customers switch to a gas water heater?
    d. **How would you likely learn about this new standard?**
    e. **Is there anything that you think would make transitioning to this standard easier? If so, what?**
18. Now, please think back to the installation scenarios I presented earlier. Could one or two of you share how, if at all, your approach to these projects would change under this standard?

Thoughts On Heat Pump Water Heater (15 Minutes)

To close our conversation today, I want to talk a bit about heat pump water heaters (sometimes known as hybrid water heaters).

19. Chat box time again – please type three words that capture what you think about heat pump water heaters.
    a. What are the pros/cons? Why aren't these installed more often in your areas? [PROBE FOR: REASONS ASIDE FROM HIGHER COST, SUCH AS INSTALLATION CHALLENGES, COMFORT/PERFORMANCE CONCERNS, AVAILABILITY, PROFITABILITY, ETC.]
20. For those of you that have installed HPWHs, what customer circumstances caused you to install a HPWH? [PROBE FOR: CUSTOMER PREFERENCE, INSTALLATION CONDITIONS (FUEL-TYPE), INCENTIVES, UPSELL, PROFITABILITY, ETC.]
    a. What has been your experience installing HPWHs? How is it similar or different from conventional tank water heaters? [PROBE FOR: CHALLENGES WITH VENTING, ELECTRIC UPGRADES, SIZE, ETC.]
    b. **Is there a reason you do not install more HPWHs? If so, why?**
21. **If that hypothetical federal standard I presented became a reality, how would you respond? What water heater solution(s) would you recommend/install for your customers?** [MODERATOR TO LISTEN FOR INSTANCES WHERE INSTALLERS WOULD NOT INSTALL A HPWH AND PROBE FOR THEIR REASONING AND ALTERNATIVE SOLUTION.]

a. In households with an electric water heater, do you think this standard would cause you to only install HPWHs as replacements? Why or why not?

b. Do you think this standard would impact the type of water heater you would recommend to households with gas water heaters? Why or why not?

c. What other challenges do you think might surface with a standard such as this? [PROBE FOR: HOT WATER SUPPLY, RECOVERY RATE, OTHER PERFORMANCE CHALLENGES, ETC.]

22. What support would you need/want if this federal standard became a reality? Who do you think is best situated to provide you that support? [PROBE FOR: TRAININGS, MANUFACTURERS, DISTRIBUTORS CODE OFFICIALS, INCENTIVES, ETC.]

    a. [REFERENCE RESPONSES IN Q9] Thinking about the resources/tools mentioned earlier, how, if at all, would you use those if this standard was implemented?