Learning from those who came before: How utility incentive programs can alleviate supply chain friction for heat pump water heaters

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ABSTRACT

Jurisdictions around the country are pursuing building electrification strategies to meet their climate goals. Heat pump technologies will play a central role in building electrification, yet adoption of heat pumps for water heating has lagged behind that of heat pumps for space heating.

This paper presents a comprehensive picture of how the residential heat pump water heater (HPWH) market functions. Drawing on 69 in-depth interviews with architects, engineers, builders, distributors, and installers who work in both the single-family and multifamily markets, we describe barriers to more widespread adoption of HPWHs. Additionally, we review utility programs working to target these barriers and reduce them.

As program designs for heat pump water heaters are still emerging, there is value in exploring best practices of mature programs and identifying common lessons learned to help optimize implementation and reduce market friction across the supply chain. We interviewed program staff from the northeastern, northwestern, and southwestern United States to collect their insight and synthesize findings related to common opportunities and challenges faced by program staff across the country. Coupling together the best practices from these programs with our interviews of supply chain actors allows us to pinpoint exactly where and how utility programs can intervene to move the market. This holistic understanding of the supply-side and demand-side markets is necessary in order to target pain points and ensure that this viable heat pump technology will be demanded, designed, sold, and installed.

Introduction

"Eighteen states plus the District of Columbia and Puerto Rico have now set 100% clean energy goals for electricity" according to a recent analysis by the Clean Energy States Alliance (2021). Transitioning end-uses from natural gas fuels to electric fuels, such as through heat pump adoption, is one way that states will be able to meet their climate goals and fulfill their transition clean energy. Yet, the adoption of heat pumps for water heating has lagged behind their adoption for space heating. Many consumers and market actors are unfamiliar with heat pump water heaters (HPWHs), which suppresses customer demand. The relatively low demand for HPWHs currently reverberates through the supply chain. Contractors are reluctant to offer expensive and unfamiliar equipment to customers, particularly when they perceive installation as more complicated, and distributors are hesitant to stock water heaters the plumbers may not buy. Utility incentive programs have been an effective way to intervene in markets and spread awareness of energy-efficient appliances. In this paper, we review the supply chain for water heaters in the United States and identify friction points between market actors to reveal key junctures where incentive programs can intervene to ensure that HPWHs are selected over other equipment.

Methods

To explore where and how utility programs can alleviate supply chain friction in the HPWH market, we conducted structured in-depth interviews with HPWH supply chain actors across the country, deployed an online Delphi study with HPWH installers in California, and performed a characterization of

the HPWH supply chain in Illinois. Across complementary research efforts, we conducted in-depth interviews with 69 HPWH market actors, including market-rate and low-income new construction professionals in the single-family and multifamily markets (30), installers in single-family retrofit markets (20), distributors (7), mature HPWH program staff (6), local government and housing authority staff (4), and manufacturers (2). Each market actor answered questions tailored to their area of expertise, which included HPWH installation best practices, customer barriers to adoption, utility incentive programs, HPWH-specific training opportunities, electrification policies, and the evolution of the HPWH market across the country in recent years.

We also developed a map of the HPWH supply chain, drawing largely from a study in Illinois. Using quantitative data from secondary sources and qualitative insights from market actor interviews, we overlayed estimates of the flow of HPWH products through the supply chain. We then triangulated the size of the residential HPWH market in terms of shipments and sales, characterized the market in terms of efficient versus less efficient shipments and sales by product category type, and mapped shipments and sales into sectors and across key market actors. Understanding the supply chain is essential for identifying where transactions occur and how programs can intervene to manifest change via different market actors.

Results

Below we present an overview of the HPWH market including the supply chain and main market actors. We also review the friction points in the supply chain that act as barriers to widespread HPWH adoption. Then, we present lessons learned from mature HPWH programs that can reduce those friction points. The paper ends with conclusions about best practices for HPWH program design.

Market Overview

Half of water heaters sold in the United States go through retailers and half go through distributors, as shown in Figure 1. The distributors sell exclusively to the trades, which consist primarily of plumbers, some builders, and a small number of HVAC professionals. The distributors we spoke with do not sell to homeowners because they want the equipment installed properly by a licensed plumber, particularly for cases where the plumbing and electrical work will need to be inspected. Different states have different licensing requirements for installing a water heater; states that require a licensed plumber to install the equipment sell fewer water heaters to HVAC professionals than states that do not have such a requirement. Distributors said they do not sell online because of the risks involved with shipping water heaters, such as damage to the equipment.

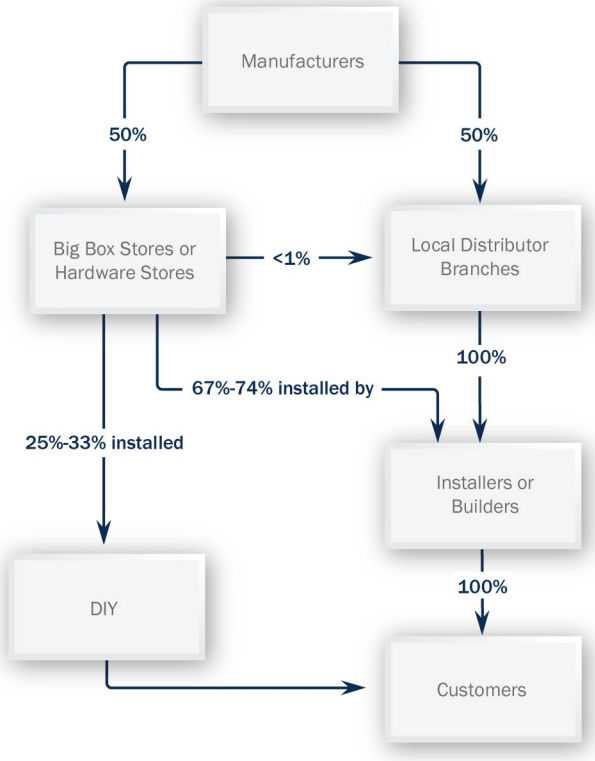

Figure 1. Water heater supply chain

A growing number of end customers reportedly purchase water heaters from big box store retailers. These stores tend to have contracts with plumbers who will install the equipment for the homeowner. In Illinois, about one-quarter to one-third of sales from retailers are reportedly installed by the homeowners themselves. One manufacturer we spoke with estimated that of all the water heaters sold at retail stores, one-third are purchased and installed by plumbers, one-third are purchased and installed do-it-yourself (DIY) style by the homeowner, and one-third are purchased by the homeowner but installed by a plumber. Distributors may purchase water heaters from big box stores, but that is rare. One big box store chain stocks HPWHs in 50% of their nationwide stores; however, the stores in primarily gas water heating markets will not carry HPWHs.

Plumbers prefer to buy water heating equipment from distributors because their suppliers have product in stock, offer prompt delivery, have better warranty support, and can pass through midstream incentive discounts. They avoid big box stores because HPWHs are not always in stock, there are lines, and they believe big box store staff are not as knowledgeable about water heating equipment as distributor staff. Distributors, in fact, can play an important educational role; plumbers sometimes approach them to seek their advice on product selection because distributors are seen as knowledgeable professionals.

Friction Points in the Supply Chain

The distributors and plumbers in the supply chain are largely motivated by two things: 1) making money by selling product, and 2) ensuring customer satisfaction. Homeowners usually want to have a sufficient supply of hot water at the lowest possible cost. Below, we review the friction points among market actors in the supply chain that inhibit adoption of HPWHs. Overall, installers' and customers' low

awareness of and familiarity with HPWHs is a primary barrier to market adoption and creates challenges for justifying the upfront cost of the equipment without understanding the full potential benefits.

Friction Point #1: Installers want their job to be done as quickly as possible and want to avoid customer call-backs, which influences the equipment they offer to retrofit customers. Related trends include:

- Preference to like-for-like water heater replacements. While installers may be willing to install HPWHs, often their jobs are replacing non-functioning water heaters as quickly as possible for the customer. The quickest way to install a new water heater is to do a like-for-like replacement and install a new version of what the customer had previously. Taking time to design a new system is often not worthwhile. When confronted with a choice, customers "will pick the easy, faster, less intrusive option" according to one interviewed plumber.

- HPWH-specific installation challenges, added materials, and associated costs. Installation challenges emerged as a common theme among installers across the country. These challenges included ducting, piping, and condensate line needs; inadequate installation space and associated temperatures; inadequate electricity service; and bulkier equipment. The ducting, piping, and condensate line needs of a HPWH create extra materials and labor costs. For example, those who were concerned about the HPWH cooling its surrounding space mentioned that they could vent out the cold air via a duct, but the extra materials and labor required to complete the ducting could add $600 to the installation costs. Further, existing water heaters are often in closets, which may not provide enough air flow for the HPWH to function properly. HPWH are about one foot taller than other tanked equipment, which prevents installation in about 15% of basements in Illinois. HPWHs are also top-heavy and somewhat more difficult to physically manage due to their heaviness and uneven weight distribution. Finally, they cannot be installed in unconditioned spaces because there is less heat in the surrounding air to draw in and heat the water.

- HPWH electrical panel upgrades and added costs. While often not a problem if replacing an existing electric water heater or in a home with central air conditioning, installers also need to be sure that there is adequate electricity service in the panel, that there is an outlet for the HPWH, and that the wires and the utility service drop to the house have adequate capacity. HPWHs generally require 240V electrical capacity, and existing homes are less likely to have an electrical panel that can accommodate the capacity required for HPWH installation. If the HPWH requires a new wire to be run from the panel, the plumber will need to hire an electrician and it could be a week before the electrician can get to the site. When the HPWH installation takes longer to complete, it equates to higher labor costs incurred by the customer. The added labor, materials, and time to ensure adequate electricity service add to an HPWH's project costs.

- Misconceptions about HPWH efficiency. Many installers did not perceive HPWHs as the most energy-efficient water heater option but instead preferred tankless water heaters for the efficiencies they believe these units offer. In particular, installers noted that parasitic heat loss results in a HPWH's energy savings performance not living up to the manufacturers' claims. For example, if a furnace is heating the conditioned air inside the home and the HPWH is located indoors, it extracts that heat to warm the water, which causes the furnace to compensate for the HPWH. Plumbers with this concern are reluctant to offer a customer a water heater product that may not realize energy savings on the homeowner's utility bill. HPWHs sited in unconditioned spaces, such as garages, do not have this issue.

- HPWH functionality features. Installers also noted concerns with functionality of HPWHs, including slow recovery rates, noisy performance, and more complexities to their controls. In order to fulfill the daily demands of families with high water usage, larger HPWHs will need to be installed—increasing costs significantly. For example, under perfect conditions, a HPWH pulls ambient heat out of the air and heats the water in the tank, which can be a slow, but energy-efficient process compared to other systems. If not sized appropriately, HPWHs may not be ideal for large families with high demand, because once the tank is emptied of hot water it takes longer to recover than other tanked water heaters. Some installers found HPWHs to be noisy and avoided them to ensure customer satisfaction. The controls of a HPWH are also more complicated than other types of water heating equipment because there are multiple modes on a keypad, compared to an on-off switch with other water heaters. Installers associated this increased complexity with a lack of reliability and increased maintenance needs.

- Applicability to retrofit market. HPWHs are often better suited for new construction because builders can accommodate HPWHs by designing enough adequate space and proper electrical capacity for the equipment in new homes, whereas retrofit installations necessitate finding an appropriate space and determine the needed upgrades in a pre-existing home not originally built to accommodate HPWHs.

Friction Point #2: Homeowner cost-consciousness and unfamiliarity with HPWHs makes them reluctant to purchase one. Related trends include:

- Upfront costs. The upfront costs of HPWHs emerged as the primary barrier to customer adoption of HPWHs. Customers are reportedly less concerned with the efficiency of their new water heater, and more concerned about upfront cost and having hot water consistently available.

- Lack of awareness. Many customers have not heard of HPWHs or are unfamiliar with their functionality, which makes them wary about selecting one for their home. Installers noted that customers very rarely inquire about HPWHs.

- Lack of education of system functionality and its advantages. Customers who are aware of HPWHs often lack education on system functionality and its advantages. For example, customers often do not understand the environmental implications of a gas system or the rationale for switching from a gas to electric system.

- Prevalence of power outages. Another customer concern is related to the use of electricity as the power source. The prevalence of power outages in California has created customer resistance to electric water heater adoption because of the inability to produce hot water during an outage. This customer concern is a misperception, however, as modern natural gas water heaters will also not work during a power outage. Modern natural gas water heaters require electricity to power their control board, ignite the pilot light, and sometimes to maintain temperature.

Friction Point #3: Distributors stock what they sell, and they do not sell a lot of HPWH. Distributors order their equipment in batches and pick what type of equipment to order based on what installers are demanding. Distributors want to stock only what is marketable and will sell in a reasonably short time. They have limited space in their warehouses and are reluctant to stock a large volume of HPWHs.

Distributors take cues from plumbers and if plumbers ask the distributor to keep HPWHs in stock, they are likely to do so.

Friction Point #4: Multifamily property owners want a space-saving option. When it comes to product selection, multifamily building owners are generally driven by their bottom line more than anything else. They want to maximize the number of units they can sell or rent and minimize the space taken up by mechanical equipment, whether in-unit or elsewhere in the building. For in-unit equipment, HPWHs cannot fit in small, cramped closets and need to be in larger closets with ventilation. Including a large, ventilated closet for every single unit is often not viable from a design standpoint because it will take up too much usable square footage. To get around this, HPWHs are sometimes placed in corridors or balconies to avoid taking up space for the unit. The space constraint may be a larger challenge in affordable housing than market rate. Market-rate, for-sale multifamily units tend to have individual water heaters in the units.

Centralized HPWHs have larger storage tanks and require more space than do gas-fired systems. The HPWH's recovery rate is slower than gas-fired equipment, so designers include large storage tanks, which take up premium space in the building. Also, gas-fired boilers can be placed almost anywhere in a building, including a basement. Due to HPWH's need for sufficient ambient air, sometimes the compressors or tanks go on the roof. Having extra weight on the roof means that a structural engineer had to design the building to support this weight, which translates into extra steel and costs for the developer.

How Incentive Programs Can Reduce Friction Points

Downstream, midstream, and upstream programs can all act to reduce friction points. However, midstream and upstream programs have the potential to achieve greater savings than traditional downstream programs because they intervene higher up in the supply chain, which generally enables these programs to reach a larger share of the market than downstream programs. We found heat pump programs taking a holistic approach and targeting actors at all points in the stream. Mature heat pump programs developed partnerships upstream and leveraged downstream customer education and outreach.

Effectively designed incentive programs can reduce friction points in the supply chain and encourage HPWH adoption by supporting contractor training and educational opportunities, informing customers about the benefits of HPWHs, engaging distributors, and creating opportunities to provide feedback to manufacturers based on market trends. The following discussion outlines specific ways in which mature incentive programs can alleviate the identified supply chain friction points:

Training and educational opportunities can improve competency and speed in the installation process, making installers more likely to recommend HPWHs. Installers report training and education opportunities are key to the promotion of emerging technologies and assert that offering free and convenient contractor training can help installers become confident with a particular technology. Training for installers should include how an HPWH works, as well as its installation requirements, efficiencies, modes, warranty, and available incentives. In particular, training efforts targeted to installers should cover the demonstrated efficiency performance of HPWHs to debunk installer misperceptions that HPWHs are not the most efficient type of water heating equipment on the market.

Installer education and training emerged as an important intervention utilized in mature HPWH programs. Program managers partnered with distributors to offer trainings in their area and incentivized installer participation through offering continuing education credits. Distributors were an effective agent because they often were already holding trainings for installers or were better suited to host technical trainings than program staff due to their familiarity with installation and troubleshooting. Distributors are

motivated to provide trainings as an opportunity to promote their equipment and to ensure effective product installation, lessening the likelihood of customer and installer dissatisfaction with HPWH technology. Sales training is another important component so that plumbers can effectively educate customers about the advantages of an HPWH. Figure 2 shows creative solutions to contractor education and training, which we continue to discuss below.

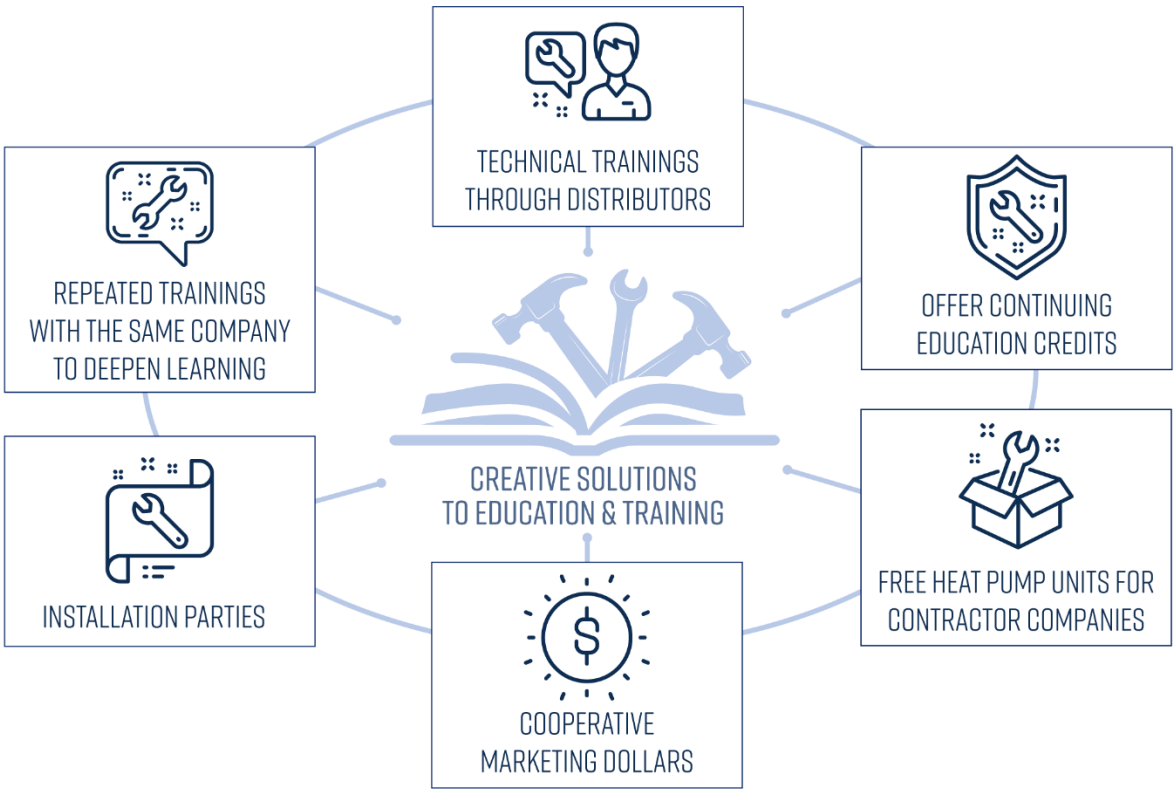

Figure 2. Creative solutions to education and training

Programs that provide cooperative marketing support or allow contractors to gain firsthand experience with HPWH helped grow the number of installations. Another strategy is for programs to offer contractors marketing dollars to boost contractor participation. This funding was offered to their installer community to promote heat pump technologies in their advertising. One specific program instituted a cooperative marketing program which paid for a portion of installers' marketing materials to effectively promote their program and HPWHs. Additionally, some mature heat pump programs offered a handful of contracting companies a free HPWH unit to install in their own homes so they can gain firsthand experience with an installation and living with the unit. They found this strategy to ease installer concerns about recovery rate, parasitic heat loss, and noisy performance. Programs have also encouraged contractors to make the installation a community event with other interested parties to showcase the technology and installation process.

Effective incentive programs emphasize customer education of HPWH efficiency benefits and available incentives, which allows homeowners and property owners to realize the true potential value of HPWHs. Despite many of the mature HPWH programs utilizing upstream or midstream implementation

models, program managers emphasized that marketing campaigns aimed at homeowners and multifamily property owners is another key strategy to drive awareness and demand. Through customer awareness campaigns, programs marketed the benefits of HPWHs to customers and built name recognition of heat pump technology. The incentive programs we studied demonstrated success using targeted marketing campaigns to promote awareness and educate customers about the benefits of HPWHs and available utility incentives. For example, one heat pump program sought to educate customers by providing user tips with each installation to ensure that customers are knowledgeable about the different features of their heat pump so they may use it more effectively. The program also utilizes digital advertising to promote their program, as well as attending in-person community events and home energy fairs. Incentives reduce the upfront cost of efficient equipment and signal to customers that the technology is supported by trusted energy partners. Promotion of HPWHs directly to end-use customers drove uptake and reduced friction at the point of sale.

Mature program design includes strengthening relationships with distributors in order to incentivize stocking and selling more HPWHs. As mentioned earlier, distributors order their equipment in batches and pick what type of equipment to order based on what installers are demanding. Therefore, distributor relationships emerged as another key strategy leveraged in effective program design in order to incentivize the stocking and selling of HPWH. The regular interactions program staff had with upstream market actors kept them informed about new products coming into the market and allowed the program to offer technical trainings to installers through the distributor networks. Program staff could also track the market share of HPWHs through detailed sales data from participating distributors. By building strong relationships with distributors, program managers felt they were on the path to effectively transform their local HPWH markets.

Multiple program managers expressed that working with a limited number of distributors to get them more invested in HPWH programs is more effective than casting a wide, but shallow net. For example, one HPWH program specifically targets the largest distributors in the area, then incentivizes them to sell more heat pump technology using a tiered bonus structure that provides more money to the distributor at the end of the year, depending upon how many heat pump units they have sold.

When program staff strengthen relationships with manufacturers, they create opportunities to provide feedback on market needs and equipment features, and thus are able to make the case for design changes in equipment specifications, like the need for a space-saving option in multifamily properties. Multifamily property owners typically want a more physical space-saving option than that which is currently available on the market for HPWH. Therefore, mature programs with existing relationships with manufacturers (and their distributors) could generate opportunities to provide such feedback and generate potential to create a more optimal system for multifamily settings. If program staff are able to develop open lines of communication with HPWH manufacturers, then they can offer information on observed market trends and existing barriers to heat pump adoption in their service territory. Such a feedback loop is considered mutually beneficial because it potentially opens up new customer segments for the manufacturer and allows a utility to capture energy savings.

Conclusions

Based on the results of our research in jurisdictions across the country, we recommend the following program design strategies to effectively reduce friction points in the supply chain for HPWHs.

Conduct marketing, education, and awareness campaigns to increase familiarity with HPWH among installers and end-users. Any HPWH program must tackle the existing misperceptions about HPWHs. The education for installers should focus on alleviating concerns about recovery rate, noisy performance,

parasitic heat loss, complex controls, and efficiencies compared to gas-fired systems. Targeting this education to a relatively small, loyal contractor base rather than broad outreach will make the best use of program funds. The education for home and property owners should emphasize the predicted energy savings, its functionality, and the health, safety, and environmental benefits from avoiding natural gas usage.

Partner with distributors because they are a key connection point in the supply chain and are optimally positioned to influence installers. Most installers view distributors as trusted partners. Distributors can provide low- or no-cost training that will reduce plumbers' installation concerns. They can also distribute materials that helps the plumber effectively inform customers about the environmental benefits and cost savings expected from a HPWH, which makes the upfront cost more palatable. Installers look to distributors for information about equipment, so this should be a natural way for plumbers to learn about HPWHs.

Build relationships with manufacturers to provide feedback on market needs, such as smaller equipment designs. The size of a HPWH is a barrier to their installation in single-family and multifamily buildings. If manufacturers are able to reduce the size of a HPWH, it will fit in more places in a home, which reduces the added materials and costs needed for its installation. It will also make it more feasible to install in multifamily buildings, whether that is a centralized system or in-unit tanks. When HPWHs are suitable for more installation spaces, particularly in the retrofit market, it will be easier for installers to specify a HPWH.

In summary, widespread HPWH adoption will help states and local governments meet their bold climate goals, but friction points in the supply chain are currently limiting sales. As we have shown, incentive programs can reduce friction points across the supply chain and boost the number of HPWH installed. In particular, programs can correct installers' misperceptions about HWPH performance and offer training to make them more confident with installation. And education of end-users on HPWH benefits will be needed to drive demand. Ultimately, effective program design to drive measures such as HPWH will be critical in the clean energy transition.

References

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