Heat Pump Integrated Control Performance Review

MA22R46-B-HPICPR
Final Report

Prepared for:

Massachusetts Program Administrators

Submitted by:

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Executive Summary

This report presents findings from follow-up research conducted on integrated controls (ICs) used with ductless mini-split heat pumps (HPs). These dual-fuel coordination systems were installed through the electrification sub-offering of the Massachusetts Residential Retail Program.

Objectives and Methodology

The Massachusetts Residential Retail Program offers rebates for residential customers to install HPs for heating and cooling through the Mass Save® program. The program offers rebates for ducted and ductless air source heat pumps (ASHPs) for both whole-home and partial-home displacement projects. Whole-home rebates require customers use HPs for heat and remove their pre-existing or legacy heating system (or use it only when the HPs are down for service or repair).[1] Partial-home rebates allow customers to keep their pre-existing heating system but require ICs to allow switching between the HPs and pre-existing system.

The program is designed to motivate customers to reduce greenhouse gas (GHG) emissions from fossil fuel heating sources by using a more efficient HP to provide a majority of the home's space heating needs. For partial-home displacements, the program requires ICs to encourage customers to prioritize the use of HPs for heating and reduce usage of their legacy fossil fuel heating systems.

The study focuses on understanding IC systems in partial displacement scenarios in single-family homes with mini-split HP systems. A previous evaluation, the *Energy Optimization Fuel Displacement Impact and Process Study*, found that homeowners who received mini-split systems with ICs often experienced more challenges with the IC system than those with central HP systems.[2] This follow-up study focuses on topics related to mini-split IC technologies and how contractors and customers experience them. While researching the technical aspects of ICs, the study team also learned more broadly about system configuration and use cases and how they support program goals to reduce/displace fossil fuel usage. The findings and recommendations therefore span the research topics broached in the prior study, as well as broader issues around configuration and use cases.

More specifically, the research goals are as follows:

- Understand whether customers and contractors using the current generation of controls have the same challenges (connectivity and usability issues) as the previous technology generations, and whether updates and familiarity (e.g., software upgrades, additional contractor experience, and training) have positively affected the satisfaction of customers and contractors with the equipment installed in 2021 and 2022.[3]

[1] Program rules on backup system usage have changed recently, but in 2022 backup fossil fuel system usage was allowed at times when the outdoor temperature was too low for efficient HP usage.

[2] Guidehouse, *Energy Optimization Fuel Displacement Impact and Process Study,* https://ma-eeac.org/wp-content/uploads/MA20R24-B-EOEval_Fuel-Displacement-Report_2021-10-13_Final.pdf.

[3] Previous study results were released in July 2021, which left limited time for program administrators (PAs) to make programmatic changes prior to this study. Customer surveys mainly drew from 2022 participants and some 2021 participants.

- Understand how customers and contractors are using the current HP and IC equipment and whether their use of the equipment and applications have changed as new versions and generations of both hardware and software have been released.
- Identify if there are opportunities for additional education or marketing/messaging to support contractors and customers around using the IC system.
- Determine whether there are specific makes/models of ICs that are underperforming (e.g., reliability, failure rates, switchovers disabled, customer or contractor complaints) and should be considered for removal from the program.

To address these research goals, the team undertook the following data collection activities:

- **IC product secondary research:** Internet desk research on the various IC systems to understand customer and contractor reporting on the functionality and usability of these systems
- **Contractor interviews:** Contractor interviews with Mass Save-qualified HP installers who install mini-split HPs and ICs to gain insight on barriers to installation, functionality of HPs and ICs, and customer feedback from the contractor perspective
- **Manufacturer interviews:** Manufacturer interviews to understand market changes for ICs, how manufacturers are adapting to feedback on IC technologies, the status on integration with smart thermostats, and contractor training capabilities and resources
- **Customer survey and interviews:** An online survey of participants to gather information on technology satisfaction, how customers use their HVAC system(s) and ICs, switchover temperature used, and experience using IC apps; the research team followed up with in-depth interviews to better understand customer experience with using HPs and ICs

The research goals for this study were technical in focus and designed around understanding the capabilities and applications of ICs installed with ductless mini-split HPs. The findings, however, are broader than these technical questions. The key findings from this study are centered around the use cases of ICs and questions of program design and education.

Key Findings and Recommendations

This section summarizes key findings and recommendations. The following image presents recommendations and findings at a Glance.

Recommendations & Findings At a Glance

Recommendation 1

Ensure that the program clearly articulates the use case for ICs with partial displacements and associated program requirements to ensure projects contribute to program goals.

SUPPORTING FINDINGS

- ICs were installed in scenarios that may not require them.
- Nearly half of customers report that their HPs are not their primary heating system or that they are using HPs for individual rooms.
- Nearly half of customers report that they do not use the ICs to automatically switch between heating systems.
- In some cases, ICs are being installed only to receive the program rebate, since there were no downstream mini-split rebates available.

Recommendation 2

Keep current mix of IC products in the Qualified Products List.

SUPPORTING FINDINGS

- IC technology, though nascent, promises improvements; manufacturers hinted at ongoing R&D that might help with connectivity and functionality.
- There were minimal differences in ease of use between IC brands, though Mitsubishi/KUMO products were most prevalent in the sample.
- Flair Puck received the most consistently negative feedback from contractors; however, customer survey responses did not corroborate this feedback. The product might also fill a niche that others do not by being able to integrate different HP brands.

Recommendation 3

Enhance trainings to provide contractors with additional guidance on IC use cases and customer education, including tools such as case studies, decision trees, and customer communications.

SUPPORTING FINDINGS

- Contractors continue to report skepticism around IC technology.
- ICs are being installed in non-optimal situations or where they are not required, and as a result ICs, in many scenarios, may not be fulfilling program goals.
- Customers report not having enough information to confidently use ICs, and enhancing contractor trainings on how to educate customers can help.

Recommendation 4

Provide educational resources to customers on HPs and ICs that outline operational FAQs and provide further emphasis on optimal switchover temperatures.

SUPPORTING FINDINGS

- 44% of respondents said they did not use the ICs to automatically switch between heating systems, and 10% indicated that they do not know if the IC automatically switches between systems.
- Customers report that the main reasons they deactivate the ICs were app connectivity failure, heating system connectivity issues, and poor WiFi.
- Customers report not having enough information to confidently use ICs.
- Customers do report being able to change the switchover temperatures and report these points are generally being set higher than recommended.

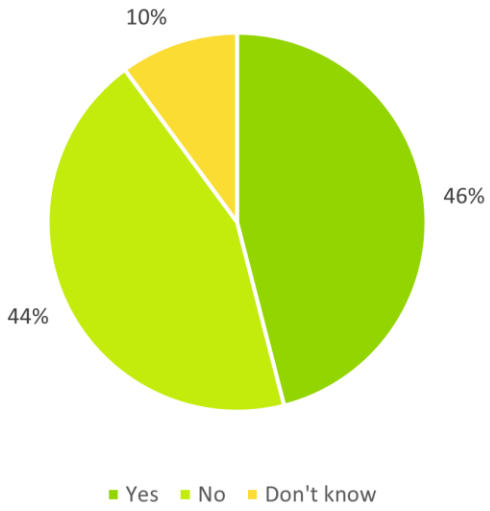
Findings

The following sections summarize key findings.

Configuration and Use Cases

- **Customer-reported HP configurations suggest that a substantial portion of customers are installing mini-split HPs and ICs in cases where the HPs are used as supplemental for heating, though program intention is for the HPs to be used as primary (in at least one zone) with the legacy fossil fuel system as backup and the IC controlling which system is active.** Customers (and contractors) often install ICs in scenarios that might not require them or be significantly well-served by them, as indicated by a combination of survey and interview data. Fewer than half of survey respondents indicated that they use the HPs as their primary heating source (i.e., customers indicate they use HPs for most of their heating needs). The customers that did not indicate that the HPs are used for most of their heating needs likely use their legacy fossil fuel system for most of their heating needs. Additionally, some customers use mini-split HPs in limited areas within their home while heating other spaces with their legacy system (it is unclear how many customers are offsetting full zones as opposed to installing HPs in single rooms). Only 38% of respondents indicated that over three-quarters of their home was served by the HPs, and 35% indicated that less than half the home was served by the HPs. Using ductless mini-splits for individual rooms or certain smaller areas of the home removes the need for ICs because the legacy heating system might be running simultaneously with the HPs. Additionally, even when customers do switch between the systems, they do not always use ICs to do so, opting instead for manual control. Some contractors instruct customers to manually switch between their heating systems. Of survey respondents, 44% indicated that they do not use their IC to switch heating systems (as shown in the figure below). IC use might be inappropriate in some cases, including those in which a homeowner would likely still need to use their legacy heating system to provide heat for other parts of the home while using the HP in one room or where customers are installing them and not using them.

Customers Using ICs to Automatically Switch Heating Source



Source: Survey question "When you are heating with your heat pump system, do you rely on the integrated controls to automatically switch between the heat pump and your other fuel-fired heating system?" Single response, n=189.

- **Forty-one percent of survey respondents indicated that they installed ICs to receive the program rebate**. Current program guidelines require that all customers who want to install mini-split HPs and keep their legacy heating systems must install an IC to receive the rebate. This requirement is driving customers to install ICs but might also be encouraging installation of ICs in cases where they are not necessarily a value-add for the customer. The rebate amount is high enough that customers want to install controls to receive its value but might not necessarily be using the products as intended or for ideal performance. These installations might not be resulting in intended outcomes. Contractors corroborated some ICs are installed only for the rebate. Additionally, some contractors recommended customers switch to manual control of the heating systems even after receiving the rebate for and installing ICs.

Customer Motivations and Customer/Contractors Satisfaction

- **Customers are primarily installing HPs for cooling purposes.** The program views HPs and ICs as a way to offset heating load, but customers are driven to install HPs primarily for cooling. Fifty-nine percent of respondents indicated that cooling was a motiving factor for HP installation, and 30% indicated that it was their primary motivator. Respondents also indicated their desire to be energy efficient as a strong motivator, though whether this was through cooling or heating is unclear. It should be noted that initial customer motivation does not necessarily reflect how they subsequently use their systems. Although customers seeking HPs for cooling might also result in displacement of fossil fuels used for heating, customers' primary motivator for installation is not completely aligned with program goals. This finding bolsters the need for additional education around the heating benefits of HPs.

- **Customers indicate that overall, they are satisfied with their new HPs, despite dissatisfaction in their ICs.** There is a substantial discrepancy between customer satisfaction with their HPs compared with ICs: Eighty-six percent of participants rated their new HP equipment a 4 or 5 on a 5-point satisfaction scale, with 1 being "not at all

satisfied" and 5 being "very satisfied," while only 47% rated their IC equipment a 4 or 5 on the same scale. Additionally, about half of survey respondents did not feel that the ICs were easy to use. There were no significant differences in ease of use among IC models installed; customers rated ease of use similarly across IC platforms used, indicating that no IC models are over- or underperforming.

Product Connectivity and Functionality/Qualified Products List

- **Customers report switchover temperatures that are higher than those indicated by the program guidance.** For example, 37% of customers reported a switchover temperature of 33°F to 50°F. Notably, 58% of customers with oil as the baseline heating fuel indicated the switchover temperature was above 30°F, and 81% indicated it was above 20°F (Table 1).[4] For context, program guidance is that the maximum switchover temperature for oil boilers is 30°F. Fewer than half of respondents report that switchover points are set by contractors or through customer agreement with the contractor, 20% indicated that a household member set the switchover temperature, and 25% indicated that they did not know who set it. The majority of customers report being able to change the switchover temperature whenever they need to, and contractors indicate that their clients change switchover points based on personal comfort or other factors.

Table 1. Customer Reported Switchover Temperatures

Fuel Type*	Switchover Temperature	Percentage Set Above Temperature	Percentage Set Below Temperature
Gas (n=22)	45°F	27%	73%
Gas (n=22)	30°F	68%	32%
Oil (n=26)	30°F	58%	42%
Oil (n=26)	20°F	81%	19%

The program also offers guidance on switchover temperatures for propane, but the base sizes for those using propane as a fuel type were too small to report on customer behavior from this survey. Note that 46% of survey respondents indicated they use the IC to switch between heating systems.

Source: Guidehouse

- **Phone application and system connectivity remain issues with the technology, but manufacturer-led changes might refocus product R&D teams to address these issues.** Specifically, contractors and customers noted Wi-Fi issues or problems with the IC apps connecting with the HPs. Contractors seemed overall skeptical of IC technology. Manufacturers interviewed (Mitsubishi, Flair, and Samsung) noted that their companies are potentially looking to grow those product lines, and address connectivity and app usability issues. They pointed out that R&D teams for major HP brands have often been located outside of North America and were geared toward products that address partial displacement scenarios that are not prevalent in areas of North America. Some manufacturers noted this scenario was changing with an increased focus on the North American market.

- **Among different IC products, there were no discernable differences in ease of use in customer responses.** Customers indicated via the survey that no IC product was

[4] The Energy Optimization Fuel Displacement Impact and Process study indicated that 43% of surveyed customers indicated their switchover temperature was above the 35°F program guidance.

significantly underperforming or overperforming. Contractors did, however, report preferring to install IC products with the same brand as the HPs installed; it should be noted that contractors' preference for IC products is influenced by their relationship with the product manufacturer (contractors often have long-standing relationships with particular HVAC manufacturers). They also reflected that the Flair Puck product was difficult to install; however, this third-party controller is useful for customers who might have multiple brands of mini-split HPs in their homes (for example, in cases where the HPs were installed at different times). Contractors also reflected some negative experiences with installing the Mitsubishi KUMO products, though this IC brand was most prevalent in the sample.

Training and Education

- **Survey respondents reflect that they receive minimal if any instruction or training on how to use ICs.** When asked in an open-ended question about contractor instructions on ICs, only 14% of survey respondents indicated that they received a thorough explanation of how to use the ICs or subsequent contractor support. Given connectivity issues (i.e., issues with the IC app connecting to the HPs, thus requiring manual control of the heating systems)[5], the "set it and forget it" approach for ICs might not be practical, and, as a result, customer education on how to use them could be beneficial.
- **Program contractors participate in HP and IC trainings from manufacturers and Mass Save,** but additional clarity on use cases for ICs and how to educate customers on their usage might be useful for ensuring that HP and IC installations are appropriately done to maximize displacement of fossil fuel usage.

Recommendations and Considerations

This section highlights study recommendations.

- **Ensure that the program clearly articulates the use case for ICs with partial displacements and associated program requirements to ensure projects contribute to program goals.** ICs were installed in scenarios that might not require them, and nearly half of customers report that their HPs are not their primary heating system or that they are using HPs in smaller areas of their homes. Additionally, nearly half of surveyed customers indicated that they do not use their ICs to automatically switch. Adding diagrams (such as decision trees or flow charts, see Appendix C) and case studies to the program website will help customers and contractors understand when ICs are needed. This information will help clarify the use case for HPs with ICs, ensuring the program is providing rebates for projects that will sufficiently reduce or eliminate fossil fuel usage. Additional clarity around use cases will help contractors recommend ICs for customers who will be using them to offset full zones or larger areas of their homes. Results from the ongoing Heat Pump Metering Study can be used to provide supporting information on fuel displacement.

[5] In these cases, customers report the app losing control capabilities over the HPs, though it is unclear if settings remain intact upon reconnection. Connectivity loss results in customers having to manually control each heating system separately in many instances.

The team's considerations to clarify the use cases are as follows:

- To access downstream rebates via the partial-home pathway, the program requires the customer to install ICs. The program should clarify program guidance around configuration and use case, specifically that for this type of project, HPs should address the heating load in either most spaces in the home or complete zones. Ideally, HP and IC systems should address all areas of the home that were originally served by a fuel system, but complete zones will also result in fossil fuel displacement. The program should emphasize that the HPs are required to be the primary heating system for the home or zone, with the ICs used to switch heating systems under certain temperatures. Essentially, for the partial-home pathway, a customer/contractor should ensure that the entire home or entire zone is covered by the mini-split HPs to receive the $1,250/ton and the IC rebate; in this scenario, the legacy heating system is used for economic reasons (different than the whole-home pathway, which allows legacy heating system usage for emergencies only). Though these are current program requirements, additional clarity is warranted to avoid customers installing HPs and ICs to serve a single room, for example.

- Some customers want to add mini-split HPs in specific rooms or add mini-splits to certain areas of the home that were not originally served by another heating system. ICs are not required or incentivized for these types of configurations as the legacy heating system will still need to operate throughout the home, even above the programmed switchover temperature. The program includes incentives if the mini-split HP is installed in a specific zone as this configuration results in some fossil fuel displacement. Current program rules regarding HP use in individual rooms as opposed to full zones should be further outlined and clarified for customers and contractors. For customers seeking this configuration, contractors can mention midstream incentives for HPs (though they are of lower value).

- **Keep current mix of IC products in the Qualified Products List (QPL).** Connectivity and functionality seem to be issues with using ICs in general, though manufacturers hinted at ongoing R&D that might alleviate this. IC technology, though nascent, promises improvements. In terms of ease of use, there were minimal differences between IC products that customers installed. While some contractors had negative feedback about the Flair Puck product, customer survey responses did not indicate that this IC product was less functional than others. Additionally, Flair's product fills a niche of third-party controllers that uniquely allow customers to utilize multiple HP brands as well as other sensors. There was some negative contractor feedback about the KUMO app, though this product accounts for the largest share of IC products installed. Though findings from the previous study suggested further research on products that should be removed from the QPL, and this study sought to determine whether certain products were underperforming, current study findings do not indicate differences in performance between IC models and therefore do not provide an objective metric for product removal. Additionally, as the IC product market is relatively nascent, the study recommends keeping the current products on the QPL to allow manufacturers to improve the functionality of the products. The more significant findings of the study center around customer usage (or lack of usage) of the ICs and their configurations.

- **Enhance trainings for contractors on IC use cases and how to educate customers**. Contractors continue to report skepticism around IC technology. They report making use of manufacturer-sponsored trainings as well as Mass Save trainings. Trainings from Mass Save should not only provide an overview of IC products as they currently do but also include more specific information on use cases where ICs make the most sense for displacing fossil fuel usage (as specified in the recommendation earlier). Diagrams (such as decision trees or flow charts) and case studies will help contractors understand when to recommend HPs and ICs to customers that meet program goals. Additionally, the contractor trainings should ensure that contractors have tools available to them to speak with customers on how to use ICs, as many customers felt they did not have enough information on the IC product and how to use it. In tandem with training opportunities, a forum for contractors to ask questions about programmatic requirements and express concerns about technologies and customer reactions could help Mass Save further tailor training offerings.[6] Enhancing contractor trainings will help ensure that contractors are recommending HPs with ICs in scenarios that encourage offsetting fossil fuel usage in full zones or throughout the house, and that customers will feel comfortable using the ICs to automatically switch between heating systems.

- **Provide educational resources to customers on HPs and ICs that outline operational FAQs and reasoning behind switchover temperature.** In addition to helping contractors educate customers, Mass Save could provide enhanced customer-facing materials on the website regarding ICs because customers report lacking information on ICs, including model-specific information. Decision-making supports such as diagrams and case studies could help customers understand when to request ICs and HPs, ensuring they will be successfully and appropriately used (though contractor advice is key to ensuring ICs are installed in the correct scenarios). FAQ resources could also help customers with troubleshooting installed systems. Additionally, insight into the switchover temperatures that emphasize efficiency and economic aspects might help customers more carefully consider cases where they change the switchover temperature, while considering customer comfort.[7] The program could also highlight midstream incentives as an alternative program pathway for customers whose configurations do not meet IC program guidance.

[6] Currently, the PAs are offering contractor trainings on ICs as well as “office hours” for contractors to ask questions.

[7] The PAs plan to update MassSave.com with a switchover temperature calculator: https://www.masssave.com/residential/rebates-and-incentives/integrated-controls/maximize-heat-pump-savings-with-integrated-controls.

1. Introduction

This report presents findings from follow-up research conducted around integrated controls (ICs) systems with ductless mini-split heat pumps (HPs) installed through the electrification sub-offering of the Massachusetts Residential Retail Program.

The Energy Optimization Impact and Process Evaluation Study (MA20R24-B-EOEVAL) identified several findings related to ICs in ductless mini-split HP partial displacement systems that the program administrators (PAs) and Energy Efficiency Advisory Council (EEAC) team agree warranted further investigation. These included:

- ***Finding.*** *The results from this study suggest that customers are not using standardized switchover temperatures for either oil or propane systems. For customers who use an IC to auto-switch, they program a variety of switchover temperatures between approximately 5°F and 45°F.*[8]

- ***Finding.*** *Contractor and distributor interviews suggest that ICs may vary widely in functionality and features depending on the manufacturer. This is common for a developing market. However, this may cause some contractors to be overwhelmed or confused and decide to give up early on the technology. For example, contractors reported experiencing connectivity issues with different brands, and problems with mismatched zoning between the fossil fuel system and new mini-split HPs that may prompt customers to override the controls.*[9]

More specifically, instead of a hard switchover or lockout temperature between backup and HP system types, the Guidehouse team found that customers might be using the controls more manually. There are several reasons for this:

- Control apps are confusing, poorly designed, and unreliable
- New ICs have fewer features than prior (smart) thermostat and are harder to program and use
- Internet connection is unreliable

The recommendations that followed from these findings included a recommendation that further research be conducted with contractors and customers to better understand their experiences with the ICs. This report summarizes the findings from the follow-up research undertaken as a result. It should be noted that the previous study recommended that further research recommend products for removal from the Qualified Products List (QPL). However, the results of this study did not find objective metrics by which to recommend removal; instead, the more significant study findings center around use cases for ICs and customer interaction with the IC systems.

1.1 Program Description

The Massachusetts Residential Electric Heating and Cooling Program offers rebates for residential customers to install HPs for heating and cooling through the Mass Save program.

[8] Guidehouse, Energy Optimization Fuel Displacement Impact and Process Study, see page ix; https://ma-eeac.org/wp-content/uploads/MA20R24-B-EOEval_Fuel-Displacement-Report_2021-10-13_Final.pdf.

[9] Ibid.

The program offers rebates for ducted and ductless air source heat pumps (ASHPs) for both whole-home and partial-home displacement projects.

- **Whole-home rebates** are for customers who intend to use the HP as their sole source of heating and cooling. These projects must completely remove the pre-existing heating system, or the homeowner must not use the pre-existing heating system unless it is for domestic hot water or in cases where the HP system is down for repair or service.[10]

- **Partial-home rebates** are for customers who plan to keep their existing heating system in place. For partial-home projects, the program requires homeowners to install ICs that allow switching between their HPs and fossil fuel systems at set temperatures. The program encourages customers to program an IC switchover temperature between 5°F and 30°F[11] as a starting point, depending on existing system fuel type. Switchover temperatures change based on prices for electricity and gas. Table 2. outlines the rebate values for the various technologies that customers can install. Midstream incentives are also available.

Table 2. Rebate Structure

Product type	Rebate amount
Whole-Home ASHP	$10,000 per home
Partial-Home ASHP	$1,250 per ton, up to $10,000; requires IC installation
IC	$500 per indoor unit, up to $1,500

Source: Guidehouse

The program is designed to motivate customers to reduce greenhouse gas (GHG) emissions from fossil fuel heating sources by using a more efficient HP to provide a majority of the home's or full zones' space heating needs. For partial-home displacements, the program requires ICs to encourage customers to prioritize the use of HPs for heating and reduce usage of their legacy fossil fuel heating systems.

1.2 Study Goals and Research Objectives

The study focuses on understanding IC systems in partial displacement scenarios in single-family homes with mini-split HP systems. The previous Energy Optimization Fuel Displacement study found that homes with mini-split systems with ICs often experienced more challenges with the IC system than those with central HP systems.[12] For this reason, the current study does not focus on customers who have ICs with central HPs.

Previously conducted research suggested that customers who install ICs are employing a wide variety of switchover temperatures to toggle between HP usage and fossil fuel system usage. The program specifies which temperatures should be used as maximum switchover points between the HP and fossil fuel system (customers might opt for lower switchover points). Changes made to this point by either contractors or customers might affect bill savings, energy

[10] Previous guidance for the whole home pathway indicated that homeowners must not use the pre-existing heating system except in cases of emergency (including very low temperatures).

[11] Switchover temperatures change periodically.

[12] Guidehouse, *Energy Optimization Fuel Displacement Impact and Process Study,* https://ma-eeac.org/wp-content/uploads/MA20R24-B-EOEval_Fuel-Displacement-Report_2021-10-13_Final.pdf. The study findings are based on data collection completed for 2019 program participants.

savings, and GHG emissions savings. Additionally, the research indicated that the products available through the IC offering varied widely in terms of functionality and features. Connectivity and usability issues in early IC platforms have made some contractors and customers wary of using these technologies.

This study is focused on research topics related to IC technology and how contractors and customers are using these platforms. While researching the technical aspects of ICs, the study team also learned more broadly about system configuration and use cases and how they support program goals to reduce/displace fossil fuel usage. As a result, the findings and recommendations span both the initial research topics as well as broader issues around configuration and use cases.

This research focuses on the installation of ductless mini-split HPs with ICs in a residential setting. The study goals are as follows:

- Understand whether customers and contractors using the current generation of controls experience the same challenges (connectivity and usability issues) as the previous ones installed in 2019 and whether updates and experiences (e.g., software upgrades, a qualified contractor list, additional contractor experience, and training) have positively affected the experience of customers and contractors with the equipment installed in 2021 and 2022.[13]
- Understand how customers and contractors are using the current HP and IC equipment and whether their use of the equipment and applications has changed as new versions and generations of both hardware and software have been released.
- Identify if there are opportunities for additional education or marketing/messaging to support contractors and customers around using the IC system.
- Determine whether there are specific makes/models of ICs that are underperforming (e.g., reliability, failure rates, switchovers disabled, customer or contractor complaints) and should be considered for removal from the program.

The evaluation team designed research activities that address the following specific research questions:

- What are the functionality and features of the ICs employed by the program? What do contractors understand about controls? What are acceptance levels, for contractors and customers, of different types of controls?
- How does customer/contractor acceptance of single versus multiple points of control differ?
- How are current customers using their ICs? Does the customer experience and use differ by control type? What have contractors observed as they interact with customers on ICs?
- What are barriers for contractors to promote and install, and for customers to maintain, ICs in their partial displacement mini-split HP systems? How could these barriers be overcome?
- How well, if at all, do these IC systems work with smart thermostats?
- Are there specific makes/models of ICs that should be considered for removal from the program due to low reliability of measure impacts?

[13] Previous study results were released in July 2021, which left limited time for PAs to make programmatic changes prior to this study.

1.3 Summary of Research Activities

Table 3. lists the activities the team conducted to answer the research questions.

Table 3. Research Activities

Activity	Description
ICs product secondary research	Internet desk research on the various IC systems to understand what customers and contractors are reporting on the functionality and usability of these systems.
Contractor interviews	Up to 12 contractor interviews with Mass Save-qualified HP installers who install mini-split HPs and ICs, to understand installation barriers, functionality of HPs and ICs, and customer feedback.
Manufacturer interviews	Up to nine manufacturer interviews to understand market changes for ICs, how they are adapting to feedback on IC technologies, integration with smart thermostats, and contractor training capabilities.
Participating customer survey	An online survey of participants to gather information on technology satisfaction, and how customers use their HVAC system(s) and ICs, switchover temperatures, and experience using IC apps.
Participating customer in-depth interviews	Follow-up in-depth interviews with participants from the survey to better understand nuances of customer experience with using HPs and ICs.

Source: Guidehouse

2. Methodology

The following sections outline the methodology for this research.

2.1 ICs Product Secondary Research

For the product research, the team conducted internet desk research on the various IC systems to understand what customers and contractors are reporting on the functionality and usability of these systems. The research looked at online product reviews and forums to determine system features, customer feedback, and system failure points. The team examined online reviews from Amazon, Home Depot, technology blogs, and Reddit forums on products such as Flair Puck Pro, Mitsubishi Kumo Cloud and Kumo Station, Ecoboee3 Smart Thermostat, Honeywell Home and D6 Thermostats, Google Nest, Bosch Connected Control, and Daikin DKN Plus Interface.

2.2 Contractor Interviews

The team conducted 12 interviews with Mass Save program-qualified contractors who install HPs with ICs. The interviews investigated the following topics:

- Experience with IC systems with a focus on:
  - Understanding what mini-split equipment and controls contractors typically install
  - Shifts in installation practices and experiences over time; have things changed since they started installing these systems?
  - Perceptions of various systems or manufacturers
  - Customer experience/feedback on the switchover or lockout temperatures and if/when contractors are called back to change it
  - Differences between hardwired ICs and Wi-Fi-connected ICs
  - Challenges with smart thermostats and ICs
  - Perspectives around multiple points of control versus a single point of control
- Customer experience with the system and usability, made up of:
  - Customer experiences around the controls; feedback that contractors have received about the systems
  - Customer reactions and responses to the ICs
  - Usability of the controls and the mini-split HPs
  - Other product feedback and training needs

The contractors interviewed for this data collection activity were responsible for around 612 HP and IC projects (around 12% of applications) at the time of the interviews (Fall 2022). Additionally, all companies the interviewees represent are on the Mass Save Heat Pump Installer Network list.

2.3 Manufacturer Interviews

The team interviewed three representatives from product manufacturers. Two of the interviewees represented major HP manufacturers that also have IC products. One interviewee represented a third-party IC manufacturer.

The interviews covered the following research questions:

- How do manufacturers view the market and changes to the IC market?
- How do their products meet the needs of the changing market, including the needs of the Mass Save programs?
- Who do manufacturers view as the main operators of ICs: customers or contractors? What factors impact this view – are ease of use of ICs and need to update switchover temperatures taken into consideration?
- What feedback have manufacturers heard from customers and how have they adapted or integrated that feedback into their software, hardware, or materials? Where do manufacturers see the market moving and how are they adapting?
- Are mini-split manufacturers considering partnering with thermostat manufacturers or making their own to enable more seamless control of ductless HPs and backup heat from a single thermostat?
- The level of contractor training and support they provide and how this might have changed in response to feedback from customers and contractors. What materials do they provide to contractors to aid them in their installations?

2.4 Participant Survey

This study also featured a participating customer survey. Table 4. describes the survey sampling strategy and survey results.

Table 4. Sample Description

Characteristic	Description
Population description	Participants in Mass Save's HP and IC offering with installation dates in 2021 and January 2022-August 2022 (77% of respondents were 2022 participants and the remaining 23% were from 2021)
Population size/sample frame	2,611 unique customers
Type of sample	Census
Recruitment strategy	Email
Completes	443
Instrument type	Web survey
Length	15 minutes
Description of contact sought	End-use customers who can provide information on using the HP/IC systems and who made the decision to install the new heating system
Participation incentive	$20 per complete

Source: Guidehouse

Specific research questions included the following:

- What heating and cooling equipment were present pre-retrofit? Is this equipment still installed? How is it used?
- Experience with IC systems including perceptions of the usability of the app and/or thermostat, experiences with setting or shifting the switchover or lockout temperature, and comparison with previous thermostat device or application. The team also asked if/how they use the remote control, e.g., do they turn the HP off if they are not in the room?
- Satisfaction and familiarity with the technology including comfort and perceived energy impacts.
- Interaction with the IC system; for example, did the customer change the IC lockout temperature setting after the contractor installed the system? If so, what temperature did they set it at?
- Demographic and building characteristics (building type, age of building, ownership status, income).

Of these survey respondents, the majority were aged 46 or older. Ninety-two percent reside in single-family detached homes, and over 60% of these homes were between 1,500 and 2,900 square feet. Most respondents' homes were built in 1979 or earlier.

2.5 Participant In-Depth Interviews

Survey respondents were asked if they were willing to share more information on their new HVAC systems via in-depth interviews. The team completed 12 interviews, representing a variety of HP and IC manufacturers and a range of satisfaction rankings with their new systems. The interview covered customer experiences, challenges, and specific usability concerns with using ductless mini-split HPs with ICs in more depth.

Specific research questions included the following:

- What heating and cooling equipment were present pre-retrofit? Is this equipment still installed? How is it used?
- Experience with IC systems including perceptions of the usability of the app and/or thermostat, experiences with setting or shifting the switchover or lockout temperature, and comparison with previous thermostat device or application. The team also asked if/how they use the remote control, e.g., do they turn the HP off if they are not in the room?
- Satisfaction and familiarity with the technology including comfort and perceived energy impacts.
- Interaction with the IC system; for example, did the customer change the IC lockout temperature setting after the contractor installed the system? If so, what temperature did they set it at?
- Demographic and building characteristics (building type, age of building, ownership status, income).

3. Research Findings

This section presents findings on customer and contractor experience with HPs and ICs in partial displacement settings. Findings draw from all research activities and are organized thematically.

3.1 Key Findings

This section provides an overview of key findings from the study, organized into four categories. These findings are as follows:

3.1.1 Configuration and Use Cases

- **Customer-reported HP configurations suggest that a substantial portion of customers are installing mini-split HPs and ICs in cases where the HPs are used as supplemental for heating, though program intention is for the HPs to be used as primary with the legacy fossil fuel system as backup and the IC controlling which system is active.** Customers (and contractors) often install ICs in scenarios that might not require them or be significantly well-served by them, as indicated by a combination of survey and interview data. Fewer than half of survey respondents indicated that they use the HPs as their primary heating source (i.e., customers indicate they use HPs for most of their heating needs). The customers that did not indicate that the HPs are used for most of their heating needs likely use their legacy fossil fuel system for most of their heating needs. Additionally, some customers use mini-split HPs in limited areas within their home while heating other spaces with their legacy system (it is unclear how many customers are offsetting full zones as opposed to installing HPs in single rooms). Only 38% of respondents indicated that over three-quarters of their home was served by the HPs, and 35% indicated that less than half the home was served by the HPs. Using ductless mini-splits for individual rooms or certain smaller areas of the home removes the need for ICs because the legacy heating system might be running simultaneously with the HPs. Additionally, even when customers switch between the systems, they do not always use ICs to do so, opting instead for manual control. Some contractors instruct customers to manually switch between their heating systems. Of survey respondents, 44% indicated that they do not use their IC to switch heating systems. IC use might be inappropriate in some cases, including those in which a homeowner would likely still need to use their legacy heating system to provide heat for other parts of the home while using the HP in one room, or where customers are installing ICs and not using them.

- **Forty-one percent of survey respondents indicated that they installed ICs to receive the program rebate.** Current program guidelines require that all customers who want to install mini-split HPs and keep their legacy heating systems must install an IC to receive the rebate. This requirement is driving customers to install ICs but might also be encouraging installation of ICs in cases where they are not necessarily a value-add for the customer. The rebate amount is high enough that customers want to install controls to receive its value but might not necessarily be using the products as intended or for ideal performance. These installations might not be resulting in intended outcomes. Contractors corroborated some ICs are installed only for the rebate. Additionally, some contractors recommended customers switch to manual control of the heating systems even after receiving the rebate for and installing ICs.

3.1.2 Customer Motivations and Customer/Contractors Satisfaction

- **Customers are primarily installing HPs for cooling purposes.** The program views HPs and ICs as a way to offset heating load, but customers are driven to install HPs primarily for cooling. Fifty-nine percent of respondents indicated that cooling was a motiving factor for HP installation and 30% indicated that it was their primary motivator. Respondents also indicated their desire to be energy efficient as a strong motivator, though whether this was through cooling or heating is unclear, and adding cooling was the primary motivator. It should be noted that initial customer motivation does not necessarily reflect how they subsequently use their systems; though customers seeking HPs for cooling might also result in displacement of fossil fuels used for heating, customers' primary motivator for installation is not completely aligned with program goals. This finding bolsters the need for additional education around the heating benefits of HPs.

- **Customers indicate that overall, they are satisfied with their new HPs, despite dissatisfaction in their ICs.** There is a substantial discrepancy between customer satisfaction with their HPs compared with ICs: Eighty-six percent of participants rated their new HP equipment a 4 or 5 on a 5-point satisfaction scale, with 1 being "not at all satisfied" and 5 being "very satisfied," while only 47% rated their IC equipment a 4 or 5 on the same scale. Additionally, about half of survey respondents did not feel that the ICs were easy to use. There were not significant differences in ease of use among IC models installed; customers rated ease of use similarly across IC platforms used, indicating that no IC models are substantially over- or underperforming.

3.1.3 Product Connectivity and Functionality/Qualified Products List

- **Customers report switchover temperatures that are higher than those indicated by the program guidance.** For example, 37% of customers reported a switchover temperature of 33°F to 50°F. Notably, 58% of customers with oil as the baseline heating fuel indicated the switchover temperature was above 30°F, and 81% indicated it was above 20°F (Table 5. Customer Reported Switchover Temperatures).[14] Fewer than half of respondents report that switchover points are set by contractors or through customer agreement with the contractor, 20% indicated that a household member set the switchover temperature, and 25% indicated that they did not know who set it. The majority of customers report being able to change the switchover temperature whenever they need to, and contractors indicate that their clients do change switchover points based on personal comfort or other factors.

Table 5. Customer Reported Switchover Temperatures

Fuel Type	Switchover Temperature	Percentage Set Above Temperature	Percentage Set Below Temperature
Gas (n=22)	45°F	27%	73%
Gas (n=22)	30°F	68%	32%
Oil (n=26)	30°F	58%	42%

[14] The Energy Optimization Fuel Displacement Impact and Process study indicated that 43% of surveyed customers indicated their switchover temperature was above the 35°F program guidance.

Oil (n=26)	20°F	81%	19%

The program also offers guidance on switchover temperatures for propane, but the base sizes for those using propane as a fuel type were too small to report on customer behavior. Note that 46% of survey respondents indicated they use the IC to switch between heating systems.

Source: Guidehouse

- **Phone application and system connectivity remain issues with the technology, but manufacturer-led changes might refocus product R&D teams to address these issues.** Specifically, contractors and customers noted Wi-Fi issues or problems with the IC apps connecting with the HPs. Contractors seemed overall skeptical of IC technology. Manufacturers interviewed (Mitsubishi, Flair, and Samsung) noted that their companies are potentially looking to grow those product lines, and address connectivity and app usability issues. They pointed out that R&D teams for major HP brands were often located outside of North America and not geared toward products that address partial displacement scenarios that are more prevalent in areas of North America.

- **Among different IC products, there were no discernable differences in ease of use in customer responses.** Customers indicated via the survey that no IC product was significantly underperforming or overperforming. Contractors did, however, report preferring to install IC products with the same brand as the HPs installed; it should be noted that contractors' preference for IC products is influenced by their relationship with the product manufacturer (contractors often have long-standing relationships with particular HVAC manufacturers). They also reflected that the Flair Puck product was difficult to install; however, this third-party controller is useful for customers who might have multiple brands of mini-split HPs in their homes (for example, in cases where the HPs were installed at different times). Contractors also reflected some negative experiences with installing the Mitsubishi KUMO products, though this IC brand was most prevalent in the sample.

3.1.4 Training and Education

- **Survey respondents reflect that they receive minimal if any instruction or training on how to use ICs.** When asked in an open-ended question about contractor instructions on ICs, only 14% of survey respondents indicated that they received a thorough explanation of how to use the ICs or subsequent contractor support. Given connectivity issues (i.e., issues with the IC app connecting to the HPs)[15], the "set it and forget it" approach for ICs might not be practical, and, as a result, customer education on how to use them could be beneficial.
- **Program contractors participate in HP and IC trainings from manufacturers and Mass Save,** but additional clarity on use cases for ICs and how to educate customers on their usage might be useful for ensuring that HP and IC installations are appropriately done to maximize displacement of fossil fuel usage.

The subsequent subsections provide additional details.

[15] In these cases, customers report the app losing control capabilities over the HPs, though it is unclear if settings remain intact upon reconnection. Connectivity loss results in customers having to manually control each heating system separately in many instances.

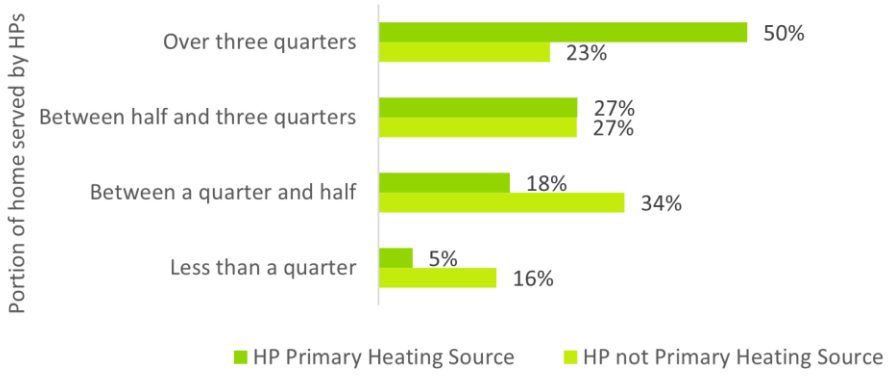
3.2 Customer and Contractor Experience with HP and IC Systems

The subsections below outline customer and contractor experience with HP and IC systems.

3.2.1 Configurations and Use Cases

Customer-reported HP configurations suggest that a substantial portion of customers are installing mini-split HPs and ICs in cases where the HPs are used as supplemental, though program intention is for the HPs to be used as primary with the legacy fossil fuel system as backup and the IC controlling which system is active. Customers who are using the HPs as their primary heating system (i.e., where HPs are used for most of their heating needs) are more likely to indicate that their entire home is served by the HPs, whereas those that do not use the HPs as the primary heating source use the HPs in living room or primary bedroom areas. Of customers who indicated that HPs were their primary heating source, 50% indicated that the HPs provide heating to over three-quarters of their home. In contrast, of those who indicate the HPs are not their primary heating source, 40% indicate that less than half their home is served by the HPs (**Error! Reference source not found.**); some customers might be offsetting an entire zone, which follows program guidance, and others might be using HPs for smaller spaces.

Figure 1. Percentage of Respondents' Homes Served by HPs



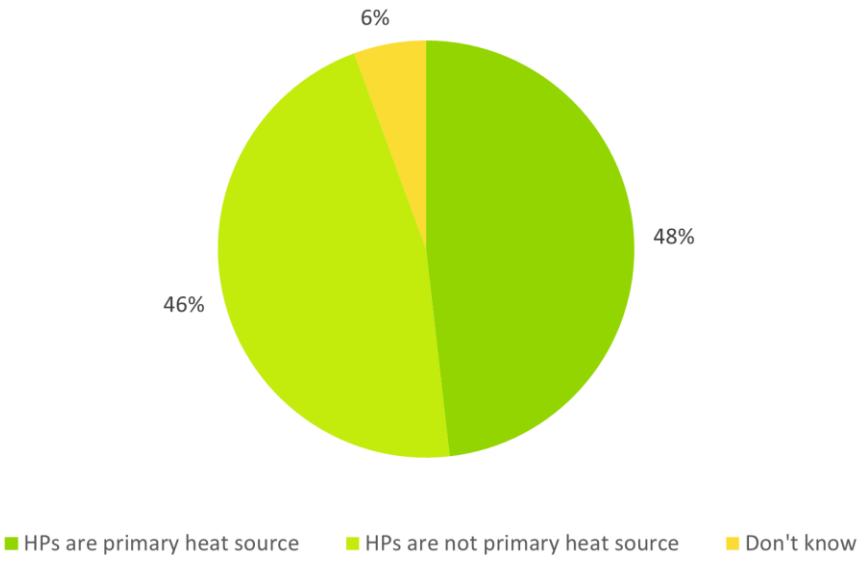
Source: Survey question "Do you use your new mini-split heat pump system for most of your heating needs?" Single response, n=319. Survey question "Approximately what percentage of your home is served by the new mini-split heat pump system?" Single response, n=308.

While these differences are expected based on whether a customer has configured their HPs to be primary, it suggests that a portion of program participants could be using HPs as supplemental or only in certain rooms of their homes, which diminishes fossil fuel displacement per home. Primary HP users are more likely to have more of the house covered by HPs, which is consistent with their primary motivations for having the fuel system as a true backup and wanting to offset fuel costs. Non-primary HP respondents are spread across all four categories of home space served by the HPs.

Fewer than half of surveyed customers use their new mini-split HPs for most of their heating needs. Forty-eight percent of survey respondents indicated that they use the HPs for most of their heating needs ("primary" HP users), and 46% said they were not using their HPs for most of their heating needs ("non-primary" HP users) (Figure 2). This data shows that only

around half of the survey respondents indicate that they are displacing heating for their entire home.

Figure 2. HPs Usage as Primary Heat Source



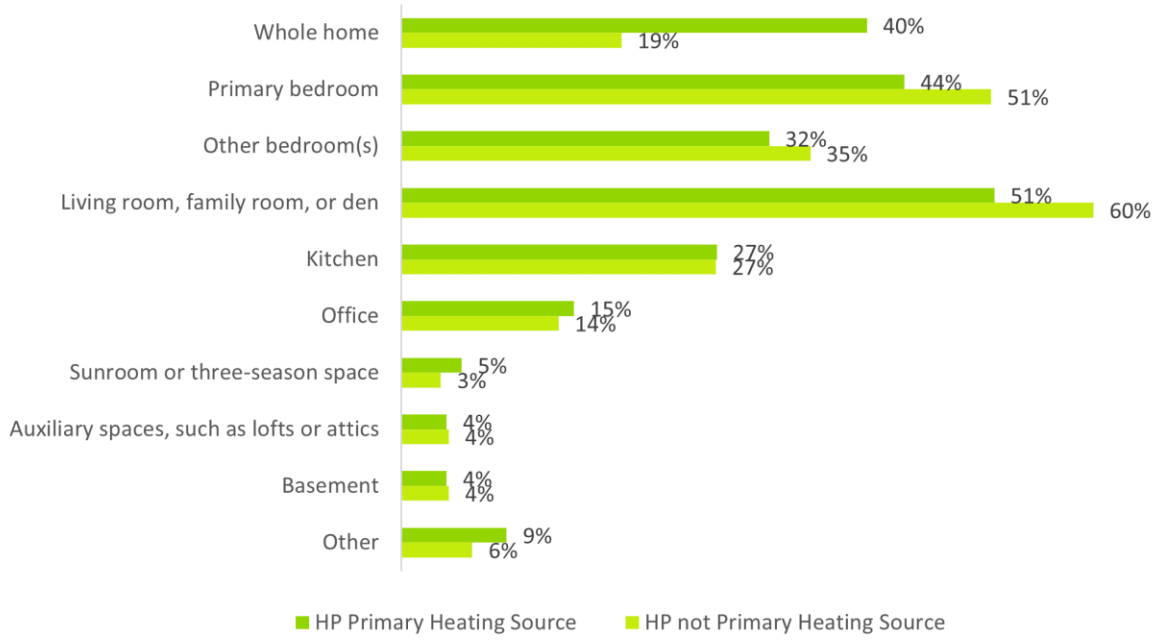
Source: Survey question "Do you use your new mini-split heat pump system for most of your heating needs?" Single response, n=319.

Non-primary and primary HP users reported different motivations for HP installation. Of the 59% of customers who say they installed the mini-split HPs to provide cooling, 57% were "non-primary" HP users, while 43% were "primary" HP users. In contrast, those who installed mini-splits to be more energy efficient were more likely to be "primary" HP users – 59% as opposed to 42% of "non-primary" HP users. Respondents were equally likely to be primary or non-primary HP users if they cited wanting the rebate as their main motivation for IC installation. Motivations for installation are discussed in the next section.

Non-primary HP users more often report that they were opting for partial replacement to avoid replacing their entire heating installation (58%) compared with primary users (42%), whereas primary users were more likely than non-primary users to cite a) their intention to use their old system as a backup and b) their desire to reduce fossil fuel usage as reasons for partial installation.

Additionally, Figure 3 shows which spaces survey respondents indicated were served by the HPs; 40% of customers who configured their HPs as the primary heating source indicated that the HPs serve the whole home as opposed to 19% of non-primary HP users. Of all survey respondents, only 38% indicated that over three-quarters of their home was served by the HPs.

Figure 3. Areas Served by HPs



Source: Survey question "Do you use your new mini-split heat pump system for most of your heating needs?". Single response, n=319. Survey question "What space(s) does your new mini-split heat pump(s) serve?" Multiple response, n=301.

Contractor feedback also supports the idea that many customers are using the HPs as non-primary heating sources, which makes IC usage not ideal. One contractor indicated, "The [installs] where you have more problems are the partial home displacement with an IC…. Thermostat in the hallway, you maybe did three bedrooms, and now maybe you have a kitchen with no heat. There's no coverage." This was followed with the contractor's sense of an ideal use case, in which the HPs are installed in the entire home and the ICs are used to switch heating source below certain temperatures, as opposed to using HPs and ICs for particular zones or rooms. "ICs work good [sic] where you…can cover the…whole home…with an IC package – it's a whole-home heating system…You don't need to put the boiler on unless it's an absolute emergency. Those are the true people that really want [HPs and ICs]. They're concerned about the environment. They want clean heat." Another contractor noted that the ideal use case for ICs is to use HPs to cover the entire home's heating load (using the IC to switch to the legacy system below certain temperatures), but also noted that installing more mini-split units can increase costs. However, survey data indicates that a substantial portion of customers are not installing enough mini-split HPs to cover their entire home/zone and make effective use of ICs; this presents a key barrier to achieving program goals. If a customer is using an HP in a smaller area of their home (e.g., a study or individual room) and that area is zoned off, some fossil fuel displacement does occur, but it is substantially less than if most or the entire heating load of the home was addressed by the HPs.

Customers primarily use the remote controls to adjust their HPs, but report using a variety of methods. Seventy-six percent of survey respondents indicated that they use the remote control to adjust the HPs, 68% said they used an app or website, and 58% said they use a smart thermostat, indicating that customers do use multiple devices to control their HPs. Additionally, 43% of customers said they use a thermostat every time they want to control the

HPs and 38% said they use the remote controls every time. Only around 19% of survey respondents said they use an app or website to control the HPs every time they use them.

Though respondents indicated multiple ways they control their HPs, the prevalence of remote control usage suggests that many customers prefer to manually control their HPs rather than exclusively use the IC app and that the HPs are supplemental heat sources instead of primary. There was no significant difference in preference for thermostats, phone/website apps, or remote controls as a means of controlling HPs between primary and non-primary HP users.

In 26% of responses, the switchover temperature was set by the contractor at a mandated point, with another 22% of respondents citing having agreed on a temperature together with their contractor. Twenty percent of respondents reported it being set themselves or by someone else in the household, and 25% indicated that they did not know who set the switchover temperature. Seventy-one percent of all respondents said the switchover point could be adjusted whenever they needed to. In 46% of cases, the switchover temperature was set below 32°F, while 38% had it set between 33°F and 50°F. Table 6 shows switchover temperatures reported by customers.[16]

Table 6. Customer Reported Switchover Temperatures

Fuel Type	Switchover Temperature	Percentage Set Above Temperature	Percentage Set Below Temperature
Gas (n=22)	45°F	27%	73%
Gas (n=22)	30°F	68%	32%
Oil (n=26)	30°F	58%	42%
Oil (n=26)	20°F	81%	19%

The program also offers guidance on switchover temperatures for propane, but the base sizes for those using propane as a fuel type were too small to report on customer behavior.

Source: Guidehouse

Contractors indicated that customers do not always use the IC switchover points as prescribed by the program because of their temperature comfort, level of understanding about the system, and interest in choosing electricity over fossil fuel. For customers who were primarily concerned with comfort, when the home became too cold when using the HPs, contractors relayed that the IC switchover temperature could be increased, whether by the contractor or by the customer if they were capable. Additionally, one contractor indicated that for customers concerned with feeling warm enough with the HPs, they set up a scenario where the fossil fuel system and HPs could run in parallel, thus making the recommended switchover temperature moot.[17] Other contractor-reported workarounds for maintaining customer comfort (and avoiding callbacks) included not installing ICs in colder rooms but including them with recommended switchover temperatures in other parts of the house. One contractor also indicated that they suggest that customers get rid of their ICs and just manually use HPs in the spring, summer, and fall, and then revert to their fossil fuel system for heat in the winter; this setup helped avoid a “callback nightmare” for the contractor.

[16] The Energy Optimization Fuel Displacement Impact and Process study indicated that 43% of surveyed customers indicated their switchover temperature was above the 35°F program guidance.

[17] The contractor did not specify if they instructed customers to use a droop routine or if the systems were running concurrently.

Two contractors also reported that some customers change switchover temperatures based on their interest in reducing fossil fuel usage. In these cases, customers want to make use of their mini-split systems at even lower temperatures than recommended by the program (the Mitsubishi Hyper Heat product was mentioned in this type of scenario). These customers feel that the IC switchover points represent a loss of control if they want to arbitrage between electric and fuel costs. In some cases, these customers also have solar PV systems, so keeping the HPs running is more advantageous to them than switching to the fossil fuel system. It should be noted that the program recommends maximum switchover temperatures, so customers seeking lower switchovers still fall within program guidance; this detail should be clearly communicated to customers by contractors and program materials.

Overall, contractors reported that customers use their IC switchover or switchover points in a variety of ways, many of which differ from program recommendations, and customer survey results indicate that most customers are aware that the switchover point can be changed when they want to.

Program rules regarding whole-home HP projects might be undermining the partial home (HP and IC) pathway. Six of the 12 contractors interviewed indicated that either they prefer to do whole-home projects (full displacement) or that those were a more popular pathway for customers. One contractor indicated that by doing the whole-home replacement pathway, the customer is not required to install ICs, which lowers the labor cost and typically increases incentive payment. That contractor explained that for the whole-home installations, customers are not necessarily required to remove their old fossil fuel system but can preserve them for emergency use. The contractor also noted that as the emergency use specification is ambiguous, there is nothing preventing a customer from using the fossil fuel system whenever they please.[18]

Another contractor also noted that customers who are familiar with how ICs work are typically the ones who do not want to use them – they prefer the whole-home option. These are the customers who are more motivated to reduce carbon emissions and be environmentally friendly; they are less concerned with how their utility costs might vary.

Another contractor said that they recommend removing the HP and IC rebate pathway from the Mass Save program, and that they would be pleased if Mass Save came up with an option that incentivized people to remove their fossil fuel systems more effectively.

Multiple contractors found that whole-home replacement with enough heads to warm the house often ended up being lower cost than that of implementing ICs, even when factoring in the rebate. For these whole-home projects, however, contractors indicated that other competitors were bidding those jobs with only two or three indoor mini-split heads, which they did not believe would provide adequate heating for the homes they were serving.

3.2.2 Customer Motivations

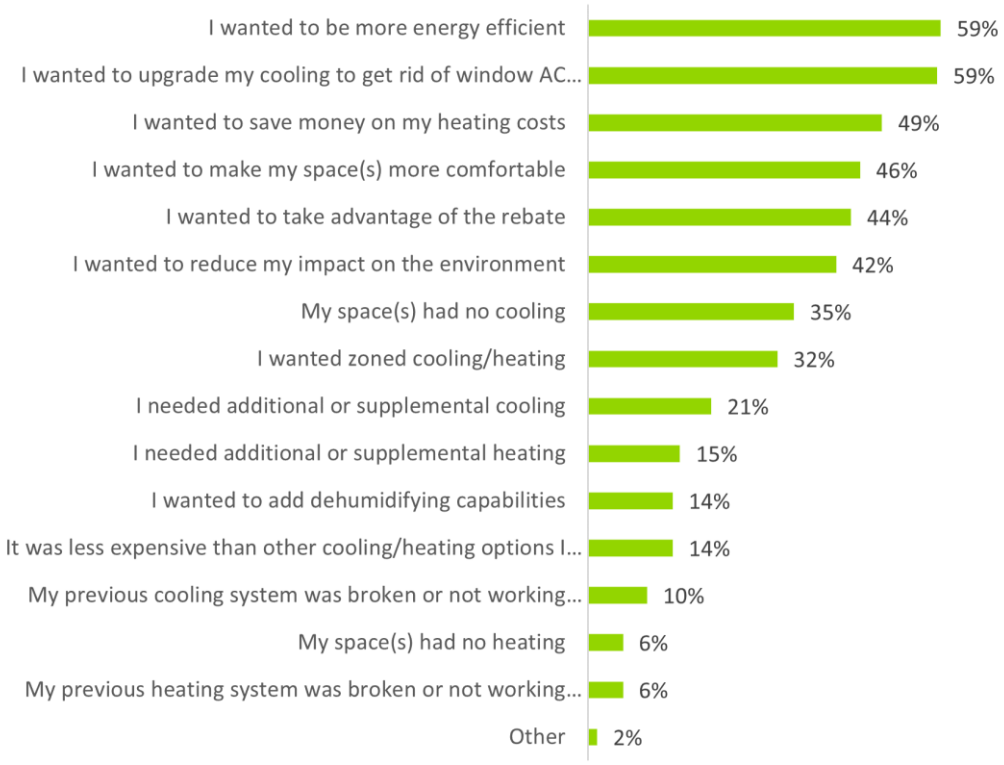
Key motivators for respondents to install HPs were to upgrade cooling/get rid of window AC units (59%) and to be more energy efficient (59%) (Error! Reference source not found.**).**

[18] Since this interview was conducted, the program has clarified rules and guidance around emergency use of a backup fossil fuel system in the whole home displacement pathway.

Customers also wanted to save money on heating costs (49%), make their homes more comfortable (46%), receive a rebate (44%), and reduce environmental impact (42%).

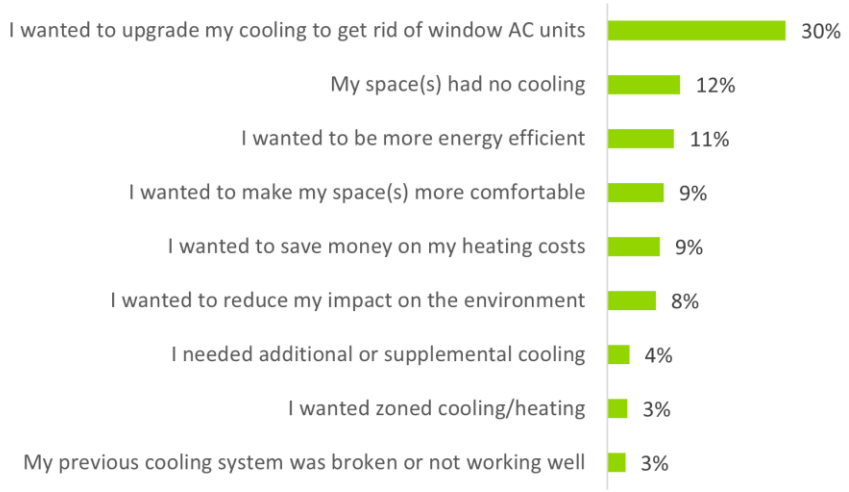
Although energy efficiency and cooling were both key motivators, when asked their primary motivation for installing HPs, customers reported that their top motivator for installing HPs was upgrading cooling or getting rid of window units. Thirty percent of respondents wanted to remove their window units, and 12% primarily installed HPs because their space had no cooling. In addition, 3% said their previous cooling system was broken or non-functional. By contrast, improving energy efficiency was the top motivator for 11% of respondents (Figure 5).

Figure 4. Reasons for HP Installation



Source: Survey question "Why did you want to install a heat pump?" Multiple response, n=324.

Figure 5. Primary Reason for HP Installation



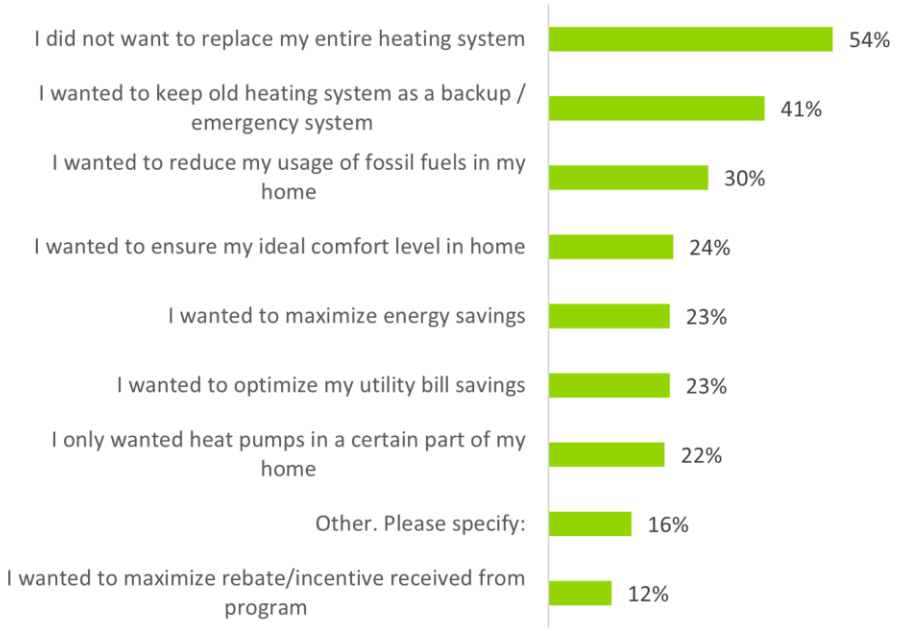
Source: Survey question "Of these motivators, which was the most important to your decision to install HPs?" Single response, n=298.

Findings from the team's in-depth interviews with customers corroborate the customer survey results. Seven of the 12 participants interviewed mentioned that cooling was one of the main reasons they decided to install HPs. One customer said that they "didn't even think about [the upgrade] from a heating perspective," as their house did not have central air. Their contractor recommended mini-splits as a more efficient cooling alternative to central air, which the customer said was "a good new selling point." They also wanted to replace their old window units because they were "noisy and non-efficient," and they found it inconvenient to install the window units and take them out when the seasons changed. Another customer who installed HPs for their cooling abilities mentioned that the old AC units were loud, clunky, and leaky.

A few contractors (n=3) from the team's in-depth contractor interviews have also encountered many customers who are interested in HPs for their cooling capabilities. One of these contractors stated that he gets "a lot of calls about cooling only" from interested customers. Another contractor said that ductless mini-splits are a popular cooling choice because they work well to cool homes with no central AC or duct work.

Respondents also indicated they opted for the partial displacement scenario over the whole-home pathway because they did not want to replace their entire heating system (54%) and they wanted to keep the legacy system as a backup or emergency heating source (41%, Figure 6). From the customer interviews, one participant wanted to add cooling without replacing their existing heating system, as they recently had the prior heating system installed and considered it very efficient. They kept their gas system in the home as a backup but have not yet had to use it due to a warmer winter season. Another customer decided to move forward with a partial displacement because they wanted to have zoned heating in the home. The new zoned heating system allows them to maintain warmer temperatures in certain rooms for their new baby while saving money by lowering the temperature in the rest of the home. One customer also added that they were not "ready to make the jump" to a fully electrified heating system. This customer was specifically worried that their pipes would freeze without their boiler system backup kicking on in cold temperatures.

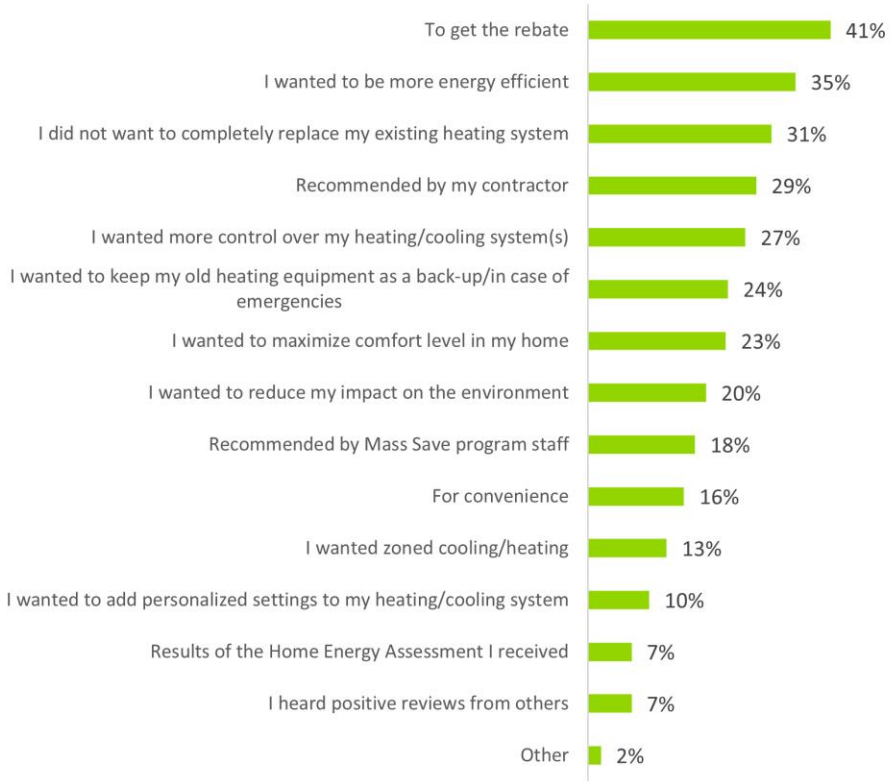
Figure 6. Reasons for Customers Choosing Partial Displacement Over Whole-Home



Source: Survey question "Mass Save® offers both whole-home and partial-home installations as part of this program. Why did you decide to move forward with a partial installation?" Multiple response, n=319.

Program rebates influence customers to install ICs, leading to some contractors and customers installing ICs they view as unnecessary. Forty-one percent of respondents indicated that they were motivated to install ICs to receive program rebates (**Error! Reference source not found.**). Only 25% of customers would have installed ICs without the rebate from Mass Save. Additionally, only 17% of customers indicated they were familiar with ICs and were considering installing them before participating in the program.

Figure 7. Reasons for IC Installation



Source: Survey question "Why did you decide to install integrated controls (controls that switch between electric and fuel heating systems)?" Multiple response, n=270.

Four of the 12 customers interviewed noted that they installed ICs because of rebate requirements. Two mentioned that their contractors directly told them they had to get ICs to receive their rebates. One participant described getting ICs as "frustrating" and "confining" because they were "spending more money just to get the rebate." Another customer said they "wish there was an option to not install ICs and explain why."[19]

Contractors also report that rebates are incentivizing customers to install ICs. Six of the 12 contractors interviewed indicated that customers are attracted by the high rebate value to install HPs and add ICs. In some cases, contractors reported customers wanting to install ductless mini-splits and ICs, even if their home and system configuration would not benefit from ICs (e.g., installing mini-split HPs in a single room instead of throughout the house), just to get the rebates. Two contractors also indicated that their customers were motivated to participate in the rebate program to secure the 0% interest loans. Contractors also indicated that some customers are motivated to install ICs for the rebate and then override them based on either personal comfort or their preference for non-fossil fuel heating types.

One contractor indicated that they install the HPs and ICs for the customer to receive the rebate but set up the HPs in parallel with the fossil fuel system. In this type of configuration, customers

[19] It should be noted that there are midstream incentives for HPs, but customers might not be aware of that initiative and the value is lower than downstream options.

can use the HPs and fossil fuel systems simultaneously so that parts of the house not served by the HP indoor head could be heated (thus eliminating one source of customer complaints, but also making the switchover points moot). In other cases, contractors and customers eliminate the ICs after installation and rebate receipt and manually operate the systems based on season, personal comfort, and fuel source preferences.

Some customers wanted to get the rebate and use their HPs as much as possible due to the high prices for fossil fuels for home heating; in these scenarios, they receive the rebate for the ICs but override them or disable them for manual control (even though they could use the ICs to prioritize HPs at even lower temperatures and set their legacy system thermostat to a lower setting). The cost of fuel in addition to the generous incentives motivates these customers' behavior. Two contractors indicated that some of these customers also have solar panels and are thus less worried about increased electric consumption.

While the program's rebates motivate customers to install ICs, having ICs as part of their heating system might not always benefit the customer. Contractors highlighted that customers are heavily motivated by rebates, even when they are "not using it for what makes sense." Incentives are a major draw, often overriding other considerations, like home setup and potential usage. One contractor estimates that "30%-40%" of the market installs ICs because "they just want the rebate," and customer survey results support this estimate. Another contractor explicitly stated that their "customers want the rebate, but not the controls." Customers ask them "why can't I just turn it off when I want?"

3.2.3 Product Connectivity and Functionality

Contractors indicate that smart thermostats can be used as the IC platform or can be used in conjunction with another IC platform. Contractors have different opinions about using thermostat integration to toggle between the mini-splits and fossil fuel heating systems, ranging from "not worth the hassle" to "necessary for the system to work."

Some contractors report using the smart thermostat as the IC platform to toggle between the HPs and fossil fuel system. These contractors mentioned that they were able to hardwire the connection between the mini-split HPs and the thermostat that also controls the legacy system. Among those who install smart thermostats, no smart thermostat model emerged as the clear leader for connectivity with HPs. Ecobee, Honeywell, and Google Nest are frequently used to varying degrees of success. Brand preference depends on the contractor.

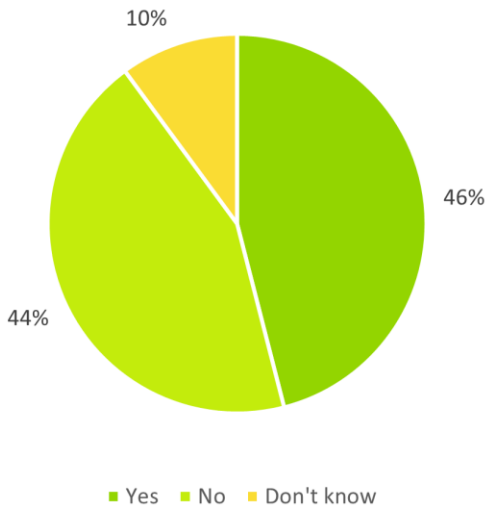
In some cases, contractors report using a smart thermostat and another IC platform, where the smart thermostat connects to the fossil fuel-based system, and the IC platform (e.g., Flair or Kumo Cloud) communicates with the HP. In some cases, contractors used the If This Then That app to connect the smart thermostat with the ICs platform. The contractors who employed this configuration reported that it is a hassle to connect the thermostat to the IC platform. An interviewed customer indicated that having to toggle between phone apps to control their legacy heating system or HPs was a hassle.

Overall, contractors prefer using a single point of control to toggle between the fossil fuel system and the HP system – either a smart thermostat or IC platform such as Mitsubishi Kumo Cloud. One contractor is currently not installing many smart thermostats because he views them as unnecessary when ICs are already being used. He indicated that using both presents additional connectivity issues. However, many customers ask their contractors to install smart thermostats, and a few have pre-existing smart thermostats.

As discussed in the earlier section, customers report that they use a variety of methods to control their heating system even though their contractors prefer a single point of control.

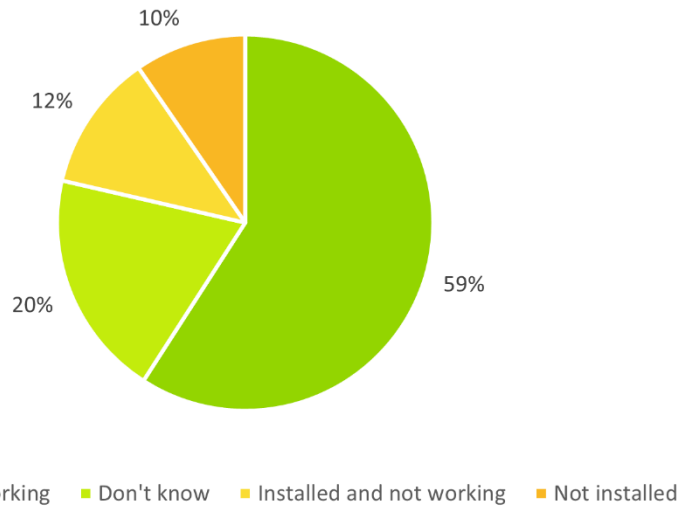
Customers are evenly split on whether they indicate that their IC is used to automatically switch between their HP and their legacy heating system. Forty-six percent of customers indicated that they use the ICs to automatically switch heating source, and 44% indicated that they do not use the ICs (Figure 8). Additionally, 59% of customers indicated that the ICs were still installed and working, and 22% said the ICs were either not working or are not installed (Figure 9). It should be noted that 20% indicated that they did not know if the ICs were still installed and working.

Figure 8. Customers Using ICs to Automatically Switch Heating Source



Source: Survey question "When you are heating with your heat pump system, do you rely on the integrated controls to automatically switch between the heat pump and your other fuel-fired heating system?" Single response, n=189.

Figure 9. Current Status of IC System

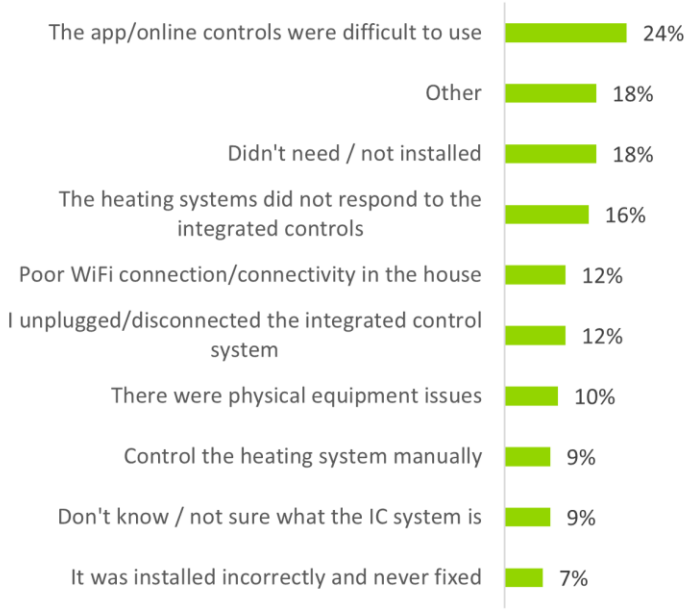


Source: Survey question "Is the integrated control system/system set up to switch between heat pump and other fuel system still installed and working?" Single response, n=323.

Customers who indicated that their ICs were not working or were not installed reported issues around difficulties using the control apps. Figure 10 shows the reasons why customers indicated their ICs were not working or were not installed. Twenty-four percent of respondents who said their ICs were not working indicated that the app was difficult to use,16% said the heating system did not respond to the ICs, and 12% indicated poor Wi-Fi. Other connectivity and functionality issues appear as reasons for customers indicating their IC was not installed or working, including that they thought they did not need the IC, or it was not ever installed (18%).

Additionally, many customers are confused about how to use their ICs. Some customers give the ICs a chance but face issues and move to manually switching between heating systems. Among customer interview participants, six participants reported experiencing issues with their IC technology. Five participants no longer use their ICs and switch between systems manually. Two participants reported that they never planned to use their ICs.

Figure 10. Reasons for IC Failure or Disconnection



Source: Survey question "Why is the integrated control system not installed or not working?" Multiple response, n=67.

Contractors also note that with wireless IC systems, Wi-Fi connectivity issues can cause functionality failure. Five contractors mentioned Wi-Fi issues affect the usability of IC products due to poor Wi-Fi connection between equipment or events of Wi-Fi outages. While IC products or smart thermostats are hardwired to existing fossil fuel heating systems, most use Wi-Fi to communicate with the mini-splits.

Many contractors report that customers experience connectivity issues after installation that prevent them from properly using their control systems. In one case, a contractor explained their standard practice was to create hardwired connections between the mini-split heads and

Ecobee smart thermostat to ensure consistent connectivity but doing so involved an increased cost and time for installation.

For the wireless products, some customers lose complete control over their heating systems—including the fossil fuel heat—when their Wi-Fi drops or their power goes out. When power returns, the Wi-Fi connection to the HPs and IC systems sometimes does not come back online automatically. One contractor who uses the Kumo Cloud system mentioned that he gets complaints from customers who experience no heat in their house after a power outage—when the IC loses connection to the HPs and sometimes customers lose control of their fossil fuel system through the platform as well (it should be noted that this this was not the case for every IC installation, but a scenario that this contractor encountered).

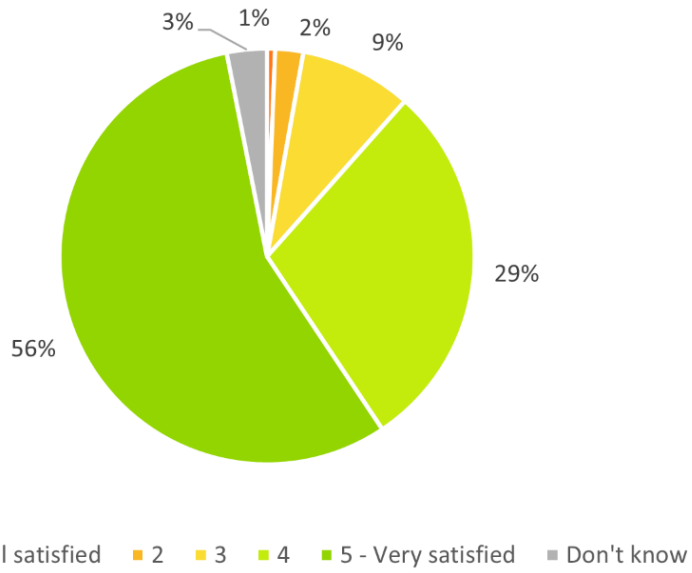
Another contractor highlighted that connectivity challenges are a larger issue for multi-level/large homes, as the Wi-Fi signal is not always strong enough to reach the whole house without adding boosters. To address this challenge, one contractor includes a dedicated router in IC install situations to minimize the capacity issues that can affect the system functionality.

Contractor feedback on Wi-Fi connectivity issues match findings from the customer survey and interviews. Some customers noted issues with Wi-Fi and app connectivity. One interviewed customer indicated that their Kumo app loses internet connection every so often and is unable to control the HPs as a result. Their workaround is to unplug and reset their Wi-Fi network and sometimes use the remote controls to operate the HPs. Additionally, three other customers indicated similar issues with lost connectivity in the interviews, and 12% of survey respondents indicated that poor Wi-Fi connectivity was an issue and another 16% reported that the heating systems did not respond to the IC.

3.2.4 Customer and Contractor Satisfaction

Overall, program participants are generally satisfied with their experience and new heating systems. Most customers (85%) rated “the overall comfort of their home after installing the new heating system and integrated controls” a 4 or 5 on a 5-point satisfaction scale with 1 being “not at all satisfied” and 5 being “very satisfied” (Figure 11). Satisfaction is even higher among customers who have seen a decrease in their combined energy bills, as 92% of those customers rated the overall comfort of their home a 4 or 5 on the satisfaction scale.

Figure 11. Overall Comfort of Home

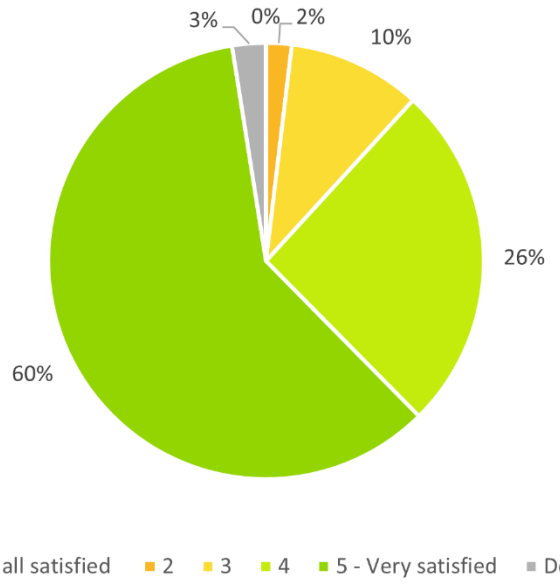


Source: Survey question "Using a scale of 1-5, with 1 meaning "not at all satisfied" and 5 meaning "very satisfied," how satisfied are you with the overall comfort of your home after installing the new heating system and integrated controls?" Single response, n=320.

Most survey respondents indicate that their electric bill has increased but their fuel bill has decreased. Sixty-eight percent of respondents indicated that their electric bill has increased, and 58% of respondents indicated that their fuel bill has decreased. Of those with oil legacy systems, 77% saw an increase in their electric bills. Of those with gas legacy systems, 69% saw an increase in their electric bills. Most respondents indicated that they believe their combined electric and fuel bills have either decreased (33%) or stayed the same (24%), and 26% of respondents indicated that their combined bill has increased. Of respondents with oil legacy systems, 48% saw a combined bill decrease; whereas 25% of those with gas legacy systems saw a combined bill decrease.

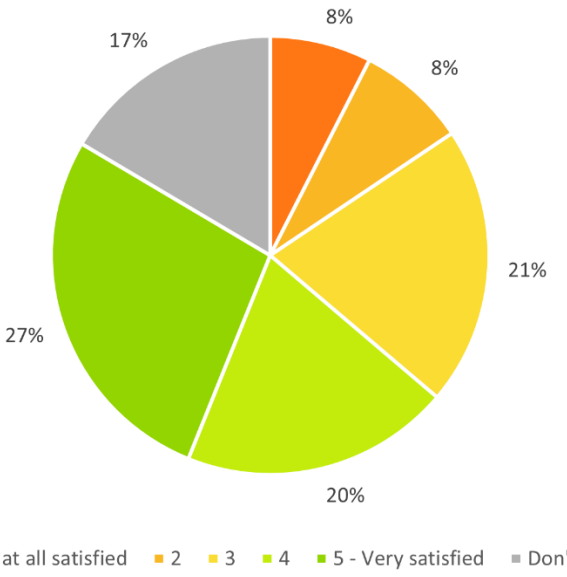
Customers report high satisfaction with the HP equipment itself but are less satisfied with the IC equipment. Eighty-six percent of participants rated their new HP equipment a 4 or 5 on a 5-point satisfaction scale, with 1 being "not at all satisfied" and 5 being "very satisfied," while only 47% rated their IC equipment a 4 or 5 (**Error! Reference source not found.**, **Error! Reference source not found.**).

Figure 12. HP Equipment Satisfaction



Source: Survey question "Using a scale of 1-5, with 1 meaning "not at all satisfied" and 5 meaning "very satisfied," how satisfied are you with the following aspects of your installation experience and the Mass Save® program? The heat pump equipment" Multiple response, n=322.

Figure 13. IC Equipment Satisfaction



Source: Survey question "Using a scale of 1-5, with 1 meaning "not at all satisfied" and 5 meaning "very satisfied," how satisfied are you with the following aspects of your installation experience and the Mass Save® program? The integrated control equipment" Multiple response, n=321.

Customers might be more satisfied with HP equipment because they have a better baseline understanding of the technology and how to use it. Forty-seven percent of participants were

familiar with HP technology and had considered installing it. Only 18% of customers had never heard of HP technology before participating in the program. In contrast, the majority (60%) of participants were not familiar with IC equipment before the program, and only 17% of customers reported being familiar with IC technology and had considered installing it before.

Despite the lower overall satisfaction with ICs, over half (55%) of customers rated their agreement with the statement "the integrated control system is easy to use" a 4 or 5 on a 5-point scale with 1 meaning "not at all agree" and 5 meaning "completely agree," and 61% of participants rated their agreement a 4 or 5 for the "integrated control system is a benefit of my new heating system." This could be because participants are conflating the IC system with the new heating system overall. Participants can feel a difference in home comfort after installing their new heating system, but they might have more difficulty discerning how the IC system is contributing. Participants might not fully understand how the ICs work because they have less background knowledge on ICs, and there are so many different potential products and configurations. Additionally, some participants might not struggle with using the IC system but find it unnecessary for their home heating and cooling needs, leading to lower satisfaction rates despite lack of issues.

Interview findings support the gap in satisfaction between HP and ICs equipment. All interviewed participants spoke very highly of their new heating systems and were satisfied with the new HPs. Seven customers reported feeling increased comfort in their home after installing the new heating system. However, 5 of the 12 interviewed participants experienced issues with the IC technology. Three participants no longer use their ICs at all and control the HPs manually. Two of these customers reported that they could use the ICs, and felt like their contractor properly explained everything, but personally prefer to manually switch between heating systems. Even those who are currently satisfied with their ICs might have experienced some initial issues or troubleshooting required before their system began working smoothly. One participant recounted that when it was first installed, the Kumo IC kept getting dropped from their Wi-Fi network. They would have to periodically reboot it for it to work with the mini-splits, and they ended up calling Mitsubishi for help. Mitsubishi recommended the participant reboot their Wi-Fi, so they had the installer come back in to do so, with no issues occurring since. This participant is now happy with their ICs but believes installing ICs is "not intuitive [and] takes a little experience and technical assistance" to get everything to work.

Among the contractors interviewed, there is general dissatisfaction with the current state of IC technology. Half of the contractors interviewed believe that improvements are needed with ICs, suggesting their performance is inconsistent. One contractor called ICs "cumbersome." In online product reviews, many customers are also not pleased with ICs. Reviewers reveal they have experienced a variety of complex installation issues when trying to connect ICs with their HPs. Connectivity and Wi-Fi issues are often brought up as major obstacles to usage. Some contractors have included workarounds like Wi-Fi extenders, but they noted they are not IT specialists. In general, contractors are enthusiastic about using mini-split HPs but reflect dissatisfaction with using ICs for their customers.

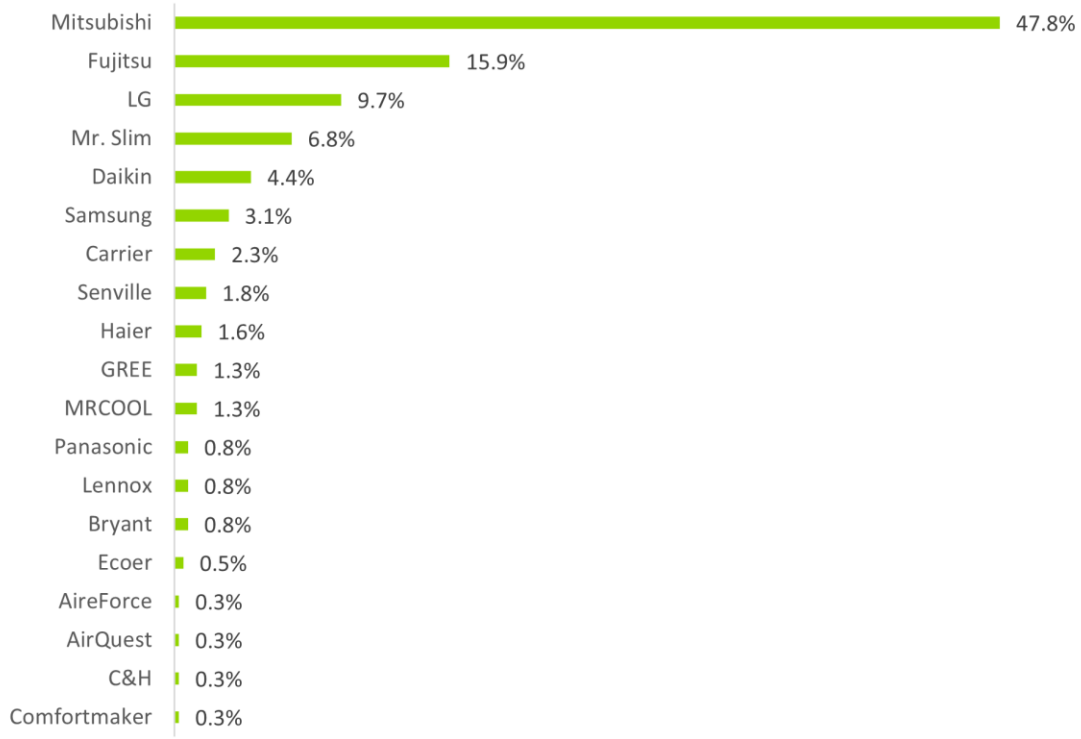
ICs might not work for every customer use case, and some contractors believe customers are better off without them. One contractor said, "I don't think requiring the IC on ductless is necessary – people can easily turn them on and off and turn on their backup, everything doesn't have to be automated. If you have it designed correctly, we don't have to force the IC."

3.3 Qualified Products

Mitsubishi appears to be a brand leader for HPs, commonly installed among customers and preferred by contractors. Mitsubishi ductless mini-split HPs had the largest share of installations among survey respondents—48% indicated they installed that particular brand. Other popular brands include Fujitsu and LG (Figure 14).

Among contractors interviewed, Mitsubishi is seen as the current market leader for HP technology because of its technological advancements and technical support offerings. Nine of the contractors interviewed indicated that they prefer to use Mitsubishi products for HPs, citing high product quality and robust technical support. Overall, these contractors were satisfied with the HP equipment from Mitsubishi. Online desk research also confirmed that Mitsubishi HP equipment, especially the Hyper Heat line, was frequently mentioned in HVAC forums as an industry leader or preferred HP brand. Unsurprisingly, contractors tend to use products they are familiar with. When asked why they prefer a certain brand, some contractors said it was because it is the brand they have always used. Contractors also relayed that their relationship with a manufacturer and other personal preferences (such as brand loyalty) have a major impact on their experience installing a certain IC product or HP.

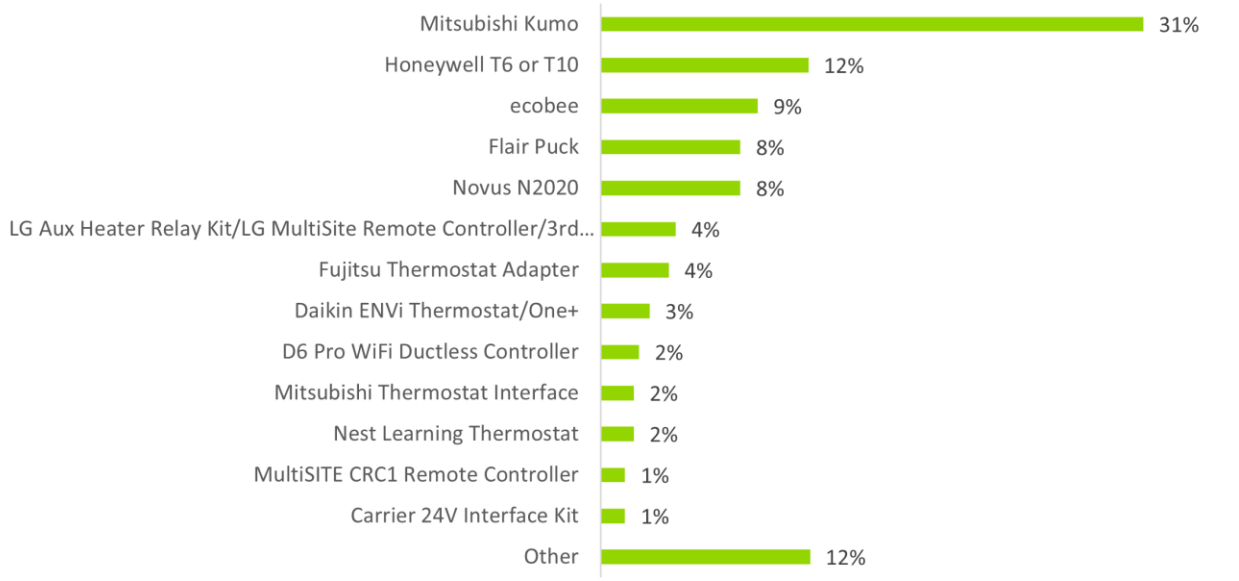
Figure 14. HP Brand Installed



Source: Tracking data, n=383.

Mitsubishi Kumo products also had the largest share of installations among ICs that survey respondents chose (Figure 15).

Figure 15. IC Brand Installed



Source: Tracking data, n=412.

Among survey respondents, there were no discernable differences in ease of use based on IC product installed. Over 50% of survey respondents completely or highly agreed that their IC system was easy to use. When broken out by IC model installed, there were limited differences between brands. Those who installed the Honeywell T6 thermostat were less likely to highly or completely agree that their IC is easy to use compared with those who did not install that IC system; however, it should be noted that this difference is based on a limited number of cases.

Contractors typically find the most success installing IC systems from the same manufacturer of the ductless mini-split unit(s), with Mitsubishi being the most popular, and they note that third-party controls are difficult to integrate. Six of the 12 contractors interviewed mentioned greatest compatibility between HP and IC products from the same manufacturer. Many manufacturers have their own apps, and contractors can connect IC systems to HPs of the same brand using these apps. Some manufacturers also offer training and technical support for incorporating their IC products with their HP products. This training and support enable contractors to more easily troubleshoot connectivity issues between products.

A preference for compatibility within brand extends beyond Mitsubishi. For example, another contractor mentioned that the Daikin AZA works best with Daikin mini-splits. Online product research also showed that incorporating third-party controls systems such as Flair Puck with mini-splits from other brands proved difficult. As new controls products enter the market, it should be noted that contractors might be more inclined to try a controls product from a trusted manufacturer.

Many contractors prefer not to install the Flair Puck Pro model. Four contractors mentioned negative experiences with the Flair Puck Pro model. One contractor specifically called out the Flair Puck for not being user friendly and another unhappy contractor described the product as "cheap." Contractors with experience installing Flair Puck products indicated that the controls did not successfully connect with the mini-splits and that the Flair Puck's infrared signal required that it be placed in a particular location to connect, and that lack of flexibility resulted in connection issues.

This feedback is consistent with the feedback the team found in the online desk research. Online reviewers also had difficulties installing the Flair Puck Pro. Many had issues with setup and connecting the Flair Puck with their mini-splits. Even some of the positive reviews mention installation quirks, with one 5-star reviewer stating that "the puck needs to be within 10 feet of unit head to work well." A customer's technical knowledge and background might also affect their feelings toward an IC product such as the Flair Puck, as a customer who is unaware of this limitation might give the product a more negative review.

However, the customer survey did not indicate differences in ease of use based on the IC model customers installed. Customers who installed the Flair Puck IC model (n=14) did not report differences in ease of use compared with those who installed other IC models.

Manufacturers of HP and IC products prefer proprietary/in-house controls and note that cross-brand interoperability is a lesser priority. One manufacturer noted that although in the past they have allowed interoperability between their HPs with other brands of controllers, they indicated that the interoperability requirements are not a priority. Their goal is to create a suite of products in-house that are meant to work together; this interviewee acknowledged that their IC user interface has much room for improvement, but the goal is to improve the platform to create a seamless experience. Another manufacturer noted that their brand purchased a software development company to meet market demand for connected home devices, reflecting a trend toward proprietary in-house control platforms. This corroborates contractors' preference to use HP and IC products within the same manufacturer family. A manufacturer of a third-party controller reflected that these third-party devices can be helpful for customers with multiple mini-split HPs of different brands or if supply chain issues arise again preventing availability of various brands. Though the customer survey did not specifically ask how frequently customers are mixing HP brands, one customer who was interviewed reflected that they were interested in third-party controllers that could integrate other devices such as temperature sensors. Another customer indicated that the mini-split HPs in their home were installed at different times, which could result in mixed brands; if other customers are installing HPs at different times with different brands, a third-party controller could be useful for integrating all units.

Manufacturers also note that the IC market represents a niche area for major brands, which has resulted in slow development; however, some manufacturers might be shifting focus. One IC product manufacturer noted that many of the major HP brands are based in Asia and their R&D divisions cater to an international market. ICs represent a very niche product line for these brands because they are really catered toward a portion of the North American market that uses oil or natural gas as a baseline heating source, and relatedly, IC technology has not been a major focus for manufacturers. This corroborates sentiments from contractors who felt that IC technology was not ready for large scale market adoption.

However, the focus seems to be shifting; another manufacturer noted that their team is launching a manufacturing division in North America with a focus on this market. They mentioned that new HP products with built-in Wi-Fi connectivity are on the horizon as well as

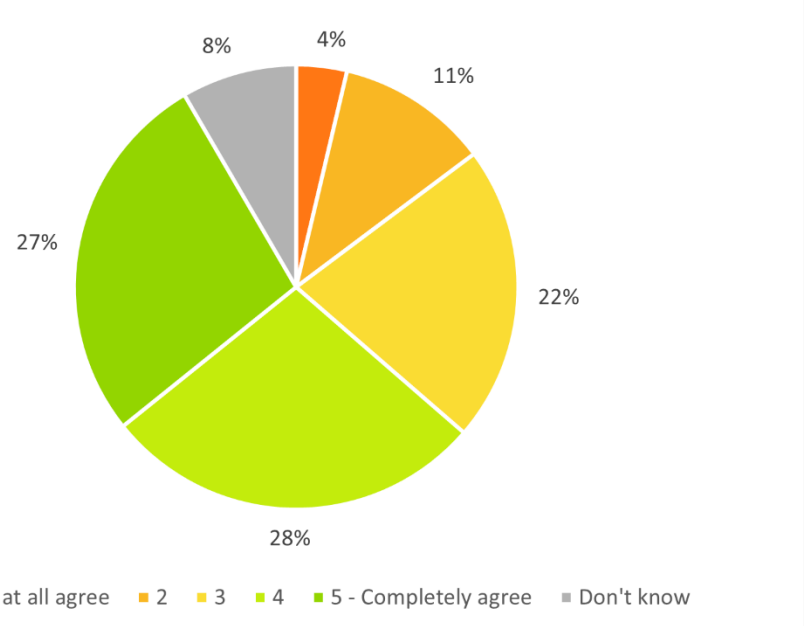
improvements to their IC platform. Additionally, a manufacturer noted that even in North American markets, ICs have been seen as a niche technology, but that with younger generations coming into home ownership, the popularity of IC and other home automation technologies is growing. Manufacturers also mentioned that they are considering incorporating demand response capabilities with their IC product offerings. It should be noted that these potential changes to manufacturers' priorities might only reflect a portion of the market. The nascent IC market might benefit from a design competition or other R&D guidance.

3.4 Training and Education

Survey results suggest that program participants feel like they do not know enough about their systems to feel confident that they are maximizing savings. Many would rather control the system manually than rely on an IC they do not understand the function of; 44% of respondents indicated that they do not use the ICs to automatically switch between heating systems, and notably 10% indicated that they do not know if they use the ICs to switch between systems.

Fifty-five percent of respondents reported the system as easy to use, while the rest did not find the ICs easy to use or indicated "Don't know." Difficulty with using ICs was also reflected when customers were asked what instructions a contractor provided about IC use to switch between systems in their own words. Eighteen percent said no instruction was given, while another 18% indicated a minimal or basic overview, some of whom were just pointed to the manual. About 26% of respondents suggested they received enough information to get started adequately, and only 13% believe they received a thorough explanation, walkthrough, or follow-up support.

Figure 16. Agreement with the Statement "The IC System is Easy to Use."



Source: Survey question "On a scale of 1-5, with 1 meaning "not at all agree" and 5 meaning "completely agree," how much do you agree with the following statements about your integrated control system? The integrated control system is easy to use." Single response, n=190.

Interviewees provided details on customer knowledge of how to use ICs. One customer indicated that they did not know what questions to begin to ask about ICs. Another interviewee

said that they recalled the contractor explaining how ICs work, but that they forgot immediately and after a week decided to operate the heating systems manually.

Contractors participate in trainings from product manufacturers and Mass Save on HP and control products, but additional training opportunities exist. Three contractors indicated that they participate in trainings offered by manufacturers. Contractors generally found the manufacturer-provided trainings useful. One contractor mentioned Mass Save trainings and said that their team finds them useful and that they take away a new learning each time. Only one contractor said they do not participate in any trainings. Regarding the manufacturer-provided trainings, it should be noted that some contractors expressed that integrating controls with HPs across different manufacturers proved challenging, potentially indicating a need for cross-product training. However, this training might be difficult to implement if most contractors are receiving trainings direct from manufacturers only. One manufacturer noted that many contractors are trained to just "slam some HPs in and leave," and that enhanced education about when to spec ICs and details on how to install them would benefit the program.

Based on the feedback indicating both a) insufficient contractor understanding/explanation and b) non-ideal IC operating conditions for a given system configuration, it is apparent that additional training and resources for vetted contractors is needed, which would include training for how to educate the customer sufficiently for them to use their systems confidently and effectively. The program provides an existing training module on ICs that offers a general overview. A follow-on training module covering specifics on use cases, troubleshooting, and customer education will provide additional support.

As effectiveness of HP/IC systems seems to vary with home configuration and existing baseline equipment and use habits, among other factors, some concrete guidance for the setup contractors recommend to customers might result in improved savings and comfort for end users (see earlier discussion on use cases).

3.5 Baseline Household and Equipment Characteristics

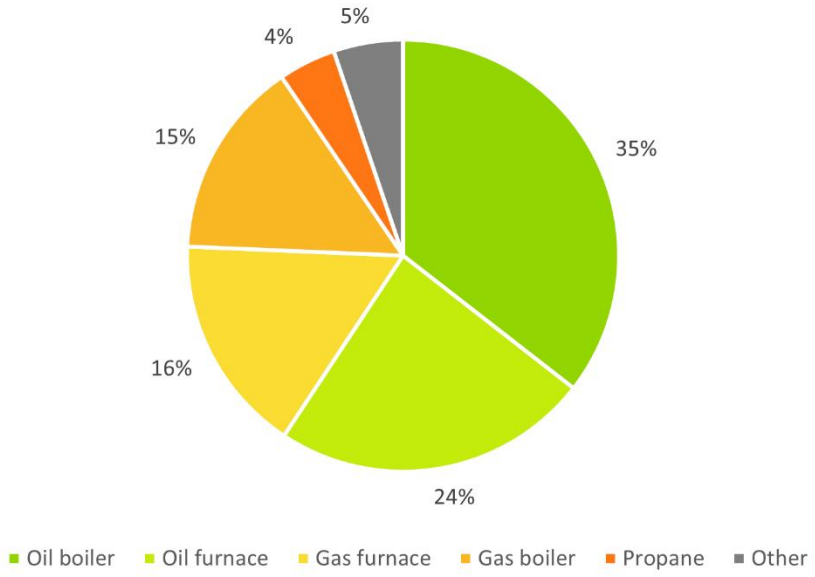
Of the 443 participants who completed the survey, 63% of their homes were between 1,500 and 2,900 square feet, while only 18% were smaller than that. Additionally, the majority (57%) of respondents' homes were built in 1979 or earlier.

Notably, six of the 12 customer interviewees had made alterations to their home such as adding solar panels, insulation, or square footage since HP/IC installation. As the installation of solar panels provides additional electrical energy input, this addition could affect net usage (and thus billing) and relatedly, behavior (toward increased reliance on HPs).

Most survey respondents indicated that they were displacing an oil boiler or furnace with an HP and IC system (Figure 17). In addition to reducing environmental impact, one customer interviewed expressed that this legacy system was effective but expensive and specified that they had no issues with their oil boiler except that oil is not cheap. Customer motivations for attempting to address this variety of situations with HPs and ICs are further discussed separately in earlier sections.

Additionally, 89% of survey respondents indicated that their legacy system was still installed and operating, which aligns with the partial-displacement scenario.

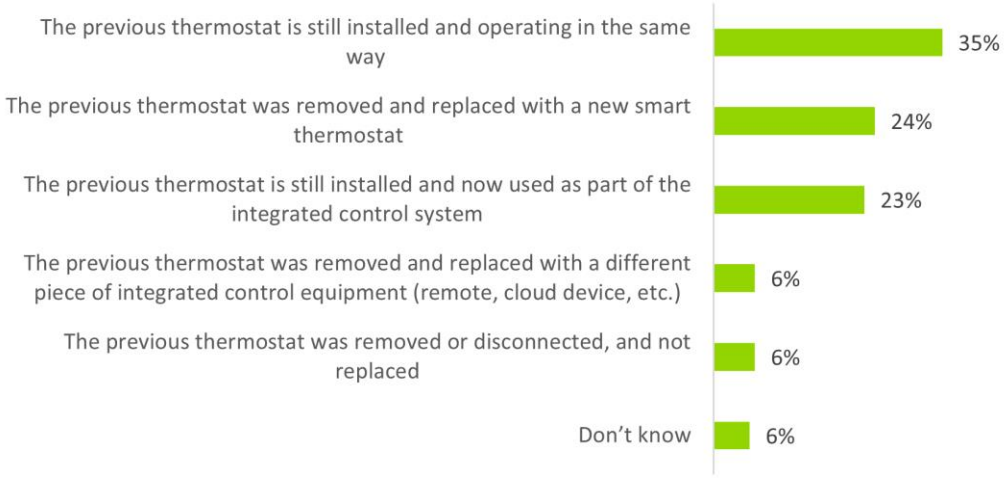
Figure 17. Previous Heating Systems



Source: Survey question "What was the primary system that heated your home before the new heat pump was installed?" Single response, n=324. Does not equal 100% due to rounding.

Forty percent of respondents indicated that they used a smart thermostat or Wi-Fi-connected thermostat to control their heating system prior to the HP and IC installation. Of those customers who had used smart thermostats previously, 35% retained them to operate their legacy systems, 24% replaced their old smart thermostat with a new one, and 23% continued to use their old smart thermostat as part of their IC system (Figure 18). The most mentioned smart thermostats during customer interviews were Nests.

Figure 18. Previous Smart Thermostat Usage



Source: Survey question "When the heat pump system was installed, was the previous thermostat removed or disconnected, or is it still installed and operating?" Single response, n=127.

3.6 Additional Program Feedback

Though not the main focus of the study, contractor interviews and customer surveys and interviews uncovered limited feedback on program processes.

Some contractors and customers experienced delays in application processing. Four contractors indicated that their customers were dissatisfied with the turnaround time for the rebates. Though contractors recognized that the program might be understaffed, they indicated that customers might not be aware and that these customers call to complain to the contractors. One contractor also noted that they would like more consistent communication from Mass Save, including greater responsiveness to questions regarding pending applications.

Some application processing delays were due to certain qualified products not being updated in the online application. One contractor said they had many applications rejected because a product that was approved was not updated on the QPL portal list. Additionally, a customer who was interviewed indicated that the rebate application process was stressful because a product that their contractor indicated was approved was not listed on the Mass Save website. They said they spent hours trying to reach someone at Mass Save to confirm whether the product was indeed qualified.

There were some miscommunications regarding program changes. One customer indicated that they initially put in an application for mini-split HPs alone, as program rules at the time allowed for incentives for just the HPs. However, the application was rejected, and the customer was told that they must install ICs to receive an incentive. The customer indicated that the program rules changed, and they received no communication about those changes from Mass Save. They were displeased that they were caught by surprise, and they indicated that it was difficult to reach anyone at Mass Save to make an appeal or sort out the application.

3.7 Recommendations and Considerations

Based on these findings, the study team recommends the following:

- **Ensure that the program clearly articulates the use case for ICs with partial displacements and associated program requirements to ensure projects contribute to program goals.** ICs were installed in scenarios that might not require them, and nearly half of customers report that their HPs are not their primary heating system or that they are using HPs in smaller areas of their homes. Additionally, nearly half of surveyed customers indicated that they do not use their ICs to automatically switch. Adding diagrams (such as decision trees or flow charts, see Appendix C) and case studies to the program website will help customers and contractors understand when ICs are needed. This information will help clarify the use case for HPs and ICs, ensuring the program is providing rebates for projects that will sufficiently reduce or eliminate fossil fuel usage. Results from the ongoing Heat Pump Metering Study can be used to provide supporting information on fuel displacement, and existing QC/QA practices could incorporate system configuration examination to ensure they match program guidelines.

  The team's considerations to clarify the use cases are as follows:

- To access downstream rebates via the partial-home pathway, the program requires the customer to install ICs. The program should clarify that for this type of project, the HPs should address the heating load in either most spaces in the home or complete zones. Ideally, HP and IC systems should address all areas of the home that were originally served by a fuel system, but complete zones will also result in fossil fuel displacement. The HPs are required to be the primary heating system for the home or zone, with the ICs used to switch heating systems under certain temperatures. Essentially, for the partial-home pathway, a customer/contractor should ideally ensure that the entire home or entire zone is covered by the mini-split HPs to receive the $1,250/ton and the IC rebate; in this scenario, the legacy heating system is used for economic reasons (different than the whole home pathway, which allows legacy heating system usage for emergencies only). Though these are current program requirements, additional clarity is warranted to avoid customers installing HPs and ICs to serve a single room, for example.

- Some customers want to add mini-split HPs in specific rooms or add mini-splits to certain areas of the home that were not originally served by another heating system. ICs are not required or incentivized for these types of configurations as the legacy heating system will still need to operate throughout the home, even above the programmed switchover temperature. The program includes incentives if the mini-split HP is installed in a specific zone as this configuration results in some fossil fuel displacement. Current program rules regarding using HPs in individual rooms as opposed to full zones should be further outlined and clarified for customers and contractors.

- Customers that use their old (or legacy) system for emergency purposes go through the whole-home pathway. However, the program should continue to clarify the definition of “emergency use” of the legacy system so that customers are discouraged sufficiently from using their fossil fuel systems in excess or in non-emergency cases. This study was not intended to examine the whole-home pathway, but additional QA/QC on the emergency use case might be helpful to ascertain that legacy systems are indeed only being used in true emergency cases. PAs have since clarified the language around whole-home pathway emergency legacy system usage.

- **Keep current mix of IC products in the QPL.** Connectivity and functionality seem to be issues with using ICs in general, though manufacturers hinted at ongoing R&D that might alleviate this challenge. IC technology, though nascent, promises improvements. In terms of ease of use, there were minimal differences between IC products that customers installed. Although some contractors had negative feedback about the Flair Puck product, customer survey responses did not indicate that this IC product was less functional than others. Additionally, Flair's product fills a niche of third-party controllers that uniquely allow customers to utilize multiple HP brands as well as other sensors. There was some negative contractor feedback about the KUMO app, though this product accounts for the largest share of IC products installed. Though findings from the previous study suggested further research on products that should be removed from the QPL, current study findings do not indicate differences in performance between IC models and therefore do not provide an objective metric for product removal. Additionally, as the IC product market is relatively nascent, the study recommends keeping the current products on the QPL to allow manufacturers to improve the functionality of the products. The more significant findings center on customer usage (or lack of usage) of the ICs and their configurations.

- **Enhance trainings for contractors on IC use cases and how to educate customers.** Contractors continue to report skepticism around IC technology. They report making use of manufacturer-sponsored trainings as well as Mass Save trainings. Trainings from Mass Save should not only provide an overview of IC products as they currently do but also include more specific information on use cases where ICs make the most sense for displacing fossil fuel usage (as specified in the recommendation earlier). Diagrams (such as decision trees or flow charts) and case studies will help contractors understand when to recommend HPs and ICs to customers that meet program goals. Additionally, the contractor trainings should ensure that contractors have tools available to them to speak with customers on how to use ICs, as many customers felt they did not have enough information on the IC product and how to use it. In tandem with training opportunities, a forum for contractors to ask questions about programmatic requirements and express concerns about technologies and customer reactions could help Mass Save further tailor training offerings.[20] Enhancing contractor trainings will help ensure that they are recommending HPs with ICs in scenarios that encourage offsetting fossil fuel usage in full zones or throughout the house and that customers will feel comfortable using the ICs to automatically switch between heating systems.

- **Provide educational resources to customers on HPs and ICs that outline operational FAQs and reasoning behind switchover temperature.** In addition to helping contractors educate customers, Mass Save could also provide enhanced customer-facing materials on the website regarding ICs because customers report lacking information on ICs, including model-specific information. Decision-making support such as diagrams and case studies could help customers understand when to request ICs and HPs, ensuring they will be successfully and appropriately used (though contractor advice is key to ensuring ICs are installed in the correct scenarios). FAQ resources could also help customers with troubleshooting installed systems. Additionally, insight into the switchover temperatures that emphasize efficiency and economic aspects might help customers more carefully consider cases where they change the

[20] Currently, PAs are offering contractor trainings on ICs as well as "office hours" for contractors to ask questions.

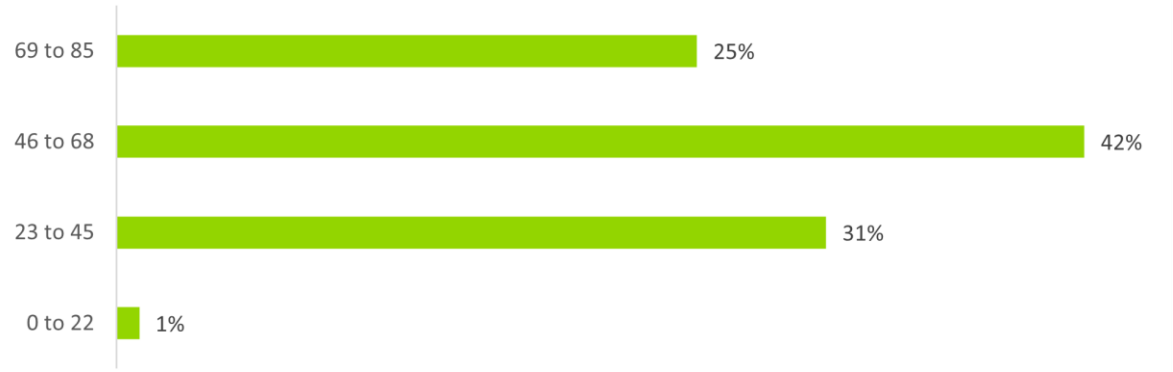
switchover temperature while considering customer comfort.[21] The program could also highlight midstream incentives as an alternative program pathway for customers whose configurations do not meet IC program guidance.

[21] PAs plan to update the Mass Save website with a switchover temperature calculator: https://www.masssave.com/residential/rebates-and-incentives/integrated-controls/maximize-heat-pump-savings-with-integrated-controls

Appendix A. Survey Respondent Demographics

For the participating customer survey, 443 completed 80% of more of the survey questions. Most survey respondents were over the age of 45.

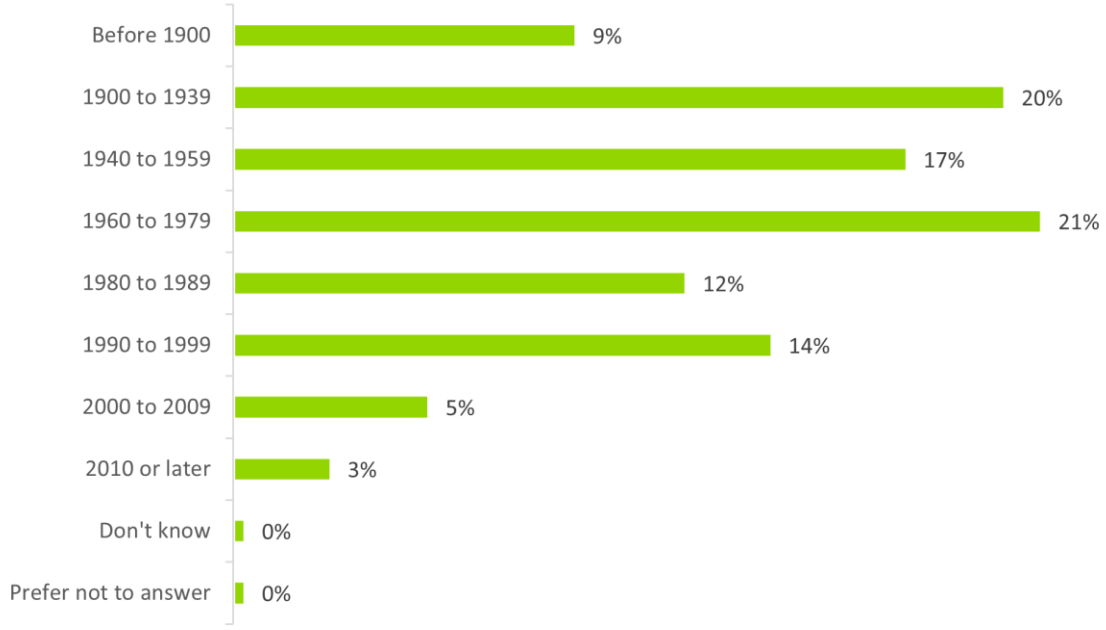
Figure 19. Age of Respondents



Source: Survey question "In what year were you born?" Single response, n=319.

Ninety-two percent of respondents live in single-family homes, and most of these homes were built before 1980. Over 62% of respondents' homes were between 1,500 and 2,900 square feet in area.

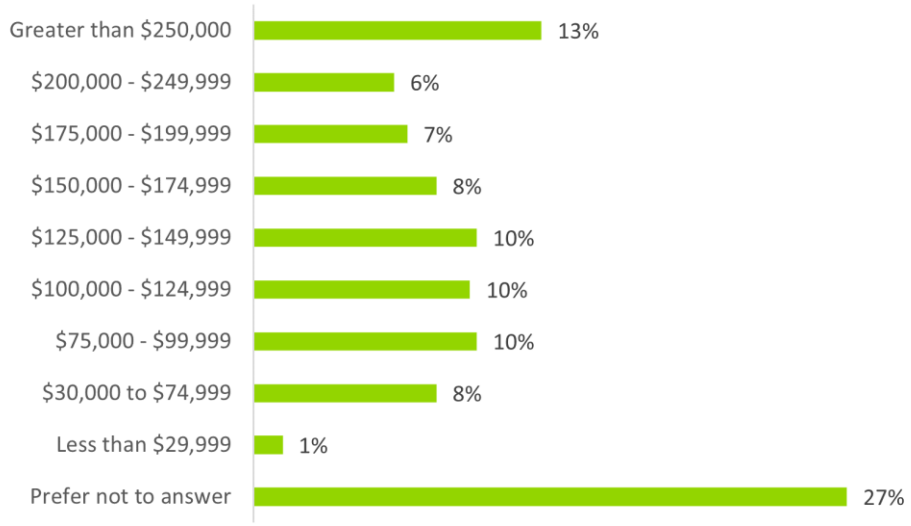
Figure 20. Respondents' Home Vintage



Source: Survey question "When was your home built?" Single response, n=319.

Over half of survey respondents made over $100,000 annually in 2022.

Figure 21. Respondents' Total Estimated Annual Income in 2022



Source: Survey question "What was your estimated total annual household income in 2022 before taxes (in other words, your gross household income)?" Single response, n=319.

Appendix B. Customer Survey Guide

[Landing Page]
Welcome! Thank you for taking this survey about the Mass Save® Residential Rebates and Incentives. We are conducting this survey to gather feedback on heat pumps with ICs to help Mass Save improve their programs. The survey will take around 20 minutes and your answers will remain confidential. As a thank you, we will be offering a $20 gift card upon completion. If you have any difficulties taking the survey, please contact [SURVEY CONTACT PERSON].

Should you have any concerns about the nature or validity of this research, please contact Tony Larson (Antonio.Larson@nationalgrid.com).

Screening

[ASK ALL]

A1. Do you currently reside at [ADDRESS]? **[SINGLE RESPONSE]**

1. Yes
2. No **[TERMINATE]**
98. Don't know **[TERMINATE]**

[ASK ALL]

A2. Our records indicate that you received a rebate from Mass Save to install heat pumps (mini-split heat pumps) at your home. Is this correct? **[SINGLE RESPONSE]**

1. Yes
2. No **[TERMINATE]**
98. Don't know **[TERMINATE]**

A3. Integrated controls are devices (such as a smart thermostat or mobile phone app) that automatically switch between a heat pump and fossil fuel heating system (such as a furnace or boiler) at a pre-set outdoor temperature. Our records indicate that you also received a rebate for Mass Save for installing integrated controls to manage your heat pump system. Is this correct? [SINGLE RESPONSE]

1. Yes
2. No [TERMINATE]
3. I got a rebate for something installed to switch between my heat pump and other heating system, but I'm not sure if it was an integrated control
98. Don't know [TERMINATE]

[ASK IF A3= 1 OR 3]

A4. How do you manage your heat pump and fuel-fired heating systems? **[SINGLE RESPONSE]**

1. I use a smart thermostat or a mobile phone app to automatically switch between my heat pump and fossil fuel heating system at a particular temperature.
2. I use my heat pump until it gets to be a certain temperature OUTSIDE, below which I switch to the existing fuel-fired system manually and turn off the heat pump

3. I use my heat pump until it gets to be a certain temperature OUTSIDE, below which I also turn on the existing fuel-fired system manually, keeping the heat pump on as well
4. I use two thermostats to control the existing fuel-fired system and heat pump systems and set them both to the same temperature
5. I use two thermostats to control the existing fuel-fired system and heat pump system, and set the heat pump to a higher temperature
6. I use two thermostats to control the existing fuel-fired system and heat pump system, and set the fuel-fired system to a higher temperature
7. I only use my heat pump to supplement the existing fuel-fired system (i.e., to make specific rooms more comfortable)
8. I use my heat pump for cooling only
9. I only use the heat pump to heat my home and do not use the fuel-fired heating system
10. Other. Please specify: **[TEXT RESPONSE]**

TERMINATION MESSAGE

Thank you for your interest in our survey. Unfortunately, you are not eligible to participate at this time.

Previous Technology Awareness

[ASK ALL]

B1. How familiar were you with heat pump technology before participating in the Mass Save program? **[SINGLE RESPONSE]**

1. I had never heard of heat pump technology before
2. I was familiar with heat pump technology but had never thought about installing it in my own home
3. I was familiar with heat pump technology and had considered installing it in my home
4. I had installed heat pump technology in my home or a past residence in the past

98. Don't know

[ASK ALL]

B2. How familiar were you with integrated control technology before participating in the Mass Save program? Integrated controls are devices (such as a smart thermostat or mobile phone app) that automatically switch between a heat pump and fossil fuel heating system at a pre-set outdoor temperature. **[SINGLE RESPONSE]**

1. I had never heard of integrated control technology before
2. I was familiar with integrated control technology but had never thought about installing it in my own home
3. I was familiar with integrated control technology and had considered installing it in my home
4. I had installed integrated control technology in my home or a past residence in the past

98. **Don't know**

Decision-Making

[ASK ALL]

C1. Why did you want to install a heat pump? Select all that apply. **[RANDOMIZE 1-16, MULTIPLE RESPONSE]**

1. I wanted to make my space(s) more comfortable
2. I wanted to add dehumidifying capabilities
3. I wanted to upgrade my cooling to get rid of window AC units
4. My space(s) had no cooling
5. My space(s) had no heating
6. I needed additional or supplemental heating
7. I needed additional or supplemental cooling
8. My previous heating system was broken or not working well
9. My previous cooling system was broken or not working well
10. I wanted to take advantage of the rebate
11. I wanted to save money on my heating costs
12. It was less expensive than other cooling/heating options I was exploring
13. I wanted to be more energy efficient
14. I wanted zoned cooling/heating
15. I wanted to reduce my impact on the environment
16. Other. Please specify: **[TEXT RESPONSE]**

[ASK ALL]

C2. Of these motivators, which was the most important to your decision to install heat pumps? **[RANDOMIZE, SINGLE RESPONSE]**

1. **[SHOW ANSWER CHOICES SELECTED AT C1]**

[ASK IF A3=1]

C3. Why did you decide to install integrated controls (controls that switch between electric and fuel heating systems)? Select all that apply. **[RANDOMIZE 1-15, MULTIPLE RESPONSE]**

1. For convenience
2. To get the rebate
3. Recommended by my contractor
4. Recommended by Mass Save program staff
5. I wanted to keep my old heating equipment as a backup/in case of emergencies
6. I wanted to maximize comfort level in my home
7. Results of the Home Energy Assessment I received
8. I did not want to completely replace my existing heating system
9. I heard positive reviews from others
10. I wanted to add personalized settings to my heating/cooling system
11. I wanted to be more energy efficient
12. I wanted zoned cooling/heating
13. I wanted to reduce my impact on the environment
14. I wanted more control over my heating/cooling system(s)

98. Other. Please specify: **[TEXT RESPONSE]**

[ASK IF A3=1]

C4. Without the rebate from Mass Save, would you have installed integrated controls for your heating system? **[SINGLE RESPONSE]**

1. Yes
2. No
98. Don't know

[ASK 2022 PARTICIPANTS]

C5. Mass Save offers both whole-home and partial-home installations as part of this program. Why did you decide to move forward with a partial installation? Select all that apply. **[RANDOMIZE 1-8, MULTIPLE RESPONSE]**

1. I wanted to keep old heating system as a backup / emergency system
2. I only wanted heat pumps in a certain part of my home
3. I did not want to replace my entire heating system
4. I wanted to maximize rebate/incentive received from program
5. I wanted to maximize energy savings
6. I wanted to optimize my utility bill savings
7. I wanted to reduce my usage of fossil fuels in my home
8. I wanted to ensure my ideal comfort level in home
9. Other. Please specify: **[TEXT RESPONSE]**
98. Don't know

Program Experience

[ASK ALL]

D1. How did you find the contractor who completed the heat pump installation? **[RANDOMIZE 1-9, SINGLE RESPONSE]**

1. They were recommended by another contractor
2. They were recommended by the Home Energy Assessment auditor
3. They were recommended by a distributor/store
4. I found my contractor on a website (please specify if you recall): **[TEXT RESPONSE]**
5. They were recommended by family or friends
6. I previously worked with the contractor
7. I looked at the list of qualified contractors from Mass Save website **[ASK 2022 PARTICIPANTS]**
8. I looked at the list of qualified contractors provided after receiving a Home Energy Assessment **[ASK 2022 PARTICIPANTS]**
9. I called Mass Save customer service number
10. Other. Please specify: **[TEXT RESPONSE]**
98. **Don't know**

[ASK ALL]

D2. Which of the following did the contractor provide regarding the heat pump installation? Select all that apply. **[RANDOMIZE 1-9, MULTIPLE RESPONSE]**

1. An explanation of how to operate heat pumps
2. An explanation of how to operate integrated controls
3. An explanation of how to use apps to operate integrated controls

4. Paperwork needed to participate in the program
5. Recommendations on which products to install
6. Recommendations on whether to do a whole-home or partial-home installation
7. Overview of the Mass Save program
8. Price estimations
9. Size and scope of project/install estimations
10. Other. Please specify: **[TEXT RESPONSE]**

98. Don't know

[ASK ALL]

D3. What instructions, if any, did the contractor give you about how to use the integrated controls/equipment used to switch between the heat pump or other heating system? **[OPEN-ENDED TEXT RESPONSE]**

Prior Equipment

[ASK ALL]

E1. What was the primary system that heated your home before the new heat pump was installed? Furnaces use hot air and boilers use hot water to heat your home. **[SINGLE RESPONSE]**

1. Oil furnace
2. Oil boiler
3. Propane/liquified petroleum gas (LPG) furnace
4. Propane/LPG boiler
5. Gas boiler
6. Gas furnace
7. Solar heating system
8. Electric baseboard
9. Electric furnace
10. Electric space heater
11. Woodstove, pellet stove, or fireplace
12. Other heat pump or ductless mini-split heat pump

10. Other. Please specify: **[TEXT RESPONSE]**

[ASK ALL]

E2. When the heat pump system was installed, what happened to the previous heating system: **<PIPE IN FROM E1>? [SINGLE RESPONSE]**

1. **The previous system was removed or disconnected, and not replaced**
2. **The previous system was removed and replaced with a new piece of equipment of the same type**
3. **The previous system was removed and replaced with both a heat pump and another type of equipment**
4. **The previous system is still installed and operating**

98. **Don't know**

[ASK ALL]

E3. Before installing the new heating system, did you have either of the following in your home: a smart thermostat device or a wireless or digitally automated thermostat connected to Wi-Fi, an app, and/or your phone?
1. **Yes**
2. **No**
98. **Don't know**

Heating System Performance

[ASK ALL]
F1. Do you use your new mini-split heat pump system for most of your heating needs? **[SINGLE RESPONSE]**
1. Yes
2. No
98. Don't know

[ASK ALL]
F2. What space(s) does your new mini-split heat pump(s) serve? Select all that apply. **[MULTIPLE RESPONSE]**
1. Whole home
2. Primary Bedroom
3. Other Bedroom(s)
4. Living Room, Family Room or Den
5. Kitchen
6. Office
7. Sunroom or three-season space
8. Auxiliary spaces, such lofts or attics
9. Basement
10. Other. Please specify all spaces not listed: **[TEXT RESPONSE]**

[ASK ALL]
F3. Approximately what percentage of your home is served by the new mini-split heat pump system? **[OPEN-ENDED NUMERIC RESPONSE]**

[ASK ALL]
F4. Is the integrated control system / system set up to switch between heat pump and other fuel system still installed and working? **[SINGLE RESPONSE]**
1. Yes – the integrated control system was installed and is working
2. No – the integrated control system was installed but is not working
3. No – the integrated control system was not installed
98. Don't know

[ASK IF F4=2 or 3]
F5. Why is the integrated control system not installed or not working? Select all that apply. **[RANDOMIZE 1-5, MULTIPLE RESPONSE]**
1. Poor Wi-Fi connection/connectivity in the house
2. Power outages / loss of power

3. The app/online controls were difficult to use
4. It was installed incorrectly and never fixed
5. There were physical equipment issues
6. I unplugged/disconnected the integrated control system
7. The integrated control system broke, and I chose not to fix it
8. The backup heating system broke / is not working anymore
9. The heating systems did not respond to the integrated controls
10. Other. Please specify: **[OPEN-ENDED TEXT RESPONSE]**

[ASK IF Error! Reference source not found.**=1]**

F6. When the heat pump system was installed, was the previous thermostat removed or disconnected, or is it still installed and operating? [SINGLE RESPONSE]

1. The previous thermostat was removed or disconnected, and not replaced
2. The previous thermostat was removed and replaced with a new smart thermostat
3. The previous thermostat was removed and replaced with a different piece of integrated control equipment (remote, cloud device, etc.)
4. The previous thermostat is still installed and operating in the same way
5. The previous thermostat is still installed and now used as part of the integrated control system

98. Don't know

[ASK IF F4=1 OR F6

F7. **Do you or a member of your household use a smart thermostat to adjust the mini-split heat pump system? [SINGLE RESPONSE]**

1. Yes
2. No

99. Don't know

[ASK IF F7=1]

F8. How often do you or a member of your household use a smart thermostat to access and adjust the mini-split heat pump system? [SINGLE RESPONSE]

1. Every time I use the mini-split heat pump system
2. Sometimes when I use the mini-split heat pump system
3. Only in case of emergencies
4. Other. Please specify: **[TEXT RESPONSE]**

[ASK IF F7=1]

F9. How do you or a member of your household use the smart thermostat to access and adjust the mini-split heat pump system? Select all that apply. [RANDOMIZE 1-4, MULTIPLE RESPONSE]

1. I use it to turn the heat pump system on/off
2. I use it to adjust the temperature of the heat pump system
3. I use it to manually switch between my fossil fuel and heat pump heating systems
4. I have set it to automatically switch between my fossil fuel and heat pump heating systems
5. Other. Please specify: [TEXT RESPONSE]

[ASK IF F7=1]

F10. How easy is it to use the smart thermostat to control your new heating system? [SINGLE RESPONSE]

1. Extremely easy
2. Very easy
3. Not very easy
4. Not easy
5. Not at all easy

[ASK IF F4=1]

F11. Do you or a member of your household use a phone app or website to access and adjust the mini-split heat pump system? [SINGLE RESPONSE]

1. Yes
2. No
98. Don't know

[ASK IF F11=1]

F12. How often do you or a member of your household use a phone app or website to access and adjust the mini-split heat pump system? [SINGLE RESPONSE]

1. Every time I use the mini-split heat pump system
2. Sometimes when I use the mini-split heat pump system
3. Only in case of emergencies
4. Other. Please specify:

[ASK IF F11=1]

F13. How do you or a member of your household use the phone app or website to access and adjust the mini-split heat pump system? [RANDOMIZE 1-4, MULTIPLE RESPONSE]

1. I use it to turn the heat pump system on/off
2. I use it to adjust the temperature of the heat pump system
3. I use it to manually switch between my fossil fuel and heat pump heating systems
4. I have set it to automatically switch between my fossil fuel and heat pump heating systems
5. Other. Please specify**: [TEXT RESPONSE]**

[ASK IF F11=1]

F14. How easy is it to use the integrated controls phone or web app to control your new heating system? **[SINGLE RESPONSE]**

1. Extremely easy
2. Somewhat easy
3. Not very easy
4. Not easy
5. Not at all easy

[ASK IF F4=1]

F15. Do you or a member of your household use a remote control to access and adjust the mini-split heat pump system? **[SINGLE RESPONSE]**

1. Yes
2. No

98. Don't know

[ASK IF F15=1]

F16. How often do you or a member of your household use a remote control to access and adjust the mini-split heat pump system? [SINGLE RESPONSE]

1. Every time I use the mini-split heat pump system
2. Sometimes when I use the mini-split heat pump system
3. Only in case of emergencies
4. Other. Please specify:

[ASK IF F15=1]

F17. How do you or a member of your household use the remote control to access and adjust the mini-split heat pump system? [RANDOMIZE 1-4, MULTIPLE RESPONSE]

1. I use it to turn the heat pump system on/off
2. I use it to adjust the temperature of the heat pump system
3. I use it to manually switch between my fossil fuel and heat pump heating systems
4. Other. Please specify: [TEXT RESPONSE]

[ASK IF F15=1]

F18. How easy is it to use the remote control to control your new heating system? **[SINGLE RESPONSE]**

1. Extremely easy
2. Somewhat easy
3. Not very easy
4. Not easy
5. Not at all easy

[ASK IF F4=1]

F19. Who can make changes to the integrated control system settings (lockout temperature, runtime, etc.)? The integrated controls **automatically switch between a heat pump and fossil fuel heating system at a pre-set outdoor temperature.** Select all that apply. **[RANDOMIZE 1-3, MULTIPLE RESPONSE]**

1. I or someone in my household
2. My contractor for daily use
3. My contractor in case of emergencies
4. Other. Please specify: **[TEXT RESPONSE]**

98. Don't know

[ASK IF F4=1]

F20. Who set the lockout temperature for the heat pump system? The lockout temperature is the point at which the system switches from using the heat pumps to the fuel equipment (e.g., boiler or furnace) as the heat source. **[RANDOMIZE 1-4, SINGLE RESPONSE]**

1. I or someone in my household set it
2. My contractor set it
3. My contractor and I agreed on a temperature together.

4. My contractor explained and set the system at a mandated lockout temperature
5. Other. Please specify: **[TEXT RESPONSE]**
98. **Don't know**

[ASK IF F4=1]
F21. What was the lockout temperature set at? **[OPEN-ENDED TEXT RESPONSE]**

[ASK IF F4=1]
F22. Is the lockout temperature on the heat pump system adjustable? **[SINGLE RESPONSE]**

1. Yes
2. No
3. Don't know
4. Other. Please specify: **[TEXT RESPONSE]**

[ASK IF F22=1]
F23. Under what circumstances do you or your contractor adjust the lockout temperature? **[MULTIPLE RESPONSE]**

1. I can adjust the lockout temperature whenever I want
2. I can adjust the lockout temperature in cases of emergencies
3. My contractor can adjust the lockout temperature whenever I want
4. My contractor can adjust the lockout temperature in cases of emergencies
5. Other. Please specify: [TEXT RESPONSE]
98. **Don't know**

[ASK IF F4=1]
F24. When you are heating with your heat pump system, do you rely on the integrated controls to automatically switch between the heat pump and your other fuel-fired heating system? **[SINGLE RESPONSE]**

1. Yes
2. No
98. Don't know

[ASK IF F4=1]
F25. On a scale of 1-5, with 1 meaning "not at all agree" and 5 meaning "completely agree," how much do you agree with the following statements about your integrated control system? **[SINGLE RESPONSE FOR EACH ROW]**

	Not at all agree 1	2	3	4	Completely agree 5	Don't know
The integrated control system helps me maintain a comfortable temperature in my home						
The integrated control system is easy to use						

The integrated control system is a benefit of my new heating system	
The integrated control system helps me reduce my home heating bill	

[ASK ALL]

F26. How has your electric bill changed since installing your new heating system? [SINGLE RESPONSE]

1. My electric bill has decreased
2. My electric bill has stayed the same
3. My electric bill has increased
4. I have not yet gotten this energy bill since installing the new heating system

98. Don't know

[ASK ALL]

F27. How has your energy bill for fuel (gas, propane, oil, or wood) heating systems changed since installing your new heating system? [SINGLE RESPONSE]

1. My fuel bill has decreased
2. My fuel bill has stayed the same
3. My fuel bill has increased
4. I have not yet gotten this energy bill since installing the new heating system

98. Don't know

[ASK ALL]

F28. How have your combined energy bills for your heating systems changed since installing your new heating system? [SINGLE RESPONSE]

1. My combined bill has decreased
2. My combined bill has stayed the same
3. My combined bill has increased
4. I have not yet gotten these bills since installing the new heating system

98. Don't know

Satisfaction

[ASK ALL]

G1. Using a scale of 1-5, with 1 meaning "not at all satisfied" and 5 meaning "very satisfied," how satisfied are you with the following aspects of your installation experience and the Mass Save program? **[RANDOMIZE, SINGLE RESPONSE FOR EACH ROW]**

	Not at all satisfied 1	2	3	4	Very Satisfied 5	Don't know
The contractor's explanation of how to						

operate the integrated controls system
The contractor's explanation of the new system's benefits
The heat pump equipment
The integrated control equipment
The integrated control app or interface **[SHOW IF F11=1]**
The ability for you to control heating in your house through the integrated controls system
The overall comfort of your home after installing the new heating system and integrated controls

[ASK IF FOR ANY ROW IN G1, RESPONDENT SELECTED <3]
G2. What could be improved about [**PIPE IN ROW TEXT FROM G1**]? **[OPEN-ENDED TEXT RESPONSE, LOOP FOR EACH ROW <3]**

Demographics

[ASK ALL]
H1. In what year were you born? **[SINGLE RESPONSE]**
1. **[NUMERICAL 4 DIGIT RESPONSE]**
99. Prefer not to answer

[ASK ALL]
H2. How many people occupied this home in 2022? Enter zero if appropriate. **[SINGLE RESPONSE PER ROW, RESTRICT RESPONSE OPTIONS TO 2 DIGITS]**

Occupant Type	Number
Children, under 18	[RECORD NUMBER]
Adults, 18 to 65	[RECORD NUMBER]
Adults, 65 and older	[RECORD NUMBER]

[ASK ALL]
H3. Which of the following best describes your home? **[SINGLE RESPONSE]**
1. Single-family home (detached)
2. Attached house (townhouse, rowhouse, or building with 2 to 4 units)
3. Mobile home or manufactured home
4. Multifamily apartment, coop, or condo (building with more than 4 units)
5. Other. Please specify: **[TEXT RESPONSE]**
99. Prefer not to answer

[ASK ALL]

H4. When was your home built? **[SINGLE RESPONSE]**

1. **Before 1900**
2. 1900 to 1939
3. 1940 to 1959
4. 1960 to 1979
5. 1980 to 1989
6. 1990 to 1999
7. 2000 to 2009
8. 2010 or later
98. Don't know
99. Prefer not to answer

[ASK ALL]

H5. **Approximately how big is your home? [SINGLE RESPONSE]**

1. **0 to 1,499 square feet**
2. **1,500 to 2,999 square feet**
3. **3000+ square feet**
98. **Don't know**
99. **Prefer not to answer**

[ASK ALL]

H6. What was your estimated total annual household income in 2022 before taxes (in other words, your gross household income)? **[SINGLE RESPONSE]**

1. Less than $29,999
2. $30,000 to $74,999
2. $75,000 - $99,999
3. $100,000 -$124,999
4. $125,000 -$149,999
5. $150,000 -$174,999
6. $175,000 -$199,999
7. $200,000 - $249,999

9. Greater than $250,000
99. Prefer not to answer

[ASK ALL]

H8. What language do you speak at home? **[MULTIPLE RESPONSE]**

14. English
15. Spanish
16. Chinese
17. Vietnamese
18. Korean
19. Japanese
20. Italian
21. Portuguese
22. Haitian
23. French

24. Russian
25. Arabic
26. Hindi
27. Greek

98. Other. Please specify: **[TEXT RESPONSE]**
99. Prefer not to answer

Closing

[ASK ALL]
I1. Thank you for participating in the Mass Save Heat Pump Program Participant Survey sponsored by the Mass Save Program Administrators! Are you willing to participate in a follow-up interview about your additional thoughts on the Mass Save heat pump program? **[SINGLE RESPONSE]**

1. Yes
2. No

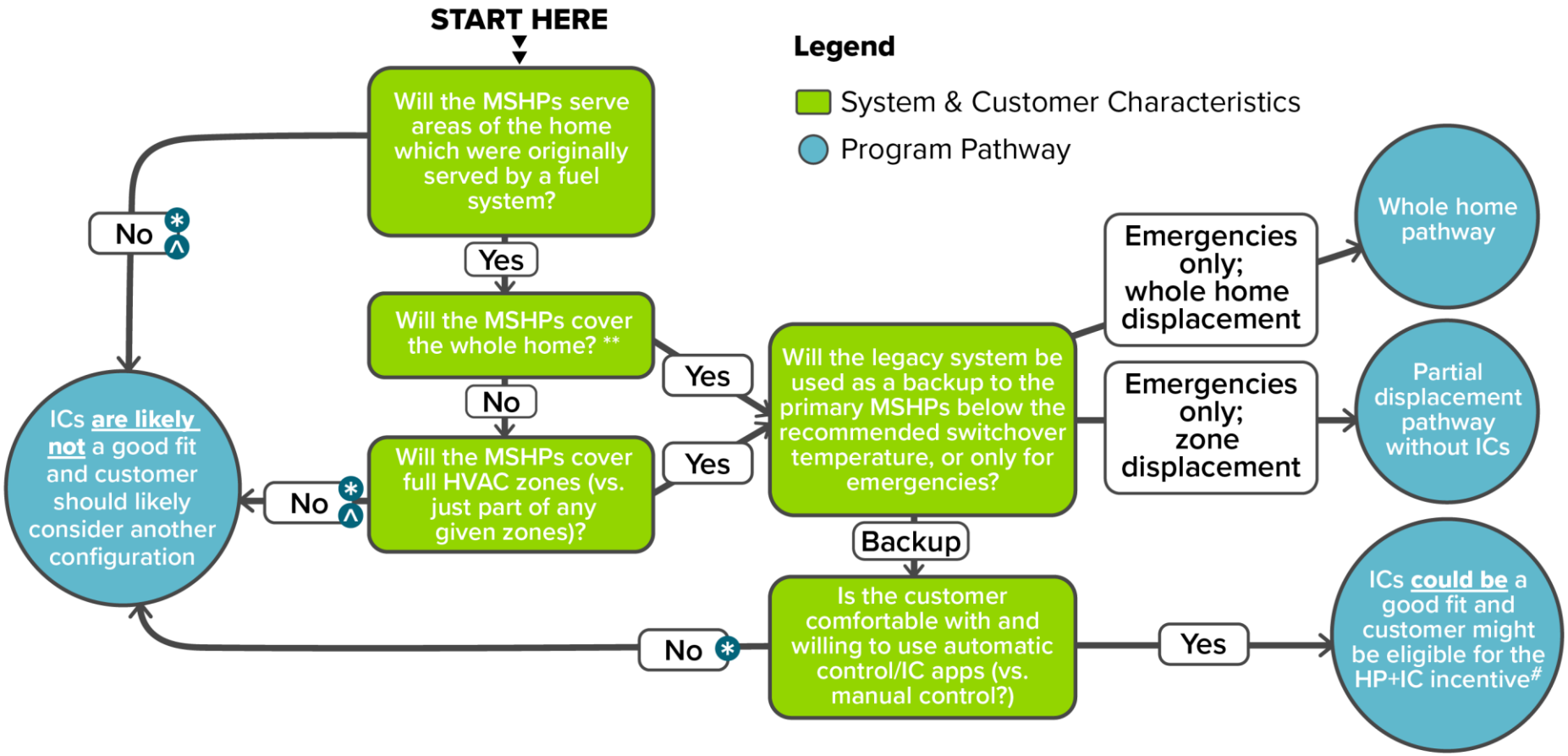
[CLOSING TEXT]

This concludes the survey. Thank you for taking the time to complete the survey. Please enter your name and email below to get your $20 e-gift card, redeemable at numerous retailers or for charitable donation through Rewards Genius and Tango Card.

Name **[TEXT RESPONSE]**
Email **[TEXT RESPONSE]**

Appendix C. Decision Tree and Use Cases

Study findings indicate that contractors are installing ICs in scenarios where they might not be a good fit or might not be a value-add to the customer. The study recommends that the program ensure that contractors are advising customers to select the most appropriate program pathway; using a decision tree (or similar resource) could help facilitate this discussion with contractors. The team provides the following graphic as an example of the kind of decision tree the program could consider providing to support contractors.



✱ *In this case, customers could still benefit from midstream incentives for MSHPs if they would like to place MSHPs in single rooms. Additionally, a customer could opt for a hardwired IC solution that allows customers to control their heating system through a wall thermostat and avoid app usage.*

^ *In this case, scaling HP and/or IC incentive based on anticipated fuel displacement (based on a combination of heating source use frequency, fuel system coverage, and/or MSHP coverage) could be considered.*

** *Auxiliary heating is sometimes used for small spaces such as bathrooms in these scenarios.*

Other factors specific to the customer's home might impact the viability of HP+IC configurations (wiring and/or WiFi limitations, nuances of home layout, etc.).