Market Characterization and Assessment Report: Single-Family Low- to Moderate-Income Heat Pump Demonstration Study (Pilot Period 2021-2022) Final Report

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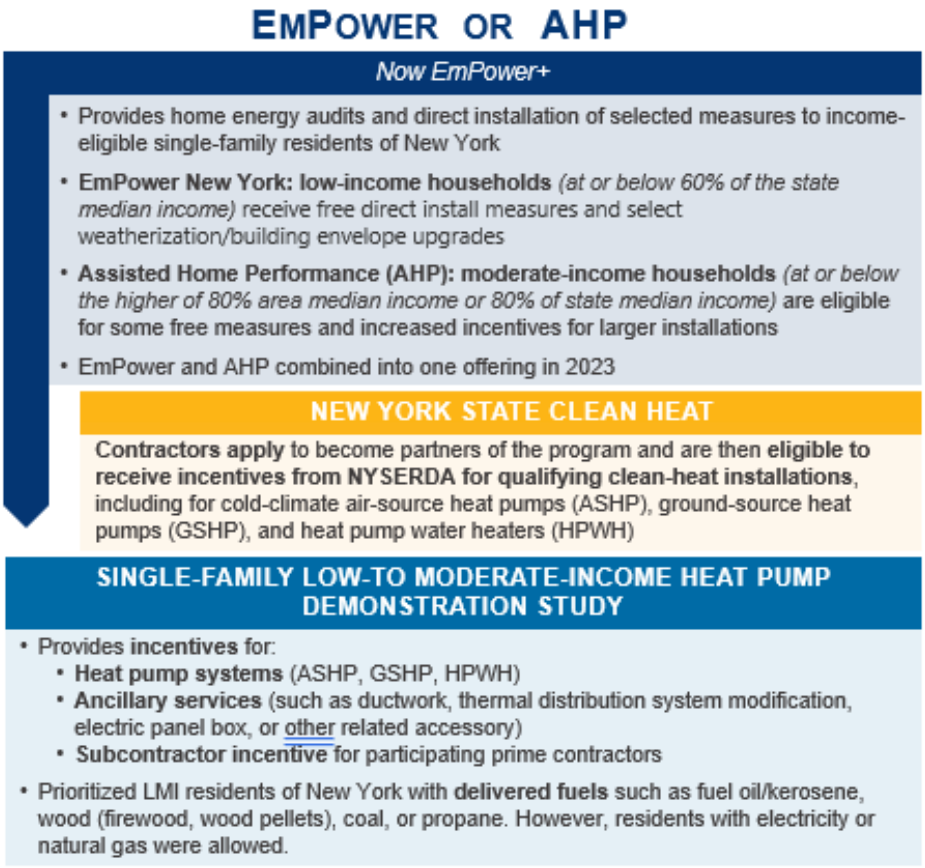
1 Introduction

1.1. Program Background and Description

The Single-Family Low- to Moderate-Income (LMI) Heat Pump Demonstration Study Pilot Program (the Pilot Program) was launched in October 2020. The primary goal of the Pilot Program was to encourage heat pump adoption in low- and moderate-income single-family housing with delivered fuels.

The Pilot Program was a collaboration between EmPower and Assisted Home Performance with ENERGY STAR® (AHP), programs (which were later consolidated into EmPower+) and NYS Clean Heat. Foundational program elements for EmPower+ and NYS Clean Heat are provided below,[1] followed by Pilot Program details. See Figure 1-1 for a map of program pathways.

Figure 1-1. Program summaries and flow



[1] See *Appendix A* for additional details on EmPower, AHP, and NYS Clean Heat.

EmPower+

- **Program Administrator:** NYSERDA
- **Eligibility:** Homeowners and renters living in one-to-four-unit housing and earning at or below the lower of 80% of state median income or area median income.
- **Services Offered:** The program offers no-cost comprehensive home energy assessments, direct install of improvements identified during the assessment by participating contractors, and customized plans to lower energy use.
- **Measures Offered**: Incentives for attic, wall, and rim joist insulation; air-sealing; health and safety items such as carbon monoxide detectors; mobile-home underbelly insulation; and replacement of inefficient refrigerator/freezer units. For homes with up-to-date insulation and air sealing, contractors can recommend heat pumps and replacement of low-efficiency natural gas heaters (although heat pumps are prioritized).

NYS Clean Heat

- **Program Administrator:** New York's electric utilities and NYSERDA.
- **Eligibility:** Owners or renters of one-to-four-unit housing.

  Measures Offered: The program offers funds for the installation of qualifying heat pump technologies. Qualification requirements are detailed in the NYS Clean Heat Program Manual.

LMI Pilot Program. Households participated in the pilot by applying to both EmPower+ and NYS Clean Heat and had the required insulation levels in their home, as detailed in *Appendix A*. Participating households could receive incentives for ductless and central ASHPs, GSHPs, HPWHs, panel boxes, and heating system distribution upgrades. Pilot Program participants, projects completed between February 2021 and August 2022, layered incentives through the EmPower+ and NYS Clean Heat programs.[2] Table 1-1 presents the incentives that were available through the Pilot Program according to entry track (EmPower or AHP).

[2] Detailed information about NYS Clean Heat incentives can be found here: https://cleanheat.ny.gov/assets/pdf/NYS-Clean-Heat-Program-Manual.pdf

Table 1-1.Pilot Program incentive levels

Offering Description	Incentive Type	EmPower Track	AHP Track
Upstate ASHP	$/10,000 BTU	$3,000	$1,500
Downstate ASHP	$/10,000 BTU	$2,200	$1,100
Upstate GSHP	$/10,000 BTU	$3,750	$3,750
Downstate GSHP	$/10,000 BTU	$3,850	$3,800
Upstate HPWH	$/unit	Normal EmPower	$975
Downstate HPWH	$/unit	Normal EmPower	$825
Panel Box Upgrade / Distribution Imp.	≤ 100 Amps	Up to $2,000	50% of cost up to $1,000

Source: NYSERDA. June 21, 2021. Heat Pump Demonstration Study Frequently Asked Questions. https://www.nyserda.ny.gov/-/media/Project/Nyserda/Files/Programs/MPP-Existing-Buildings/library/heat-pump-faq.pdf

Through the pilot between 2021 and 2022, 413 Pilot Program projects were completed. Table 1-2 provides an overview of projects by heat pump technology.

Table 1-2. Summary of completed Pilot Program projects by technology type

Technology Type	Number of Projects Completed
Ductless cold climate Air Source Heat Pump (ductless ccASHP)	285
Central ccASHP	58
Unknown ASHP	11
Ground Source Heat Pump (GSHP)	35
Heat Pump Water Heater (HPWH)	135
Total[a]	413

[a] Many projects included more than one technology type, so the number of projects completed does not add to the total number of projects.

Table 1-3 provides an overview of the extensive non-heat pump upgrades conducted in conjunction with heat pumps installed through the Pilot Program, averaging between three and four per site.

Table 1-3. Summary of non-heat pump upgrades

Non-Heat Pump Upgrade Type	Number of Upgrades Completed
Air Sealing	238
Attic or Roof Insulation	218
Foundation Wall Insulation	16
Freezer	7
Health and Safety	242
LED	122
Pipe Wrap	24
Refrigerator	14
Rim Joist Insulation	36
Shower Heads	12
Thermostats	43
Vapor Barrier	2
Wall Insulation	87
Non-HP Water Heater	29
Other Insulation	218
Additional Measures/Other	74

Source: Project files

1.2. Summary of Evaluation Objectives and Methods

NYSERDA contracted with Cadmus and Apex Analytics (the Evaluation Team) to provide preliminary insights regarding the research categories and objectives presented in Table 1-4.

Table 1-4. Research categories and objectives

Research Category: Characterize Pilot Program

Research Objectives:

- Characterize projects, including factors such as building characteristics and electric upgrades required
- Describe the economic characteristics/profiles of projects

Research Category: Identify Motivations, Barriers to Participation, and Best Practices

Research Objectives:

- Assess consumer and contractor technical awareness and identify reasons for implementation decisions
- Estimate the equipment, labor, and maintenance costs of upgrades
- Estimate funding obtained for projects from outside the NYSERDA program
- Identify the frequency of delays in project completion and the reasons behind those delays
- Identify best practices in heat pump installation, such as home weatherization upgrades, equipment sizing and selection, and Manual J calculations/blower door tests

Research Category: Partnership and Pilot Learnings and Expanded Service Offerings

Research Objectives:

- Identify the types of projects that involve subcontracting, including the dollar costs and barriers to subcontracting
- Identify opportunities to improve the future program design

Research Category: Validate Savings Model

Research Objectives:

- Validate energy savings
- Validate cost savings accounting for avoided fuel and necessary electric use
- Identify if, how, and why equipment, labor, and maintenance costs and upgrade specifications tend to change between design and install
- Validate whether customers see reduced materials, equipment, or labor maintenance costs due to upgrades

Table 1-5 presents the sample frame, total responses, and completion rate by research activity. The Evaluation Team analyzed results from the research activities to identify key findings and provide program design and delivery recommendations for consideration. Please see details regarding the study limitations in Appendix B.

Table 1-5. Research activities, sample frame, and number of completes

Research Activity	Timeframe	Population [a]	Total Responses (n) [b]	Response Rate (%)	Completes	Completion Rate (%)
Online and phone surveys of contractors [c]	Dec. 2022 – Feb. 2023	74	41	55%	39	95%
In-depth phone interviews with contractors [c]	Feb. 2023 – Apr. 2023	74	13	34%	13	100%
Online and phone surveys of enrolled customers [c]	Nov. 2022 – Jan. 2023	400	176	44%	166	94%
Online survey of customers who experienced extreme cold event [c]	Feb. 2023 – Apr. 2023	46	46	100%	46	100%
Analysis of program data	Apr. 2022 – Apr. 2024	N/A	N/A	N/A	413	100%
Analysis of EmPCalc (project) files	Apr. 2022 – Apr. 2024	N/A	N/A	N/A	351	100%
Analysis of electric billing data	Jan. 2023 – Apr. 2024	N/A	N/A	N/A	72	21%
Analysis of delivered fuels data	Jan. 2023 – Apr. 2024	N/A	N/A	N/A	30	28%

Note: For N/A values, the Evaluation Team took a census approach.

[a] Population and sample frame are identical for all activities, as the Evaluation Team used a census approach for all sampling activities.

[b] Sample frame, total responses, and completes are sourced from APPRISE disposition tables, which can be found in Appendix B

[c] Response counts from surveys and interviews shown throughout the report may vary because respondents may have skipped some questions.

[d] The extreme cold survey was added to a delivered fuel bill collection instrument. A $20 incentive was provided for initial submission of bills, with an additional $10 incentive for follow-up bills.

2 Pilot Program Evaluation Results

The following sections present analysis results for each of the four research categories presented in Table 1-4: Pilot Program Characterization; Identify Motivation, Barriers, and Best Practices; Partnerships Learnings and Expanded Service Offerings; and Validate Savings Model.

Both the customer and contractor surveys used a numerical scale of 1 to 5 for satisfaction or agreement with statements. In all cases, 1 corresponds to the lowest level of satisfaction or strong disagreement and 5 corresponds to the highest level of satisfaction or strong agreement. The Pilot Program refers to rating questions, means, or level of satisfaction using these scales. See the *Methods* section for the methodological overview and *Appendix B* for additional information on the analytical methods used in this research.

2.3 Pilot Program Characterization

The Evaluation Team explored project characterization features of the Pilot Program including project totals by location, types, predicting equipment costs, equipment replacement, and planned home upgrades.

2.3.1 Project Profiles

Location: Based on project files, of the 413 projects completed through the Pilot Program, most projects were located upstate, as shown in Table 2-1.

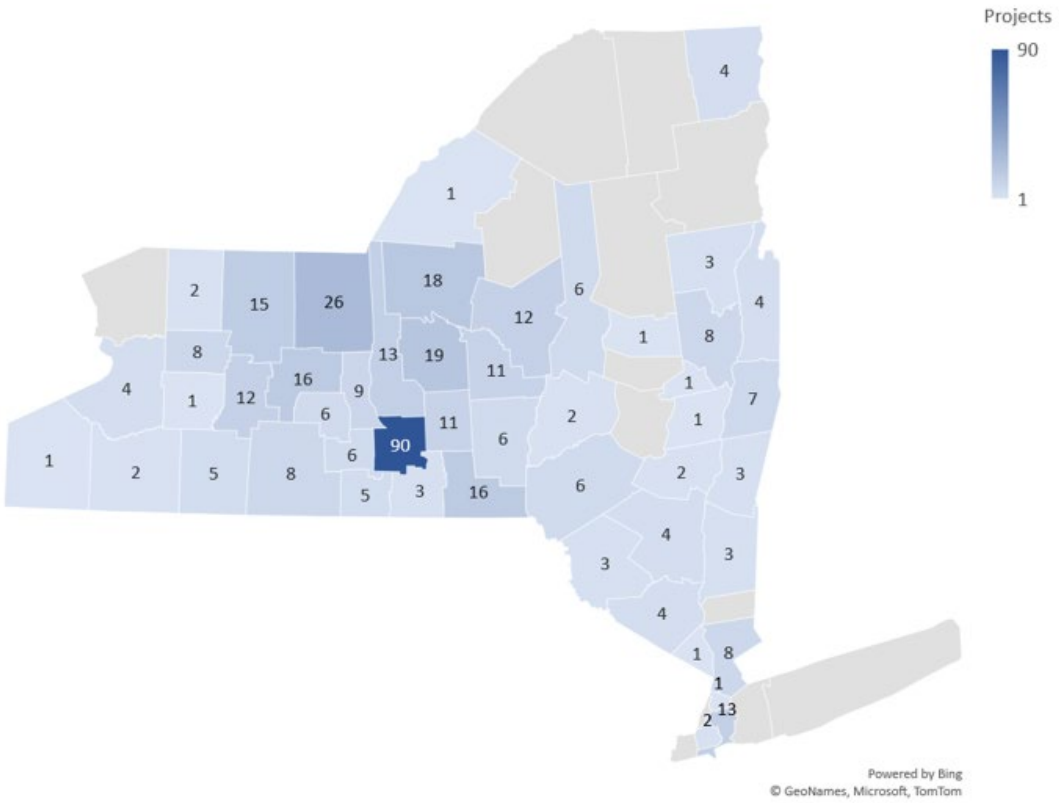
Table 2-1. Projects by region

Region [a]	Completed Projects Included in Sample
Hudson Valley	22
Upstate	375
NYC	16
Long Island	0
Total	**413**

Source: Project files
[a] Hudson Valley counties include Dutchess, Greene, Orange, Putnam, Rockland, Ulster, and Westchester. Upstate counties include all counties not listed in other categories. NYC counties include Bronx, Kings, Queens, New York, and Richmond counties. Long Island counties include Nassau and Suffolk.

Participation was spread across much of the state, with participants in 49 counties, with the highest concentration of participation in Central New York and the Finger Lakes, as shown in Figure 2-1. Ithaca was a hotspot, with 90 participants in Tompkins County alone.

Figure 2-1. Map of count of projects by county



Source: Project files

Project Types. As described in Table 1-2, the most common system installed through the Pilot Program was ductless ccASHPs (69%, 285 of 413), followed by central ccASHPs (14%, 58 of 413) and GSHPs (8%, 35 of 413). HPWHs were installed in 33% of projects (135 of 413), with 27% of projects including both HP and HPWH equipment (112 of 413). Supplemental services, such as electric panel and duct system upgrades, were also offered through the Pilot Program. Panel upgrades were included in 21% of projects and duct systems were upgraded in 18% of projects. In addition, as described in Table 1-3 most pilot projects (76%) included an envelope upgrade; of those, 58% involved air sealing, 53% attic or roof insulation, and 68% some kind of wall insulation.

Table 2-2. Prior Fuel Systems

Central ccASHP

Space Heating Fuel Type	Number of Projects (n=413)
Coal	3
Electricity	19
Kerosene	2
Oil	53
Pellets	4
Propane	49
Wood	15
Natural Gas	8
Total	**153**

Ductless ccASHP

Space Heating Fuel Type	Number of Projects (n=413)
Coal	7
Electricity	35
Kerosene	8
Oil	52
Pellets	7
Propane	42
Wood	34
Natural Gas	4
Total	**189**

GSHP

Space Heating Fuel Type	Number of Projects (n=413)
Electricity	1
Oil	13
Pellets	2
Propane	15
Wood	4
Total	**35**

No Space Heating Equipment Upgrade or Unknown

Space Heating Fuel Type	Number of Projects (n=413)
No Space Heating Equipment Upgrade or Unknown	36
Total	**36**

Predicting Equipment Cost. The Evaluation Team identified a wide range of costs for heat pump equipment. After testing various factors to explain differences in project costs,[3] the Evaluation Team found that the best predictor of heat pump equipment cost was the cost per kBtu.[4] More specifically, although the heat pump nameplate capacity and efficiency rating approaches vary across manufacturers and models, the approach to calculating heat pump capacity at 5°F is more consistent.

As shown in Table 2-3, ductless heat pumps and ccASHPs have very similar overall costs, while total GSHP costs are higher, mostly because of the expense for drilling the heat transfer wells.[5]

[3] See *Appendix B* for details.

[4] This could be implemented as cost per ton or cost per kBtu of heating capacity at 5°F (both are directly correlated to kBtu).

[5] Mustafa Omer, Abdeen. 2008. "Ground-Source Heat Pumps Systems and Applications." *Renewable and Sustainable Energy Reviews* (12, issue 2); p. 344–371. https://EconPapers.repec.org/RePEc:eee:rensus:v:12:y:2008:i:2:p:344-371

Table 2-3. Heat pump equipment cost per heating capacity

Equipment Type	Average Heating Capacity at 5°F (Btu/hr)	Average Equipment Cost	Average Cost/Heating Capacity ($/kBtu/hr)
GSHP	47,445[a]	$34,043	$718
Ductless ccASHP	45,722	$19,102	$440
ccASHP	47,080	$19,040	$440

Source: Project files
[a] The listed capacity for GSHPs is the overall rated capacity, because their ratings are based on the incoming ground loop water temperature rather than on outdoor temperature.

Equipment Replacement and Cooling. Just over half of surveyed customers (54%, 91 of 168) reported that the pre-existing heating equipment in their home was working without any issues at the time their heat pump was installed. These customers most commonly reported that their primary source of cooling prior to installing the heat pump was window air conditioners (49%, 82 of 168) and fans (43%, 72 of 168).

Planned Home Upgrades. Customers provided insights on upcoming major home energy projects, with 32% of surveyed customers (54 of 170) reporting plans to make major home upgrades *within the next year*. The most common upgrades reported were new major appliances (47%, 26 of 55) and room remodeling or additions (45%, 25 of 55).

2.4 Motivations, Barriers, and Best Practices

The Evaluation Team explored Pilot Program experience, specifically motivations for and barriers to Pilot Program participation, as well as contractor installation best practices. This section begins with contextual data on conversion rates[6] by equipment type to provide additional insight into contractor installation practices. Detailed findings pertaining to the following subtopics follow the contextual data: customer motivations to equipment and contractor motivations to participate in the program; barriers to completing projects; customer reliance on and satisfaction with new equipment; customer callbacks, equipment costs; external project funding sources; the frequency of project delays; and best practices for heat pump installations in LMI single-family homes including sizing, use of backup systems and integrated controls, as well as additional home improvements, system use, and education.

[6] Conversion rates indicate the percentage of customers who moved forward with a heat pump recommendation.

2.4.1 Conversion Rates

Equipment Installation Rates. To contextualize the analysis, the Evaluation Team surveyed contractors about the conversion rates for heat pumps in their Pilot Program projects. For all technologies except GSHP, over half of recommendations led to customers installing the recommended equipment (Table 2-4).

Table 2-4. Conversion rates by equipment type

Technology	Mean conversion rate	Median conversion rate	Contractors with 100% conversion
Ductless ccASHP (n=27)	59%	70%	3
Ducted ccASHP (n=29)	61%	60%	3
GSHP (n=9)	36%	15%	2
HPWH (n=24)	60%	75%	4

Source: Contractor survey

Importantly, just over half the customer survey respondents (54%, 91 of 168) reported that their pre-existing heating equipment was working without issues at the time their heat pump was installed, and 39% (66 of 168) reported that the pre-existing heating equipment was working but had performance issues.

2.4.2 Pilot Program Experience

Motivations for and Barriers to Participation. When asked about the importance of various factors for installing their heat pumps, surveyed customers reported similar motivations for ccASHP, GSHP, and HPWH. Customers' primary motivations for installing their equipment were financial, with the exception of GSHP customers who reported environmental concerns as their strongest motivator (Table 2-5).

Table 2-5. Customers' motivations for installing equipment—average influence

Motivation	Ductless ccASHP (n=102)	Ducted ccASHP (n=35)	GSHP (n=23)	HPWH (n=24)
Saving money	4.67	4.62	4.17	4.83
Improving home comfort with better cooling	4.62	4.25	3.55	4.25
Improving home comfort with better heating	4.58	4.15	3.68	4.17
Reducing environmental impacts	4.18	4.36	4.43	4.13
Adding additional heating	3.91	2.83	2.95	3.65
Replacing old equipment	3.74	3.94	3.86	3.32

Source: Customer survey
Note: Customers ranked all motivators on a scale of 1-5, with 1 indicating *not influential* and 5 indicating *extremely influential*.

The majority of surveyed contractors reported valuing the incentives offered, citing customer heat pump affordability (due to incentives) and improved close rates for projects as significant factors influencing their decision to participate in the Pilot Program. A smaller number noted expansion of offered services as their primary motivator, with fewer citing improvements in business processes around heat pumps and a shift of business focus to heat pumps as motivators (Table 2-6).

Table 2-6. Contractor-reported benefits of pilot program incentives

Technology	Percentage of Surveyed Contractors	Number of Surveyed Contractors (n=35)
Customer heat pump affordability	54%	19
Improved close rate for projects	51%	18
Expansion of offered services	11%	4
Improvement of business processes around heat pumps	6%	2
Shift of business focus to heat pump	6%	2

Source: Contractor Survey

During contractor interviews, 69% of contractors (9 of 13) noted that across all technology types, the substantial incentives available and potential energy cost savings of heat pumps were the most effective selling points to encourage customers to participate in the Pilot Program. However, these contractors also revealed that they viewed upfront cost as customers' primary consideration,

and potential barrier, when deciding whether to install heat pumps. In addition, most surveyed contractors (57%, 20 of 35) agreed that cost was a concern, noting that the primary reason for not moving forward with contractor recommendations was that the customer could not afford the required up-front contribution if incentives would not fully cover the cost of the equipment and installation.

Interviewed and survey contractors cited cost as a key outstanding challenge even though the Pilot Program provided enhanced incentives for ancillary services, building envelope upgrades, and the heat pumps themselves—which were designed to mitigate upfront cost concerns for LMI customers interested in heat pump technologies. Thirty-one percent of surveyed contractors (9 of 29) cited cost or financing concerns as a prominent barrier to working with LMI customers. Specifically, one interviewed contractor explained that cost was an issue because some incentives (such as those for HPWHs) covered the cost of equipment but not installation. Relatedly, interviewed contractors reported lack of home readiness and the presence of structural challenges as the technical challenges they most commonly faced in completing heat pump installations (Table 2-7).

Table 2-7. Technical or structural deficiencies preventing completion of heat pump installations

Challenge	ccASHP Percentage	ccASHP Count (n=12)	GSHP Percentage	GSHP Count (n=2)	HPWH Percentage	HPWH Count (n=11)
Home readiness or structural challenges	42%	5	100%	2	36%	4
Need for electric panel upgrades	17%	2	50%	1	18%	2
Prohibitive cost of meeting airtightness requirements	25%	3	0%	0		-

Source: Contractor interviews
Note: Respondents frequently cited multiple barriers when answering this question. Answers regarding the cost of installation are not reported here.

Due to the complexity of projects, surveyed contractors' perceptions of customers cost sensitivity greatly outweighed their perceptions of other possible customer concerns such as the performance of the heat pump, which was only reported by 17% of surveyed contractors (6 of 35).

Heating Equipment Reliance. Most customer survey respondents (69%, 108 of 156) reported that they mainly use their heat pump system on its own for heating. A majority of customer respondents similarly also reported only using their pump system for cooling 89%, 96 of 108).

As shown in Table 2-8, customer respondents who indicated they still use their pre-existing heating system after heat pump installation most commonly reported using their heat pump first and the pre-existing system only if needed and running both systems together (Table 2-9).

Table 2-8: How customers decide when to use the heat pump for heating

Decision Factor	For Heating Count (n=50)	For Heating Percentage
Use the heat pump(s) first and activate the other heating systems only if needed	23	46%
Use heat pump only when using specific areas of the home	9	18%
Use the other heating system first and active the heat pump only if needed	6	12%
Allow thermostat or controls system to determine which heating equipment is used	4	8%
Never use the heat pump	2	4%

Source: Customer surveys

Table 2-9. How the heat pump system is used for heating/cooling

Usage Pattern	For Heating Count (n=43)	For Heating Percentage	For Cooling Count (n=9)	For Cooling Percentage
Primarily use the heat pump and occasionally use the pre-existing system	14	32%	3	33%
Run both together	24	56%	5	56%
Primarily use the pre-existing system and occasionally use the heat pump	5	12%	1	11%

Source: Customer surveys

As shown in Table 2-10 customer respondents cited inadequate heating or cooling as the most common reason for using the pre-existing system, followed by a perception that the existing systems is more economical, and the systems serving different areas/rooms in the home.

Table 2-10. Reasoning for using pre-existing system

Reason	Heating Count (n=49)	Heating Percentage	Cooling Count (n=12)	Cooling Percentage
Heat pump does not adequately heat/cool space	18	37%	3	25%
Pre-existing system is more economical for heating/cooling	14	29%	2	17%
Pre-existing system and heat pump serve different areas/rooms	12	24%	2	17%
Pre-existing system can provide heat during power outages	11	22%	-	

Source: Customer surveys

In addition to the customer survey, almost half of the extreme cold weather survey[7] respondents (42%; 17 of 40) reported using only their heat pumps during the extreme cold weather event. The remaining 58% of extreme cold weather respondents supplemented their heat pump's heating capabilities with a pre-existing or backup heating system or used only the backup system to heat their home. As shown in Table 2-11, most commonly, these additional systems were wood fireplaces/wood pellet stoves or electric space heaters.

Table 2-11. Extreme cold weather findings: additional heating type used

Additional Heating Equipment Used	Responses Percentage	Responses Count (n=23)
Electric Space Heater	28%	11
Fuel Oil/Propane Central Heating	20%	8
Firewood, Fireplace, or Wood Pellet Stove	18%	7
Electric Resistance Backup/Baseboard Heater	5%	2
Natural Gas or Kerosene Space Heater	3%	1

Source: Extreme cold weather survey

[7] From February 3 to February 6, 2023, the Northeast experienced an extreme cold snap. During this period, temperatures ranged from 4 to -6 degrees Fahrenheit between New York City and Hartford, CT. This provided an opportunity for the Evaluation Team to assess customer satisfaction with heat pump technologies under adverse conditions.

Similar to the customer survey, extreme cold weather respondents who used additional heating systems during the cold snap most commonly indicated that the heat pump alone could not heat the entirety of their home sufficiently (Table 2-12).

Table 2-12. Reasons for using additional heating systems during cold snap

Reason	Responses Percentage	Responses Count (n=19)
Too cold for heat pump to keep up	42%	8
One area of home remained cold	37%	7
Concerns about electricity costs	11%	2
Concerns about heat pump freezing	5%	1
Perception that alternate fuels provide more heat	5%	1

Source: Extreme cold weather survey

Cooling Equipment Reliance. Most customer respondents also reported that they use only their heat pump system for cooling (89%, 96 of 108). Of the 12 who still reported using their pre-existing cooling system, two each noted that the new heat pumps and the pre-existing cooling systems serve different areas/rooms, that the heat pump does not adequately cool the space, and that the old system is more economical, while the other six gave a variety of verbatim answers including “fans are more convenient” and “I prefer to open windows.”

Hot Water Equipment Reliance Most customer respondents (86%, 70 of 81) said they do not have equipment in their home that generates hot water other than the HPWH. Customer respondents reported that they tend to operate their HPWH in auto or hybrid mode (46%, 5 of 11) or in efficiency or economy mode (35%, 4 of 11).

Customer Satisfaction. As shown in Table 2-13, a majority of customers reported being satisfied with the performance of their heat pump on hot and cold days. However, for those heating and cooling customer respondents who indicated they were less than satisfied (a rating of 1 or 2) the most common issues were with equipment performance, increased energy costs, and issues or delays during installation (Table 2-14).

Table 2-13. Breakdown of ASHP customer satisfaction with heat pump performance

Rating (1 to 5)	Satisfaction on Hot Days (% total) (n=137)	Satisfaction on Cold Days (% total) (n=140)
5	80%	40%
4	13%	32%
3	4%	15%
2	2%	5%
1	2%	9%

Source: Customer surveys
Note: While these satisfaction questions were asked of both ASHP and GSHP customers, no GSHP customer responded to either of them.

Table 2-14. Drivers of customer dissatisfaction

Driver	Overall Percentage	Overall Count (n=42)	EmPower Percentage	EmPower Count (n=33)	AHP Percentage	AHP Count (n=9)
Issues with equipment performance	64%	27	55%	18	100%	9
Increased energy costs	43%	11	30%	10	11%	1
Issues or delays during installation	10%	4	3%	1	33%	3

Source: Customer surveys

HPWHs customers respondents were most satisfied with the ease of use (75% *very satisfied*, 41 of 55) and with the amount of hot water produced (63% *very satisfied*, 35 of 56). Some customers reported being less satisfied with the noise of the HPWH (15% rated this as a 1 or 2, 8 of 56).

As shown in Table 2-15, although most extreme cold weather respondents did not experience issues with ice accumulation or indoor unit noise levels, nearly half (17 of 39) reported that outdoor units were noisier than usual.

Table 2-15. Extreme cold weather: feedback

Response	Yes Percentage	Yes Count	No Percentage	No Count	Not Sure Percentage	Not Sure Count
Ice Accumulation of the outdoor unit(s) that did not defrost on its own (n=38)	8%	3	66%	25	26%	10
Operation of indoor unit(s) nosier than usual (n=39)	18%	7	72%	28	10%	4
Operation of outdoor unit(s) noise than usual (n=39)	36%	14	44%	17	21%	8

Source: Extreme cold weather survey

Customer Callbacks. Interviewed contractors reported that, at the time of the survey, most projects (92%, 12 of 13) had not required post-installation callbacks or visits and that when callbacks are required, they are typically to rectify user error (Table 2-16).

Table 2-16. Frequency of and reasons for post-installation contractor callbacks

Callback Frequency or Reason	Contractors Percentage	Contractors Count (n=13)
Performed callbacks to rectify user error	62%	8
Performed callbacks for installation or equipment issues	31%	4
Reported higher callback rates for elderly customers	23%	3

Source: Contractor interviews

Frequency and Cause of Delays. As shown in Table 2-17, interviewed contractors reported on the frequency of delays across heat pump technologies, as well as the degree to which these delays were significant (defined as being more than 30 days off from the original estimate). Surveyed customers indicated that roughly a third of ASHP (30%, 43 of 143) and HPWP (33%, 19 of 55) projects were delayed and over half of GSHP (58%, 14 of 24) projects were delayed.

Table 2-17. Project delays by heat pump technology

Response	Ducted ASHP Percentage	Ducted ASHP Count (n=18)	Ductless ccASHP Percentage	Ductless ccASHP Count (n=19)	GSHP Percentage	GSHP Count (n=7)	HPWH Percentage	HPWH Count (n=17)
Average percentage of projects significantly delayed	38%	7	39%	7	26%	2	34%	6
Reported at least one significant delay	89%	16	89%	17	86%	6	88%	15

Source: Contractor survey

Surveyed Contractors (Table 2-18) and surveyed customers (Table 2-19) provided insight on the cause of these delays.

Table 2-18. Project delays by contractor-reported cause

Response	Ducted ASHP Percentage	Ducted ASHP Count (n=18)	Ductless ccASHP Percentage	Ductless ccASHP Count (n=19)	GSHP Percentage	GSHP Count (n=7)	HPWH Percentage	HPWH Count (n=17)
Supply chain	67%	12	68%	13	57%	4	47%	8
COVID-19	22%	4	26%	5	29%	2	18%	3
Obtaining project approval from permitting authority	22%	4	26%	5	14%	1	12%	2
Labor shortage	22%	4	21%	4	29%	2	12%	2
Needing additional equipment	6%	1	5%	1	14%	1	6%	1

Source: Customer survey

Table 2-19. Project delays by customer-reported cause

Cause of delay	ASHP Percentage	ASHP Count (n=42)	GSHP Percentage	GSHP Count (n=14)	HPWH Percentage	HPWH Count (n=19)
COVID-19	26%	11	21%	3	11%	2
Supply chain	21%	9	36%	5	16%	3
Obtaining project approval	12%	5	14%	2	11%	2
Needing additional equipment	12%	5	21%	3	21%	4
Labor shortage	10%	4	7%	1	11%	2

Source: Customer survey

Equipment Costs. Through reviewing the program tracking database, the Evaluation Team found that GSHPs were usually the most expensive type of heat pump equipment, as shown in Table 2-20. The Team also found that ASHP equipment is cheaper in the upstate region ($18,962/project) than in the Hudson Valley ($22,425/project) or in NYC ($21,240/project).

Table 2-20. Summary of heat pump equipment project costs

Heat Pump Equipment Included	Projects Reviewed	Average Equipment Cost	Equipment Cost/ Nominal Cooling Ton
ASHP	253	$19,208	$4,292
ASHP, HPWH	98	$24,549	$7,185
GSHP	21	$47,475	$11,325
GSHP, HPWH	14	$39,172	$8,426
HPWH	19	$2,848	N/A

Source: Project database

As shown in Table 2-21, panel upgrades and duct modifications added significant costs to heat pump projects that included them.

Table 2-21. Panel upgrade and duct modification costs

Heat Pump Equipment Included	Average Cost of Panel Upgrade	Average Cost of Distribution Modification
ASHP	$2,159	$2,750
ASHP, HPWH	$3,257	$1,769
Total of ASHP and ASHP + HPWH	$2,642	$2,400

Source: Project database

The traditional AHP/EmPower measures were broken into four categories: air sealing, ceiling and roof insulation, wall insulation, and other. Traditional project costs for the various combinations of traditional measures are shown in Table 2-22.[8]

[8] The only envelope upgrade package with sufficient sample to show variability by region was the Air Sealing, Attic, and Wall Insulation group. NYC ($11,996/project) had higher costs than Hudson Valley ($10,037/project), which had higher costs than Upstate ($8,906/project).

Table 2-22. Traditional measure project costs

Envelope Upgrade Group	Air Sealing	Attic and Roof Insulation	Wall Insulation Group	Project Percentage	Project Count (n=407)	Average Non-Heat Pump Cost
Air Sealing, Attic, and Wall Insulation	Yes	Yes	Yes	42%	169	$9,077
Ceiling and Wall Insulation	No	Yes	Yes	7%	30	$8,050
Air Sealing and Wall Insulation	Yes	No	Yes	10%	42	$6,647
Wall Insulation Only	No	No	Yes	10%	40	$5,925
Air Sealing and Attic Insulation	Yes	Yes	No	4%	15	$5,286
Air Sealing Only	Yes	No	No	3%	12	$2,030
Ceiling Insulation Only	No	Yes	No	1%	4	$2,030
No Envelope Upgrades	No	No	No	23%	95	$751

Source: Project database

External Project Funding Sources. Per the Project database, many projects were partially funded by the customer or building owner, and almost all projects received additional utility or third-party funding, as shown in Table 2-23.

Table 2-23. Average funding by project source

Incentive Type	Average Funding Provided for Projects without Customer Contribution (n=247)	Average Funding Provided for Projects with Customer Contribution (n=191)	Overall Average Funding (n=438)
NYSERDA Incentive	$12,332	$12,672	$12,480
Utility/Third-Party Incentive	$5,566	$7,053	$6,214
Customer Contribution	$0	$7,779	$3,392
Total Heat Pump Cost	$17,898	$27,504	$22,087

Source: Project database

Most surveyed customers did not remember what sources of funding they received for their project.[9] Of those who did remember, the most common response was that they had received funding only from NYSERDA. NYS Clean Heat and the NYS Weatherization Assistance Program were the most common sources of non-NYSERDA funding (Table 2-24).

[9] Because projects for many LMI Pilot Program participants were fully covered by incentives (i.e., no out-of-pocket costs), customers may not have been aware of the different funding sources contractors leveraged for those projects.

Table 2-24. Sources of funding

Source	All Customers Percentage	All Customers Count (n=173)	EmPower Percentage	EmPower Count (n=116)	AHP Percentage	AHP Count (n=57)
Don't know	60%	103	63%	73	53%	30
NYSERDA only	26%	45	27%	31	25%	14
NYS Clean Heat	5%	8	12%	14	9%	5
NYS Weatherization Assistance Program	5%	8	4%	5	4%	2
Energy Smart Loan for GSHPs	2%	3	0%	0	5%	3
Other	3%	6	3%	3	5%	3
Green Jobs Loan	1%	1	0%	0	2%	1

Source: Customer surveys

2.4.3 Project Best Practice Insights

Sizing. Surveyed contractors reported their practices for sizing heat pump equipment for participating homes. Across technology types, contractors reported using Manual J calculations most frequently to determine equipment sizing (Table 2-25).

Table 2-25. Contractor-reported methodology used to determine equipment sizing

Methodology	ASHP Percentage	ASHP Count (n=32)	GSHP Percentage	GSHP Count (n=7)	HPWH Percentage	HPWH Count (n=22)
Manual J calculations	31%	10	75%	3	40%	4
Utility bill analysis/historical consumption data	9%	3	13%	1	13%	3
Manufacturer software	6%	2	13%	1	9%	2
Energy modeling	6%	2	13%	1	9%	2
Other	9%	3	29%	2	9%	2
No response	47%	15	43%	3	55%	12

Source: Contractor survey
Note: Multiple answers allowed

In addition, interviewed contractors commonly reported using household size and manufacturer recommendations as guidelines for sizing HPWH equipment (Table 2-26).

Table 2-26. Contractor-reported approaches to HPWH equipment sizing

Consideration	HPWH Percentage	HPWH Count (n=11)
Household size	45%	5
Following manufacturer recommendations	36%	4
Customer preferences	18%	2
System costs	27%	3
Ability to meet hot water demands	27%	3
Physical limitations of the home	27%	3

Source: Contractor interview

Backup System Removal. Surveyed contractors reported differing approaches to their recommendations for removing existing equipment. Contractors installing ASHP and GSHP systems rarely recommended keeping the existing system, while about a third of contractors installing HPWH equipment made this recommendation (Table 2-27).

Table 2-27. Contractor-reported recommendation to remove existing equipment by technology

Recommendation	ASHP Percentage	ASHP Count (n=17)	GSHP Percentage	GSHP Count (n=5)	HPWH Percentage	HPWH Count (n=23)
Never recommended keeping existing system	12%	2	40%	2	9%	2
Recommended keeping existing system in at least one but fewer than 33% of projects	65%	11	100%	5	30%	7
Always recommended keeping existing system	18%	3	0%	0	4%	1
Cited system redundancy as a reason to keep existing system	41%	7	40%	2	17%	4
Cited lack of a valid reason to remove existing system	18%	3	0%	0	4%	1
Cited customer peace of mind as a reason to keep existing system	18%	3	20%	1	48%	11

Source: Contractor survey
Note: Multiple answers allowed.

Of surveyed contractors who recommended keeping the existing system as a backup (84%, 16 of 19), half (8 of 16) recommended switching to a backup system at 10°F or lower, and only one recommended switching to the backup at temperatures over 30°F (the warmest temperature specified). These findings align with responses from surveyed customers, 83% (58 of 70) who reported 10°F or lower as the lowest outside temperature for which their installer said their heat

pumps would function. The warmest temperature range for which customers were told to switch to their backup system was 31°F to 40°F (1%, 1 of 70).

Most interviewed contractors (92%, 11 of 12) performed only full heating load replacements, with the remaining contractor saying they did full heating load replacements 95% of the time.

Use of Integrated Controls. Contractors who installed ASHP and HPWH equipment were about evenly split, with roughly half reporting that they never installed integrated controls and half reporting that they did install them. As shown in Table 2-28, contractors who installed GSHP equipment were more likely to install integrated controls.

Table 2-28. Contractor-reported recommendations for integrated controls

Recommendation	ASHP Percentage	ASHP Count (n=17)	GSHP Percentage	GSHP Count (n=5)	HPWH Percentage	HPWH Count (n=10)
Never recommend integrated controls	47%	8	13%	1	60%	6
Reported installing integrated controls	53%	9	50%	4	40%	4
Recommend integrated controls in 30% or fewer projects	71%	12	38%	3	20%	2
Reported not always recommending integrated controls because they were unnecessary	29%	5	13%	1	40%	4
Reported no issues installing integrated controls	47%	8	38%	3	40%	4
Reported high cost and complexity as an issue	12%	2	25%	2	10%	1
Reported difficulty educating customers as an issue	6%	1	13%	1	0%	0
Reported perceived reduction in heat pump performance and functionality as an issue	6%	1	0%	0	10%	1

Source: Contractor survey

Additional Home Improvements. Beyond heat pump or HPWH installations, many projects completed through the Pilot Program included an array of other improvements including building envelope, electrical panel upgrades or service, and thermal distribution system upgrades. Nearly all surveyed contractors (95%, 21 of 22) noted that they made envelope improvements either as a technical best practice (50%, 11 of 22), as required by the Pilot Program to make the home "heat pump ready" with improvements to wall and attic insulation or airtightness (41%, 9 of 22), or because they always recommend envelope improvements (18%, 4 of 22). Surveyed contractors

reported that code and program requirements were the primary reasons for implementing electrical upgrades; specifically, they said that expanding amperage from electrical service (such as to 200 amps) was the most prominent need (50%, 9 of 18). The other 50% (9 of 18) reported a variety of reasons for implementing upgrades, such as meeting manufacturer or program requirements and accessing all available incentives. Only 8% of contractors (3 of 39) completed any distribution upgrades.

System Education. Table 2-29 presents the type of education materials provided by surveyed contractors. Table 2-30 reports what surveyed customers reported receiving.

Table 2-29. Contractor-reported educational materials provided to customers by technology

Education Materials	ASHP Percentage	ASHP Count (n=17)	GSHP Percentage	GSHP Count (n=5)	HPWH Percentage	HPWH Count (n=10)
Provided educational materials	100%	17	100%	5	100%	10
Tips for efficient performance	88%	15	100%	5	90%	9
Control and set temperatures	94%	16	100%	5	100%	10
How to clear debris	82%	14	40%	2	90%	9

Source: Contractor survey

Table 2-30. Customer-reported educational materials received by technology

Educational Materials	ASHP Percentage	ASHP Count (n=93)	GSHP Percentage	GSHP Count (n=24)
How and when to clean filters	65%	92	54%	13
Control and set thermostat	78%	108	83%	20
How to clear debris	44%	62	13%	3
Nothing – Contractor did not teach about system	8%	11	8%	2

Source: Contractor survey
Note: Survey did not ask customers for information about HPWH educational materials provided.

2.5 Partnership and Pilot Learnings and Expanded Service Offerings

The Evaluation Team examined project records and gathered contractor feedback regarding subcontractor partnerships, project and partnership challenges, as well as feedback on the program design and feedback on how to accelerate heat pump adoption.

2.5.1 Partnerships

Subcontractor Partnerships. Per the database records, 21% of projects (88 of 413) included a subcontractor for heat pump projects. For all 88 of these projects, the subcontractor received a $500 subcontractor incentive.

Nearly half of surveyed contractors using subcontractors worked predominantly with pre-existing partners, whereas those forming new partnerships exclusively engaged with new partners. Just over half of all surveyed contractors expressed a high likelihood of maintaining long-term working relationships, with those in new partnerships showing a particularly strong inclination towards continuity (Table 2-31).

Table 2-31. Contractor partnerships with subcontractors

Partnership	Contractors Percentage	Contractors Count (n=19)	Contractors who formed new partnerships with subcontractors Percentage	Contractors who formed new partnerships Count (n=5)
Pre-existing partners	47%	9	-	-
New Partnerships	26%	5	100%	5
Very likely to maintain long-term working relationship	53%	10	80%	4
Somewhat likely to maintain long-term working relationship	26%	5	20%	1
Not at all likely to maintain long-term working relationship	21%	4	-%	-

Source: Contractor Survey

2.5.2 Challenges

Contractor Challenges. Surveyed contractors most commonly reported dealing with program paperwork as a challenge, followed by poor communication and difficulties identifying Heat Pump subcontractors (Table 2-32).

Table 2-32. Contractor general challenges

Response	Surveyed Contractors Percentage	Surveyed Contractors Count (n=31)
Challenges with program paperwork	41%	13
Poor program communication	25%	8
Challenge identifying Heat Pump subcontractors	13%	4
Other (i.e. incentives are too low, marketing is not effective, there should be more avenues of funding)	22%	7

Source: Contractor Survey
Note: Multiple responses allowed

In addition to general challenges, as shown in Table 2-33, 42% (8 of 19) of contractors who used subcontractors reported several more specific challenges when working with subcontractors.

Table 2-33. Challenges reported by contractors who used subcontractors

Response	Contractors who reported challenges working with subcontractors Percentage	Contractors who reported challenges working with subcontractors Count (n=8)
Challenges with Pilot Program explanation	40%	4
Cost and supply chain issues	30%	3
Subcontractor availability	10%	1

Source: Contractor interviews

2.5.3 Satisfaction

General Satisfaction. Surveyed contractors rated their level of satisfaction with several Pilot Program components on a 5-point scale, where 1 meant not at all satisfied and 5 meant very satisfied. As shown in Table 2-34, surveyed contractors rated various aspects of the Pilot Program, giving the highest average scores to the process to participate and types of equipment eligible. Customer participation criteria received a slightly lower score, while the amount of paperwork was rated significantly lower.

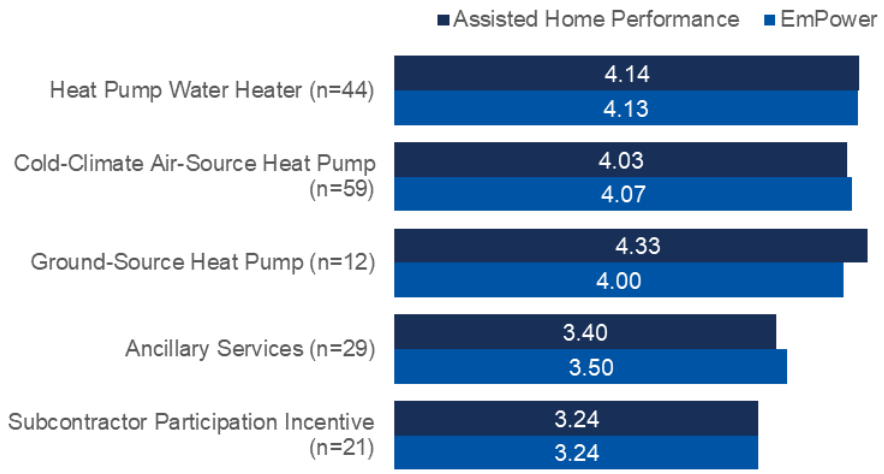
Table 2-34. Average contractor satisfaction ratings for pilot program components

Category	Average satisfaction out of 5 (n=39)
Process to participate	3.96
Types of equipment eligible	3.73
Customer participation criteria	3.69
Amount of paperwork	2.81

Source: Contractor Survey

Incentive Satisfaction. Surveyed contractors also rated the appropriateness of the incentive levels. As shown in Figure 2-2, overall, contractors were generally satisfied with the heat pump incentive levels, but satisfaction with the ancillary services and subcontractor incentives was lower.

Figure 2-2. Mean Score of Appropriateness of Pilot Program Incentive Levels Reported by Contractors (n=39)



Source: Contractor survey

Despite reporting that incentives were generally appropriate, contractors who expressed low satisfaction[10] with one or more elements of the program most often mentioned the amount of the incentive as their primary reason (Table 2-35).

[10] Defined as giving a satisfaction rating of 3 or lower on a scale of 1-5.

Table 2-35. Reasons for contractor low satisfaction ratings

Response	Less Satisfied Contractors Percentage	Less Satisfied Contractors Count (n=22)
Incentives too low	64%	14
Unclear communication from NYSERDA	14%	3
Inflexible program rules	9%	2
Contractor pass-through incentive too low	9%	2
Processing time too long	9%	2
Customer eligibility constrains	5%	1

Source: Contractor interviews
Note: Multiple responses allowed

These contractors (60%, 13 of 22) were specifically unsatisfied with incentives for ductwork or electrical panel upgrades and EmPower HPWH incentives. (Note that four responses indicating that incentives were too low came from contractors who reported high satisfaction with all program elements.) A smaller proportion of contractors said that incentives for subcontractors were insufficient (Table 2-36).

Table 2-36. Specifics on incentive dissatisfaction

Response	Less Satisfied Contractors Percentage	Less Satisfied Contractors Count (n=22)	Inadequate Incentive Responses Percentage	Inadequate Incentive Responses Count (n=13)
Inadequate subcontractor incentive	14%	3	0%	0
Inadequate incentives for ductwork or electrical	9%	2	15%	2
Inadequate EmPower HPWH incentives	18%	4	30%	4

Source: Contractor Survey

2.5.4 Contactor Feedback: Pilot Design and Acceleration of Equipment Adoption

Pilot Program Design. Surveyed and interviewed contractors most commonly suggested higher incentives, a more streamlined participation process, and better communication about program requirements as potential design improvements (Table 2-37).

Table 2-37. Contractors' suggestions for program improvement

Suggestion	Surveyed Contractors Percentage	Surveyed Contractors Count (n=33)	Interviewed Contractors Percentage	Interviewed Contractors Count (n=13)
Increase incentives	36%	12	46%	6
Streamline participation process	24%	8	46%	6
Improve communication	15%	5	23%	3
Expand program	9%	3	0%	0
Increase customer marketing and education	9%	3	8%	1
Reduce air sealing requirements	6%	2	31%	4
Other	12%	4	31%	4

Source: Contractor surveys and interviews
Note: Answers to these questions frequently contained multiple suggestions.

While 38% of interviewed contractors (5 of 13) had no suggestions for how to improve the Pilot Program, as presented in Table 2-37, similar to surveyed contractors, six interviewed contractors recommended streamlining the process and paperwork for participating. In addition to the 13 interviewed contractors, four recommended adding flexibility around insulation and building envelope requirements.[11] Two of these contractors specifically suggested flexibility for airtightness requirements, particularly for homes that narrowly miss the airtightness requirement or are in densely populated neighborhoods where wind affects heat loss differently. Three of the four acknowledged the importance of rigorous requirements while also supporting limited case-by-case exceptions.[12]

[11] Although the Pilot Program provides incentives for ancillary needs to complete the heat pump installation, such as ductwork, thermal distribution system modification, an electric panel box, or other related accessories, the program does not cover weatherization or envelope upgrades. Homes that need envelope upgrades or improvements must have those issues remedied before they are eligible for a heat pump through the Pilot Program, possibly by participating in EmPower+ if they are eligible.

[12] During a presentation of these interim results on June 20, 2023, NYSERDA Pilot Program staff clarified that they did add flexibility to the Pilot Program's airtightness requirements (to 7 ACH for most homes and 12 ACH for mobile homes), and that they are reviewing this requirement further for future program implementation.

Accelerating Heat Pump Adoption. Surveyed and interviewed contractors provided a range of suggestions to accelerate adoption of heat pumps in LMI households (Table 2-38). Beyond the overlapping feedback on the pilot design above (desire for additional incentives), when considering how to accelerate heat pump adoption contractors also noted additional customer education material and staff training as positive contributors.

Table 2-38. Contractor suggestions for accelerating adoption of heat pumps

Response	Surveyed Contractors Percentage	Surveyed Contractors Count (n=35)	Interviewed Contractors Percentage	Interviewed Contractors Count (n=6)
Additional incentives	91%	32	17%	1
Additional customer educational materials	51%	18	50%	3
Staff training	37%	13	17%	1
NYSERDA-provided marketing materials	34%	12	17%	1
NYSERDA's endorsement of contractors to increase credibility with customers	26%	9	-	-
Increase availability of equipment	-	-	17%	1

Source: Contractor surveys

2.6 Savings Validation

The Evaluation Team determined the validity of NYSERDA's savings by analyzing energy (delivered fuel) displacement and utility bill savings; reviewing costs and upgrade specification changes, including project cost and upgrade changes; and investigating perceived reductions in costs and maintenance including utility bill cost satisfaction and maintenance.

2.6.1 Energy Displacement

Delivered Fuel Displacement. The Evaluation Team analyzed the delivered fuels displacement by comparing the tracked savings from the project data files known as "EmPCalc files" with the evaluated savings. Evaluated savings were estimated by subtracting the consumption estimates in the delivered fuels survey from the tracked pre-installation delivered fuel consumption.

As shown in Table 2-39, overall, the delivered fuel savings derived from the billing analysis are similar to the savings reported in EmPCalc files**.** However, six projects[13] out of 30[14] in the sample had non-zero delivered fuel savings, even though there were no delivered fuel savings recorded in the EmPCalc files. For projects that displaced oil, propane, and kerosene heating, the average evaluated delivered fuel savings was 92 MMBtu, representing 96% of the savings estimated in the EmPCalc files. For sites with wood heating displaced, the average evaluated delivered fuel savings was 113 MMBtu, representing 94% of the savings estimated in the EmPCalc files. With a sample size of two, wood pellets have an estimated 87 MMBtu of evaluated savings, representing 100% of the savings estimated in the EmPCalc files.

Table 2-39. Delivered fuel sample impacts by group

Group	Average EmPCalc Savings Estimated (MMBtu/home)	Average Evaluation Savings Estimated	Realization Rate	n
Zero Savings Estimate	-	52	N/A	6
Oil, Propane, and Kerosene	95	92	96%	14
Wood	120	113	94%	8
Wood Pellets	87	87	100%	2

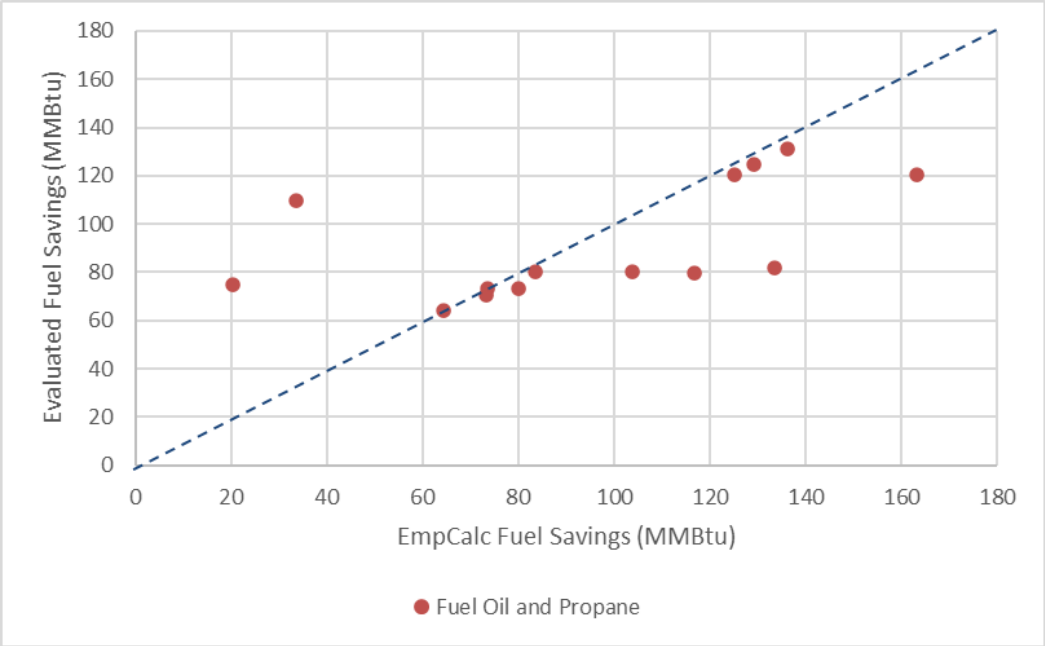
Source: Project files

As shown in Figure 2-3, the evaluated fuel savings for most of the oil and propane projects are only slightly lower than the EmPCalc savings, with most points lying close to the blue dashed line of equal savings.

[13] Of the six projects in the sample with zero MMBtu savings recorded, five had an electric resistance heat baseline listed and one had a coal heating system baseline listed.

[14] 30 projects provided usable delivered fuels data as part of survey efforts.

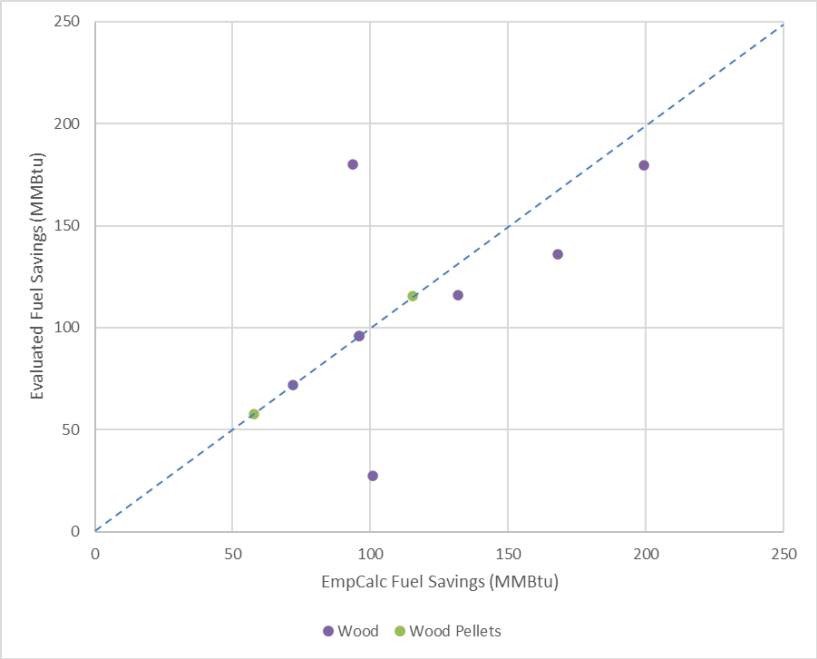
Figure 2-3. Evaluated fuel oil and propane savings from delivered fuel survey versus EmpCalc fuel savings



Source: Project files

As shown in Figure 2-4, most wood projects and wood pellet projects have evaluated fuel savings that are comparable to EmPCalc savings.

Figure 2-4. Evaluated wood and wood pellet savings from delivered fuel survey versus EmPCalc fuel savings



Source: Project files

2.6.2 Utility Bill Impacts

The Evaluation Team estimated bill impacts using measured delivered fuel displacement, assumed seasonal coefficient of performance, and current prices to provide the direction and magnitude of likely bill impacts. The winter of 2022-2023 had historically high energy prices, with delivered fuels costing approximately 50% more than in the previous three years.[15] As shown in Table 2-40, customers with oil, kerosene, or propane heat before installing their heat pump typically saved more than $2,000 during the winter of 2022-2023, while customers heating with firewood saved closer to $1,000.

[15] Specific assumptions are outlined in *Appendix C*.

Table 2-40. Estimated household annual bill savings by fuel type

Fuel	Displaced Fuel (MMBtu)	Cost of Avoided Fuel	Increased Electricity Usage (kWh)	Electricity Cost	Annual Bill Savings
Oil	92	$3,300	10,756	$2,151	$1,149
Kerosene	92	$3,961	10,756	$2,151	$1,809
Propane	92	$3,568	10,756	$2,151	$1,417
Firewood	113	$2,258	6,617	$1,323	$934
Wood Pellets	87	$1,733	10,155	$2,031	$(299)

Source: Project files and database

Customers with non-liquid delivered fuels such as wood and wood pellets (16%, 68 of 438) may have very different experiences than those with liquid fuels and potentially than each other. Firewood can be expensive to purchase at the market rate (up to an estimated average of $2,300 annually). However, it is possible that customers (particularly rural customers) are acquiring their wood in less expensive ways, such as harvesting it themselves or buying it in bulk from local suppliers. Therefore, while the savings for firewood could be over $900 annually, the high variability in cost from person to person leads to actual savings that are less certain.

Additionally, customers with wood and wood pellets are not as likely as those with other fuel types to realize utility bill savings from converting to a heat pump system. Wood pellets are not only an efficient fuel source but are also relatively inexpensive—it may cost less than $1,800 per year to warm a home with wood pellets. Based on the Evaluation Team's analysis of the winter 2022-2023 fuel costs, participating wood pellet customers were at risk of losing a small amount of money (approximately $300 for the season) by switching to an electric heat pump system.

2.6.3 Costs and Upgrade Specification Changes

Project Cost Changes. Based on Pilot Program files, 13% of the projects (47 of 351) had a likely cost change from the start of the project (as documented in the test-in EmPCalc files) to the finish of the project (as documented in the final project database). Seven percent of the projects (25 of 351) initially had water heaters in the EmPCalc files, but ultimately those water heaters were funded by Office of Temporary Disability Assistance program or the NYS Clean Heat program, so while the database costs changed for these projects, the actual costs did not change. In addition, 7% of projects (24 of 351) had clear errors in their cost documentation, which most commonly were caused by double-counting of health and safety costs. Table 2-41 details discrepancies between the EmPCalc files and the final program database.

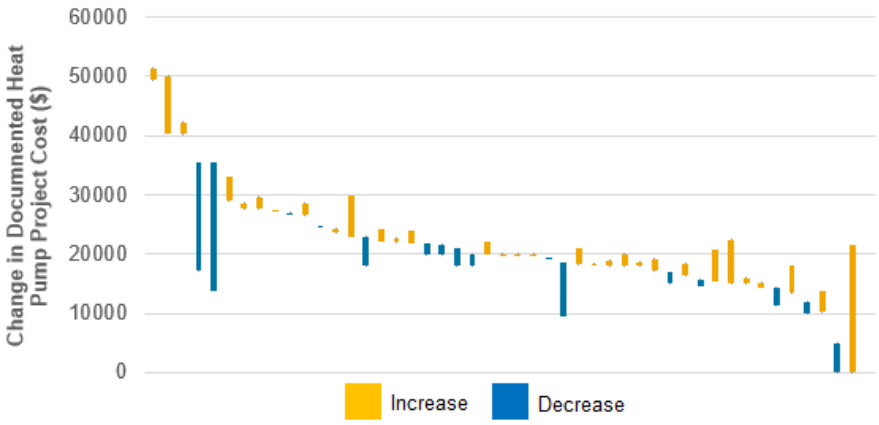
Table 2-41. Characterization of project cost changes

Cost Change Category	Count	Percentage
No changes from EmPCalc to database	230	66%
Likely cost change	47	13%
Water heater funded elsewhere	25	7%
Error	24	7%
Project removed	10	3%
ASHP removed from final	5	1%
Missing project ID	5	1%
Pending approval	3	1%
Project moved to other funding entirely	2	1%
Total projects reviewed	**351**	**100%**

Source: Delivered fuel data

Figure 2-5 shows each of the project files for which costs either increased or decreased between the EmPCalc test-in files and the final program database files. The most common cost changes are small increases to the project cost: 28% (13 of 47) had increases of $1,000 or less. Some of the cost changes may be due to documentation errors or correction of documentation errors, like the two projects at the far right edge of the figure, one of which started with zero costs and one of which finished with zero costs.

Figure 2-5. Change in documented heat pump project costs



Source: Project files

A majority of surveyed contractors (78%, 29 of 37) reported that air and ground source heat pump installation costs deviated from original estimates, whereas only half of surveyed contractors (50%, 11 of 22) reported changes in the costs of HPWH projects.

Table 2-42 presents project aspects that influenced cost changes. For ASHP/GSHP projects modifications to the project design and inflated material costs were the most frequently reported; whereas, inflated materials costs were the leading factor driving cost changes in HPWH projects.

Table 2-42. Reasons why costs deviated from original estimates

Response	ASHP/GSHP Projects Percentage	ASHP/GSHP Projects Count (n=37)	HPWH Projects Percentage	HPWH Projects Count (n=22)
Modifications to the design	12	32%	-	-
Inflated material costs	12	32%	8	22%
Added scope	11	30%	-	-
Supply chain constraints on product availability	8	22%	-	-
Increased labor costs	7	19%	3	14%
Extended timeline for projects made original estimates sensitive to increasing inflation	5	14%	-	-

Source: Contractor surveys

Project Upgrade Changes. Over half of surveyed contractors across all system types reported making changes to their original plans and installing a differently sized heat pump, primarily because of changes related to building envelope work. Just under 30% of HPWH contractors reported making such changes, which were made in all cases because the original equipment was too tall for the designated space (Table 2-43).

Table 2-43. Reasons for making changes to heat pump or HPWH system size

Response	ASHP/GSHP Size Count (n=36)	ASHP/GSHP Size Percentage	HPWH Size Count (n=22)	HPWH Size Percentage
No changes made	17	41%	15	68%
Changes related to building envelope work	14	41%	-	-
Customer interest	4	38%	-	-
Incentive availability	4	16%	-	-
Increased labor costs	7	24%	-	-
Original equipment was too tall for the space	-	-	6	27%

Source: Contractor surveys

2.6.4 Perceived Reduction in Costs and Maintenance

Utility Bill Costs. Most customer respondents reported that they were satisfied with their cooling costs since the installation of their heat pumps, with 81% (118 of 146) rating themselves as satisfied and only 3% (4 of 146) rating themselves as dissatisfied. There was slightly less consensus for heating costs: 61% (95 of 155) of surveyed customers rated themselves as satisfied with their heating costs and 15% (23 of 155) rated themselves as dissatisfied.

Maintenance. Most surveyed customers reported that they have not needed maintenance for their heat pump since installation, with most of the remainder needing maintenance once per year (Table 2-44).

Table 2-44. Frequency of maintenance and filter replacement

Response	Maintenance or Service Percentage	Maintenance or Service Count (n=163)	Filter Change Percentage	Filter Change Count (n=168)
Not yet had or needed	61%	100	15%	25
Once per year	31%	50	13%	22
Twice per year or more often	9%	14	22%	27
Once every three months or more often	-	-	48%	80
Don’t know	2%	4	2%	4

Source: Customer Survey

3 Key Findings and Recommendations

The findings and recommendations presented in this section are based on insights from 413 LMI Pilot Program participants. These participants were all residents of New York who replaced heating systems that relied on delivered fuels such as fuel oil, wood, coal, or propane[16], with heat pumps.

3.3 Finding 1

LMI customers are motivated to install heat pumps not only to save money, but also to improve their home comfort and to replace systems before burnout. In addition, many delivered fuel customers are meeting the majority of their heating and cooling needs with their new heat pumps. Most surveyed Pilot Program participants were motivated to install a heat pump to save money (heat pumps: 89%, 143 of 160; HPWHs: 83%, 42 of 51) and to improve home comfort with better cooling (85%, 140 of 165) or heating (82%, 131 of 161). In addition, most participants replaced their old heating and/or cooling systems before failure with their new heat pump (93%, 157 of 168).[17] After installing the heat pump system, most participants with delivered fuel met their primary heating and cooling needs with their new heat pumps (69%, 108 of 156). However, a small subset of participants (31%, 49 of 156) still used their pre-existing heating and cooling systems because they either perceive them to be more economical than the heat pump (29%, 14 of 49) or believe that the pre-existing system would help them to remain comfortable (37%, 18 of 49).

Contractor reported providing and customer indicated they received a variety of educational resources; however, when considering how to accelerate heat pump adoption contractors noted additional customer education material and staff training, in addition to expanded incentives, would be helpful.

[16] The study population homes were previously heated with coal (2%), cord or pellet wood (16%), propane (27%), fuel oil (34%), or by other fuels such as electricity and kerosene (21%). For further considerations about this Pilot Program, see *Appendix B*.

[17] This 93% (157 of 168) consists of 54% (91 of 168) who reported that their pre-existing heating equipment was working without issues at the time their heat pump was installed and 39% (66 of 168) who reported that their pre-existing heating equipment was working but had performance issues.

Recommendation 1a

Expand marketing and educational resources of heat pump technologies to further emphasize increased home comfort in addition to bill savings and proper equipment usage. These expanded marketing and educational resources targeting contractors and customers may include items such as: Contractor instructions and marketing assets, e.g., case studies; Fact sheets and contractor training that support contractors in identifying funding options to better support customer decision-making and capitalizing on their existing motivations; and Customer-facing resources explaining or demonstrating heat pump technologies, such as videos, infographics, or equipment tutorials, that are promoted on the NYSERDA website or social media[18]

Recommendation 1b

Consider conducting follow-up research with Pilot Program participants. Since surveyed customers were relatively new heat pump owners at the time of this evaluation, consider conducting follow-up research with Pilot Program participants to assess if and how they have changed their system usage over time and whether they have increased familiarity with heat pumps.

3.4 Finding 2

Heat pumps and heat pump water heaters significantly displaced delivered fuels and lowered utility bills for LMI residents. The evaluated projects with liquid delivered fuels (63%, 259 of 413) have consistent displacement and annual cost savings, while those with wood-based delivered fuels (16%, 66 of 413) may have higher variability in displacement and lower cost savings.

Projects with liquid delivered fuels such as oil (33%, 137 of 413), propane (27%, 110 of 413), and/or kerosene (3%, 12 of 413) had relatively consistent fuel displacement (about 92 MMBtu), similar to what was estimated in the EmPCalc files (96% realization rate). Paired with winter 2022-2023 delivered fuel costs, the savings for these three fuel types for households that installed new Pilot Program equipment were all above $1,000 per year.

[18] NYS Clean Heat launched a Heat Pump Planner webpage (https://cleanheat.ny.gov/planner) in November 2021. This is a valuable resource that did not appear to be well-known by program participants.

Recommendation 2

Consider prioritizing and marketing heat pump technologies to households that use fuel oil, propane, and kerosene for primary heating. Focusing on these fuels will maximize consistent fuel displacement and utility bill savings for the consumer.

3.5 Finding 3

Current incentive mechanisms for needed envelope, weatherization, and ancillary electrification improvements in LMI households are not always sufficient to meet the heat pump eligibility requirements. Although NYSERDA and NYS Clean Heat provide incentives to LMI residents for envelope, weatherization, ancillary electrification services[19] to support heat pump systems, the incentives for these services are not always sufficient to meet the heat pump eligibility requirements for participation in the Pilot Program.

During surveys and interviews, contractors expressed general satisfaction with the level of incentives offered for ccASHPs, GSHPs, and HPWHs. In addition, although satisfaction with the incentives for ancillary services (such as ductwork or electrical upgrades) was lower than that for heat pumps,[20] contractors noted that if no funding had been available for ancillary services, some projects would not have been completed because this additional work often adds significant costs to heat pump installations (54%, 19 of 35). These costs are partially mitigated by precursor programs to the Pilot Program, such as EmPower+, which provides funding for envelope and weatherization improvements for eligible homes.

Contractors mentioned that their concerns with the ancillary services and envelope incentives are specific to LMI customers (60%, 13 of 22). These contractors said that they do not want to propose work that would result in any out-of-pocket costs for LMI customers and typically the need for ancillary and envelope upgrades in LMI homes can be more extensive than in market-rate housing, and more extensive than what is supported by EmPower+. Although contractors reported that LMI housing stock is generally in poor condition, they also acknowledged that

[19] Such as ductwork or electrical upgrades.

[20] Surveyed contractors (n=39) rated the appropriateness of incentives for each measure and service provided through the Study on a scale of 1-5. EmPower Contractor Mean Scores by Measure: HPWH 4.13, ccASHP 4.07, GSHP 4.00, Ancillary Services 3.50, and Subcontractor Participation Incentive 3.24. AHP Contractor Mean Scores by Measure: GSHP 4.33, HPWH 4.14, ccASHP 4.03, Ancillary Services 3.40, and Subcontractor Participation Incentive 3.24.

needs vary greatly from home to home—while some homes may only need minor repairs or upgrades with little additional cost, others need significant repairs, which can lead to costs of tens of thousands of dollars before the home is eligible to receive a heat pump (60%, 6 of 10).

While retaining the standards for home envelope needs (to ensure they are "electrification-ready" before heat pumps are installed) can help customers save money and maintain comfort after a heat pump installation, it may be possible to refine the Pilot Program rules to add flexibility, such as increasing funding for homes with more severe issues or adding nuance to the restrictions based on home envelope quality. At the same time, contractors understand that it can be difficult to establish different rules and different levels of funding for each home in a standardized incentive program.

Recommendation 3a

Consider whether a future program focus is to reach LMI customers whose homes may need only modest improvements to be electrification-ready or to serve all LMI customer homes. If the program is intended to transform all LMI customer homes, then re-examine two key elements to the extent possible:

- **Level of incentives** both within the Pilot Program and from programs that support the program (EmPower+ and NYS Clean Heat).
- **Eligibility requirements** (in particular, airtightness) to ensure that those requirements reflect LMI market conditions.

Recommendation 3b

Consider developing a single-point-of-contact concierge service to inform interested customers about available incentives (e.g., program, state, and federal) and connect them with contractors who can help implement necessary energy efficiency upgrades and installation of heat pump technologies.

4 Methods

The Evaluation Team validated energy savings in accordance with *International Performance Measurement and Verification Protocol* standards and conducted an analysis of delivered fuel displacement and utility bill savings. The analysis, results, conclusions, and recommendations resulting from this evaluation will inform and be applied to long-term programmatic decision-making support interventions developed and administered by NYSERDA in coordination with the New York State Department of Public Service and the New York utilities.

For this Pilot Program, the Evaluation Team conducted a survey of participating customers (*Appendix D*), a survey of participating contractors (*Appendix E*), and detailed interviews with a subset of participating contractors (*Appendix F*). In addition, the Evaluation Team reviewed relevant project files and analyzed customer billing data.

To encourage participation, customer and contractor surveys did not require respondents to provide answers to any questions. This resulted in different n-values for different questions.

4.3 Surveys

The Evaluation Team conducted two major surveys for this evaluation: one with customers who received heat pumps or HPWHs through the Pilot Program (known as customers) and one with participating contractors. In addition, as part of a request for customers to provide information about delivered fuels, the Evaluation Team developed a short survey about the extreme cold weather event that occurred in the Northeast between February 3 and February 6, 2023. The cold weather event survey was sent as part of the delivered fuel data collection effort.

4.3.1 Customer Survey

From November 2022 to January 2023, the Evaluation Team ran a mixed-mode customer survey (hosted on Qualtrics). The purpose of the survey was to investigate research objectives from the perspective of the heat pump/HPWH end user by exploring key topics such as motivations to install, experience with installation, and experience with heat pump/HPWH usage.

Customers' contact data were collected in program data files. The Evaluation Team recruited customers via email and phone, and therefore respondents could complete the survey online independently or over the phone with Evaluation Team staff. Overall, 400 customers were eligible for the survey (based on the number of completed projects as of the survey launch), which resulted in 166 completed surveys. A detailed disposition report of survey efforts is

outlined in *Appendix B* and the full survey instrument (with specific research objectives) is in *Appendix D*.

4.3.2 Contractor Survey

From December 2022 to February 2023, the Evaluation Team ran a mixed-mode survey (hosted on Qualtrics) for contractors who participated in the Pilot Program, after receiving their contact information from NYSERDA. The purpose of the survey was to investigate research objectives from the perspective of the heat pump/HPWH installer and to explore key topics such as barriers to installation, installation best practices, and insights into subcontractor partnerships.

The Team recruited participating contractors via email and phone; therefore, respondents could have completed the survey online independently or over the phone with Evaluation Team staff. Overall, 74 contractors were eligible for the survey (based on the number of completed projects as of the survey launch), which resulted in 39 completed surveys. A detailed disposition report of survey efforts is presented in *Appendix B* and the full survey instrument (with specific research objectives) is in *Appendix E*.

4.3.3 Survey Analysis

The Evaluation Team analyzed both surveys using the Qualtrics built-in analysis capabilities for generating frequencies and crosstabs. Because of the small sample sizes, there were not enough responses to allow for cross-group statistical testing.

4.4 Interviews

In addition to gaining insights about many aspects of the Pilot Program through the surveys, the Evaluation Team interviewed willing participating contractors from February 2023 to April 2023 to gain a deeper understanding about key research objectives. The Evaluation Team designed the interview to further explore barriers to participation (for both contractors directly and their customer perceptions), best practices, and feedback on pilot design for future iterations.

The Evaluation Team used two approaches to recruit participating contractors for the interview. The primary approach was a rolling recruitment after the survey, in which the Team invited surveyed contractors to complete an interview at a later date. However, when the rolling recruitment did not result in enough interviews from surveyed contractors, the Evaluation Team opened the interview effort to contractors who had not completed the survey. The Team invited 38 contractors to be interviewed (not including previously surveyed contractors who declined a follow-up interview), and with encouragement to participate from NYSERDA Pilot Program

staff, these contractors provided 13 additional interviews. The full interview instrument (with specific research objectives) is in *Appendix F*.

4.4.1 Interview Analysis

The Evaluation Team took live notes during interviews and completed analysis in Excel. During the analysis, the Team used the matrix of questions and answers to synthesize key themes and ideas identified in the interviews.

4.5 Project File Review

NYSERDA provided the Team with EmPCalc files populated by participating contractors, which acted as the project applications, and with a program database for the project file review. The EmPCalc files include the cost of each component (heat pump equipment, water heater, panel upgrade, distribution upgrade, and other non-heat pump project costs).

To start, the Evaluation Team processed all EmPCalc files using a VBA script, aggregating fields into one tracking sheet. The Team characterized projects and confirmed information about building characteristics, heat pump and water heater type, electric updates, previous fuels, efficiency, and other upgrades that were included in the project files. The EmPCalc files do not consistently include details of the equipment installed, including the make, model, quantity, size, or efficiency. The program database includes cost fields to compare heat pump costs and total project costs without labor data as a separate item, but the database does not include all the same cost fields as the EmPCalc data. Per discussions with the Pilot Program implementer, participating contractors manually calculate and enter the aggregated heat pump cost field in the database, which introduced opportunities for error.

The Team matched all the information in the database to the EmPCalc files, flagging differences between the EmPCalc files and the program database at the most granular level possible, and sent those discrepancies to the implementer for clarification. After the implementer confirmed or corrected all the remaining discrepancies, the Evaluation Team then performed the cost analysis.

For this analysis, the Evaluation Team used the test-in files from the EmPCalc data and the final program database and compared costs from the initial test-in data with those in the final program data to determine how the cost data changed. The Team also assessed which component cost was changing to find errors, site detail changes, and true cost changes to the equipment.

4.5.2 Billing Analysis

The Evaluation Team estimated the delivered fuel billing impacts for each site installed date before October 1, 2021 that responded to the delivered fuel survey by subtracting the stated consumption for winter 2021-2022 from the documented pre-installation annual delivered fuel consumption. The Team then compared these impacts with the estimated heat pump and water heating MMBtu savings estimates from the EmPCalc files using five detailed steps:

1. Extract the documented amount of delivered fuel displaced for each project.
2. For each delivered fuel survey respondent with sufficient data, estimate the amount of 2021-2022 fuel displaced by comparing reported consumption for the winter of 2021-2022 to the documented pre-installation consumption data.
3. Estimate the heating load by assuming the efficiency of the baseline systems.
4. Multiply the heating load by the estimated coefficient of performance (COP) and convert the outcome to kilowatt-hours to estimate electricity increases.
5. Multiply the electricity and fuel impacts by prices to estimate bill impacts.

The Evaluation Team found problems with the single-family electric billing data, which precluded a complete analysis in this report. First, the electricity data was impacted by large variations in the amount of electricity savings expected for different measures. For fuel switches, increases in electricity were expected, while for other measures, electricity decreases were expected, making the analysis complicated and requiring a larger sample size. The electric billing analysis sample was not large enough because of an insufficient number of post-installation reads for most sites, resulting from a combination of bimonthly billing and estimated reads. Many sites also did not have an early enough installation date to have a full winter of post-installation data, reducing the sample further. When matching the delivered fuels data with the billing data after cleaning, the small number of sites for which complete electricity meter data was available led to a very small subset of delivered fuels and electric data for which all data was complete. Table 4-1 demonstrates the number of accounts lost at each cleaning step and the size of the final electric sample.

Table 4-1. Electric billing evaluation attrition

Billing Data	Count	Percentage Remaining
Total Accounts in EmPCalc data	351	100%
Accounts in billing data	347	99%
Has location information for weather data	344	98%
Has installation complete date	307	87%
Has post-installation complete data	290	83%
Has data from before winter 2020	267	76%
Has data through March 2022	237	68%
Has install date before November 2021	152	43%
Has at least six billing data observations each in pre and post periods	72	21%

Appendix A. Detailed Program Overviews

This appendix provides further detail about programs that precede the Heat Pump Demonstration Pilot Program: EmPower, AHP, and NYS Clean Heat. It also provides information about the insulation levels required to participate in the Pilot Program.

EmPower+ *(Previously EmPower New York and Assisted Home Performance)*

NYSERDA previously operated two LMI energy efficiency incentive programs as part of the Clean Energy Fund Portfolio: EmPower New York (EmPower) and Assisted Home Performance (AHP).[21] At the time the Pilot Program was conducted, EmPower and AHP were separate programs. However, because of the similarity of program operations and offerings, which differed only in the income brackets targeted and the levels of incentive offered, in 2023 NYSERDA merged EmPower and AHP into a combined program called EmPower+ that will continue to operate unchanged.

EmPower+ is funded through the Systems Benefit Charge, the federal Home Energy Assistance Program, the New York State Joint Utilities, and the Regional Greenhouse Gas Initiative. The program includes home energy assessments for participants, as well as implementation of various energy efficiency and clean energy systems by participating contractors. NYSERDA directly compensates contractors based on pre-approved work scopes. Homeowners and renters living in one-to-four unit housing and earning at or below the lower of 80% of state median income or area median income are eligible for EmPower+ enrollment. The program offers incentives for "core" energy efficiency improvements including insulation, air sealing, health & safety items, and replacement of inefficient refrigerator/freezer units. For homes that have had air sealing and insulation completed, contractors can recommend other upgrades including heat pumps and high-efficiency natural gas heating systems.

EmPower New York

EmPower provided no-cost energy efficiency solutions to low-income New Yorkers living in single-family residential buildings (one to four units). To be eligible, a household needed to be at or below 60% of state median income. NYSERDA operated this program as part of the Clean

[21] More information can be found in the LMI Focus Area of the 2022 Compiled Investment Plan: https://www.nyserda.ny.gov/About/Funding/Clean-Energy-Fund

Energy Fund Portfolio. EmPower provided incentives up to $10,000. Office of Temporary and Disability Assistance customers received up to $20,000 for single-unit buildings or $20,000 per eligible unit for two- to four-unit buildings.

Assisted Home Performance

AHP provided no-cost energy efficiency solutions to low- and middle-income New Yorkers living in single-family residential buildings (one to four units). To be eligible, a household needed to fall at or below the higher of 80% of the median income in the area or 80% of the state median income. AHP customers received incentives covering 50% of project cost up to $5,000 for single-unit buildings. Customers with two- to four-unit buildings received up to $5,000 for the first unit with $2,500 for each additional unit, with AHP paying 50% of the project cost.

New York State Clean Heat

New York State Clean Heat is a collaboration between NYSERDA and six New York State investor-owned electric utilities: Consolidated Edison, Central Hudson Gas & Electric, Orange & Rockland, New York State Electric and Gas, National Grid, and Rochester Gas and Electric Corporation. The program provides incentives for home and building owners to install electric heat pumps, focusing on LMI customers and aiming to reduce the average cost of heat pump installation by at least 25%. The program also includes workforce development incentives, funding for consumer outreach and education, funding for technological innovation and development, and a plan to build out the heat pump supply chain.[22]

Pilot Program Installation Requirements

Table A-1 displays the insulation levels required to participate in the Pilot Program.

[22] More information can be found at https://www.nyserda.ny.gov/All-Programs/Heat-Pump-Program.

Table A-1. Insulation requirements for participation in pilot program

Area	Required Insulation Level
Walls	R-14
Attic	R-30 average
Attic Hatch	R-20
Pull-Down Stairs	R-13
Rim Joists	R-14
Mobile Home Walls	R-6
Mobile Home Attic	R-24
Mobile Home Belly	R-21
Airtightness	5 ACH (air changes per hour)

Appendix B. Detailed Methodology

To supplement the Methodology section above, this appendix hosts additional detail for the five main research activities and a brief discussion of the study limitations.

Customer Survey

Table B-1 shows key dispositions of the customer survey effort.

Table B-1. Customer survey key dispositions

Disposition Stage	Number of Records
Available Valid Sample with Contact Information	400
Completed Online before Phone Recruitment	74
Completed Online after Phone Recruitment	22
Completed Via Phone	70
Partial Completes	10
Total Responses	176
Total Completes	166

Contractor Survey

Table B-2 shows key dispositions of the contractor survey effort.

Table B-2. Contractor survey key dispositions

Disposition Stage	Number of Records
Available Valid Sample with Contact Information	74
Completed Online before Phone Recruitment	0
Completed Online after Phone Recruitment	25
Completed Via Phone	14
Partial Completes	2
Total Responses	41
Total Completes	39

Contractor Interview

Table B-3 shows key dispositions of the contractor interview effort.

Table B-3. Contractor interview key dispositions

Disposition Stage	Number of Records
Available Sample with Contact Information	74
Declined Interview at time of Survey	29
Not Reached or Declined to Participate in Interview	32
Completed Interview (recruited via survey)	7
Completed Interview (recruited via additional phone call)	6
Total Responses	13

Database and Project File Review

Although the Evaluation Team started by reviewing cost data from the Pilot Program database, the EmPCalc files (generally equivalent to project applications) contained more granular project component-level cost data than the database; therefore, the Team relied on EmPCalc files for the analysis. However, the revised copies of the EmPCalc files did not contain a full updated set of data—many of these files had incomplete cost data and did not match the original test-in EmPCalc files or the database, making them of limited use. As a result, the Team used the test-in EmPCalc files as the primary source of cost data.

The version 8.x EmPCalc files provide a significant amount of cost data for various equipment such as heat pumps, hot water equipment, panel upgrades, and duct improvements. However, there are still opportunities to improve data quality. The majority of projects included in older versions of the EmPCalc files (5.x and 6.x) show the disaggregation of costs, including for duct and panel upgrades. These older versions have fields for make, model, size, and efficiency of equipment installed, but the fields are not always filled out. For example, only some portions are present in notes and the files do not show the number of indoor heads installed. While the newer EmPCalc files (8.x) have a limited number of projects, they also have fields for make, model, size, and efficiency; however, these fields are often filled out incorrectly. The new files are missing fields for existing system, consumption, and number of indoor heads installed. The completeness of data varies across different iterations of EmPCalc files; the test-in files typically have completed cost data and subsequent files typically have missing or incomplete cost data.

Billing Analysis

The Evaluation Team performed an analysis of delivered fuels savings comparing the tracked savings from the EmPCalc files with the evaluated savings. The Team estimated the evaluated savings by subtracting the delivered fuels survey consumption estimates from the tracked pre-installation delivered fuel consumption. The Team converted all delivered fuels into units of MMBtu of heat content to enable a consistent comparison of savings across fuels. While the tracking database did not contain actual energy savings, the EmPCalc files did include estimates of MMBtu savings for ccASHPs and HPWHs.

The Team used the cost and equipment efficiency assumptions listed in Table B-4 in conjunction with the average delivered fuels displaced (listed in *2.6 Savings Validation* to estimate annual cost savings.

Table B-4. Winter 2022-2023 fuel and electricity cost assumptions

Fuel	Price	Unit	Btu/unit	Electricity Price ($/kWh)	Fuel Price ($/MMBtu)	Fuel Efficiency	Expected Seasonal COP
Oil	$5.00	gallon	139,000	$0.20	$35.97	80%	2.00
Kerosene	$6.00	gallon	139,000	$0.20	$43.17	80%	2.00
Propane	$3.50	gallon	90,000	$0.20	$38.89	80%	2.00
Firewood	$400.00	cord	20,000,000	$0.20	$20.00	40%	2.00
Wood Pellets	$20.00	MMBtu	1,000,000	$0.20	$20.00	80%	2.00

The expected seasonal COP is not known at this time but is intended to be inclusive of a HPWH, ASPH, and backup electricity usage associated with installing HPWHs and ccASHPs. For example, a cold-climate heat pump operating in a milder part of New York that is sized to meet almost all loads without electric resistance backup would likely have a seasonal COP higher than 2.0, the conservative value assumed. The Team used this conservative COP and the other assumptions listed in Table B-4 to estimate electricity increases associated with the reductions in delivered fuel usage and accompanying costs.

Study Limitations

A number of factors, including those outlined below, limited the conclusions the Evaluation Team was able to draw from the evaluated project data. Specifically, relatively small sample sizes

for specific analyses limited the ability to apply general, widespread conclusions to customer/population sub-segments. Additional detail with respect to precision and confidence intervals for select analyses are provided below.

Although there are limitations with wide scale application of the results of this evaluation, the relative precision supporting the findings is sufficient and, as a result, the findings of this pilot evaluation are considered actionable.

- The 90% two-tailed relative precision[23] for avoided fuel impacts was 17% for oil/propane/kerosene group and 26% for wood.
- The sample frame evaluated avoided fuel consumption for oil/propane/kerosene is 92 +/- 16 MMBtu, resulting in 17% relative precision (15.5/92 = 17%). The corresponding evaluated avoided fuel consumption for wood is 113 +/- 28 MMBtu, resulting in 26% relative precision, based on a sample of 8 projects. For wood pellets, the sample size is only two and results should not be considered statistically significant.
- The sample size for the oil/propane/kerosene stratum avoided delivered fuel consumption and bill savings impact estimates is 14. The evaluators used an n-1 degrees of freedom in the t-value estimate, which is conservative, but appropriate for small sample sizes.

A ratio estimator was utilized in the evaluation statistics, which is commonly used in evaluations where initial estimates of savings vary, but hypothetically reflect the actual variation in savings across projects in the sample. With a ratio estimator, the statistics center around the ratio estimate for each point in your sample, rather than the mean. The ratio estimate for each site is calculated by multiplying the realization rate for the stratum by the tracking data estimate for the site. The error for each site is then calculated by comparing the measured result for each site to the ratio estimate for that site. In this evaluation, calculating statistics around the mean instead of the ratio estimate would have given a very similar result, approximately 12% relative precision instead of 17% relative precision, which further corroborates the statistical results presented within this report. The evaluation sample included one site in particular that was predicted to have small savings but had large evaluated savings, which caused the mean statistics to appear better than the ratio estimator statistics.

[23] Two-tailed relative precision refers to the two-sided error band around an estimate divided by the estimate.

Other sources of error

Limitations and considerations include:

- Typical projects sites include a mixture of energy efficiency measures that save delivered fuels, energy efficiency measures that save electricity, and fuel switching measures that decrease delivered fuel consumption while increasing electricity consumption.
- Heat pumps may increase or decrease cooling electricity consumption, depending on prior equipment.
- Many project sites have mixed heating fuel baselines:
    - Several project sites believed to have only electricity savings turned out to also have delivered fuel savings.
    - At least one project site reported having no heating equipment prior to heat pump installation.
- Changes in utility bills are impacted by other household changes, such as occupancy variation, changes in house contents, renovations and additions, etc.
- Many project sites have semi-monthly electricity data or estimated reads, which reduces the resolution of data for the calculation of billing analysis regressions.
- There is a potential response bias for delivered fuel, as people who used zero delivered fuels after heat pump installation will have a much easier time submitting delivered fuel receipts than those who used more than zero. Conversely, people may have rejected requests for delivered fuel bills out of hand if they had nothing to report.
- There may be a bias towards long-term occupants, as people who moved between installation and outreach would not be able to respond to survey requests.

In addition, the Evaluation Team found problems with the single-family electric billing data, which precluded complete analysis of all projects in this report and was also a driver of smaller sample sizes in bill-related analyses. First, the electricity data was impacted by large variations in the amount of electricity savings expected for different measures. For fuel switches, increases in electricity were expected, while for other measures, electricity decreases were expected, complicating the analysis and requiring a larger sample size. The electric billing analysis sample was not possible for some sites because of an insufficient number of post-installation reads for most sites, resulting from a combination of bimonthly billing and estimated reads. In addition, many project sites did not have an early enough installation date to have a full winter of post-installation data, reducing the sample further. When matching the delivered fuels data with the

billing data after cleaning, the small number of sites for which complete electricity meter data was available led to a very small subset of sites for which delivered fuels and electric data and program data were all complete.

Finally, as shown in the tables below, due to significant attrition in complete data across multiple research activities, the final data sample was often too small to draw widespread, general conclusions for desired subsets of the population. Table B-5 presents the number of accounts lost at each cleaning step and the size of the final electric sample.

Table B-5. Electric Billing Data Attrition

Step	Count	% Attrition
Full Population of Completed Projects	413	-
1. Missing Site Data	-10	2.4%
2. Missing Billing Data	-42	10.2%
3. Negative Meter Reads	-6	1.5%
4. Missing Start Date	-51	12.3%
5. Insufficient # Observations	-87	21.1%
6. Missing Zip Code	-7	1.7%
Total Attrition	-203	49.2%
Final Modeled Accounts	210	-

Table B-6 presents the number of households from the total population that submitted delivered fuel receipts, the number that did not complete the survey, those who did not provide usable data, and the number of modeled accounts.

Table B-6. Delivered Fuel Data Attrition

Step	Count	% Attrition
Full Population of Completed Projects	413	-
1. Did Not Complete Survey	-307	74.3%
2. Did Not Provide Usable Delivered Fuel Data	-76	18.4%
Total Attrition	-383	92.7%
Final Modeled Accounts	30	-

Table B-7 presents the initial invite number, those who did not complete the survey or interview, as well as number of surveys completed by customers and contractors, and the number of interviews completed by contractors.

Table B-7. Survey and Interview Attrition

Step	Customer Survey	Contractor Survey	Contractor Interview
Full Population Invited	295	37	13
Did Not Complete	-50 (17%)	0	0
Completed	245	37	13

Appendix C. Additional Impact Findings

Table C-1 shows the breakdown of project component combinations. The most common project combinations included ductless ccASHP with weatherization (21%), central ccASHP with weatherization (10%), and ductless ccASHP alone (8%).,

Table C-1. Heat Pump Project Components

Type of Heat Pump	HPWH	Weatherization	Duct Upgrade	Panel Upgrade	Number of Projects	% of Total
Central ccASHP	No	No	No	No	7	2%
Central ccASHP	No	No	No	Yes	5	1%
Central ccASHP	No	No	Yes	No	8	2%
Central ccASHP	No	No	Yes	Yes	1	0%
Central ccASHP	No	Yes	No	No	43	10%
Central ccASHP	No	Yes	No	Yes	18	4%
Central ccASHP	No	Yes	Yes	No	19	5%
Central ccASHP	No	Yes	Yes	Yes	4	1%
Central ccASHP	Yes	No	No	No	3	1%
Central ccASHP	Yes	No	No	Yes	3	1%
Central ccASHP	Yes	No	Yes	No	3	1%
Central ccASHP	Yes	Yes	No	No	14	3%
Central ccASHP	Yes	Yes	No	Yes	14	3%
Central ccASHP	Yes	Yes	Yes	No	9	2%
Central ccASHP	Yes	Yes	Yes	Yes	2	0%
ccASHP Total	**-**	**-**	**-**	**-**	**153**	**37%**
Ductless ccASHP	No	No	No	No	32	8%
Ductless ccASHP	No	No	No	Yes	4	1%
Ductless ccASHP	No	Yes	No	No	87	21%
Ductless ccASHP	No	Yes	No	Yes	13	3%
Ductless ccASHP	No	Yes	Yes	No	3	1%

Type of Heat Pump	HPWH	Weatherization	Duct Upgrade	Panel Upgrade	Number of Projects	% of Total
Ductless ccASHP	No	Yes	Yes	Yes	1	0%
Ductless ccASHP	Yes	No	No	No	7	2%
Ductless ccASHP	Yes	No	No	Yes	3	1%
Ductless ccASHP	Yes	No	Yes	No	1	0%
Ductless ccASHP	Yes	Yes	No	No	22	5%
Ductless ccASHP	Yes	Yes	No	Yes	13	3%
Ductless ccASHP	Yes	Yes	Yes	No	2	0%
Ductless ccASHP	Yes	Yes	Yes	Yes	1	0%
Ductless Total	**-**	**-**	**-**	**-**	**189**	**46%**
GSHP	No	No	No	No	1	0%
GSHP	No	No	Yes	No	4	1%
GSHP	No	Yes	No	No	9	2%
GSHP	No	Yes	No	Yes	1	0%
GSHP	No	Yes	Yes	No	5	1%
GSHP	No	Yes	Yes	Yes	1	0%
GSHP	Yes	No	No	No	3	1%
GSHP	Yes	No	Yes	No	3	1%
GSHP	Yes	Yes	No	No	2	0%
GSHP	Yes	Yes	No	Yes	1	0%
GSHP	Yes	Yes	Yes	No	4	1%
GSHP	Yes	Yes	Yes	Yes	1	0%
GSHP Total	**-**	**-**	**-**	**-**	**35**	**8%**
None	Yes	No	No	No	7	2%
None	Yes	Yes	No	No	13	3%
Unknown	-	-	-	-	16	4%
Total	**-**	**-**	**-**	**-**	**413**	**100%**

Caveats on Customer Bill Impacts

Firewood. This analysis shows that firewood customers have large bill savings, but savings are dependent on firewood prices and woodstove efficiency. If homeowners are cutting, splitting, or drying firewood themselves, the cost of firewood is lower than purchasing already-processed firewood.

Electricity Costs. In future years, participants can expect the cost of electricity to remain stable. Electricity prices in New York are not as volatile as in other regions for a variety of reasons. Bill savings may decrease if the price of delivered fuels prices drops, but customers should still achieve bill savings.

Heat Pump Controls. Heat pump efficiency and capacity decline at very cold temperatures, which changes the economics of heating with heat pumps versus a backup heating system. This report addresses only the economics of annual usage and not the economics of optimal heat pump control, but the Pilot Program should align with evaluations of other electrification programs around operating backup delivered fuel heating systems during extreme cold temperatures.

Appendix D. Customer Data Collection Instrument

This survey instrument was designed using the Learning Objectives for the Single-Family Heat Pump Evaluation as a guide, as shown in the table below. Research questions addressed by program data do not appear in the table.

Research Category	Research Questions	Corresponding Section
Identify Participation Barriers/Motivations, Best Practices	• What motivated the customer to install the measures? • How did customers learn of the pilot opportunity • How satisfied are customers with various program aspects	Sections B, J
Identify Participation Barriers/Motivations, Best Practices	• How satisfied are customers with program experience, incentive levels, and equipment performance? • What NEBs did customers experience?	Sections I, J
Characterize Projects/the Market	• Assess customer demographics (e.g., income-levels, education levels, utilization of utility-assistance programs, do they own or lease their home)	Sections B, L
Validate Savings Model	• Customer Behaviors: • How much of heating/cooling load is being met by the new heat pump system versus their backup system • What is driving customer decisions for when to use their backup system versus their new system? • How has customer energy behaviors changed since the installation of their new system (what level of energy-use snapback has occurred?)	Sections C, D, E, F, G, H
Validate Savings Model	• Identify if, how, and why equipment, labor, and maintenance costs and upgrade specifications tend to change between design and install	Section H

Target Quota to achieve 90/10 confidence and precision=58 completes total. According to the proportion of project types in the study population, the study has soft targets for 4 projects that include GSHPs and 16 projects that include HPWHs

Sampling Plan: Cadmus will use the program EmpCalc files and the Heat Pump Demo database to compile the sample frame. From these files, Cadmus will pull in customer names, customer address, date of project completion, first and last name, email addresses, phone numbers, geographic location of projects (downstate vs. upstate), the types of technologies installed, the program through which the customer participated, and whether customer contributed financially to the project. Where possible, Cadmus will supplement missing emails from the Heat Smart Campaign databases.

Introduction and Screener

Welcome to the NYSERDA Heat Pump Experience Survey!

You have been selected to participate in this important survey because our records indicate a heat pump system was installed in your home or building as part of the NYSERDA EmPower or Assisted Home Performance Program.

This survey should take 15 minutes to complete. If you complete the survey, you will receive a $10 online Amazon gift card as a thank you for your time.

The New York State Energy Research and Development Authority (NYSERDA) is sponsoring this research and has contracted with Cadmus and APPRISE to conduct this survey. The information you provide will be used for research purposes only and will be kept confidential to the extent permitted by law including but not limited to the Freedom of Information Law (FOIL).

Click the Next button below to begin the survey.

A. Survey Screeners

S0. Please enter your Access Code to begin. Your Access Code is included in the letter or email you received about the survey.

Enter Access Code : _____

A1. Our records show that a heat pump system was installed at your address shown below in the last two years. Is that correct?
[ADDRESS]
[CITY], NY

1. Yes
2. No – Heat Pump system was not installed [THANK AND TERMINATE: Thank you for your interest in this study. To participate in the survey, you must be familiar with a heat pump installed at the address above. We have noted your response. Thank you for your time.]
3. No – address is incorrect [THANK AND TERMINATE: Thank you for your interest in this study. To participate in the survey, you must be familiar with a heat pump installed at the address above. We have noted your response. Thank you for your time.]

98. Don't know / Not sure [SKIP TO A6]

A2. Are you currently living in the same home where the heat pump was installed?

1. Yes
2. No - I own the property, but the home is occupied by someone else
3. No - I no longer live in or own the property [THANK AND TERMINATE: Thank you for your interest in this study. To participate in the survey, you must be familiar with a heat pump installed at the address above. We have noted your response and will reach out with any questions. Thank you for your time.]

A3. Did you already participate in a survey related to your experience with the heat pump equipment?

1. Yes
2. No

A4. Did you agree for a meter to be temporarily installed at your home to track real-time usage of electricity? This meter would be for research purposes to evaluate the heat pump study.

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

A5. Are you familiar with why the heat pump system was installed and how the system is used for heating or cooling?

1. Yes
2. No

A6. **[ASK IF 5=No]** Thank you for your interest in this study. To participate in the survey, you must be familiar with a heat pump installed at the address above. This survey will ask questions about why the heat pump was installed, how you use it for heating or cooling, and how it has performed in your home. If someone else who lives in the home is familiar, please include their name and phone number below.

Enter Name [ALLOW TEXT ENTRY]

Enter Phone [ALLOW TEXT ENTRY]

B. Residential Building Info

The next set of questions ask about the home where the heat pump was installed.

B1. [ADAPTED FROM NYS HP SURVEY] Which of the following best describes the type of building where the heat pump was installed?

1. A one-family house detached from any other house

2. A one-family house attached to one or more houses
3. A building with 2 to 4 apartments
4. A manufactured home
5. Another type of building (please describe): **[OPEN-ENDED TEXT RESPONSE]**

B2. [ADAPTED FROM NYS HP SURVEY] **[IF HOME_AGE=N/A]** About when was the building or home built?

1. 2000 or later
2. 1990 to 1999
3. 1980 to 1989
4. 1970 to 1979
5. 1960 to 1969
6. 1950 to 1959
7. 1940 to 1949
8. 1939 or earlier

B3. **[ASK IF 2=1]** Do you or a member of your household own or rent the home where the heat pump was installed?

1. Own the home
2. Rent the home

B4. **[ASK IF A3=2]** Is electricity paid for separately from rent, or is electricity included in rent?

1. Electricity is paid for separately
2. Electricity is included in rent

B5. **[ASK IF A3=2]** Is heating paid for separately from rent or an electricity bill, or is heating included in rent or with an electricity bill?

1. Heating is paid for separately from rent and electricity
2. Heating is paid for separately from rent but included in the same bill as electricity
3. Heating is included in rent and electricity
4. Heating is included in rent but separate from electricity

B6. [ADAPTED FROM NYS HP SURVEY] Our records show that your heat pump was installed **[DATE_COMPLETION]**. About how many people lived in the home at that time?

1. Number of people _____

B7. About how many people live in the home currently?

1. Number of people _____

B8. Thinking back to the **most recent winter** during late 2021 and early 2022, how many people were usually present in the home on a typical weekday between 9am and 5pm?

1. Number of people _____

B9. Thinking back to the **winter two years ago** during late 2020 and early 2021, how many people were usually present in the home on a typical weekday between 9am and 5pm?

1. Number of people _____

B10. Outside of your participation in the **[PROGRAM NAME]** program that installed the heat pump, have any other updates been made to your home or to major appliances in your home in the last two years?

1. Yes
2. No

B11. [ADAPTED FROM NYS HP SURVEY] **[IF A10=1]** What type of updates were made to your home in the last two years? Please select all that apply.

1. Room remodeling or addition
2. New insulation or siding
3. New windows or doors
4. New major appliances (refrigerator, oven, washer, dryer, etc.)
5. Other update (please describe): **[ALLOW TEXT ENTRY]**

B12. [ADAPTED FROM NYS HP SURVEY] [ASK FOR EACH ITEM SELECTED PREVIOUSLY IN B11] About when did this update take place: [INSERT EACH A11 ITEM SELECTED]? [CARRY FORWARD CHOSEN RESPONSES IN A11] [FORMAT AS MATRIX TABLE WITH TEXT ENTRY WITH TWO COLUMNS LABELED “MONTH” AND “YEAR”]

B13. **[ASK IF #2=2 OR A3=1]** Do you have plans to make upgrades to the home or major appliances in the next year?

1. Yes
2. No

B14. [ADAPTED FROM NYS HP SURVEY] **[IF A13=1]** What type of updates are you planning to make to your home in the next year? Please select all that apply.

1. Room remodeling or addition
2. New insulation or siding
3. New Windows or Doors
4. New major appliances (refrigerator, oven, washer, dryer, etc.)
5. Other update (please describe): **[ALLOW TEXT ENTRY]**

C. Awareness and Motivations

C1. [UNIQUE TO THIS STUDY] [IF HP_MEASURE=ASHP OR GSHP] Had you heard of **[HP_MEASURE_TEXT]**s before participating in the [PROGRAM NAME] program and receiving information from NYSERDA or the contractor who performed the work?

1. Yes
2. No

C2. [UNIQUE TO THIS STUDY] [IF HP_MEASURE=NONE] Had you heard of heat pumps before participating in the [PROGRAM NAME] program and receiving information from NYSERDA or the contractor who performed the work?

1. Yes
2. No

C3. [UNIQUE TO THIS STUDY] Had you heard of heat pump water heaters before participating in the [PROGRAM NAME] program and receiving information from NYSERDA or the contractor who performed the work?

1. Yes
2. No

C4. [UNIQUE TO THIS STUDY] How did you learn about the heat pump component of the program? Please select all that apply. **[RANDOMIZE ORDER OF RESPONSES UP THROUGH OTHER]**

1. Marketing from NYSERDA
2. Outreach or materials from HeatSmart

3. The contractor who did the work on this project
4. A home energy audit
5. Your electric utility company
6. A friend, family member, or colleague
7. Other (please specify): **[ALLOW TEXT ENTRY]**

98. Don't know

C5. **[IF HP_MEASURE=ASHP OR GSHP]** How important were each of the of following factors in your decision to install the heat pump system? Please answer on a scale of 1 to 5, where 1 is 'not at all important' and 5 is 'very important,' **[SELECT ALL THAT APPLY; RANDOMIZE ORDER OF RESPONSES UP THROUGH OTHER; PROVIDE MATRIX TABLE THAT HAS "1 - NOT AT ALL IMPORTANT," "2," "3," "4," 5 – "VERY IMPORTANT," AND N/A AND DON'T KNOW.]**

1. Reducing the amount that you pay for cooling or heating your home
2. Reducing your environmental impacts or carbon footprint
3. Improving home comfort with additional or better heating
4. Improving home comfort with additional or better cooling
5. Replacing existing equipment that was old or not working correctly
6. Adding additional heating
7. Other (please specify): **[ALLOW TEXT ENTRY]**

C6. **[IF HPWH=YES]** How important were each of the of following factors in your decision to install the heat pump water heater? Please answer on a scale of 1 to 5, where 1 is 'not at all important' and 5 is 'very important,' [SELECT ALL THAT APPLY; RANDOMIZE ORDER OF RESPONSES UP THROUGH OTHER; PROVIDE MATRIX TABLE THAT HAS "1 - NOT AT ALL IMPORTANT," "2 – NOT REALLY IMPORTANT," "3 – SOMEWHAT IMPORTANT," "4 – IMPORTANT," 5 – "VERY IMPORTANT," AND N/A AND DON'T KNOW.]

1. Reducing the amount that you pay for water heating in your home
2. Reducing your environmental impacts or carbon footprint
3. Improving hot water availability and consistency
4. Replacing existing equipment that was old or not working correctly
5. Adding additional hot water capacity to your home

C7. In addition to the heat pump incentives received from this [PROGRAM NAME] program, which of the following incentives or loans did you use to help fund your new heat pump system? [MULTIPLE RESPONSES ALLOWED]

1. **[IF HP_MEASURE=GSHP]** Energy Smart Loan for ground source heat pumps
2. Green Jobs – Green New York loans for ductwork upgrades
3. New York State Weatherization Assistance Program
4. NYS Clean Heat
5. Other (please specify) **[ALLOW TEXT ENTRY]**
6. None

98. Don't Know – my contractor handled all incentives for me

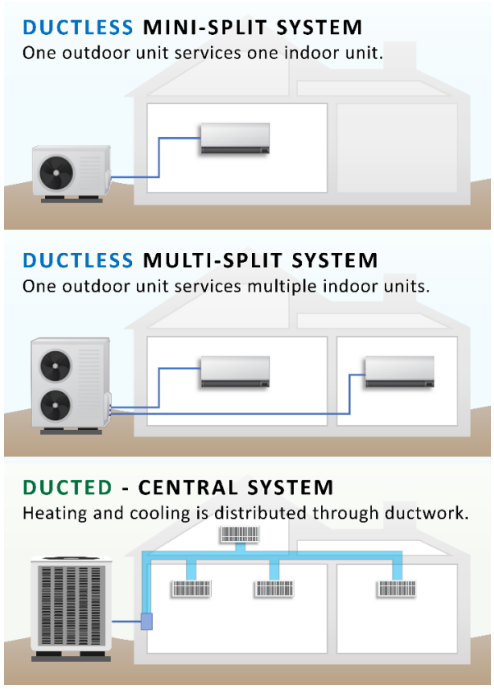
D. Space Heating System and Behavior

[ASK IF HP_MEASURE=ASHP OR GSHP]

D1. [ADAPTED FROM NYS HP SURVEY] **[IF HP_MEASURE=ASHP]** Which type of air source heat pump system(s) did you have installed in your home?

1. A ductless mini-split with one indoor unit that provides heating/cooling (no ductwork is used)
2. A ductless multi-split with multiple indoor units providing heating/cooling (no ductwork is used)
3. A ducted central system where heating and cooling is distributed through ducts and vents

98. Don't know



D2. [UNIQUE TO SURVEY] **[IF HP_MEASURE=GSHP]** What type of ground source heat pump system(s) did you have installed in your home?

1. A system that provides heat out of ducts in the home
2. A system that provides heat out of radiators, baseboards, or in-floor radiant heat
98. Don't know

D3. [ADAPTED FROM NYS HP SURVEY] At the time your heat pump was installed, what was the status of any pre-existing heating equipment you had for your home? **[LIMIT TO ONE CHOICE]**

1. The pre-existing heating equipment was working without issues
2. The pre-existing heating equipment was working, but had issues with performance
3. The pre-existing equipment was broken and not usable

D4. **[IF C3=1 or 2]** Do you still use your pre-existing heating system even though the new heat pump system was installed?

1. Yes
2. No

D5. [ADAPTED FROM NYS HP SURVEY] **[IF C4=1]** Why is the pre-existing system still used for heating even though the new heat pump system was installed? Please select all that apply. **[ADD RANDOMIZATION THROUGH 'OTHER']**

1. The new heat pump(s) and pre-existing heating system(s) serve different areas/rooms
2. The new heat pumps(s) do not adequately heat the space
3. The pre-existing system is more economical for heating
4. The pre-existing system can provide heat during power outages
5. Other (please specify): **[ALLOW TEXT ENTRY]**

98. Don't know

D6. [ADAPTED FROM NYS HP SURVEY] **[IF C4=1]** Which of the following best describes how you decide when to use the heat pump(s) for heating in your home? **[ADD RANDOMIZATION THROUGH 'OTHER']**

1. Use heat pump(s) first and activate the other heating systems only if needed
2. Use the other heating system first and active the heat pump only if needed
3. Allow thermostat or controls system to determine which heating equipment is used
4. Use heat pump **only** when using specific areas of the home
5. Never use the heat pump
6. Other (please specify): **[ALLOW TEXT ENTRY]**

98. Don't know

D7. **[IF C4=1]** Down to what approximate outdoor temperature will you use your heat pump system **without** your pre-existing heating system? I'm going to read a list of temperature ranges. Please tell me when to stop.

1. At or above 60 degrees (F)
2. 50 to 59 degrees (F)
3. 40 to 49 degrees (F)
4. 30 to 39 degrees (F)
5. 20 to 29 degrees (F)
6. 10 to 19 degrees (F)
7. 0 to 9 degrees (F)

8. -1 to -9 degrees (F)
9. At or below -10 degrees (F)
10. I do not ever use the heat pump for heating **alone**
11. [PHONE ONLY: IF NO ANSWER HAS YET BEEN CHOSEN, SAY, "Let me repeat the question" AND THEN START AGAIN.]

[DEFINE AND ASSIGN HEAT_SWITCH_TEMP_UPPER_BOUND = CHOSEN C7]

D8. [IF (C4=1) AND (C7 ≠ 10 OR 11)] [SAY: "Great."] Keeping in mind that you solely use the heat pump down to [INSERT RESPONSE FROM C7], down to what approximate outdoor temperature will you use your heat pump system with the support of your pre-existing heating system? [SAY: "Again, I'm going to read a list of temperature ranges. Please tell me when to stop."] [IMPORTANT INSTRUCTION: DO NOT READ FULL LIST AGAIN. START READING RESPONSES *AT THE ANSWER GIVEN IN* D7.*]*

1. 50 to 59 degrees (F)
2. 40 to 49 degrees (F)
3. 30 to 39 degrees (F)
4. 20 to 29 degrees (F)
5. 10 to 19 degrees (F)
6. 0 to 9 degrees (F)
7. -1 to -9 degrees (F)
8. At or below -10 degrees (F)
9. I do not use the heat pump for heating at all

[DEFINE AND ASSIGN HEAT_SWITCH_TEMP_LOWER_BOUND = CHOSEN D9 RESPONSE]

D9. [IF (C9 IS DISPLAYED) AND (C7 ≠ 10 OR 11) AND (C9≠9)] Between [HEAT_SWITCH_TEMP_LOWER_BOUND] and [HEAT_SWITCH_TEMP_HIGHER_BOUND], how do you typically use your heat pump and pre-existing heating system for heating?

1. Primarily use the heat pump and occasionally use the pre-existing heating system
2. Primarily use the pre-existing heating system and occasionally use the heat pump
3. Run both together

D10. [UNIQUE TO THIS SURVEY] After your heat pump was installed, what was the typical temperature your thermostat was set to in the winter during the following times?

1. When you are home and awake (Fahrenheit): [ALLOW NUMBERIC TEXT ENTRY BETWEEN 50-90]
2. When you are home and asleep (Fahrenheit): [ALLOW NUMBERIC TEXT ENTRY BETWEEN 50-90]
3. When you are away from home (Fahrenheit): **[ALLOW NUMBERIC TEXT ENTRY BETWEEN 50-90]**

D11. [UNIQUE TO THIS SURVEY] Before your heat pump was installed, was the thermostat typically set to the same temperature, a higher temperature, or a lower temperature **during the winter** compared with after the heat pump was installed?

1. Temperature was set about the same as before
2. Temperature was set lower before (colder)
3. Temperature was set higher before (warmer)

E. Cooling System and Behaviors

[ASK IF HP_MEASURE=ASHP OR GSHP]

E1. [NYS HP SURVEY] Before installing the heat pump, what was the **primary** source of cooling for your home? Please select all that apply.

1. Central air conditioning
2. Ducted air source heat pump [FOR PHONE: REMIND PARTICIPANT OF DEFINITION IF NEEDED: "A ducted air source heat pump distributes the heated or cooled air through a central ducted system and vents." FOR ONLINE: MAKE THIS HOVER TEXT.]
3. Room air conditioners (window unit)
4. Portable air conditioners (i.e., non-window-mounted air conditioning units that can be moved to different parts of the house)
5. Fans
6. Dehumidifiers
7. I had no way to previously cool my home
8. Other (please specify): **[ALLOW TEXT ENTRY]**

98. Don't know

E2. [UNIQUE TO THIS SURVEY] **[IF D1=1-3, 7 (OTHER)]** Do you still use your pre-existing cooling system even though the new heat pump system was installed?

1. Yes
2. No

98. Don't know

E3. [UNIQUE TO THIS SURVEY] **[IF D2=1]** Why is the pre-existing system still used for cooling even though the new heat pump system was installed? Please select all that apply.

1. The new heat pump(s) and pre-existing cooling system(s) serve different areas/rooms
2. The new heat pumps(s) do not adequately cool the space.
3. The pre-existing system is more economical for cooling
4. Other reason (please specify): **[ALLOW TEXT ENTRY]**

98. Don't know

E4. **[IF D2=1]** Up to what approximate outdoor temperature will you use your heat pump system **without** your pre-existing cooling system? I'm going to read a list of temperature ranges. Please tell me when to stop.

1. At or below 49 degrees (F)
2. 50 to 59 degrees (F)
3. 60 to 69 degrees (F)
4. 70 to 79 degrees (F)
5. 80 to 89 degrees (F)
6. 90 to 99 degrees (F)
7. 100 to 109 degrees (F)
8. At or above 110 degrees (F)
9. I do not ever use the heat pump for cooling **alone**
10. [PHONE ONLY: IF NO ANSWER HAS YET BEEN CHOSEN, SAY, "Let me repeat the question" AND THEN START AGAIN.]
[DEFINE AND ASSIGN COOL_SWITCH_TEMP_LOWER_BOUND I= CHOSEN D4 RESPONSE]

E5. **[IF (D4 IS DISPLAYED) AND (D4 ≠ 9 or 10)]** **[SAY: "Thank you."]** To confirm, you mean that when it reaches about **[INSERT RESPONSE FROM D4]**, you turn on your pre-existing cooling system to support your heat pump's cooling capability?

1. Yes
2. No [GO BACK TO D4 AND ASK AGAIN]

E6. **[IF (D2=1) AND (D4 ≠ 9 OR 10)]** **[SAY: "Great."]** Keeping in mind that you solely use the heat pump up to **[INSERT RESPONSE FROM D4]**, up to what approximate outdoor temperature will you use your heat pump system **with the support of** your pre-existing cooling system? **[SAY: "Again, I'm going to read a list of temperature ranges. Please tell me when to stop."]** **[IMPORTANT INSTRUCTION: DO NOT READ FULL LIST AGAIN. START READING RESPONSES *AT THE ANSWER GIVEN IN E4.]***

1. At or below 49 degrees (F)
2. 50 to 59 degrees (F)
3. 60 to 69 degrees (F)
4. 70 to 79 degrees (F)
5. 80 to 89 degrees (F)
6. 90 to 99 degrees (F)
7. 100 to 109 degrees (F)
8. At or above 110 degrees (F)
9. I do not use the heat pump for cooling at all

[DEFINE AND ASSIGN COOL_SWITCH_TEMP_UPPER_BOUND = CHOSEN E6 RESPONSE]

E7. **[IF D6 IS DISPLAYED AND D6 ≠ 9]** **[SAY: "Thank you again."]** To confirm, you mean that when it reaches about **[INSERT RESPONSE FROM D6]**, you turn off your heat pump and rely solely on your pre-existing cooling system?

1. Yes
2. No [GO BACK AND ASK D6 AGAIN]

E8. [IF (D6 IS DISPLAYED) AND (D4≠ 9 OR 10) AND (D6 ≠ 9)] Between [COOL_SWITCH_TEMP_LOWER_BOUND] and [COOL_SWITCH_TEMP_HIGHER_BOUND], how do you typically use your heat pump and pre-existing cooling system for cooling?

1. Primarily use the heat pump and occasionally use the pre-existing cooling system
2. Primarily use the pre-existing cooling system and occasionally use the heat pump
3. Run both together

E9. [UNIQUE TO THIS SURVEY] After your heat pump was installed, what was the typical temperature your thermostat was set to in the summer during the following times?

1. When you are home and awake (Fahrenheit): **[ALLOW NUMBERIC TEXT ENTRY BETWEEN 50-90]**
2. When you are home and asleep (Fahrenheit): **[ALLOW NUMBERIC TEXT ENTRY BETWEEN 50-90]**
3. When you are away from home (Fahrenheit): **[ALLOW NUMBERIC TEXT ENTRY BETWEEN 50-90]**

E10. [UNIQUE TO THIS SURVEY] Before your heat pump was installed, was the thermostat typically set to the same temperature, a higher temperature, or a lower temperature during the summer compared with after the heat pump was installed?

1. Temperature was set about the same as before
2. Temperature was set lower before (colder)
3. Temperature was set higher before (warmer)

F. System Controls and Maintenance

[ASK IF HP_MEASURE=ASHP OR GSHP]

F1. [ADAPTED FROM E4 THE FUTURE] Which of the following ways do you control your heat pump? Please select all that apply. **[RANDOMIZE 1-6]**

1. **[IF C4=1 OR D2=1]** A thermostat that controls my heat pump and my other heating/cooling system
2. A smart thermostat for my heat pump only (such as Nest, Honeywell, or Ecobee)
3. A programmable thermostat for my heat pump only
4. A remote control that came with the heat pump (i.e., remote)
5. A smartphone app
6. Controls or buttons on the heat pump itself
7. Other (please specify): **[ALLOW TEXT ENTRY]**

98. Don't know

F2. [ADAPTED FROM E4 THE FUTURE] About how often are the heat pump air filters cleaned/replaced?

1. Once every three months or more often
2. Twice per year
3. Once per year
4. I have not yet had or needed to clean/replace the air filters

98. Don't know

F3. [ADAPTED FROM E4 THE FUTURE] How often do you receive maintenance/servicing from a contractor on your heat pump?

1. Twice per year or more often
2. Once per year
3. I have not yet had or needed maintenance/servicing

98. Don't know

G. Contractor Education

[ASK IF HP_MEASURE=ASHP OR GSHP AND (A3=1 OR 2=2)]

G1. [ADAPTED FROM E4 THE FUTURE] What did you learn from the contractor who installed your **[HP_MEASURE_TEXT]** about your **[HP_MEASURE_TEXT]**? Please select all that apply. **[RANDOMIZE OPTIONS UP THROUGH "OTHER"]**

1. How and when to clean filters
2. How to set the heat pump thermostat
3. How to set thermostats on pre-existing equipment to maximize savings
4. Cleaning debris from the outdoor unit
5. When to get maintenance checks
6. Other (please specify): **[ALLOW TEXT ENTRY]**
7. Nothing, (contractor did not teach me how to use my system).

98. Don't know/don't remember

G2. [E4 THE FUTURE] What is the lowest outside temperature your installer said your heat pump would function at?

1. 31 to 40 degrees (F)

2. 21 to 30 degrees (F)
3. 11 to 20 degrees (F)
4. 1 to 10 degrees (F)
5. -11 to 0 degrees (F) or lower
6. -10 degrees (F) or lower

98. Don't know/don't remember

H. Domestic Hot Water HPWH

H1. **[IF HPWH=NO]** Did you or a contractor install a heat pump water heater in your home?

1. Yes
2. No

H2. [IF H1=1] About when was that heat pump water heater installed? Please state the month and year.

1. [ALLOW TEXT ENTRY]

H3. [NYS HP SURVEY] **[IF HPWH=Yes OR H1=1]** Is there any other equipment in your home used to generate hot water? Please select all that apply. **[ALLOW MULTIPLE RESPONSES]**

1. Yes – an additional hot water heater
2. Yes - a ground source heat pump that also generates hot water
3. Yes – another device (please describe): **[ALLOW TEXT ENTRY]**
4. No [EXCLUSIVE RESPONSE]

98. Don't know

H4. [NYS HP SURVEY] **[IF HPWH=Yes OR H1=1]** In what control mode do you typically operate the heat pump water heater?

1. Efficiency or Economy mode
2. Auto or Hybrid mode
3. Electric or Heater mode
4. Other (please describe): **[ALLOW TEXT ENTRY]**

98. Don't know

H5. [ADAPTED FROM NYS HP SURVEY] **[IF HPWH=Yes OR H1=1]** What type of area in your home is the heat pump water heater installed?

1. Area that is heated and cooled
2. Area that is heated, but not cooled
3. Area that is cooled, but not heated
4. Basement or crawlspace without heating or cooling [IF PHONE], or
5. Another area that is not heated or cooled (please specify location):

H6. [UNIQUE TO THIS STUDY] **[IF HPWH=NO AND H1=2]** Did your contractor recommend that you install a heat pump water heater to replace your existing water heater?

1. Yes
2. No

H7. [UNIQUE TO THIS STUDY] **[IF H6=1]** And why did you decide to not install a new heat pump water heater? **[OPEN-ENDED TEXT RESPONSE]**

I. Experience of Installation

I1. To what extent did the project meet your expectations for timeliness of completion?

1. Much faster than I expected
2. Slightly faster than I expected
3. About as long as I expected to complete
4. Slightly longer to complete than I expected
5. Much longer to complete than I expected

98. Don’t know

I2. [UNIQUE TO THIS STUDY] Were there any significant delays in installing the heat pump?

1. Yes
2. No

98. Don't know

I3. [UNIQUE TO THIS STUDY] **[IF H2=1]** What were the cause(s) of the delay? **[OPEN-ENDED TEXT RESPONSE]**

I4. **[IF HP_MEASURE=ASHP or GSHP]** Was the total cost to install the heat pump system itself lower, higher, or about the same as the original estimate for the work when the project began?

1. Lower than estimated
2. Higher than estimated
3. About the same as estimated

I5. **[IF HPWH=Yes]** Was the total cost to install the heat pump water heater system lower, higher, or about the same as the original estimate for the work when the project began?

1. Lower than estimated
2. Higher than estimated
3. About the same as estimated

I6. [UNIQUE TO THIS STUDY] **[IF (H4=1 OR 2) OR (H5 = 1 OR 2)]** To the best of your knowledge, why were the final costs [HIGHER/LOWER] than estimated? **[OPEN-ENDED TEXT RESPONSE]**

I7. [NYS HP STUDY] Since the heat pump was installed, has it needed any significant repairs or replacement of parts?

1. Yes
2. No

98. Don't know

I8. [NYS HP STUDY] **[IF H7=1]** What significant repairs or replacements have been needed**?** **[OPEN-ENDED TEXT RESPONSE]**

J. Non-Energy Benefits

The following will ask about things you may have experienced as a result of the energy efficiency improvements made to your home.

J1. **[IF HP_MEASURE=ASHP or GSHP]** Please indicate if each of the following items has improved, stayed the same, or worsened in your home since the installation of your heat pump system [PROVIDE THE CHOICES IMPROVED, WORSE, OR STAYED THE SAME. RANDOMIZE RESPONSES]

1. Noise levels when heating or cooling your home
2. Humidity levels when heating your home
3. Humidity levels when cooling your home
4. Quality of indoor air when heating or cooling your home
5. Health and well-being of members in your home during hot and cold periods
6. Ability to control and manage energy use
7. Comfort level in the home during hot periods
8. Comfort level in the home during cold periods

J2. **[IF HPWH=Yes]** Please indicate if each of the following items has improved, stayed the same, or worsened in your home since the installation of your heat pump water heater system [PROVIDE THE CHOICES IMPROVED, WORSE, OR STAYED THE SAME; RANDOMIZE OPTIONS]

1. Noise levels when the water heater operates
2. Comfort level of water temperature
3. Hot water availability and consistency

K. Satisfaction

K1. [UNIQUE TO THIS STUDY] **[IF HP_MEASURE=ASHP OR GSHP]** On a scale of 1 (one) to 5 (five) with '1' being Very Dissatisfied and '5' being Very Satisfied, please indicate your level of satisfaction with the following aspects of your **new [HP_MEASURE_TEXT]**? **[PROVIDE MATRIX TABLE WITH "1 – VERY DISSATISFIED," "2 – SOMEWHAT DISSATISFIED," "3 – NEITHER SATISFIED NOR DISSATISFIED," "4 – SOMEWHAT SATISFIED," AND "5 – VERY SATISFIED" AND N/A. RANDOMIZE OPTIONS.]**

1. Heating performance on very cold days
2. Cooling performance on very hot days
3. Noise level
4. Ease of Use
5. Reliability
6. Maintenance Needs
7. Heating costs

8. Cooling costs

K2. **[IF ANY PROMPT IN J1 RATED < 3]** What challenges have you experienced with your heat pump system? **[ALLOW TEXT ENTRY]**

K3. [LEVERAGED FROM NYSERDA'S STANDARD PROCESS QUESTIONS] **[IF HP_MEASURE=ASHP OR GSHP]** On a scale of 1-10, how likely are you to recommend **[HP_MEASURE_TEXT]** technology to a friend, family member, or colleague? **[PROVIDE 1-10 NUMERIC SCALE WITH 'ALREADY DID RECOMMEND' AND 'DON'T KNOW]**

K4. [UNIQUE TO THIS SURVEY] **[IF HPWH=Yes]** On a scale of 1 (one) to 5 (five) with '1' being Very Dissatisfied and '5' being Very Satisfied, please indicate your level of satisfaction with **your new heat pump water heater system** in the following areas? **[PROVIDE MATRIX TABLE WITH "1 – VERY DISSATISFIED," "2 – SOMEWHAT DISSATISFIED," "3 – NEITHER SATISFIED NOR DISSATISFIED," "4 – SOMEWHAT SATISFIED," AND "5 – VERY SATISFIED" AND N/A. RANDOMIZE OPTIONS.]**

1. Amount of hot water produced
2. Time to obtain hot water
3. Ease of use
4. Reliability
5. Noise
6. Maintenance Needs
7. Operating costs

K5. [UNIQUE TO THIS SURVEY] **[IF ANY PROMPT IN J3 RATED < 3]** What challenges have you experienced with your heat pump water heater? **[ALLOW TEXT ENTRY]**

K6. [LEVERAGED FROM NYSERDA'S STANDARD PROCESS QUESTIONS] **[IF HPWH=Yes]** On a scale of 1 to 10 with 1 being very unlikely and 10 being very likely, how likely are you to recommend heat pump water heater technology to a friend, family member, or colleague? **[PROVIDE 1-10 NUMERIC SCALE WITH 'ALREADY DID RECOMMEND' AND 'DON'T KNOW.]**

K7. [LEVERAGED FROM NYSERDA'S STANDARD PROCESS QUESTIONS] **[IF 2=2 OR B3=1]** On a scale of 1 (one) to 5 (five) with '1' being Very Dissatisfied and '5' being Very Satisfied, please indicate your level of satisfaction with each of the following: **[PROVIDE MATRIX TABLE WITH "1 – VERY DISSATISFIED," "2 – SOMEWHAT DISSATISFIED," "3 – NEITHER SATISFIED NOR**

DISSATISFIED," "4 – SOMEWHAT SATISFIED," AND "5 – VERY SATISFIED" AND N/A . RANDOMIZE OPTIONS 1–5]

1. Ease of program application/enrollment process for the Heat Pump
2. Quality of heat pump contractor staff (**[CONTRACTOR_NAME]**)
3. Quality of contractor staff that conducted your home audit or weatherization work (e.g. air sealing or insulation)
4. Rebate or incentive amount for the system
5. Energy savings
6. Overall Satisfaction with the program

K8. [LEVERAGED FROM NYSERDA'S STANDARD PROCESS QUESTIONS] **[IF ANY PROMPT IN J7 RATED < 3]** Why you were dissatisfied with the following aspects of the NYSERDA Heat Pump Demonstration Study program? **[FORM-STYLE QUESTION; PIPE IN ANY RESPONSE FROM J7 RATED < 3; ALLOW TEXT ENTRY FOR EACH CHOICE]**

1. [OPEN-ENDED TEXT RESPONSE]

K9. [LEVERAGED FROM NYSERDA'S STANDARD PROCESS QUESTIONS] On a scale of 1-10 where 1 is *not at all likely* and 10 is *very likely,* how likely are you to recommend an offering like the NYSERDA Heat Pump Demonstration Study to a friend, family member, or colleague? **[PROVIDE 1-10 NUMERIC SCALE WITH 'ALREADY DID RECOMMEND' AND 'DON'T KNOW.]**

L. Demographics

We are almost done! The final questions will ask you about your utilities, yourself, and your household. This will only be used for research purposes and will remain confidential.

L1. Before the heat pump system was installed, what types of fuel were you purchasing for your heating equipment? Please select all that apply.

1. Electricity
2. Natural Gas
3. Fuel Oil or Kerosene
4. Propane
5. Wood
6. Coal

7. Other (Specify)

L2. [SMBS TENANT SURVEY] What is the highest level of education anyone currently living in your household has completed?

1. Less than high school
2. Some high school
3. High school graduate or equivalent (e.g., GED)
4. Trade or technical school
5. Some college, no degree
6. College degree (e.g., Bachelor's degree)
7. Some graduate school
8. Graduate degree (e.g., Masters or Doctorate degree)
99. Prefer not to answer

L3. [SMBS TENANT SURVEY] Which of the following best describes your household's total annual income?

1. Less than $25,000
2. $25,000 to less than $30,000
3. $30,000 to less than $35,000
4. $35,000to less than $50,000
5. $50,000 to less than $75,000
6. $75,000 to less than $100,000
7. $100,000 or more
99. Prefer not to answer

L4. [SMBS TENANT SURVEY] **[IF A3=2]** In the last 12 months, has your household received assistance or a housing subsidy to help pay for rent?

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

L5. [SMBS TENANT SURVEY] **[IF A3 ≠2]** In the last 12 months, has your household received energy assistance to help pay for your electric or heating?

1. Yes
2. No

98. Don't know

M. Closing

M1. To thank you for completing the survey, we would like to send you a $10 Amazon gift card. Please provide the email address you would like the gift card sent to. The gift card will be emailed to you within one week. **[ALLOW TEXT ENTRY]**

1. [OPEN-ENDED TEXT RESPONSE]

M2. **[IF 4≠1 OR L1≠1]** Would you like to earn another gift card? We are offering additional gift cards for participants that provide information on their heating fuel suppliers and heating fuel deliveries. Would you be interested? [IF ONLINE, THEN: (This question is just to assess your interest. Choosing yes below does *not* commit you to providing additional information.)] [IF PHONE, **THEN SAY "This is just to assess your interest. You will have a chance to opt out once we reach out with additional details."]**

1. Yes
2. No

M3. **[IF L2= 1 AND SURVEY CHANNEL = PHONE]** Thank you. We will contact you about this additional request.

1. What is the best email address to reach you at? **[RECORD RESPONSE. CONFIRM SPELLING ONCE NOTED]**
2. What is the best phone number to reach you at? [RECORD RESPONSE. CONFIRM NUMBER ONCE NOTED, OR IF THEY SAY SOMETHING LIKE "THIS ONE."]

N. Delivered Fuel Consent Form

[IF L2= 1 AND SURVEY CHANNEL = ONLINE]

Thank you for your interest! We are conducting additional research on energy savings associated with the heat pump technologies, on behalf of NYSERDA. To do so, we need to understand the heating fuel usage at your home prior to when your new equipment was installed and since it was installed. For that purpose, we would like to collect a copy of your delivered fuel bills (e.g., wood pellets, propane, oil, coal, etc.):

- We will provide an **incentive of $20** for copies of all delivered fuel receipts/invoices you have paid between the installation of your equipment and now.

- Additionally, we will provide an **incentive of $10** for each future delivered fuel receipt/invoice you provide every two months going forward for the next 12 months.

Your participation in our study is very important and will help NYSERDA to design programs that improve home comfort and reduce energy bills. This data will be kept strictly confidential in accordance with all privacy laws and used solely for the purpose of this study. We won't share your billing information with others and will only extract the fuel usage amount from your bills. Analysis results will be published as summary data and will not identify individual respondents.

N1. Have you or anyone in your home used or purchased delivered fuel for water heating or space heating since the installation of your heat pump?

1. Yes
2. No [SKIP TO N7]

98. Don't Know [SKIP TO N7]

N2. Are you willing to provide a receipt/invoice for all delivered fuel bills paid since the installation of your equipment on **[DATE_COMPLETION]** for a $20 Amazon online gift card? You will receive your online gift card via email within two weeks of providing your bill.

1. Yes, I can provide a copy of my bills via a photo or screenshot
2. Yes, I can provide my bill details via telephone
3. No, I don't have a copy of my past bills, nor can I obtain copies of receipts from my provider
4. No, I did not pay money for the delivered fuel I used

N3. Are you willing to provide a receipt/invoice for all future delivered fuel bills that you will pay every two months for the next 12 months for a $10 Amazon gift card each time? You will receive your online gift card via email within two weeks of providing your bill.

1. Yes, I can provide a copy of my bills via a photo or screenshot
2. Yes, I can provide my bill details via telephone
3. No

N4. **[IF M1=1 AND M2=3]** Great! Please upload a photo or screenshot of all delivered fuel bills paid since **[DATE_COMPLETION]** via this form here **[LINK TO QUALTICS FORM]**. To qualify for an incentive, the bills will need to show the invoice date,

quantity of fuel purchased (gallons, number of wood cords, etc.), and the bill dollar amount.

N5. **[IF M1=1 AND M2=1]** Great! Please upload a photo or screenshot of all delivered fuel bills paid since **[DATE_COMPLETION]** to **[LINK TO QUALTICS FORM]**. You will be sent an email every two months to remind you send us your delivered fuel bills going forward.

N6. **[IF N2=2 OR N3= 2]** Great! Please provide your phone number, and we will call you within two weeks to collect that information. **[OPEN-ENDED TEXT RESPONSE]**

N7. **[IF M1=2 OR 3]** [LEVERAGED FROM NYS HP Survey] Alternatively, with your permission, we can work with your delivered fuel provider to obtain your energy usage data. Do you have a specific company from whom you regularly purchase heating fuel?

1. Yes [SKIP TO N10]
2. No

N8. [IF N7=2] Can you estimate of how much fuel you have used since the heat pump was installed and how much that fuel cost?

1. Yes
2. No

N9. [IF N8=1] Great! Please provide your estimates via this form: **[LINK TO QUALTICS FORM2]**. You will be sent an email every two months to remind you to complete this form.

N10. [IF N7=1] Please indicate below if you have the authority to give permission to obtain energy usage data from your fuel dealer. The next question will provide an official authorization statement and ask for your signature. If you do not have the authority to allow the release of your energy usage data, please provide contact information for the individual who does have this authority. Should you have any questions, please contact Josh Carey at josh.carey@cadmusgroup.com.

1. Yes, I will share my energy consumption data with Cadmus on behalf of NYSERDA and have the authority to do so
2. I don't have the authority to give permission.
3. I do not give permission to Cadmus on behalf of NYSERDA to obtain my energy consumption data

N11. **[IF N10=1]** [LEVERAGED FROM NYS HP Survey] First, please provide your first and last name and the date below. **[ALLOW TEXT ENTRY] [REQUIRED RESPONSE IF DISPLAYED]**

1. Full Name: [OPEN-ENDED TEXT RESPONSE]
2. Date: [OPEN-ENDED TEXT RESPONSE]

N12. **[IF N10=2]** [LEVERAGED FROM NYS HP Survey] Please provide the contact information for the person authorized to release energy usage data. We will contact this person to request their permission. **[ALLOW TEXT ENTRY]**

1. Name: [OPEN-ENDED TEXT RESPONSE]
2. Title: [OPEN-ENDED TEXT RESPONSE]
3. Phone number (including area code): **[OPEN-ENDED TEXT RESPONSE]**
4. Email address: [OPEN-ENDED TEXT RESPONSE]

N13. [IF N10=1] [REQUIRE RESPONSE IF DISPLAYED] The Energy Usage Data Release Authorization reads as follows:

NYSERDA requests permission to access historic utility data for the accounts associated with the address provided. By selecting "I consent" below, I authorize the New York State Energy Research and Development Authority (NYSERDA), and its designated representatives, to access energy billing and consumption data for the site identified. As an authorized representative of the site, I authorize NYSERDA, and its designated representatives, to access and use any available energy consumption information and data. I understand this information will be used to evaluate energy use patterns for the purpose of measuring energy performance and determining the potential and actual energy savings resulting from evaluated or implemented energy projects. I understand that NYSERDA is subject to the NYS Freedom of Information Law, Public Officers law, Article 6, and that NYSERDA cannot guarantee confidentiality of any information submitted.

1. I consent
2. I do not consent

N14. **[IF N10=1]** Please provide the following information for all fuel dealers used to meet your home's heating needs. A representative will contact you to collect further details if needed. **[ALLOW TEXT ENTRY]**

1. Fuel Distributor #1 Name: [OPEN-ENDED TEXT RESPONSE] [REQUIRE RESPONSE IF DISPLAYED]
2. Fuel Distributor #1 Fuel Type: [OPEN-ENDED TEXT RESPONSE] [REQUIRE RESPONSE IF DISPLAYED]
3. Fuel Distributor #1 Address: [OPEN-ENDED TEXT RESPONSE] [REQUIRE RESPONSE IF DISPLAYED]
4. Fuel Distributor #1 Phone
5. Fuel Distributor #1 Email: [OPEN-ENDED TEXT RESPONSE] [REQUIRE RESPONSE IF DISPLAYED]
6. Account contact on record with fuel dealer #1 (if other than yourself): **[OPEN-ENDED TEXT RESPONSE] [REQUIRE RESPONSE IF DISPLAYED]**
7. Fuel Distributor #2 Name: [OPEN-ENDED TEXT RESPONSE]
8. Fuel Distributor #2 Fuel Type: **[OPEN-ENDED TEXT RESPONSE]**
9. Fuel Distributor #2 Address: **[OPEN-ENDED TEXT RESPONSE]**
10. Fuel Distributor #2 Phone or Email: **[OPEN-ENDED TEXT RESPONSE]**
11. Account contact on record with fuel dealer #2 (if other than yourself): **[OPEN-ENDED TEXT RESPONSE]**
12. Fuel Distributor #3 Name: [OPEN-ENDED TEXT RESPONSE]
13. Fuel Distributor #3 Fuel Type: **[OPEN-ENDED TEXT RESPONSE]**
14. Fuel Distributor #3 Address: **[OPEN-ENDED TEXT RESPONSE]**
15. Fuel Distributor #3 Phone or Email: **[OPEN-ENDED TEXT RESPONSE]**
16. Account contact on record with fuel dealer #3 (if other than yourself): [OPEN-ENDED TEXT RESPONSE]

O. Delivered Fuel Quantity and Price Form

Hello! Thank you for taking more time out of your day to share your delivered fuel consumption information with us. As we mentioned, the purpose of this is to understand the heating fuel usage at your home since the heat pump system was installed. Your participation in our study is very important and will help NYSERDA to design programs that improve home comfort and reduce

energy bills. This data will be kept strictly confidential in accordance with all privacy laws and used solely for the purpose of this study. We won't share your billing information with others and will only extract the fuel usage amount from your bills. Analysis results will be published as summary data and will not identify individual respondents.

As a reminder, for providing information on your delivered fuel procured since the installation of your equipment now, you will receive a **$20 Amazon online gift card.** Additionally, we will provide an incentive of **$10 for each future delivered fuel form you complete** every two months going forward for the next 12 months. You will receive your online Amazon gift card via email within two weeks of providing your delivered fuel information.

O1. Is this your first time providing information to us about your delivered fuel quantity, or is it a follow-up about two months after you last provided this information?

1. First time
2. Follow-up

O2. What types of the following fuels have you used for space or water heating since the installation of your heat pump system?

1. Coal
2. Fuel oil
3. Natural gas
4. Propane
5. Face wood
6. Wood pellets

O3. [O1=1] Please indicate how much of the following types of fuel sources you purchased or procured since the installation of your heat pump system.

1. [IF O2=1] Pounds of Coal: [NUMERIC RESPONSE]
2. [IF O2=2] Gallons of Fuel Oil: [NUMERIC RESPONSE]
3. [IF O2=3] Therms of Natural Gas: [NUMERIC RESPONSE]
4. [IF O2=4] Gallons of Propane: [NUMERIC RESPONSE]
5. [IF O2=5] Cords of Face Wood: [NUMERIC RESPONSE]
6. [IF O2=6] Pounds of Wood Pellets: [NUMERIC RESPONSE]

O4. [O1=2] Please indicate how much of the following types of fuel sources you purchased in the past two months.

1. [IF O2=1] Pounds of Coal: [NUMERIC RESPONSE]
2. [IF O2=2] Gallons of Fuel Oil: [NUMERIC RESPONSE]
3. [IF O2=3] Therms of Natural Gas: [NUMERIC RESPONSE]
4. [IF O2=4] Gallons of Propane: [NUMERIC RESPONSE]
5. [IF O2=5] Cords of Face Wood: [NUMERIC RESPONSE]
6. [IF O2=6] Pounds of Wood Pellets: [NUMERIC RESPONSE]

O5. [O1=1] Please estimate the average price you paid per unit of fuel since you installed your heat pump.

1. [IF O2=1] Dollars per Pounds of Coal: [NUMERIC RESPONSE]
2. [IF O2=2] Dollars per Gallons of Fuel Oil: [NUMERIC RESPONSE]
3. [IF O2=3] Dollars per Therms of Natural Gas: [NUMERIC RESPONSE]
4. [IF O2=4] Dollars per Gallons of Propane: [NUMERIC RESPONSE]
5. [IF O2=5] Dollars per Cords of Face Wood: [NUMERIC RESPONSE]
6. [IF O2=6] Dollars per Pounds of Wood Pellets: [NUMERIC RESPONSE]

O6. [O1=2] Please estimate the average price you paid per unit of fuel since in the past two months.

1. [IF O2=1] Dollars per Pounds of Coal: [NUMERIC RESPONSE]
2. [IF O2=2] Dollars per Gallons of Fuel Oil: [NUMERIC RESPONSE]
3. [IF O2=3] Dollars per Therms of Natural Gas: [NUMERIC RESPONSE]
4. [IF O2=4] Dollars per Gallons of Propane: [NUMERIC RESPONSE]
5. [IF O2=5] Dollars per Cords of Face Wood: [NUMERIC RESPONSE]
6. [IF O2=6] Dollars per Pounds of Wood Pellets: [NUMERIC RESPONSE]

O7. Please enter your first name, last name, and the email you would like the Amazon online gift card sent to. Again, you will receive your online gift card via email within two weeks of providing your bills.

1. First Name
2. Last Name
3. Email Address
4. Phone Number

P. End of Survey Message

This completes the survey. Your responses are very important to NYSERDA. We appreciate your participation and thank you for your time. Have a good day.

You can learn more about NYSERDA's resources for residents and homeowners to improve their homes' efficiency and comfort at https://www.nyserda.ny.gov/Residents-and-Homeowners.

Appendix E. Contractor Survey Instrument

This survey instrument was designed using the Learning Objectives for the Single-Family Heat Pump Evaluation as a guide.

Research Category	Research Questions	Corresponding Section
Characterize Projects / the Market	• What are contractor firmographics (level of experience with heat pumps, company size)? • What are the likely causes behind the geographic distribution of sites and the distribution of Low-Income customers and moderate-income customers? • Why were electrical panel or service upgrades implemented? • Why were thermal system upgrades implemented?	Section B Section D
Identify Participation Barriers / Motivations, Best Practices	• What were motivations to participating? • What % of projects came from clean and heating cooling campaigns versus the contractors? • What were best practices in heat pump installation?	Section C Section E
Assess Satisfaction, Promote Partnerships, Market Learning	• What barriers did contractors see to program participation for themselves? • What barriers did contractors see to program participation for homeowners? • How can the design of the program be improved? • Did the project spur referrals? • Did contractors obtain new certifications related to installation of heat pumps or other upgrades, after participating in a or project? • How many projects included subcontracting that led to long-lasting partnerships?	Section F Section C
Validate Savings Model	• Was the size of the heat pump reduced between design and install due to other building upgrades (e.g., building shell measures)? • Did upgrade or design specifications change between the design and install?	Section G

Target Quota = 34

Soft Targets: Soft targets by measure are based on the proportion of installed measures. Note that many projects include two of the following measures (e.g. GSHPs + HPWHs or ASHPs + HPWHs)

- 6 projects that include GSHPs
- 20 projects that include HPWHs
- 28 project that include ASHPs

A. Introduction

Welcome to the NYSERDA Heat Pump Demonstration Study Participating Contractor Survey!

This important survey will help NYSERDA to better understand your experiences as a participating contractor with the NYSERDA Single Family Heat Pump Demonstration Pilot that was delivered through the EmPower and Assisted Home Performance programs. The survey takes approximately 20 to 25 minutes to complete, and as a thank you for your time, you will receive a $50 Amazon gift card if you complete the survey.

Please click "next" to begin the survey.

B. Company Firmographics

First, we'd like to understand your company's background.

B1. Including yourself, approximately how many employees does your company have? **[OPEN-ENDED NUMERIC RESPONSE]**

B2. **[IF EMPOWER/AHP CONTRACTOR = YES and CLEAN HEAT CONTRACTOR = NO]** When you subcontract work with heat pump or heat pump water heater contractors, do you typically work with the same subcontractors, or do you tend to work with different subcontractors each time?

1. Same subcontractors
2. Different subcontractors each project
3. This is my first project with heat pump or heat pump water heater subcontractors
4. NA – We do not subcontract work with heat pumps (we do the work ourselves)

B3. **[IF CLEAN HEAT CONTRACTOR=YES]** In the past year, about what percent of your single-family HVAC installations were…**[RESPONSES MUST SUM TO 100%]**

1. Ducted cold climate air source heat pumps? **[PERCENTAGE RESPONSE]**
2. Ductless minisplit cold climate air source heat pumps? **[PERCENTAGE RESPONSE]**
3. Ground source heat pumps? **[PERCENTAGE RESPONSE]**
4. Something else? [PERCENTAGE RESPONSE]

B4. **[IF CLEAN HEAT CONTRACTOR=YES]** In the past year, about what percent of your single-family water heater installations were **heat pump water heaters**? Please enter a number without the percentage sign (%).

1. [PERCENTAGE RESPONSE]

C. Contractor Motivations

For the remainder of this survey, please provide answers based on your experience with the NYSERDA pilot only.

C1. What motivated you to participate in the Pilot? **[MULTIPLE RESPONSES ALLOWED, RANDOMIZE]**

1. (Gain more experience with heat pumps)
2. (Gain more experience with heat pump water heaters)
3. (Gain more experience with weatherization/insulation)
4. (Incentive amounts for customer made it easy to get work)
5. **[IF EMPOWER/AHP CONTRACTOR = NO and CLEAN HEAT=YES]** (I was asked to subcontract with the main contractor)
6. (Differentiate my company's offerings from competitors)
7. (Find additional customers or projects)
8. (OTHER) **[RECORD VERBATIM]**

C2. What was your main source of project leads for the pilot? Please select only one. [RANDOMIZE]

1. (HeatSmart campaigns)
2. (Customer inquiry)
3. (NYSERDA)
4. **[IF EMPOWER/AHP CONTRACTOR=YES AND CLEAN HEAT CONTRACTOR = NO](** The project's heat pump or heat pump water heater contractor)
5. [IF EMPOWER/AHP CONTRACTOR=NO AND CLEAN HEAT CONTRACTOR = YES] (The project's prime contractor)
6. (Other: Please describe) **[RECORD VERBATIM]** [PERCENTAGE RESPONSE]

C3. How many referrals for cold climate heat pump or heat pump water heater projects do you estimate resulted from your participation in the Heat Pump Demonstration Pilot? These referrals would be for work that either took place as part of the pilot or outside of the pilot.

1. [RECORD NUMBER]

C4. Did your company or employees obtain new certifications related to installation of heat pumps, heat pump water heaters, or weatherization measures as a result of participating in the Pilot?

1. (Yes)
2. (No)

C5. [IF C4=1] What kind of certifications did you or your company receive? [OPEN-ENDED RESPONSE] [RECORD VERBATIMS]

C6. What type of training, if any, did you pursue in order to participate in the pilot?

1. [RECORD VERBATIMS]

C7. [IF EMPOWER/AHP CONTRACTOR = YES and CLEAN HEAT CONTRACTOR = YES and ASHP=YES] Prior to participating in the study, did you complete any cold climate heat pump installations?

1. (Yes)
2. (No)
98. (Don’t know)

C8. **[IF EMPOWER/AHP CONTRACTOR = YES and CLEAN HEAT CONTRACTOR = YES and GSHP=YES]** Prior to participating in the study, did you complete any ground source heat pump installations?

1. (Yes)
2. (No)
98. (Don’t know)
99. (Refused)

C9. **[IF EMPOWER/AHP CONTRACTOR = YES or IF CLEAN HEAT CONTRACTOR = NO]** Did you form any **new** partnerships with heat pump subcontractors as part of the heat pump pilot, or did you work with subcontractors with whom you already had a working relationship?

1. (We formed new partnerships)
2. (We worked with pre-existing partners)

98. (Don't know)

C10. [IF EMPOWER/AHP CONTRACTOR=YES AND CLEAN HEAT CONTRACTOR = NO] OR [C9=1 OR 2] Where 1 is *not at all likely* and 5 is *very likely*, how likely are you to maintain a long-term working relationship with the same heat pump subcontractor(s) in the future? [PROGRAM SCALE 1-5 WITH "1 – NOT AT ALL LIKELY" AND "5 – VERY LIKELY."]

D. Frequency of Equipment Recommendations

D1. Thinking about the projects you completed through the Pilot, please estimate the percentage of projects for which you recommended installing each of the following technologies.

1. **Ducted** cold-climate air source heat pumps **[PERCENTAGE RESPONSE]**
2. **Ductless** cold-climate air source heat pumps **[PERCENTAGE RESPONSE]**
3. Ground source heat pumps **[PERCENTAGE RESPONSE]**
4. Heat pump water heaters **[PERCENTAGE RESPONSE]**

D2. **[FOR ANY RESPONSE IN D1>0]** Using your best guess, what percentage of customers ended up adopting the technology after you recommended it?

1. Ducted cold-climate air source heat pumps **[PERCENTAGE RESPONSE]**
2. Ductless cold-climate air source heat pumps **[PERCENTAGE RESPONSE]**
3. Ground source heat pumps **[PERCENTAGE RESPONSE]**
4. Heat pump water heaters **[PERCENTAGE RESPONSE]**

D3. **[IF EMPOWER/AHP CONTRACTOR=YES]** On pilot projects for which you implemented envelope upgrades, what was the main reason you did so?

1. **[RECORD VERBATIM]**

98. (Don't know)
99. (Refused)

D4. **[IF ELECTRIC PANEL INCENTIVE = YES]** On pilot projects for which you implemented electric panel or service upgrades, what was the main reason you did so? **[RESPONSE]**

1. **[RECORD VERBATIM]**
98. (Don't know)
99. (Refused)

D5. **[IF DISTRIBUTION INCENTIVE UPGRADE = YES]** On pilot projects for which you implemented thermal distribution system upgrades, such as ductwork, what was the main reason you did so?

1. **[RECORD VERBATIM]**
98. (Don't know)
99. (Refused)

D6. What were the primary reasons customers did **not** move forward with recommendations?

1. **[RECORD VERBATIM]**
98. (Don't know)
99. (Refused)

E. Installation Best Practices

These next few questions focus on heat pump and heat pump water heater installation and equipment sizing practices.

E1. [IF CLEAN HEAT CONTRACTOR = YES] AND [ASHP=YES or GSHP=YES] How did you determine appropriate equipment size when planning the air or ground source heat pump technology installations for this Pilot? [OPEN-ENDED RESPONSE] [PRE-CODE PHONE RESPONSES AND BIN OPEN-ENDS INTO THOSE CODES]

1. (Used rule of thumb based on house size)
2. (Replace existing system with the same size of new equipment)
3. (Accounted for weatherization or insulation measures that may have reduced electric load)
4. (Use commercial software to model building loads to size new system (for example, Wrightsoft))
5. (Based on air flow capacity of existing ducts)
6. (Manual J calculation)

7. (NYSERDA's Clean Heat Incentive Calculator)

8. (Other)

E2. [IF CLEAN HEAT CONTRACTOR = YES] [IF HPWH=YES] How did you determine appropriate equipment size when planning the heat pump water heater technology installations for this Pilot? [OPEN-ENDED RESPONSE] [PRE-CODE PHONE RESPONSES AND BIN OPEN-ENDS INTO THOSE CODES]

1. **[RECORD VERBATIM]**

2. (Used rule of thumb based on house size)

3. (Replace existing system with the same size of new equipment)

4. (Use commercial software to model building loads to size new system (for example, Wrightsoft))

5. (NYSERDA's Clean Heat Incentive Calculator)

6. (Sized to fit existing height/conditions)

98. (Don't know)

E3. **[IF ASHP=YES OR GSHP=YES] [IF CLEAN HEAT CONTRACTOR = YES]** When participating in this Pilot, for what percentage of your projects did you conduct a blower door test? Please enter a number without the percentage sign (%).

1. **[RECORD PERCENTAGE VERBATIM]**

98. (Don't know)

99. (Refused)

E4. **[IF CLEAN HEAT CONTRACTOR = YES]** Which of the following was the single most important consideration when sizing **heat pumps systems** for customers as part of this Pilot?

1. Energy savings

2. Upfront cost

3. Long-term cost savings

4. Comfort

5. Having enough space for heat pump systems, or

6. Something else? **[RECORD VERBATIM]**

E5. **[IF CLEAN HEAT CONTRACTOR = YES & HPWH=YES]** Which of the following was the single most important consideration when sizing **heat pumps water heater systems** for customers as part of this Pilot?

1. Energy savings
2. Upfront cost
3. Long-term cost savings
4. Ability to meet peak demand for hot water
5. Physical limitations/barriers
6. Something else? **[RECORD VERBATIM]**

E6. **[IF CLEAN HEAT CONTRACTOR = YES] AND [IF ASHP=YES or GSHP=YES]** For what percentage of heat pump projects that were part of this Pilot did you recommend that customers retain their existing HVAC system as a backup system? Please enter a number without the percentage sign (%). **[DO NOT READ RESPONSES]**

1. [PERCENTAGE RESPONSE]

98. (Don't know)
99. (Refused)

E7. **[IF CLEAN HEAT CONTRACTOR = YES] AND [IF ASHP=YES or GSHP=YES]** And why did you recommend that they retain their existing HVAC system as a backup system? **[OPEN-ENDED; RECORD VERBATIM]**

E8. **[IF CLEAN HEAT CONTRACTOR = YES] AND [IF ASHP=YES or GSHP=YES]** AND **[IF E6>0%]** At what temperature in Fahrenheit do you recommend that customers switch from using their heat pump system to using their backup system?

1. (40 degrees (F) or higher)
2. (31 to 40 degrees (F))
3. (21 to 30 degrees (F))
4. (11 to 20 degrees (F))
5. (1 to 10 degrees (F))
6. (0 degrees (F) or lower)

98. (Don't know)
99. (Refused)

E9. **[IF CLEAN HEAT CONTRACTOR = YES] AND [IF ASHP=YES or GSHP=YES]** When recommending heat pumps to participants in the NYSERDA Heat Pump Demonstration Pilot, for what percentage of projects do you recommend that customers install integrated controls rather than manually controlling the system? Your best estimate is fine.

1. [PERCENTAGE RESPONSE]
98. (Don't know)
99. (Refused)

E10. **[IF E10<100%]** Why don't you always recommend that customers install integrated controls? **[OPEN-ENDED; RECORD VERBATIM]**

E11. **[IF CLEAN HEAT CONTRACTOR = YES] AND [IF ASHP=YES or GSHP=YES]** What challenges have you faced, if any, with projects for which you set up integrated controls?

1. **[RECORD VERBATIM]**
98. (Don't know)
99. (Refused)

E12. **[IF CLEAN HEAT CONTRACTOR = YES]** AND **[IF ASHP=YES or GSHP=YES]** Do you provide educational materials or instruction to your customers about their heat pump system?

1. Yes
2. No

E13. **[IF E12=1]** What key topics or items are covered in the education that you provide to customers about their heat pump system? **[MULTIPLE RESPONSES ALLOWED, RANDOMIZE]**

1. (How to turn the heat pump on or off)
2. (How to set temperatures)
3. (Information on common problems and what to do)
4. (How to change filters)
5. (How to clear debris, snow, or ice from heat pumps)
6. (Tips to keep the heat pump running efficiently)

7. (Other)
98. (Don't know)

F. Satisfaction and Barriers

F1. On a scale of 1 to 5 where 1 is *not at all satisfied* and 5 is *very satisfied*, how satisfied were you with each of the following Pilot components? As a reminder, these questions are about the heat pump pilot only, not the broader EmPower or Assisted Home Performance programs. **[READ EACH PROMPT. REPEAT SCALE AS NEEDED.] [PROGRAM SCALE 1-5 WITH "1 – NOT AT ALL SATISIFED" AND "5 – VERY SATISIFED" and add an N/A option.] [RANDOMIZE OPTIONS]**

1. Paperwork
2. Application process for customers to receive incentives
3. Level of communication from NYSERDA
4. Participation criteria for customers Information available about the study
5. The types of eligible upgrades or equipment
6. Application process for contractors to participate in the pilot

F2. Level of communication from CLEAResultOn a scale of 1 to 5, where 1 is *not at all appropriate* and 5 is *very appropriate,* how appropriate were the pilot's incentive levels for the following technologies? **[READ EACH PROMPT. REPEAT SCALE AS NEEDED.] [PROGRAM SCALE 1-5 WITH "1 – NOT AT ALL APPROPRIATE" AND "5 – VERY APPROPRIATE." INCLUDE N/A BUT DO NOT READ IT AS AN ANSWER OPTION.] [ADD RANDOMIZATION]**

1. **[IF ASHP=YES]** EmPower cold climate air source heat pumps
2. **[IF ASHP=YES]** Assisted Home Performance cold climate air source heat pump
3. **[IF HPWH=YES]** EmPower Heat pump water heaters
4. **[IF HPWH=YES]** Assisted Home Performance Heat pump water heaters
5. **[IF GSHP=YES]** EmPower Ground source heat pumps
6. **[IF GSHP=YES]** Assisted Home Performance Ground source heat pumps
7. **[DISTRIBUTION UPGRADE INCENTIVE = YES OR ELECTRIC PANEL INCENTIVE = YES]** EmPower Ancillary services, such as electric panel, distribution system upgrades, or health and safety

8. **[DISTRIBUTION UPGRADE INCENTIVE = YES OR ELECTRIC PANEL INCENTIVE = YES]** AHP Ancillary services, such as electric panel, distribution system upgrades, or health and safety

9. Subcontractor participation incentive

F3. **[IF ANY ITEM ABOVE RATED<4 in E2]** You rated one or more items above below a rating of 4. Please share any information to explain why you rated one or more items above below a rating of 4. **[OPEN-ENDED RESPONSE]**

F4. In what ways did the pilot incentives help your project? **[OPEN-ENDED RESPONSE]**

F5. What percent of projects you completed within NYSERDA's Pilot experienced delays of more than 30 days? Your best estimate is fine.

1. [PERCENTAGE RESPONSE]
98. (Don't know)
99. (Refused)

F6. [IF F5 > 0%] In your experience, what were the most typical reasons for project delays? [DO NOT READ RESPONSES] [MULTIPLE RESPONSES ALLOWED] [RANDOMIZE ALL RESPONSES BEFORE 'OTHER']

1. (Supply chain-issues)

2. (Labor shortage)

3. (Additional equipment was needed that was not planned)

4. (Obtaining approval needed from program staff to implement the project)

5. (COVID-19)

6. (Other) [RECORD VERBATIM]
98. (Don't know)

F7. **[IF EMPOWER/AHP CONTRACTOR=YES AND CLEAN HEAT CONTRACTOR = NO]** What barriers or challenges did you face when working with heat pump or heat pump water heater subcontractors? **[OPEN-ENDED RESPONSE]**

1. **[RECORD VERBATIM]**
98. (Don't know)
99. (Refused)

F8. **[IF EMPOWER/AHP CONTRACTOR=NO AND CLEAN HEAT CONTRACTOR = YES]** What barriers or challenges did you face when working with EmPower/AHP contractors? **[OPEN-ENDED RESPONSE]**

1. **[RECORD VERBATIM]**

98. (Don't know)
99. (Refused)

F9. What challenges did you face when working with low-to-moderate income households during the pilot? **[OPEN-ENDED RESPONSE]**

1. **[RECORD VERBATIM]**
98. (Don't know)
99. (Refused)

F10. What can NYSERDA do to facilitate contractor partnerships on projects like these? **[OPEN-ENDED RESPONSE]**

1. [**Record VERBATIM]**
98. (Don't know)
99. (Refused)

F11. What suggestions to do you have to improve the NYSERDA Heat Pump Demonstration Pilot? **[OPEN-ENDED RESPONSE]**

1. **[RECORD VERBATIM]**
98. (Don't know)
99. (Refused)

G. Validate Savings Model

The next questions ask about project scope and planning for your Study projects.

G1. [IF ASHP=YES or GSHP=YES] For projects where the **heat pump system size** you installed was different from the size you originally planned, what caused the change? Select all that apply. **[DO NOT READ RESPONSES] [MULTIPLE RESPONSES ALLOWED] [RANDOMIZE ALL RESPONSES BEFORE 'OTHER']**

1. (Customer wanted more capacity)
2. (Improvements in insulation, windows, or air sealing reduced building load)
3. (Wanted to avoid upgrading the electric service or electric panel)
4. (Expected incentives or financing were not approved)
5. (Other (Please describe)) **[RECORD VERBATIM]**
6. (No projects had a change in heat pump system size) **[EXCLUSIVE RESPONSE]**

G2. **[IF HPWH = YES]** For projects where the **heat pump water heater size** you installed was different from the size you originally planned, what caused the change? Select all

that apply. **[MULTIPLE RESPONSES ALLOWED] [RANDOMIZE ALL RESPONSES BEFORE 'OTHER']**

1. (Original equipment was too tall for available space)
2. (Changed size to align with existing pipe connections)
3. (Wanted to avoid upgrading the electric service or electric panel)
4. (Expected incentives or financing were not approved)
5. (Other (Please describe))
6. (No projects had a change in heat pump water heater size) **[EXCLUSIVE RESPONSE]**

G3. [IF ASHP=YES or GSHP=YES] For projects where the installed **heat pump system cost** changed from your original estimate, what typically caused the change? **[MULTIPLE RESPONSES ALLOWED]**

1. Original product was not available
2. Change in project design
3. Change in available incentives/financing
4. Additional scope added/needed
5. Change in material costs
6. Change in labor costs
7. (I'm not aware of changes to the cost of my project(s)) **[EXCLUSIVE RESPONSE]**
8. (Other)

98. Don't know **[EXCLUSIVE]**

G4. [IF HPWH=YES] For projects where the installed **heat pump water heater cost** changed from your original estimate, what typically caused the change? [RANDOMIZE]

1. Change in project design
2. Change in available incentives/financing
3. Additional scope added/needed
4. Change in material costs
5. Change in labor costs

6. (I'm not aware of changes to the cost of my project(s)) **[EXCLUSIVE RESPONSE]**

7. (Other) [RECORD VERBATIM]

98. Don't know **[EXCLUSIVE]**

G5. Which forms of support would be valuable to companies like yours to help accelerate the adoption of cold climate heat pumps ground source heat pumps, or heat pump water heater projects by low-to moderate-income households? **[DO NOT READ RESPONSES] [MULTIPLE RESPONSES ALLOWED, RANDOMIZE]**

1. (Additional Incentives)

2. (Training for staff)

3. (Marketing materials)

4. (Educational materials about heat pumps for customers)

5. (Endorsement of work)

6. (Other (Please specify)) **[RECORD VERBATIM]**

98. (Don't know)
99. (Refused)

H. Obtain Contact Info for Subcontractors

H1. **[IF EMPOWER/AHP CONTRACTOR=YES]** As part of this research, NYSERDA would like to contact subcontractors who worked with participating contractors during the study to understand subcontractors heat pump installation practices and experiences. Can you please provide the contact information for subcontractors that assisted your company as part of the Pilot project work?

1. Yes

2. No

3. Our company does not use subcontractors.

H2. **[IF G1 = 1]** Please provide the subcontractor company name, contact name, email address, and phone number.

1. Subcontractor Company Name

2. Contact Name

3. Email

4. Phone

H3. Which of the following equipment did that subcontractor install as part of the pilot? Please select all that apply.

1. Ducted cold climate air source heat pumps
2. Ductless minisplit cold climate air source heat pumps
3. Ground source heat pumps
4. Distribution system upgrade
5. Electric panel upgrade

98. Don't Know

I. Closing

I1. As a thank you for your time for completing the survey, we would like to send you a $50 Amazon gift card. This gift card would be e-mailed to you. Please provide the following information so that we can email the gift card to you.

1. Name: **[RECORD VERBATIM]**
2. Phone number: **[RECORD VERBATIM] [IF ASKED WHY, SAY: "SO WE CAN EASILY CONTACT YOU IF WE HAVE PROBLEMS SENDING YOUR GIFT CARD."]**
3. Email address: **[RECORD VERBATIM]**

98. (Don't know)
99. (Refused)

I2. We are offering an additional $100 gift card for participation in a 30-minute follow-up interview about specific installation best practices and challenges you faced to participating in the NYSERDA's Heat Pump Demonstration Pilot. Would you be interested in participating in this additional research? **[DO NOT READ RESPONSES] [IF NEEDED, SAY: "We expect the interview should only take about 30 minutes to complete. In about 1-2 weeks, we would give you a call and ask you more in-depth questions about your experience with the program. We can also call ahead and schedule a time to talk if you would prefer."]**

1. (Yes)
2. (No) [SKIP TO END]

98. (Don't know) [SKIP TO END]
99. (Refused) [SKIP TO END]

I3. Please provide the best phone number to reach you. You can expect another call in about 1-2 weeks about this additional research.

You have completed the survey. Thank you for your time and participation!

Appendix F. Contractor Interview Instrument

This survey instrument was designed using the Learning Objectives for the Single-Family Heat Pump Evaluation as a guide.

Research Category	Research Objectives	Question Numbers
Identify Participation Barriers / Motivations, Best Practices	Identify participation process and barriers contractors saw to program participation (for themselves and homeowners)	Section E
Identify Participation Barriers / Motivations, Best Practices	Assess contractor practices in installation and post-installation customer education	Sections D and G
Promote Partnerships, Market Learning and Expanded Service Offerings	Identify contractors' suggested improvements to the program's SOW design, research needed to scale this program, or other services that should be provided to developers to reduce costs	Section H

The Cadmus team is conducting in-depth interviews with heat pump contractors to gather market insights and inform market barriers and best practices. The sample for in-depth interviews will be derived using a nested sample approach. These interviews follow respondent completion of a heat pump contractor survey and designed to probe specific topics to uncover deeper and more nuanced insights.

Target Quota: These interviews are requested in follow up to the contractor survey (target n=34), and while Cadmus will aim to achieve at least 10 interviews, the target is dependent on number of heat pump contractor survey completes.

Cadmus will attempt to collect at least 10 interviews from an anticipated small sample size (34 survey completes, so a response rate of just under 30% response rate to get 10 responses for these interviews). We can attempt to reach the soft targets listed here but will not screen/terminate interviews based on these quotas. Soft targets for contractors who performed the following work as part of the study are as follows; it is likely that some respondents will fit into multiple categories (such as HPWHs and mini-splits):

- Technology Type
    - 2 GSHP contractors
    - 6 ASHP contractors
    - 2 HPWH contractors
- **Contractor Company Size:** The contractor survey will collect information on the number of people employed by the contractors' companies. Based on the survey

responses, Cadmus will determine the employee count threshold for the following categories

- Small company
- Large company

Sample Source: Heat Pump Demonstration Study Tracking Data and NYSERDA Contractor survey respondents

A. Email Invitation

To: [EMAIL]

From: [CADMUS STAFF NAME]

Subject: Help NYSERDA improve heat pump programs

Dear [FIRSTNAME AND LASTNAME],

Thank you for your recent participation in a survey about your experience with the New York State Energy Research and Development Authority's (NYSERDA) Single Family Heat Pump Demonstration Pilot, which was delivered through the EmPower and Assisted Home Performance programs. We would like to schedule a follow-up interview with you to assess participation barriers, heat pump installation practices, and your suggestions to improve the demonstration pilot. Your input is very important to us and will be kept confidential and only used for research purposes. **The interview will take 25-30 minutes to complete**. **As thanks for completing the interview, we will send you a $100 Amazon gift card.**

Interviews will be conducted [INSERT DATE] through [INSERT DATE]. I am available at the times and dates shown below to conduct the interview with you. Please let me know if any of those times work for you; if not, I can send over additional times.

[INSERT TIMES AND DATES]

If you have any questions about the legitimacy of this research, contact Jeremy Simpson, NYSERDA Project Manager by emailing Jeremy.Simpson@nyserda.ny.gov.

Thank you in advance for sharing your experiences and your time.

[CADMUS STAFF NAME]

B. Reminder Invitation

To: [EMAIL]

From: [CADMUS STAFF NAME]

Subject: Don't forget to help NYSERDA with your feedback!

Dear [FIRSTNAME AND LASTNAME],

We are still hoping you'll share deeper insights into your experience as a heat pump installer for NYSERDA's Single Family Heat Pump Demonstration Pilot, which was delivered through the EmPower and Assisted Home Performance programs. Your input is very important to us, will be kept confidential, and only used to help NYSERDA improve programs and support for contractors and customers across the state. **As thanks for completing the interview, we will send you a $100 Amazon gift card**.

Interviews will be conducted [INSERT DATE] through [INSERT DATE]. I am available at the times and dates shown below to conduct the interview with you. Please let me know if any of those times work for you; if not, I can send over additional times.

[INSERT TIMES AND DATES]

If you have any questions about the legitimacy of this research, contact Jeremy Simpson, NYSERDA Project Manager by emailing Jeremy.Simpson@nyserda.ny.gov. Thank you in advance for sharing your experiences and your time.

[CADMUS STAFF NAME]

C. Introduction

Hello, may I please speak with **[CONTACT NAME]**?

Hello, my name is **[INTERVIEWER NAME]**, calling on behalf of NYSERDA about your participation in its Single Family Heat Pump Demonstration Pilot. This is a follow-up call to discuss participation barriers and installation best practices. We are offering a $100 gift card to respondents who complete the interview, which should take around 30 minutes.

C1. Is this a good time for you to talk?

1. (Yes)
2. (No) [schedule callback]

98. (Don't know) [schedule callback]
99. (Refused) **[THANK AND TERMINATE]**

BACK-UP INFORMATION, NOT TO BE PROGRAMMED:

IF RESPONDENT SAYS IT IS NOT A CONVENIENT TIME, tell respondent that the interviews will be conducted from [INSERT DATE] through [INSERT DATE], ask if respondent would like to arrange a more convenient time for us to call them back or if you can leave a message for that person.

IF RESPONDENT IS NOT AVAILABLE, "We would like to call back when 'you are' or 'he or she is' available. What is the best time to call back?" "Is this the best phone number to reach you/he/she on when we try back?" **TRY TO GET SPECIFIC TIME AND DATE. IF REPSONDENT IS UNSURE, PROVIDE A POSSIBLE DATE AND WORK FROM THERE.**

[IF NEEDED]: This interview is for research purposes only and this is not a sales call. We value your feedback so that we can improve our program offerings and will keep all feedback anonymous to the greatest extent possible.

D. Screeners and Contractor Details

Thank you for agreeing to participate. Before we begin, I just want to confirm your experience in the heating/cooling (HVAC) industry to ensure you qualify.

D1. Which of the following types of heat pumps has your company installed as part of the NYSERDA's single family heat pump demonstration pilot? **[READ RESPONSES. SELECT ALL THAT APPLY.]**

1. Ground-source heat pumps
2. Air-source heat pumps
3. Ducted central systems
4. Single-zone ductless mini-split systems
5. Multi-zone ductless mini-split systems
6. Heat pump water heaters
7. None of the above **[THANK AND TERMINATE]**

Great – we will be focusing on these heat pump technologies today.

D2. Does your company also install the following residential, high efficiency equipment types… **[READ RESPONSES. SELECT ALL THAT APPLY.]**

1. Furnaces
2. Air conditioners
3. Tankless water heaters
4. Boilers
5. High efficiency tank water heaters

D3. Does your company also do the following type of work in residential homes:

1. Insulation
2. Air sealing
3. Home energy audits

E. Customer Acquisition

Let's start with your sales process and how it related to the NYSERDA demonstration pilot participation process.

E1. [ASK IF SUBCONTRACTOR = YES] Was your company involved in selling heat pump projects directly to the customers that were in the demonstration pilot, or were the projects already specified to include heat pumps?

1. (Yes, involved in direct customer sales)
2. (No, projects already specified heat pumps) **[SKIP THIS SECTION]**

E2. During the sales process, how did you promote NYSERDA's Single Family Heat Pump Demonstration Pilot to your customers? [PROBE ON THE FOLLOWING]

1. [IF HEAT SMART = YES] To what extent did you rely on the HeatSmart campaigns to obtain leads for the pilot?
2. [IF EMPOWER/AHP = YES] To what extent did you integrate the study promotion into your normal Assisted Home Performance or EmPower leads and conversations during the home audit?
3. [IF CLEAN HEAT CONTRACTOR = YES] To what extent did you promote the study during your normal course of business selling HVAC?

E3. What do you consider to be the top barriers to recommending **ground source heat pumps** to **low-to-moderate income customers** with a technically feasible site through this pilot? In other words, what would stop you from recommending a ground source

heat pump to low-to-moderate income customers through this pilot? **[PROBE: cost of equipment compared with customer's budget and available incentives, , condition of low-income homes (what specific conditions?), need to upgrade electric panel, need to upgrade electric service, need for distribution upgrades]**

1. How does this vary by Assisted Home Performance or EMPOWER customers?
2. How does this vary by geography (upstate vs. downstate, urban vs. rural)?

   To what extent do the need for distribution upgrades present a barrier to pilot participation?

E4. What do you consider to be the top barriers to recommending **ductless minisplits** to **low-to-moderate income customers** with a technically feasible site through this pilot? In other words, what would stop you from recommending **ductless minisplit heat pumps** to low-to-moderate customers through this pilot versus market rate customers? **[PROBE: cost of equipment compared with customer's budget and available incentives, , condition of low-income homes (what specific conditions?), need to upgrade electric panel, need to upgrade electric service, need for distribution upgrades]**

1. Single-zone ductless mini-split systems
2. Multi-zone ductless mini-split systems
3. How does this vary by Assisted Home Performance or EMPOWER customers?
4. How does this vary by geography (upstate vs. downstate, urban vs. rural)?

E5. What do you consider to be the top barriers to recommending **central ducted air source heat pumps** to **low-to-moderate income customers** with a technically feasible site through this pilot? In other words, what would stop you from recommending **central ducted air source heat pumps** to customers through this pilot versus market rate customers? **[PROBE: cost of equipment compared with customer's budget and available incentives, , condition of low-income homes (what specific conditions?), need to upgrade electric panel, need to upgrade electric service, need for distribution upgrades]**

1. Ducted central systems
2. How does this vary by income levels or geography?

E6. What do you consider to be the top barriers to recommending **heat pump water heaters** to **low-to-moderate income customers** with a technically feasible site through this pilot? In other words, what would stop you from recommending **heat pump water heaters** to customers through this pilot? What would prevent you from recommending heat pump water heaters compared to standard water heaters. **[PROBE: cost of equipment compared with customer's budget and available incentives, , condition**

of low-income homes (what specific conditions?), need to upgrade electric panel, need to upgrade electric service, need for distribution upgrades]

1. How does this vary by customer type, such as income levels or geography?

E7. What aspects of the pilot were **easy** to present to customers during initial sales discussions?

1. Did this vary by the following…
2. Heat pump system type (e.g. ASHP versus GSHPs or HPWHs)
3. Whether customers did or did not have existing cooling systems
4. Assisted Home Performance vs. EmPower homes?

E8. What aspects of the pilot were more **challenging** to convey to customers in that initial step?

1. Did this vary by the following…
2. Heat pump system type
3. Whether customers did or did not have existing cooling systems?
4. Assisted Home Performance vs. EmPower homes?

E9. How, if at all, did the **demonstration pilot** affect customer demand for:

1. [ASK IF D1=GSHP] Ground source heat pumps? **[INCREASED, DECREASED, STAYED THE SAME]**
2. [ASK IF D1=ASHP] Air source heat pumps? **[INCREASED, DECREASED, STAYED THE SAME]**
3. [ASK IF D1=HPWH] Heat pump water heaters? **[INCREASED, DECREASED, STAYED THE SAME]**

E10. [IF HEAT SMART CAMPAIGN=YES] From your experience, in what ways has the **HeatSmart campaign** affected customer demand for: **[MARK AS N/A IF RESPONDENT UNAWARE OF THE HEATSMART CAMPAIGN]**

1. [ASK IF D1=GSHP] Ground source heat pumps? **[INCREASED, DECREASED, STAYED THE SAME]**
2. Why do you say that?
3. [ASK IF D1=ASHP] Air source heat pumps? **[INCREASED, DECREASED, STAYED THE SAME]**

4. Why do you say that?

5. [ASK IF D1=HPWH] Heat pump water heaters? **[INCREASED, DECREASED, STAYED THE SAME]**

6. Why do you say that?

E11. Did you face any instances where recommended the following technologies through the pilot but did not receive approval from the program staff? What caused that to happen?

1. Ground source heat pumps
2. Ductless minisplits
3. Air source heat pumps
4. Heat pump water heaters
5. Electric panel upgrade
6. Distribution upgrade

F. Specification and Installation

Next, we'd like to talk a bit more about the system specification and installation process for your projects involved in the demonstration pilot.

F1. What challenges, if any, did you face when designing or installing the heat pump technologies for this pilot **that you don't typically experience in your normal business**?

1. Did this vary by whether the customer participated in Assisted Home Performance vs. EmPower?
2. Did this vary by whether the home needed an electric upgrade or a distribution upgrade?
3. Did this vary by heat pump technology? [PROBE: how were these challenges influenced by program processes, requirements, or customer type]
4. [ASK IF D1=1] Ground source heat pumps?
5. [ASK IF D1=2] Air source heat pumps? [PROBE: was the home set up for heating and cooling zones, difficulty setting up integrated controls, spotty or no-WIFI made it challenging to set up controls]
6. [ASK IF D1=2.1] Central, ducted air source heat pumps
7. [ASK IF D1=2.2] Single-zone ductless mini-split systems

8. [ASK IF D1=2.3] Multi-zone ductless mini-split systems

9. [ASK IF D1=3] Heat pump water heaters?

F2. [IF MINISPLITS=YES or GSHPs=YES] How did you set expectations for system distribution for the pilot? What impact does this have on sizing and equipment selection?

1. For ductless minisplits, how do you determine which rooms you install indoor units in?

2. For rooms without indoor units, do you typically install supplemental heat?

F3. [ASK IF D1= ASHP] For this pilot, did you install any heat pump systems that were partial replacements for the original heating system, or did you only install full replacements?

1. (Partial replacements only), (Some partial, some full replacements), or (Full replacement only)

2. Was this different from the types of heat pump projects you do outside the pilot? How so, why?

F4. [ASK IF F3=1 or 2] For pilot projects where you recommended that they keep their existing heat system as a backup, how often did you recommend that they use **integrated controls** for their heat pumps?

1. Would you say…Very often, Somewhat often, Not too often, or Not at all often?

2. Was this different from the types of projects you do outside the pilot? How so/why?

3. What types of integrated controls did you install for ducted ASHPs?

4. (Integrated controls (e.g. dual-fuel thermostats + sensors))

5. (Smartphone app)

6. (Handheld remote)

7. (Combination of above)

8. (Other)

9. What kind of integrated controls did you install for ductless minisplits?

10. (Integrated controls (e.g. dual-fuel thermostats + sensors))

11. (Smartphone app)

12. (Handheld remote)

13. (Combination of above)

14. (Other)

15. For projects without integrated controls, did you still install controls as part of the system?

16. What kind of controls did you install?

F5. [ASK IF D1= ASHP] For the pilot projects, Under what circumstances did you recommend removing the existing heating system?

1. How, if at all, do you consider/evaluate the condition of the building envelope when making a recommendation for existing heating system removal?

F6. [ASK IF D1= ASHP AND INTEGRATED CONTROLS=YES] For the pilot projects, did your approach to equipment sizing and selection and system design change depending on whether a customer is looking for a whole-home heating solution or primary heating with backup? If so, how?

1. Is this approach different than your non-pilot heat pump projects? If so, how?

G. Post Installation and Customer Education

Next, let's walk through your commissioning process and any callback issues you experienced with your single-family customers who participated in the NYSERDA Demonstration Pilot.

G1. When educating the pilot customers about how to use their heat pump system, what method or types of information did you find to be most successful?

1. Does this differ from the projects you installed outside the pilot?

2. Did you find that you needed to provide more, less, or the same amount of education to the pilot customers about their heat pump systems than those outside the pilot?

G2. [ASK IF D1=ASHP] We learned from other studies that small refrigerant leaks are common for heat pump installations and typically go undetected until the system stops performing.

1. Did any of the systems you installed through the NYSERDA demonstration pilot require you to address a refrigerant line leak?

2. What installation and QC processes do you follow for managing risk of refrigerant leakage? (Probe about topics including: lineset type, approach to connections between piping (e.g. flaring, brazing), pressure testing and evacuation of lines with nitrogen for at least an hour.)

G3. What installation or performance issues within your NYSERDA demonstration pilot projects did customers report, if any? *(Probe for issues related to distribution of heated/cooled air, and for differences among system types)*

G4. What, if anything, have you changed in your sales, design, installation, or customer education approach to avoid issues your pilot customers have experienced?

1. Are any of these changes specific to low-to-moderate income customers?

G5. Out of all the single-family projects you installed through the pilot, approximately what percent of the time did you need to return to the customer's home again?

1. For what types of reasons did you receive a callback?
2. How often are callbacks due to user error?
3. Is there a type of control, heat pump, or customer for which you are more likely to receive a callback to fix an issue?

H. Opportunities for Improvement

Finally, we have a few questions about how the demonstration pilot could be improved if it were to be launched into a fully operational program.

H1. What challenges that we have not discussed, if any, did you face participating in the pilot that you do not typically face in your other heat pump projects?

H2. How would you change the pilot to improve the experience for contractors? Specifically, the:

1. Pilot scope of work design process
2. [IF contractor is not the prime] Subcontracting process
3. Pilot application process [PROBE: if they respond "simplify the process", ask HOW it can be simplified or streamlined. We want specific details.]
4. Pilot application paperwork [PROBE: if they respond "simplify the application", ask HOW it can be simplified or streamlined. We want specific details.]
5. Pilot guidelines and/or requirements [PROBE: if they want less stringent guidelines, what specific guidelines do they want changed and to what?]
6. Incentive payment process
7. Any other topics?

H3. What changes would you suggest to NYSERDA if it decides to scale up this pilot to a full-scale program?

1. What is needed to scale up your air- or ground-source heat pump business through this program, so that you are generating at least twice as many projects?

2. What would it take to increase the number of heat pump water heaters you install?

F6. What other comments, feedback, or suggestions you'd like to share with us about the pilot?

I. Closing

Those are all our questions. Let's collect your contact information so we can send your $100 online Amazon gift card. We won't use this information for anything but gift card fulfillment. We will send you the gift card via email within two weeks of the interview. Please contact Josh Carey at Joshua.Carey@cadmusgroup.com if you have any issues with the card.

I1. What is the best email to send the gift card?

1. Name: **[RECORD NAME]**

2. Phone number: **[RECORD VERBATIM] [IF ASKED WHY, SAY: "SO WE CAN EASILY CONTACT YOU IF WE HAVE PROBLEMS SENDING YOUR GIFT CARD."]**

3. Email address: **[RECORD EMAIL ADDRESS]**

4. (Don't know)

5. (Refused)

This completes the interview. We appreciate your participation and thank you for your time. Have a good [evening/day].