DMSHP Integrated Controls Market Effects Indicator Baselines

(MA21X15-E-ICMEBASE)

FINAL REPORT

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SUBMITTED TO:
The Massachusetts Electric & Gas Program Administrators

SUBMITTED BY:
NMR Group, Inc.
DNV

DMSHP Integrated Controls Market Effects Indicator Baselines

Study Objectives

This study attempted to provide baseline measurements of indicators of market effects attributable to the PAs' efforts to develop and support the Massachusetts market for integrated controls for use with ductless mini-split heat pump (DMSHP) systems in conjunction with existing fossil-fuel-fired heating equipment. The indicators are meant to be used in a future study to quantify the market effects from the PAs' support for these controls.

Methodology

This study took advantage of the opportunity to add questions to interviews with market actors and a web survey of customers as part of the Energy Optimization Fuel Displacement Impact and Process Evaluation (MA20R24-B-EOEVAL). It was not expected to gather enough data to establish baselines for all the indicators, especially market sales and other data from busy market actors.

In-depth Interviews with 18 contractors who install DMSHPs and four distributors of DMSHPs and other HVAC equipment

Web Survey of Mass Save customers in single-family homes who received fuel displacement measure rebate(s) in 2019

Secondary Data Analysis and Indicator Measurement of 2019 and 2020 program tracking data, 2021 KPI data, 2019 HARDI DMHSP sales data

Key Findings

The study establishes baselines for two of the six market progress indicators it attempted to measure.

- "Partial displacement" participants (i.e., participating customers who installed a DMSHP system with an integrated control while keeping their existing heating system) who said that they used their DMSHP system for heating: 47%.
- Contractors who were "very confident" in the effectiveness and reliability of integrated controls: 25%.
- Contractors who were "not at all confident" in the effectiveness and reliability of integrated controls: 31%

These values suggest that the market is still immature. Uptake by the target market has been modest. The study also offers insights for program implementers.

Recommendation

1. Reword questions designed to measure two of the indicators.

Considerations

1. It would be prudent for the program to further explore the extent to which some customers have integrated controls installed without intending to use them and how best to turn around these customers' attitudes.
2. If the PAs move forward with a market effects indicator baseline study for residential heat pumps, consider using the opportunity to simultaneously collect baseline data for the remaining MPIs.
3. Since it is unknown whether more Massachusetts HARDI data will become available, it would be prudent for the PAs to undertake a more comprehensive effort to collect distributor sales data for residential heat pumps.

Table of Contents

EXECUTIVE SUMMARY **1**
GOAL 1
BACKGROUND 1
KEY FINDINGS, RECOMMENDATIONS, AND CONSIDERATIONS 3
INDICATOR-RELATED FINDINGS 3
MARKET SIZING 4
INSIGHTS FOR PROGRAM IMPLEMENTERS 4
FUTURE OPPORTUNITIES TO MEASURE INDICATORS 5
METHODOLOGY 5
LIMITATIONS 6
SECTION 1 INTRODUCTION **7**
1.1 GOAL 7
1.2 BACKGROUND 7
1.3 INDICATORS OF MARKET EFFECTS/MARKET PROGRESS AND STUDY SCOPE 8
SECTION 2 METHODS **10**
2.1 WEIGHTING 11
2.2 SAMPLE CHARACTERISTICS 11
2.2.1 Contractor Sample Characteristics 11
2.2.2 Distributor Sample Characteristics 12
2.2.3 Customer Sample Characteristics 12
SECTION 3 FINDINGS **13**
3.1 MARKET PROGRESS INDICATOR BASELINES 14
3.1.1 Market Progress Indicators Estimated 14
3.1.2 Market Progress Indicators Not Estimated 17
3.2 CUSTOMER USE OF INTEGRATED CONTROLS 21
3.2.1 In-service Rate 21
3.2.2 Heating System Management Methods 23
3.2.3 Reasons for Installing Integrated Control 24
3.3 MARKET SIZING UPDATE 24
SECTION 4 KEY FINDINGS, RECOMMENDATIONS AND CONSIDERATIONS **28**
4.1 INDICATOR-RELATED FINDINGS 28
4.2 MARKET SIZING 29

4.3 INSIGHTS FOR PROGRAM IMPLEMENTERS 29
4.4 FUTURE OPPORTUNITIES TO MEASURE INDICATORS 30
APPENDIX A PRIMARY DATA COLLECTION METHODS 33
4.4.1 Program Description 33
4.4.2 Contractor and Distributor Interviews 34
4.4.3 Contractor Interviews 34
4.4.4 Distributor Interviews 35
4.4.5 Customer Survey and Interviews 36
APPENDIX B PARTICIPANT SURVEY 38
B.1 INTERVIEW GUIDE 38
B.1.1 Introduction 38
B.1.2 Module B: Baseline Questions 38
B.1.3 Module D: Customer Experience and Interactions with Heating/Cooling Systems and Controls 39
APPENDIX C DISTRIBUTOR INTERVIEW GUIDE 42
C.1 INTERVIEW GUIDE 42
C.1.1 Introduction 42
C.1.2 Business Characteristics and Introduction 42
C.1.3 Heat Pump Systems Residential Market 43
C.1.4 Distributor's Experience with Integrated Controls 44
C.1.5 Conclusion 45
APPENDIX D CONTRACTOR INTERVIEW GUIDE 46
D.1 INTERVIEW GUIDE 46
D.1.1 Introduction 46
D.1.2 Contractor Recommendations/Sales Approach (PARTICIPANTS AND NONPARTICIPANTS) 48
D.1.3 Installation and Programming of Equipment (PARTICIPANTS AND NONPARTICIPANTS) 48

Figures

FIGURE 1: REGIONS SERVED BY CONTRACTORS (N=17, MULTIPLE RESPONSES) 11
FIGURE 2: CUSTOMER SURVEY SAMPLE DISPOSITION 12
FIGURE 3: REASON FOR NOT USING DMSHP FOR ALL OR MOST OF HEATING (N=59) 16
FIGURE 4: CONTRACTOR CONFIDENCE IN INTEGRATED CONTROLS (N=16) 16
FIGURE 5: CUSTOMER AWARENESS OF INTEGRATED CONTROLS (N=136) 22

FIGURE 6: CUSTOMER USE OF INTEGRATED CONTROLS BY PRIMARY HEAT SOURCE 23
FIGURE 7: ALTERNATIVE METHODS OF MANAGING HEATING SYSTEMS.....23
FIGURE 8: REASONS FOR INSTALLING AN INTEGRATED CONTROL (N=120, MULTIPLE RESPONSES).....24

Tables

TABLE 1: MARKET PROGRESS INDICATORS AND SOURCES..... 3
TABLE 2: INDICATORS OF MARKET EFFECTS/MARKET PROGRESS FROM THE MA19X09-B-INTCTRME STUDY..... 9
TABLE 3: MARKET PROGRESS INDICATORS AND SOURCES.....13
TABLE 4: ADDITIONAL TOPICS AND DATA SOURCES.....14
TABLE 5: MPI BASELINE VALUES.....14
TABLE 6: REASONS INDICATORS LACKED SUFFICIENT DATA TO ESTIMATE BASELINES.....17
TABLE 7: MPI 4 CONTRACTOR INTERVIEW QUESTIONS.....18
TABLE 8: MPI 5 DISTRIBUTOR INTERVIEW QUESTIONS 18
TABLE 9: MPI 6 CONTRACTOR AND DISTRIBUTOR INTERVIEW QUESTIONS.....19
TABLE 10: CONTRACTOR AND DISTRIBUTOR RECOMMENDATION OF INTEGRATED CONTROLS 21
TABLE 11: NUMBER OF PARTICIPANTS AND REBATED SYSTEMS, RESIDENTIAL DMSHP INTEGRATED CONTROLS, BY YEAR 25
TABLE 12: UPDATED 2019 ESTIMATED POTENTIAL MARKET SIZE AND ADOPTION BY THE TARGET MARKET AND MARKET SHARE, BASED ON ACTUAL REBATE DATA.....26
TABLE 13: 2020 ESTIMATED POTENTIAL MARKET SIZE AND ADOPTION BY THE TARGET MARKET AND MARKET SHARE, BASED ON ACTUAL REBATE DATA.....27

Acronyms

Acronym	Definition
ASHP	Air Source Heat Pump
CAC	Central Air Conditioning
DMSHP	Ductless Mini-Split Heat Pump
EO	Energy Optimization
HARDI	Heating Air Conditioning & Refrigeration Distributors International
HP	Heat Pump
HSPF	Heating Seasonal Performance Factor
HVAC	Heating, Ventilation, and Air Conditioning
KPI	Key Performance Indicator
MF	Multifamily
MPI	Market Progress Indicator
NTG	Net-to-Gross
PA	Program Administrator
PTLM	Program Theory and Logic Model
SEER	Seasonal Energy Efficiency Ratio
SF	Single-Family

ES

Executive Summary

This report presents final results from the *Ductless Mini-split Heat Pump Integrated Controls Market Effects Indicator Baselines* study (MA21X15-E-ICMEBASE). The Cross-Cutting Market Effects/Net-to-Gross (NTG) evaluation team, led by NMR Group, Inc. and supported on this study by DNV, prepared this report for the Massachusetts Program Administrators (PAs).[1] NMR and DNV are collectively referred to as "the NMR team" throughout this document.

GOAL

The goal of this evaluation was to establish baselines for indicators of market effects that could be attributed to the PAs' efforts to develop and support the Massachusetts market for integrated controls for use with ductless mini-split heat pump (DMSHP) systems in conjunction with existing fossil-fuel-fired heating equipment. Mass Save offers rebates on the integrated controls to customers who heat their homes with delivered fuels and have or install DMSHPs. The market effects indicator baselines are meant to be used as input for a future study to quantify the market effects from the PAs' support for integrated controls, specifically in homes heated by delivered fossil fuels, as outlined in the study *Evidence for Market Effects from Support for Ductless Mini-split Heat Pump Integrated Controls* (MA19X09-B-INTCTRME).[2]

BACKGROUND

To achieve the optimal use of DMSHPs with backup heating systems, it is necessary to understand the crossover temperature when a fossil-fuel heating system becomes the more cost-effective heating method, and to set both heating system thermostats differently relative to the crossover point. Given the distribution and range of systems, this process is confusing for customers who are also considering comfort. The PAs concluded that a product able to automatically switch between a DMSHP and a fossil-fuel-fired heating system depending on the temperature – an integrated control – could increase DMSHP heating use. Finding no integrated control product readily available on the market, in 2018 the PAs developed a specification for integrated controls[3] and reached out to manufacturers to encourage them to produce equipment to meet it. In 2019, the PAs began offering generous rebates for customers heating with delivered fuels who install DMSHPs with qualified integrated controls.

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[1] The PAs comprise Berkshire Gas, Cape Light Compact, Eversource, Eversource Gas of Massachusetts, Liberty Utilities, National Grid, and Until.

[2] NMR Group, Inc. and DNV, Inc. 2020. Evidence for Market Effects from Support for Ductless Mini-split Heat Pump Integrated Controls (MA19X09-B-INTCTRME). Report submitted to the Massachusetts Energy Efficiency Program Administrators, April 15. Accessed January 26, 2022 from https://ma-eeac.org/wp-content/uploads/MA-19X09-B-INTCTRME_Evidence-for-MEs-from-DMSHP-ICs-Report_Final_2020.4.15.pdf.

[3] The specification can be found in Appendix B of NMR Group, Inc. and DNV, Inc. 2020. Evidence for Market Effects from Support for Ductless Mini-split Heat Pump Integrated Controls (MA19X09-B-INTCTRME). Report submitted to the Massachusetts Energy Efficiency Program Administrators, April 15. Accessed January 26, 2022 from https://ma-eeac.org/wp-content/uploads/MA-19X09-B-INTCTRME_Evidence-for-MEs-from-DMSHP-ICs-Report_Final_2020.4.15.pdf.

In 2020, the study *Evidence for Market Effects from Support for Ductless Mini-split Heat Pump Integrated Controls* (MA19X09-B-INTCTRME) found the PAs to have been partly responsible for launching the Massachusetts market for DMSHP integrated controls and for accelerating the development of this market in the state and the Northeast. This laid the groundwork for PAs' quantifying and claiming savings from the market effects of Mass Save support for integrated controls for use with DMSHPs that displace fossil fuels. Market effects are "sustained increases in the adoption and penetration of technologies and practices resulting from market changes induced by market intervention" (i.e., contributing to launching the Massachusetts market for DMSHP integrated controls and providing program support for this infant market). Market effects indicators are metrics that can be measured to help determine if market effects are occurring as expected in the target market.[4]

The PAs have developed a logic model showing how they expect that the existence of integrated controls and PA support will result in short-term and long-term responses among market actors and market effects. The PAs also proposed eight "market progress indicators" (MPIs) with which to track the expected market effects (Table 1). The MA19X09-B-INTCTRME study added a ninth indicator and proposed data sources with which to measure indicators of market effects and a plan to quantify market effects in the future.[5] Because there was essentially no market for controls for this application before the PAs' specification, it was assumed that program-supported sales of integrated controls constituted the vast majority of market-level sales, and that market-level sales would be close to zero without the program. Many other indicators were expected to start at or close to zero too. Only the indicators associated with participating customers and with HVAC distributors and contractors installing program-supported equipment were likely to be greater than zero.

In early 2020, an opportunity arose to try to establish baselines for some of the indicators at minimal cost by adding questions to a planned process and impact evaluation gathering data from the same groups of market actors and customers that the MA19X09-B-INTCTRME study identified as sources for the integrated controls MPIs. As this study, *Energy Optimization Fuel Displacement Impact and Process* (MA20R24-B-EOEVAL),[6] had an ambitious scope, it was expected to not gather enough data to establish baselines for all the indicators, especially market sales and other data from busy market actors. The PAs added questions to the MA20R24-B-EOEVAL study data collection instruments to measure the six MPIs in **boldface** in Table 1. NMR wrote the questions with which to the MPIs were to be measured.

Note that the integrated controls in question meet the specification the PAs developed. The target market is Massachusetts homes heated with delivered fuels that could potentially use DMSHPs

[4] NMR Group, Inc. 2019. Action Plan for Measuring Market Effects. Submitted to the Electric and Gas Program Administrators of Massachusetts, February 15. Accessed from https://ma-eeac.org/wp-content/uploads/Action_Plan_Measuring_Market_Effects_FINAL_2019.02.15.pdf.

[5] In the process of determining how to measure the indicators, with the PAs' approval they were adjusted slightly from the indicator listing in the MA19X09-B-INTCTRME study. Specifically, the words "sold or" were added to indicator #4; the words "associated with DMSHP systems" were added to indicator #5; and indicator #9 was added.

[6] Guidehouse, Inc. 2021. Energy Optimization Fuel Displacement Impact and Process Study (MA20R24-B-EOEVAL). Submitted to the Electric and Gas Program Administrators of Massachusetts, October 13. Accessed from https://fileservice.eea.comacloud.net/FileService.Api/file/FileRoom/14155451.

for heating and benefit from an integrated control (i.e., existing single- and multifamily oil- and propane-heated homes of up to nine units per structure and without ducts).

Table 1: Market Progress Indicators and Sources

Boldface denotes the indicators meant to be measured via data collected as part of the MA20R24-B-EOEVAL study.

Market Progress Indicator (numbered per MA19X09-B-INTCTRME)	Data Source	Associated Outcome
1. Percentage of homes and small businesses with cold-climate DMSHPs	Saturation data + HARDI HVAC data	Customers with delivered fuel heating adopt heat pumps with integrated controls
2. Percentage of program participants using DMSHPs for heating	Customers	"
3. Percentage of homes and small businesses with DMSHPs that use their DMSPHs for most or all their heating homes Short Term, small businesses Long Term	Add-on question for saturation study participants	"
4. Percentage of DMSHPs sold or installed that have integrated controls (with and without program incentives)	**Contractors, saturation studies**	**Increased saturation of cold-climate heat pumps with integrated controls**
5. Change in sales of integrated controls associated with DMSHP systems (inside and outside the Mass Save program)	**Contractors, distributors, rebate data, HARDI HVAC data**	**Increased sales of integrated controls**
6. Percentage of distributors and HVAC contractors that promote integrated controls	**Contractors, distributors**	**Distributors and HVAC contractors promote integrated controls**
7. Price of integrated controls	**Distributors**	**None**
8. Number of manufacturers offering integrated controls	Distributors, manufacturer websites	Begin manufacturing and offering integrated controls
9. Contractor confidence in the effectiveness and reliability of integrated controls	Contractors	Lack of contractor confidence in integrated controls

KEY FINDINGS, RECOMMENDATIONS, AND CONSIDERATIONS

INDICATOR-RELATED FINDINGS

The study establishes baselines for two of the six market progress indicators it attempted to measure. The baseline values for these two indicators suggest that the market is still

immature and there is ample room for the market to mature. These MPIs and their baselines are:

> 2. Percentage of program participants using DMSHPs for heating, measured as the percentage of "partial displacement" participants (i.e. participating customers who installed a DMSHP system with an integrated control while keeping their existing heating system, and said that they used their DMSHP system for heating: 47% [n=119])
>
> 9. Contractor confidence in the effectiveness and reliability of integrated controls, measured as the percentage of contractors who said they were "very confident" versus "not at all confident" in the effectiveness and reliability of integrated controls: 25% Very Confident, 31% Not At All Confident (n=16)

The study did not estimate baseline values for three market progress indicators because of lack of responses. This was due primarily to the data collection situation and was in line with expectations.

The study did not estimate baseline values for one of the six market progress indicators (MPI 6) because of ineffective question wording.

Recommendation. Since an integrated control must be installed for customers to obtain a substantial rebate, redesign the question for MPI 6 or add a follow-up to assess the likelihood of a distributor or installer recommendation with no associated rebate.

MPI 2 is currently worded "Percentage of program participants using DMSHPs for heating," which does not precisely describe the true metric of interest: DMSHP partial displacement participants using DMSHPs for heating.

Recommendation. Re-word MPI 2.

Market Sizing

Uptake by the target market has been modest. From 2019 to 2020, the number of households in the estimated target market that adopted DMSHPs with integrated controls grew to 0.5% from 0.3%.

Insights for Program Implementers

Partial displacement customers who report heating primarily with DMSHPs are more likely to say they rely on the integrated control to automatically switch between heating systems.

About two-thirds (65%) of respondents who were aware that an integrated control was installed with their DMSHP system and said that the control was working also said they relied on them to automatically switch between the DMSHP and existing fuel-fired heating system. This somewhat low in-service rate is corroborated by the contractor interviews: around one-half (nine out of 17) of the contractors had heard from some of their customers that they did not intend to use the integrated controls but installed them for the rebate.

Consideration: It would be prudent for the program to further explore the extent to which some customers have integrated controls installed without intending to use them and how best to turn around the attitudes of some contractors and customers.

FUTURE OPPORTUNITIES TO MEASURE INDICATORS

There may be an upcoming opportunity to collect missing MPI baseline data from market actors. The PAs are developing the program theory and a logic model (PTLM) for Mass Save support for residential heat pumps. They have also proposed that, very soon, the Cross-cutting NTG/Market Effects evaluation team should develop indicators of market progress based on the expected outcomes in the logic model and undertake a study to measure baseline values for the indicators. This presents another opportunity to simultaneously collect baseline data for the remaining MPIs for DMSHP integrated controls, as long as it does not add to the response burden.

Consideration: If the PAs move forward with a market effects indicator baseline study for Mass Save support for residential heat pumps, consider using the opportunity to simultaneously collect baseline data for the remaining MPIs for DMSHP integrated controls while being mindful of the response burden.

The PAs have previously obtained meaningful sales data from *participating* distributors and contractors. With appropriate questioning, it should be possible to extrapolate data from participating market actors to the broader market.

Consideration: We do not yet know if HARDI data from 2020 and beyond will be available for use in a future study. Therefore, it would be prudent for the PAs to undertake a more comprehensive effort to collect distributor data for residential heat pumps, as appropriate, to meet the goals of measuring market effects from Mass Save support for DMSHPs and for integrated controls.

Section 4 presents an approach to gathering sales data from participating distributors and contractors and extrapolating it to the market.

METHODOLOGY

The results presented in this report are based on primary data collected by the Guidehouse MA20R24-B-EOEVAL team in spring 2021 and analyzed by NMR, and on secondary data analyzed by NMR. The Guidehouse MA20R24-B-EOEVAL data collection comprised:

- In-depth interviews with a total of 18 contractors who install DMSHPs from among 112 contractors contacted out of a sample frame of 540 (a 16% response rate). Seventeen of the 18 responding contractors were qualified as “participating”; that is, the Guidehouse study team matched them back to fuel optimization rebate recipients. All participating contractors answered the questions specific to this study.
- In-depth interviews with four distributors of DMSHPs and other HVAC equipment out of a sample frame of 120 unique distributor companies. The MA20R24-B-EOEVAL team called ten distributors, prioritizing HVAC distributors that had multiple store locations across the state, and completed four interviews, a 40% response rate.

- A web-based survey of Mass Save customers living in single-family homes who received fuel displacement measure rebate(s) in 2019. These rebates are for installing a central (ducted) heat pump or mini-split HPs (ducted or ductless) in a home that had an existing fossil fuel or electric resistance baseline heating system. The survey yielded responses from 328 2019 rebate recipients out of a sample frame of 1,452 eligible recipients (a 23% response rate). Each responding customer was categorized in one of two fuel displacement scenarios:
    - **Partial displacement.** The existing delivered fuel-fired system is left in place and either one or multiple HP systems are installed. An integrated control (or controls if more than one HP system) is installed to coordinate the operation of the delivered fuel-fired heating equipment and the HP system based on pre-defined outdoor air temperature ranges.
    - **Full displacement.** The customer removes or disconnects their existing fossil fuel or electric resistance baseline heating system and replaces all space heating loads with HPs, either for their whole home or for specific heating zones throughout their home. No integrated control is installed.
- NMR analyzed the following secondary data:
    - 2019 and 2020 program tracking data and 2021 Key Progress Indicator (KPI) data.
    - 2019 and Q1 2020 sales of DMHSP systems purchased from D+R International (i.e., Heating, Air-conditioning, & Refrigeration Distributors International [HARDI] sales data).

LIMITATIONS

Some limitations to this research include:

- Data were collected from HVAC distributors and contractors early in 2021, during the COVID pandemic and prior to widely available vaccines. This made securing and completing interviews with these groups more difficult than usual.
- The contractor results may be biased because all the contractors who answered questions meant to measure market effects had installed systems supported by fuel optimization rebates.
- With just four respondents, none of whom answered questions assessing the market for residential DMSHPs firms, the distributor results should be considered anecdotal.

Section 1 Introduction

This report presents final results from the *Ductless Mini-split Heat Pump Integrated Controls Market Effects Indicator Baselines* study (study # MA21X15-E-ICMEBASE). The Cross-Cutting Market Effects/Net-to-Gross evaluation team, led by NMR Group, Inc. and supported on this study by DNV, prepared this report for the Massachusetts Program Administrators (PAs).[7] (NMR and DNV are collectively referred to as "the NMR team" throughout this document.)

1.1 Goal

The goal of this evaluation was to establish baselines for indicators of market effects attributable to the PAs' efforts to develop and support the Massachusetts market for integrated controls for use with ductless mini-split heat pump (DMSHP) systems in conjunction with existing fossil-fuel-fired heating equipment. Mass Save offers rebate on the integrated controls to customers who heat their homes with delivered fuels and have or install DMSHPs. The market effects indicator baselines are meant to be used as input for a future study to quantify the market effects from the PAs' support for integrated controls for use with fossil-fuel-fired heating equipment, specifically in homes heated by delivered fuels, as outlined in the study *Evidence for Market Effects from Support for Ductless Mini-split Heat Pump Integrated Controls* (MA19X09-B-INTCTRME).[8]

1.2 Background

To achieve the optimal use of DMSHPs with backup heating systems, it is necessary to understand the crossover temperature when a fossil-fuel heating system becomes the more cost-effective heating method, and to set DMSHP and backup heating system thermostats differently depending on whether temperatures are above or below the crossover point. This process is confusing for customers given the distribution and range of systems, especially when they must also consider comfort. The PAs concluded that a product able to automatically switch between a DMSHP and a fossil-fuel-fired heating system depending on the temperature – an integrated control – could optimize and increase the use of DMSHPs for heating. Finding no integrated control product readily available, in 2018 the PAs developed a specification for integrated controls[9] and reached out to manufacturers to encourage them to produce equipment to meet it. In 2019, the PAs began offering generous rebates for customers heating with delivered fuels who

[7] The PAs comprise Berkshire Gas, Cape Light Compact, Eversource, Eversource Gas of Massachusetts, Liberty Utilities, National Grid, and Until.

[8] NMR Group, Inc. and DNV, Inc. 2020. Evidence for Market Effects from Support for Ductless Mini-split Heat Pump Integrated Controls (MA19X09-B-INTCTRME). Report submitted to the Massachusetts Energy Efficiency Program Administrators, April 15. Accessed January 26, 2022 from https://ma-eeac.org/wp-content/uploads/MA-19X09-B-INTCTRME_Evidence-for-MEs-from-DMSHP-ICs-Report_Final_2020.4.15.pdf.

[9] The specification can be found in Appendix B of NMR Group, Inc. and DNV, Inc. 2020. Evidence for Market Effects from Support for Ductless Mini-split Heat Pump Integrated Controls (MA19X09-B-INTCTRME). Report submitted to the Massachusetts Energy Efficiency Program Administrators, April 15. Accessed January 26, 2022 from https://ma-eeac.org/wp-content/uploads/MA-19X09-B-INTCTRME_Evidence-for-MEs-from-DMSHP-ICs-Report_Final_2020.4.15.pdf.

install DMSHPs with qualified integrated controls. Since PA support for heat pump integrated controls is considered neither a program nor an initiative, this report refers to such support as an intervention. This intervention is offered through the EO Fuel Displacement program, which helps customers install heat pumps to reduce reliance on energy- and CO2-intensive delivered fuels (fuel oil and propane) and electric resistance baseboard heating systems. Though integrated controls could be used with heating equipment fired by natural gas as well as delivered fuels – as the Massachusetts Joint State-Wide Electric and Gas Three-Year Energy Efficiency Program for 2022 – 2024[10] makes clear – the PAs are prioritizing customers for electrification who heat with oil, propane, or electric resistance.

In 2020, the study *Evidence for Market Effects from Support for Ductless Mini-split Heat Pump Integrated Controls* (MA19X09-B-INTCTRME) found the PAs partly responsible for launching the Massachusetts market for DMSHP integrated controls for use in homes heated primarily by delivered fuels and for accelerating its development in Massachusetts and the Northeast. This laid the groundwork for PAs' quantifying and claiming savings from the market effects of Mass Save support.

Market effects are "sustained increases in the adoption and penetration of technologies and practices resulting from market changes induced by market intervention" (i.e., contributing to launching the Massachusetts market for DMSHP integrated controls). Market effects indicators are metrics that can be measured to help determine if market effects are occurring as expected in the target market.[11]

1.3 Indicators of Market Effects/Market Progress and Study Scope

The PAs have developed a logic model showing how they expect integrated controls and PAs' support will result in short-term and long-term responses among market actors and the market effects. The PAs also proposed eight "market progress indicators" (MPIs) with which to track the expected market effects (Table 2). The MA19X09-B-INTCTRME study added a ninth indicator and proposed data sources with which to measure indicators of market effects and a plan to quantify market effects in the future .[12] Because there was essentially no market for controls for this application before the PAs' specification, it was assumed that program-supported sales constituted the vast majority of market-level sales, and that market-level sales would be close to zero without the program. Many other indicators were expected to start at or close to zero too. Only the indicators associated with participating customers and with HVAC distributors and contractors installing program-supported equipment were likely to be greater than zero.

In early 2020, an opportunity arose to try to establish baselines for some indicators at minimal cost by adding questions to a planned process and impact evaluation gathering data from the

[10] D.P.U. 21-120 – D.P.U. 21-129. Three-Year Plan 2022-2024. November 1, 2021. Exhibit 1. Accessed January 26, 2022 from https://ma-eeac.org/wp-content/uploads/Exhibit-1-Three-Year-Plan-2022-2024-11-1-21-w-App-1.pdf.
[11] NMR Group, Inc. 2019. Action Plan for Measuring Market Effects. Submitted to the Electric and Gas Program Administrators of Massachusetts, February 15. Accessed from https://ma-eeac.org/wp-content/uploads/Action_Plan_Measuring_Market_Effects_FINAL_2019.02.15.pdf.
[12] In the process of determining how to measure the indicators, with the PAs' approval they were adjusted slightly from the indicator listing in the MA19X09-B-INTCTRME study. Specifically, the words "sold or" were added to indicator #4; the words "associated with DMSHP systems" were added to indicator #5; and indicator #9 was added.

same groups of market actors and customers that the MA19X09-B-INTCTRME study identified as sources for the integrated controls MPIs. As this study, *Energy Optimization Fuel Displacement Impact and Process* (MA20R24-B-EOEVAL),[13] had an ambitious scope, it was not expected to gather enough data to establish baselines for all the indicators, especially market sales and other data from busy market actors. The PAs added questions to the MA20R24-B-EOEVAL study data collection instruments to measure the six MPIs in **boldface** in Table 2. NMR wrote the questions to measure the MPIs.

Table 2: Indicators of Market Effects/Market Progress from the MA19X09-B-INTCTRME Study

Market Progress Indicator (numbered per MA19X09-B-INTCTRME)
1. Percentage of homes and small businesses with cold-climate DMSHPs
2. Percentage of program participants using DMSHPs for heating
3. Percentage of homes and small businesses with DMSHPs that use their DMSPHs for most or all of their heating homes
4. Percentage of DMSHPs sold or installed that have integrated controls (with and without program incentives)
5. Change in sales of integrated controls associated with DMSHP systems (inside and outside the Mass Save program)
6. Percentage of distributors and HVAC contractors that promote integrated controls
7. Price of integrated controls
8. Number of manufacturers offering integrated controls
9. Contractor confidence in the effectiveness and reliability of integrated controls

[13] Guidehouse, Inc. 2021. Energy Optimization Fuel Displacement Impact and Process Study (MA20R24-B-EOEVAL). Submitted to the Electric and Gas Program Administrators of Massachusetts, October 13. Accessed from https://fileservice.eea.comacloud.net/FileService.Api/file/FileRoom/14155451.

Section 2 Methods

The results presented in this report are based on primary data collected by the Guidehouse MA20R24-B-EOEVAL team in spring 2021 and analyzed by NMR, and on secondary data analyzed by NMR.

The Guidehouse MA20R24-B-EOEVAL data collection comprised:

- In-depth interviews with a total of 18 contractors who install DMSHPs from among 112 contractors contacted out of a sample frame of 540 (a 16% response rate). Seventeen of the 18 responding contractors qualified as "participating"; that is, the Guidehouse study team matched them back to fuel optimization rebate recipients. All participating contractors answered the questions specific to this study.
- In-depth interviews with four distributors of DMSHPs and other HVAC equipment out of a sample frame of 120 unique distributor companies. The MA20R24-B-EOEVAL team called ten distributors, prioritizing HVAC distributors that had multiple store locations across the state, and completed four interviews, a 40% response rate.
- A web-based survey of Mass Save customers living in single-family homes who received fuel displacement measure rebate(s) in 2019. These rebates are for installing a central (ducted) heat pump or mini-split HPs (ducted or ductless) in a home that had an existing fossil fuel or electric resistance baseline heating system. The survey yielded responses from 328 rebate recipients out of a sample frame of 1,452 eligible recipients (a 23% response rate). Each responding customer was categorized in one of two fuel displacement scenarios:
    - **Partial displacement.** The existing delivered fuel-fired system is left in place and either one or multiple HP systems are installed. An integrated control (or controls if more than one HP system) is installed to coordinate the operation of the delivered fuel-fired heating equipment and the HP system based on pre-defined outdoor air temperature ranges.
    - **Full displacement.** The customer removes or disconnects their existing fossil fuel or electric resistance baseline heating system and replaces all space heating loads with HPs, either for their whole home or for specific heating zones throughout their home. No integrated control is installed.

Details of the MA20R24-B-EOEVAL study's sampling and data collection methods can be found the original study. They are also excerpted in Appendix A.

Note that while the MA20R24-B-EOEVAL study included customers who had installed central heat pumps, here NMR analyzed data only for customers who installed DMSHP systems.

NMR analyzed the following secondary data:

- 2019 and 2020 program tracking data and 2021 Key Progress Indicator (KPI) data.

- 2019 and Q1 2020 sales of DMHSP systems purchased from D+R International (i.e., Heating, Air-conditioning, & Refrigeration Distributors International [HARDI] sales data).

2.1 WEIGHTING

NMR originally meant to weight the answers to sales data and other quantitative questions collected from distributors and installers using the number of employees as a proxy[14] for relative share of the market. Since none of the few responding distributors provided quantitative data and since responding contractors provided enough quantitative data for just one question, the NMR team ultimately did not weight data for either group. The MA20R24-B-EOEVAL also did not weight the results of any of that study's questions of distributors or contractors. The customer survey data were not meant to be weighted.

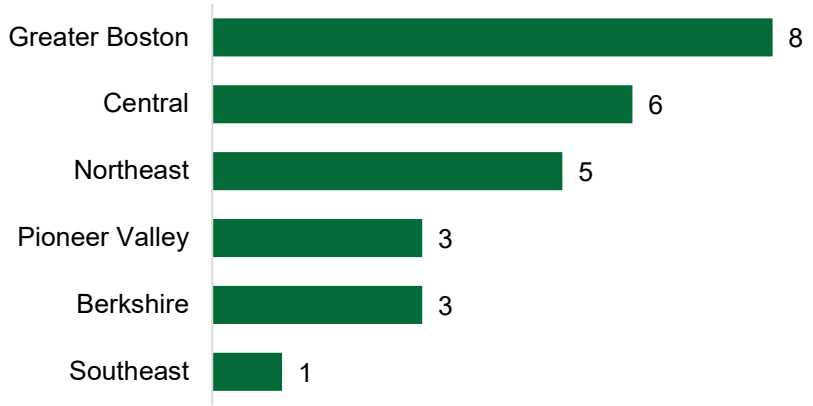
2.2 SAMPLE CHARACTERISTICS

The NMR team examined key characteristics of each sample.

2.2.1 Contractor Sample Characteristics

While the MA20R24-B-EOEVAL study interviewed a total of 18 contractors, the contractor questions for this study were asked of non-participating contractors only. The 17 participating contractors interviewed for this study worked for companies ranging in size from two to 200 employees, with an average of 32 employees. At the time the data was collected, all of the companies served one or more regions of Massachusetts, and three also served regions outside of Massachusetts. Figure 1 displays the number of contractors serving each region of Massachusetts.

Figure 1: Regions Served by Contractors (n=17, multiple responses)



[14]The proxy for distributors, the number of FTE employees that work at their locations in Massachusetts; for installers, the number of FTE employees at each company's locations that routinely install ductless mini-split heat pump systems in Massachusetts.

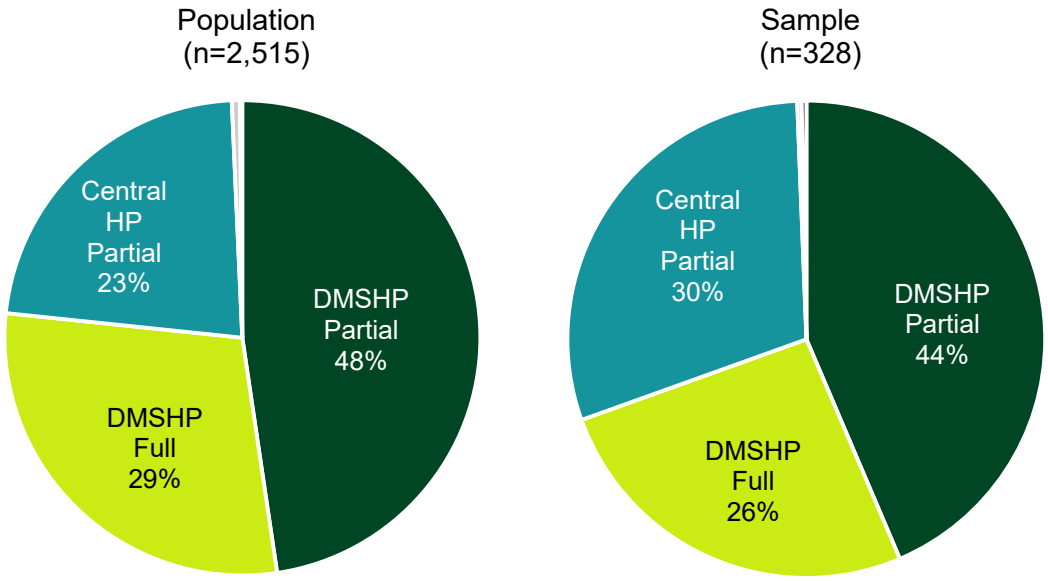
2.2.2 Distributor Sample Characteristics

At the time the distributor interviews were conducted, the four distributors interviewed for this study served all of New England, and one also served customers outside of New England. The distributors had between four and ten locations in Massachusetts, all of which sold DMSHP equipment. These companies ranged in size from 40 to over 200 employees.

2.2.3 Customer Sample Characteristics

Figure 2 displays the customer survey sample disposition. The population comprises 2019 recipients of fuel displacement measure offerings. The population and sample percentages in Figure 2 come from the number of unique customers and survey completes above in Table 2-7. Nearly one-half (48%) of 2019 fuel displacement rebate recipients installed DMSHPs with integrated controls (DMSHP partial displacement). Forty-four percent (143) survey respondents installed DMSHPs with integrated controls. Since the market effects indicators are meant to quantify the market effects from the PAs' support for DMSHP integrated controls, the questions NMR wrote for Guidehouse's customer survey were directed to this subset of 143 survey respondents.

Figure 2: Customer Survey Sample Disposition



*Integrated controls on existing DMSHP and Central HP partial displacement account for less than 1% of both population and sample.

Section 3 Findings

This study attempted to establish baselines for six of the nine market progress indicators identified in the *Evidence for Market Effects from Support for Ductless Mini-split Heat Pump Integrated Controls* study (MA19X09-B-INTCTRME). It also gathered information about participating customers' use of integrated controls and updated the estimate of 2019 market sizing presented in the MA19X09-B-INTCTRME study. This section describes how each MPI was meant to be measured, and presents the MPI baselines that could be measured through the data collected and additional information for use in program planning. Table 3 displays the MPIs and other topics this study investigated and data source(s) for each indicator or topic. The indicators **in boldface** are ones for which the MA20R24-B-EOEVAL study yielded sufficient data to successfully measure the baseline.

Table 3: Market Progress Indicators and Sources

Boldface denotes the MA20R24-B-EOEVAL study provided sufficient data to successfully measure the baseline

Market Progress Indicator (numbered per MA19X09-B-INTCTRME)	Data Source	Associated Outcome
1. Percentage of homes and small businesses with cold-climate DMSHPs	Saturation data + HARDI HVAC data	Customers with delivered fuel heating adopt heat pumps with integrated controls
2. Percentage of program participants using DMSHPs for heating	Customers	"
3. Percentage of homes and small businesses with DMSHPs that use their DMSPHs for most or all of their heating homes	Add-on question for saturation study participants	"
4. Percentage of DMSHPs sold or installed that have integrated controls (with and without program incentives)	Contractors, saturation studies	Increased saturation of cold-climate heat pumps with integrated controls
5. Change in sales of integrated controls associated with DMSHP systems (inside and outside the Mass Save program)	Contractors, distributors, rebate data, HARDI HVAC data	Increased sales of integrated controls
6. Percentage of distributors and HVAC contractors that promote integrated controls	Contractors, distributors	Distributors and HVAC contractors promote integrated controls
7. Price of integrated controls	Distributors	None

8. Number of manufacturers offering integrated controls	Distributors, manufacturer websites	Begin manufacturing and offering integrated controls
9. Contractor confidence in the effectiveness and reliability of integrated controls	Contractors	Lack of contractor confidence in integrated controls

This study also sought information on the following topics (Table 4). The topics **in boldface** are ones which were successfully measured with the MA20R24-B-EOEVAL study or other secondary data.

Table 4: Additional Topics and Data Sources

Other Topics	Data Source
Participating customer awareness, understanding, and use of integrated controls	**Customers**
In-service rate for rebated integrated controls	Contractors, **Customers**
Rate of adoption of DMSHPs with integrated controls by the target market	**Rebates + HARDI data**
Remaining number of MA homes in the target market	**Rebates + HARDI data**
MA share of all residential DMSHP systems that included integrated controls for use in homes heated primarily by delivered fuels	Rebates + HARDI data

3.1 Market Progress Indicator Baselines

Due to insufficient data, the NMR team could not establish baselines for four of the six MPIs we aspired to assess. As Table 3 shows, there was sufficient data to establish baselines only for MPIs 2 and 9. Below, we present the baseline values for these two MPIs and explain why baselines could not be established for the others.

3.1.1 Market Progress Indicators Estimated

Table 5 displays the MPI baseline value(s) or status for each indicator. Almost one-half (47%) of 2019 "partial displacement" participants (i.e., participating customers who installed a DMSHP system with an integrated control while keeping their existing heating system) said they used their DMSHP system for all or most of their heating needs. One-quarter (25%) of the contractors interviewed were very confident in the effectiveness and reliability of integrated controls.

Table 5: MPI Baseline Values

Market Progress Indicator	Baseline Value or Estimation Status
2. Percentage of program participants using DMSHPs for heating *Measured as percentage of "partial displacement" participants (i.e. participating customers who installed a DMSHP system with*	47% (n=119)

an integrated control while keeping their existing heating system, and said that they used their DMSHP system for heating)	
4. Percentage of DMSHPs sold or installed that have integrated controls (with and without program incentives)	Insufficient data to estimate
5. Change in sales of integrated controls associated with DMSHP systems (inside and outside the Mass Save program)	Insufficient data to estimate
6. Percentage of distributors and HVAC contractors that promote integrated controls	Question wording issue
7. Price of integrated controls	Insufficient data to estimate
9. Contractor confidence in the effectiveness and reliability of integrated controls *Measured as percentage of contractors who said they were "very confident" versus "not at all confident" in the effectiveness and reliability of integrated controls*	25% Very Confident, 31% Not At All Confident (n=16)

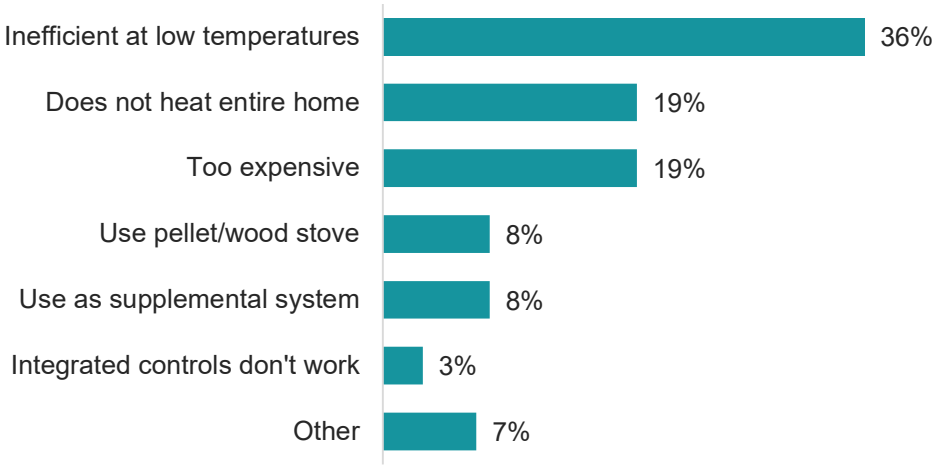
3.1.1.1 Indicator 2, Percentage of Program Participants Using DMSHPs for Heating

The MPIs are meant to quantify the market effects from the PAs' support for *integrated controls for use with DMSHP systems*, not for all types of heat pump controls. MPI 2 refers to the percentage of program participants using DMSHPs for heating. Thus NMR limited this MPI to partial displacement participants. We measured this indicator as the percentage of DMSHP partial displacement participants who (1) were aware they had an integrated control, (2) said the controls were still installed and working, and (3) said they used their DMSHP system for heating.[15] Of the 119 respondents who were aware of the integrated control and said it was installed and working, 47% reported using their DMSHP systems for all or most of their heating.[16]

The survey asked the remaining DMSHP partial displacement respondents why they did not use their DMSHP for all or most of their heating. As Figure 3 shows, the most commonly cited reason (mentioned by 36% of respondents) was that DMSHPs are inefficient at low temperatures. The next most commonly cited reasons were that the DMSHP system did not heat the entire home (19%) or was too expensive to run (19%), followed by respondents' primarily using a pellet or wood stove (8%) or using the DMSHP system as a supplemental heating system (8%). Only 3% of respondents who did not use their DMSHP system for all or most of their heating said it was because their integrated control did not work.

[15] See Customer Use of Integrated Controls for question phrasing and results.
[16] B13. [ASK IF B3 = 2 or 3] Do you use your new mini-split heat pump system for all (or most) of your heating needs?

Figure 3: Reason for Not Using DMSHP for All or Most of Heating (n=59)



B14. [ASK IF B13=2] What is the reason for not using your new heat pump for all (or most) of your heating needs?

3.1.1.2 Indicator 9, Contractor Confidence in the Effectiveness and Reliability of Integrated Controls

The NMR team measured this as the percentage of contractors who said they were "very confident" versus "not at all confident" in the effectiveness and reliability of integrated controls. Contractors offered their perspectives on the effectiveness and reliability of integrated controls in in-depth interviews. Figure 4 shows that just over two-fifths (44%) of the 16 contractors who shared their perspectives on the effectiveness and reliability of integrated controls were somewhat confident and one-quarter (25%) were very confident.[17] Nearly one-third (31%) of the contractors were not at all confident in the effectiveness and reliability of integrated controls.

From the perspective of the MPI, this result is perhaps to be expected given that integrated controls for use with DMSHPs are a new technology and the market is still nascent. From the perspective of the PA support for this fuel displacement measure, this result indicates a need to improve contractor confidence in the technology.

Figure 4: Contractor Confidence in Integrated Controls (n=16)

[17] One of the 17 contractors did not have enough experience with integrated controls to form an educated opinion on the effectiveness and reliability of these products.

5. How confident are you in the effectiveness of ductless mini-split heat pump integrated controls?

3.1.2 Market Progress Indicators Not Estimated

Table 6 displays the MPIs the NMR team was not able to estimate and why. Below, we discuss how we measured these MPIs and the related challenges.

Table 6: Reasons Indicators Lacked Sufficient Data to Estimate Baselines

Market Progress Indicator	Issue
4. Percentage of DMSHPs sold or installed that have integrated controls (with and without program incentives)	Just one contractor answered sales data questions
5. Change in sales of integrated controls associated with DMSHP systems (inside and outside the Mass Save program)	No distributors answered sales data questions
6. Percentage of distributors and HVAC contractors that promote integrated controls	Ineffective question wording
7. Price of integrated controls	Ran out of time for all but two respondents to answer

3.1.2.1 Indicator 4, Percentage of DMSHPs sold or installed that have integrated controls (with and without program incentives)

This indicator was meant to be measured with the sales data questions asked of distributors and contractors. Because of the already-high response burden for interviewees and that collecting sales data was not the primary focus on the study, the PAs and evaluation team hoped only to get responses to the sales data questions from a handful of market actors. The MA20R24-B-EOEVAL team emailed these questions to distributors and contractors prior to the interviews, requested the data during the interviews, and emailed up to two reminders after the interviews. None of the distributors and just one of the 17 contractors emailed responses back. With just one respondent we cannot generalize from the data and cannot report the data here due to confidentiality concerns. The remaining 16 indicated they did not track these data, did not have permission to share it, or found it too burdensome to gather.

Table 7: MPI 4 Contractor Interview Questions

Question	Ductless Mini-Split Heat Pump
a) How many heat pumps did you and your company install in homes in Massachusetts in 2019, by system type? (your best estimate is ok)	n=
b) Of total 2019 installs, what % included integrated controls?	%
c) Of total 2019 installs, about what % received a rebate through the Mass Save Fuel Optimization offerings (a rebate of $1,250/ton)?	%
d) What % of heat pumps with integrated controls were cold climate heat pumps? (i.e. for DMSHPs, a SEER of at least 18 and HSPF of at least 10; for central HPs, a SEER of at least 16 and HSPF of at least 9.5 with a capacity ratio of 67%)	%
e) Of the cold climate heat pumps with integrated controls, about what % received a rebate through Mass Save?	%

3.1.2.2 Indicator 5, Change in sales of integrated controls associated with DMSHP systems (inside and outside the Mass Save program)

The NMR team attempted to measure this MPI with the distributor interview questions in Table 8. Under the circumstances the PAs and evaluation team had similarly low expectations for obtaining answers to sales data questions from distributors. The MA20R24-B-EOEVAL team emailed these questions to distributors prior to the interviews and requested the data during the interviews, but obtained none. Two of the four distributors interviewed said they did not track this type of information, while the other two said they did not have permission to share it.

Table 8: MPI 5 Distributor Interview Questions

Question	Ductless Mini-Split Heat Pump
a) Roughly what percent of the total Massachusetts market for residential heat pump systems would you say your company's sales represented in 2019 (by heat pump type)?	%
b) Thinking about the heat pump systems your company sold in 2019 that were intended for use in Massachusetts, about what percent of these were cold-climate systems? (For DMSHPs: SEER of at least 18 and HSPF of at least 10.	%
c) Thinking about all the heat pump systems your company sold in 2019 that were intended for use in Massachusetts, not just cold-climate systems, what percent of these did you sell with integrated controls?	%
d) what percent of the cold-climate heat pump systems did you sell with integrated controls?	%
e) Thinking just about your locations that routinely sell heat pump systems intended for use in Massachusetts: In 2019,	N=

about how many residential heat pump systems were sold for use in Massachusetts?	
f) Thinking about just your locations that routinely sell heat pump systems that are installed in Massachusetts, did these locations stock or sell integrated controls for use with heat pumps in 2019?	Yes or No

3.1.2.3 Indicator 6, Percentage of distributors and HVAC contractors that promote integrated controls

The NMR team attempted to measure this indicator with the contractor and distributor interview questions in Table 9.

Table 9: MPI 6 Contractor and Distributor Interview Questions

Contractors	Distributors
	3. When talking with contractors about heating retrofits with ductless mini-split heat pumps, would you say that you recommend integrated controls…
5. How often do you recommend integrated controls for ductless mini-split heat pump systems? a. Would you say all the time, about 75% of the time, about 50% of the time, about 25% of the time, or never?	1. All of the time 2. About 75% of the time 3. About 50% of the time 4. About 25% of the time 5. Less than 25% of the time 6. Never

As the results of these questions (

Table 10) show, while most distributors (three of four) and more than half of contractors (11 of 17) said they always recommended integrated controls, these respondents also all volunteered information making it clear that the customer would "always" be eligible for the integrated controls rebate because integrated controls are required to obtain the $1,250-per-ton fuel optimization rebate.

MPI 6 was intended to assess the percentage of distributors and contractors promoting integrated controls on their own merit. In retrospect, we should have designed the question to consider the program requirement through re-wording or by adding a follow-on question to assess the likelihood of market actors recommending an integrated control to a customer if there were no rebate associated with it. As the question wording did not consider the substantial incentive associated with integrated controls, the results should not be used as a baseline.

Table 10: Contractor and Distributor Recommendation of Integrated Controls

How Often Recommend Integrated Controls	Contractors (n=17)	Distributors (n=4)
100% as long as customer is eligible for integrated control rebate	11	3
0%	3	1
It depends[18]	2	0
Don't know	1	0

3.1.2.4 Indicator 7, Price of integrated controls

The NMR team attempted to measure this indicator by asking distributors how the prices of integrated controls for DMSHPs had changed since their company first began to offer them. This was a lower priority question and if interviews ran long, the interviewers omitted it. As a result, it was asked of only two respondents, neither of whom offered a usable answer.

3.2 Customer Use of Integrated Controls

Here, we provide additional information about customers' self-reported use of integrated controls to supplement the findings presented in the *Energy Optimization Fuel Displacement Impact and Process* study (MA20R24-B-EOEVAL).

3.2.1 In-service Rate

The NMR team drafted customer survey questions to assess if DMSHP partial displacement customers were aware they had integrated controls, if the controls were still installed and working, and if customers relied on them to switch between their two heating systems. Figure 5 combines respondents based on their answers to these questions. Of the 136 DMSHP partial displacement customers, 88% were aware an integrated control was installed with their system, and just over two-thirds (71% or 97 customers) said their integrated control was still installed and working.[19]

Of the 97 customers who were aware an integrated control was installed and working with their system, 65% said they relied on the integrated control to coordinate their fossil fuel and DMSHP heating systems. [20] This somewhat low in-service rate is corroborated by the contractor interviews: around one-half (nine out of 17) of the contractors had heard from some of their customers that they did not intend to use the integrated controls but installed them because they wanted the rebate.

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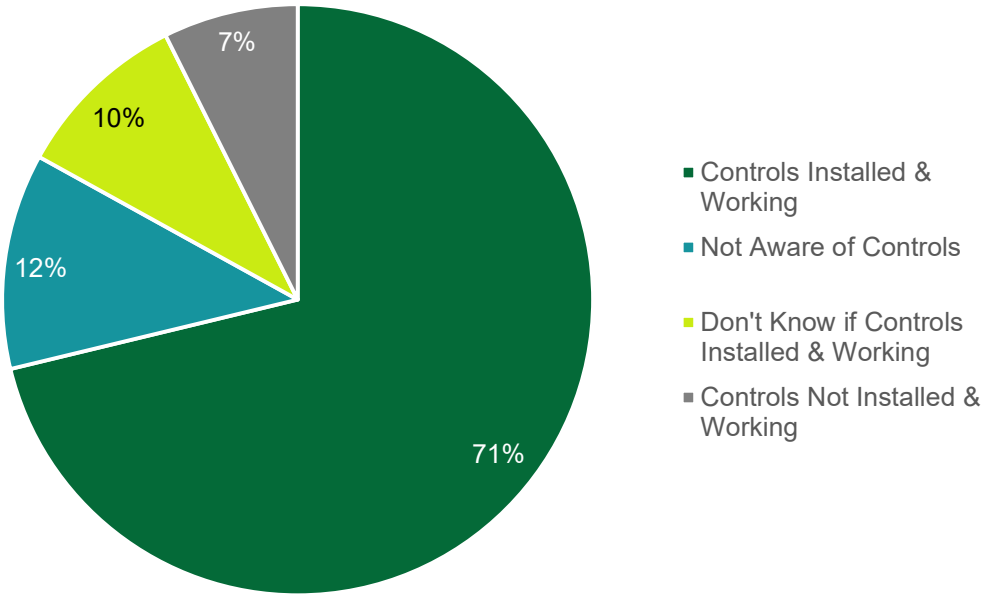
[18] Respondent provided qualitative, not quantitative response, such as "all except for non-tech savvy customers" or "as long as it's the right situation."

[19] Ten respondents said their integrated controls were not installed and working. One-half (five) did not know why the integrated controls were not working, two said it was because of internet connectivity issues, and two said it was because it was too difficult to set them up.

[20] Percentages differ from those reported in Energy Optimization Fuel Displacement Impact and Process Study (MA20R24-B-EOEVAL) due to the use of different bases. In this report we excluded respondents who were not aware of having integrated controls from the base of: (1) percentage reporting that their integrated controls were installed and working and (2) percentage reporting that they rely on integrated controls to automatically switch between heating systems.

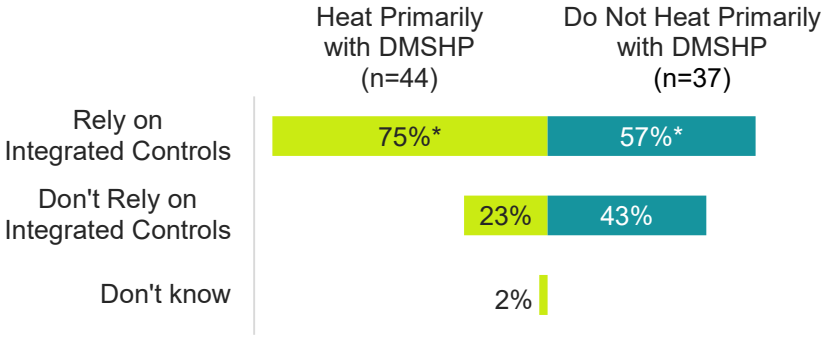
Figure 5: Customer Awareness of Integrated Controls (n=136)



D1. According to our records, an integrated control was installed to manage your heat pump system. The control is designed to automatically switch between your heat pump system and your fuel-fired heating system when the outdoor temperature drops below a certain point. Are you aware that your system has this control?
D3. Is the integrated control still installed and working?
D6. [ASK IF D3=1] When you are heating with your heat pump system, do you rely on the integrated control to automatically switch between the heat pump and your other fuel-fired heating system?

DMSHP partial displacement customers who said they heated primarily with DMSHPs were more likely than customers who did not to report relying on their integrated control to automatically switch between the DMSHP and existing fuel-fired heating systems. Figure 6 looks at DMSHP partial displacement customers who were aware that an integrated control was part of their system and confirmed the integrated control was installed and working. Three-quarters (75%) of these customers who heated primarily with DMSHPs and had working integrated controls said they relied on the control to automatically switch between heating systems, compared to only 57% of customers who did not heat primarily with DMSHPs.

Figure 6: Customer Use of Integrated Controls by Primary Heat Source

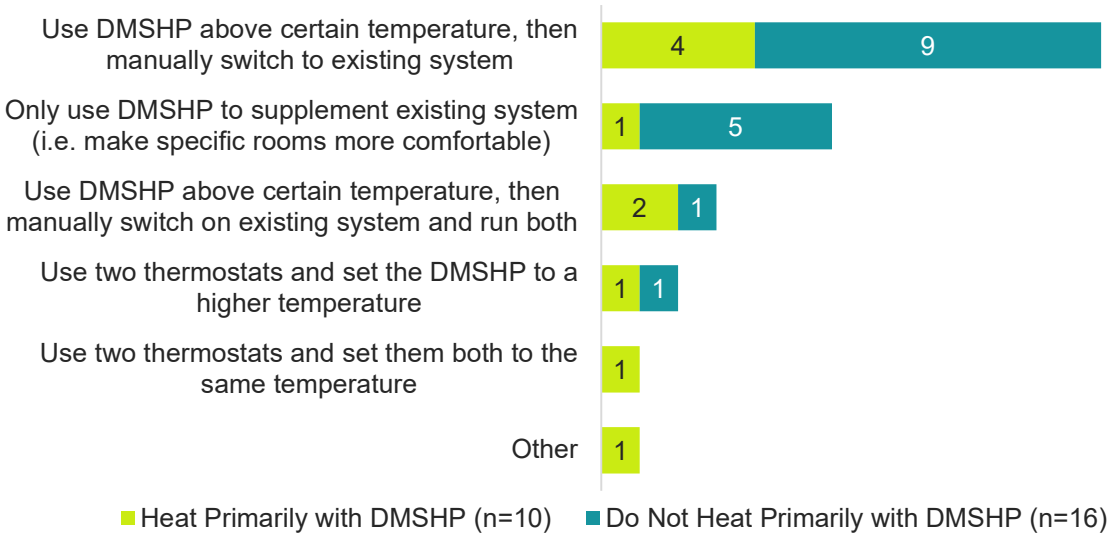


B13. [ASK IF B3 = 2 or 3] Do you use your new mini-split heat pump system for all (or most) of your heating needs?
D6. [ASK IF D3=1] When you are heating with your heat pump system, do you rely on the integrated control to automatically switch between the heat pump and your other fuel-fired heating system?
* Difference is significant at 90% confidence.

3.2.2 Heating System Management Methods

Figure 7 displays the ways in which DMSHP partial displacement customers who did not rely on their integrated controls managed their two heating systems. The most common method was to use the DMSHP until it gets to be a certain temperature outside, then manually switch it off and switch on the existing fuel-fired system. Four respondents who heated primarily with their DMSHP system and nine respondents who heated primarily with their existing system said they used this method.

Figure 7: Alternative Methods of Managing Heating Systems

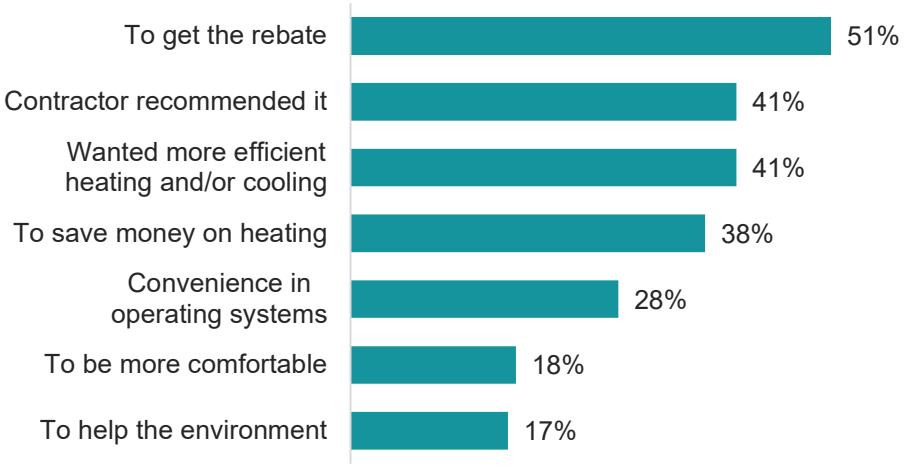


D7. [ASK IF D6=2 or D3=2] What do you do instead to manage your heat pump and fuel-fired heating systems?

3.2.3 Reasons for Installing Integrated Control

The survey asked DMSHP partial displacement customers who were aware they had an integrated control why they chose to install the control. Figure 8 displays customers' reasons for installing an integrated control. The most cited reason was to get the rebate, mentioned by around one-half (51%) of respondents. Additionally, around two-fifths of respondents installed an integrated control because of a contractor recommendation (41%), to have more efficient heating and/or cooling (41%), or to save money on heating (38%).

Figure 8: Reasons for Installing an Integrated Control (n=120, multiple responses)



D4. Why did you choose to install an integrated control? (Select all that apply)

Two-thirds of customers (66%) with an integrated control said their contractor gave them instructions about how to operate the control. This guidance may have included a demonstration or tutorial on how the phone application works, a walk-through on how to change the settings if needed, or telling the customer that the control is automatic and they don't need to do much.[21]

> The contractor "explained how it worked, how I would know if it was working, and to pretty much let it do its own thing."

3.3 Market Sizing Update

The 19X09-B-INTCTRME study produced rough estimates of the rate of adoption of DMSHPs with integrated controls by the target market, the remaining number of Massachusetts homes in the target market, and the Massachusetts share of all residential DMSHP systems with integrated controls for use in homes heated primarily by delivered fuels. These estimates were preliminary because they were based on the PAs' 2019 key performance indicator (KPI) data rather than on

[21] Guidehouse, Inc. 2021. https://ma-eeac.org/wp-content/uploads/MA20R24-B-EOEval_Fuel-Displacement-Report_2021-10-13_Final.pdf. Report submitted to the Electric and Gas Program Administrators of Massachusetts, October 13.

program tracking data cleaned and finalized by DNV. The NMR team updated these estimates by replacing the KPI data with final 2019 program tracking data from DNV. The NMR team also estimated the potential market size for 2020 using 2020 program tracking data and the results of the draft Massachusetts residential baseline study. The team was not able to calculate a 2020 DMSHP integrated controls delivered fuels market share because HARDI data more recent than Q1 2020 are not currently available.

Table 11 shows the number of households that installed residential DMSHPs with integrated controls and the number of DMSHP systems with integrated controls in 2019 and 2020 based on the program tracking data. As the table indicates, the number of rebated DMSHP systems with integrated controls for use in homes heated primarily by delivered fuels increased by 70% (from 1,767 to 3,002).

Table 11: Number of Participants and Rebated Systems, Residential DMSHP Integrated Controls, by Year

	2019	2020
Number of **participating households** that installed at least one DMSHP system with an integrated control	1,429	2,308
Number of residential DMSHP **systems** installed with an integrated control	1,767	3,002

As with the 19X09-B-INTCTRME study, we used U.S. Census data[22] and Massachusetts Residential Baseline Studies[23, 24] to develop rough annual estimates of the target market: Massachusetts households in housing units[25,26] heated with delivered fuels that could potentially use DMSHPs for heating and benefit from an integrated control (i.e., existing single- and multifamily oil- and propane-heated homes of up to nine units per structure, without ducts). As neither the proportion of homes with ducts nor the number of homes heated by delivered fuels is reported in the Massachusetts Residential Baseline Studies referenced, the team used as a proxy the proportion of homes heated with a boiler powered by a fuel other than natural gas.

Table 12 shows the updated 2019 estimates of the potential target market; the rate of adoption of DMSHPs with integrated controls by the target market in 2019 (assuming all such systems were supported by the program); the remaining number of Massachusetts homes in the target market at the beginning of 2020; and the share of all residential DMSHP systems sold in 2019 by Massachusetts distributors with integrated controls for use in homes heated primarily by delivered fuels. Table 13 shows these estimates for 2020, excluding the market share estimate for 2020, since 2020 HARDI sales data are not currently available. As the tables show, from 2019 to 2020:

[22] Specifically, ACS 5-year data profiles for 2019.
[23] Guidehouse. 2020. *Massachusetts Residential Baseline Study*. Report prepared for the Electric and Gas Program Administrators of Massachusetts. March 31, 2020. Accessed February 2, 2022 from https://ma-eeac.org/wp-content/uploads/RES-1-Residential-Baseline-Study-Ph4-Comprehensive-Report-2020-04-02.pdf.
[24] Draft Residential Saturation Study dated November 19, 2021.
[25] Includes single-family and multifamily one- to nine-unit homes.
[26] As it is not possible to identify high-rise buildings from the ACS data, the team used homes of ten or more units as a proxy for high-rise buildings and excluded them from the estimate since they are very unlikely to be heated primarily with delivered fuels.

- The number of target homes dropped by 5% (from roughly 460,000 to roughly 437,000). This is primarily due to the most recent baseline study finding a lower saturation of homes heated with oil-fired boilers than in 2018, which at the time of the 19X09-B-INTCTRME study was the most recent period for which baseline results were available.
- The number of households that installed one or more rebated DMSHP systems with integrated controls increased by 62% (from 1,429 to 2,308).
- In 2020, roughly 0.5% of target market households adopted DMSHPs with integrated controls, up from 0.3% in 2019.

Table 12: Updated 2019 Estimated Potential Market Size and Adoption by the Target Market and Market Share, Based on Actual Rebate Data

MA SF & MF Housing Units (SF/MF up to nine/structure)	Percent of All Housing Units[1]	Number of Units [2]
A. All housing units	100%	2,420,000
B. All housing units heated with oil-fired or "other fuel" boiler (potential target market for 2019)	19%[3]	460,000
Final Estimate of 2019 Adoption & Market Share		
C. Count of 2019 rebates for DMSHPs with integrated controls for use in homes heated primarily by delivered fuels, **by DMSHP system**		1,767
D. Count of 2019 rebates for DMSHPs with integrated controls for use in homes heated primarily by delivered fuels, **by household**		1,429 [4]
E. Remaining potential target market size as of January 2020 (B-D, rounded)		459,000 [5]
F. 2019 rate of target market's adoption of DMSHPs with integrated controls (D/B)		0.3%
G. 2019 DMSHP integrated controls delivered fuels market share (C/2019 MA DMSHP sales from HARDI data)		19.7%

[1] Source: Guidehouse. 2020. *Massachusetts Residential Baseline Study*. Report prepared for the Electric and Gas Program Administrators of Massachusetts. March 31, 2020. Information is for 2019, calculated from Figure 3-8.
[2] Source: U.S. Census, ACS five-year data profiles for 2019. Rounded to nearest thousand. Includes occupied and vacant homes in one to nine unit buildings; excludes mobile homes. Accessed February 3, 2022 from: https://data.census.gov/cedsci/table?q=United%20States&t=Heating%20and%20Air%20Conditioning%20%28HVAC%29%3APhysical%20Characteristics%3AUnits%20and%20Stories%20in%20Structure&g=0400000US25&y=2019&tid=ACSDP5Y2019.DP04
[3] The value reported here in the 19X09-B-INTCTRME study was much lower (14%). This is because (a) it erroneously excluded the 20% of units heated with boilers fired with "other" fuels and (b) it was based on 2018 saturation data, as 2019 data were not yet available.
[4] By household based on final 2019 program rebate data. Excludes rebates for integrated controls installed as retrofits to DMSHPs already in use.
[5] Rounded to nearest thousand.

Table 13: 2020 Estimated Potential Market Size and Adoption by the Target Market and Market Share, Based on Actual Rebate Data

MA SF & MF Housing Units (up to nine/structure)	Percent of All Housing Units[1]	Number of Units [2]
A. All housing units	100%	2,427,000
B. All housing units heated with oil-fired or "other fuel" boiler	18%	437,000
Estimate of 2020 Adoption & Market Share		
C. Count of 2020 rebates for DMSHPs with integrated controls for use in homes heated primarily by delivered fuels, **by DMSHP system**		3,002 [3]
D. Count of 2020 rebates for DMSHPs with integrated controls for use in homes heated primarily by delivered fuels, **by household**		2,308 [3]
E. Potential remaining target market size as of January 2021 (B-D, rounded)		435,000 [4]
F. 2020 rate of target market's adoption of DMSHPs with integrated controls (D/B)		0.5%
G. 2020 DMSHP integrated controls delivered fuels market share		unavailable

[1] Source: Draft Residential Saturation Study dated November 19, 2021. Information is calculated from Figure 3-10.
[2] Source: U.S. Census, ACS five-year data profiles for 2019. (More recent data were not available at the time of this study.) Rounded to nearest thousand. Includes occupied and vacant homes in one to nine unit buildings; excludes mobile homes. Accessed February 3, 2022 from: https://data.census.gov/cedsci/table?q=United%20States&t=Heating%20and%20Air%20Conditioning%20%28HVAC%29%3APhysical%20Characteristics%3AUnits%20and%20Stories%20in%20Structure&g=0400000US25&y=2019&tid=ACSDP5Y2019.DP04
[3] Based on final 2020 program tracking data. Excludes rebates for integrated controls installed as retrofits to DMSHPs already in use.
[4] Rounded to nearest thousand.

Section 4 Key Findings, Recommendations and Considerations

4.1 Indicator-Related Findings

The study establishes baselines for two of the six market progress indicators it attempted to measure. The baseline values for these two indicators suggest that the market is still immature. These MPIs and their baselines are:

> 2. Percentage of "partial displacement" participants (i.e. participating customers who installed a DMSHP system with an integrated control while keeping their existing heating system) who said that they used their DMSHP system for heating: 47% [n=119])
>
> 9. Contractor confidence in the effectiveness and reliability of integrated controls, measured as the percentage of contractors who said they were "very confident" versus "not at all confident" in the effectiveness and reliability of integrated controls: 25% Very Confident, 31% Not at All Confident (n=16)

As these values are well below 100%, there is ample room for growth in these indicators.

The study did not estimate baseline values for three market progress indicators because of lack of responses. This was due primarily to the data collection situation and was in line with expectations.

The study did not estimate baseline values for one of the six market progress indicators (MPI 6) because of ineffective question wording.

> **Recommendation:** Since an integrated control must be installed for customers to obtain a substantial rebate, redesign the question for MPI 6 or add a follow-up to assess the likelihood of a distributor or installer recommendation with no associated rebate. For example,
>
> - "If integrated controls were not a program requirement, how often would you promote them?" or,
> - "How often do you promote integrated controls to your customers with natural gas?"[27]

MPI 2 is currently worded "Percentage of program participants using DMSHPs for heating," which does not precisely describe the true metric of interest: DMSHP partial displacement participants using DMSHPs for heating.

> **Recommendation:** Redesign MPI 2:

[27] Customers who heat with natural gas are not eligible for the EO Fuel Displacement rebates.

2. Percentage of program participants who installed DMSHPs with integrated controls using DMSHPs for heating

4.2 Market Sizing

Uptake by the target market has been modest. From 2019 to 2020:

- The number of homes in the target market for fuel displacement with DMSHPs with an integrated control dropped by 5%, primarily due to the publication of a recent baseline study finding drop in the saturation of homes heated with oil-fired boilers.
- The number of households that installed one or more rebated DMSHP systems with an integrated control increased by 62% (from 1,429 to 2,308).
- The number of households in the estimated target market that adopted DMSHPs with integrated controls grew to 0.5% from 0.3%.

4.3 Insights for Program Implementers

There is opportunity for the PAs to work on improving contractor confidence in the effectiveness and reliability of integrated controls. Just 25% of contractors said they were "very confident" in the effectiveness and reliability of integrated controls, while 31% said they were "not at all confident." The PAs may want to examine and consider what program improvements might help in building the confidence of the remaining 44% of contractors.

Partial displacement customers who report heating primarily with DMSHPs are more likely to say they rely on the integrated control to automatically switch between heating systems. Three-quarters (75%) of the customers who reported heating primarily with their DMSHP system and had working integrated controls said they relied on the control to automatically switch between heating systems, compared to only 57% of customers who did not heat primarily with their DMSHP system.

The somewhat low in-service rate (65%) and contractor anecdotes suggest that a proportion of customers may have had integrated controls installed without intending to use them. In Section 3.2, we noted that about two-thirds (65%) of respondents who were aware that an integrated control was installed with their DMSHP system and said that the control was working said they relied on the controls to automatically switch between the DMSHP and existing fuel-fired heating system. Around one-half (nine out of 17) of the contractors said they had heard from some of their customers that they did not intend to use the integrated controls but installed them because they wanted the rebate. While slightly over half (51%) of customers who had integrated controls installed with their DMSHP system said they installed the control to get the rebate, they were not asked whether they had intended to use the control in the first place.

> **Consideration**: It would be prudent for the program to further explore the extent to which some customers have integrated controls installed without intending to use them and how best to turn around these customers' attitudes.

4.4 Future Opportunities to Measure Indicators

There may be a better opportunity to collect missing MPI baseline data from market actors. The PAs are developing the program theory and a logic model (PTLM) for Mass Save support for residential heat pumps. They have proposed that, very soon, the Cross-cutting NTG/Market Effects evaluation team should develop indicators of market progress based on expected logic model outcomes and undertake a study to measure baseline values for the indicators. This presents another opportunity to simultaneously collect baseline data for the remaining MPIs for DMSHP integrated controls, as long as it does not add too much to the response burden.

> **Consideration:** If the PAs move forward with a market effects indicator baseline study for Mass Save support for residential heat pumps, consider using the opportunity to simultaneously collect baseline data for the remaining MPIs for DMSHP integrated controls while being mindful of the response burden.

The PAs have previously obtained meaningful sales data from *participating* distributors and contractors. With appropriate questioning, it should be possible to extrapolate data from participating market actors to the broader market. Despite the difficulties the MA20R24-B-EOEVAL team had collecting sales data, we know that it is possible to get meaningful sales data from *participating* distributors and contractors. More favorable circumstances would include a shorter, more narrowly focused data collection instrument; recruiting help from program implementation staff; the opportunity to also respond via web; a very substantial incentive; and a business climate not so disrupted by a pandemic. For example, as part of the Residential HVAC Efficient Market Share Estimates (TXC52) study, in 2018, NMR successfully gathered unit sales data from ten participating distributors (out of a sample frame of 34) for selected commonly installed residential HVAC equipment and information about the relative efficiency level of the systems sold. In 2019, NMR compared these data to data purchased from HARDI and estimated that the TXC52 respondents' sales covered approximately 63% of the central air conditioner (CAC) market in Massachusetts, 59% of the central ASHP market, 26% of the mini-split ASHP market, 10% of the gas furnace market, and 9% of the gas boiler market. These figures were relatively comparable to the coverage of HARDI data for the same period.

> Consideration: The most recent Massachusetts HARDI data available are for Q1 2020. We do not yet know if more Massachusetts data will become available in future. Therefore, it would be prudent for the PAs to undertake a more comprehensive effort to collect distributor data for residential heat pumps, as appropriate, to meet the goals of measuring market effects from Mass Save support for DMSHPs with integrated controls.

Approach to gathering sales data from participating distributors and contractors and extrapolating it to the market. The data could be gathered from participating distributors and contractors, triangulated, and used to extrapolate the total size of the market. Using sales data only from participating market actors is not ideal, as this would not represent the total market, but we know from the TXC52 study that it is possible to obtain data when it is a study's primary goal and the burden is not too great. Gathering data from these groups should provide enough information to update the sales-related indicators and eventually quantify market effects even if more recent data do not become available from HARDI. This would entail the following:

- To maximize the likelihood of success, prime key distributor contacts well in advance via outreach by program staff, with a particular focus on larger distributors.
- For a limited number of equipment types and efficiency levels, ask participating distributors to estimate sales for the year of interest, using the same approach as in 2018. For each type of equipment, this should yield:
    - An estimate of the share of the Massachusetts market represented by the sales of distributors who responded.
    - The mean and total number of units (systems) sold across all distributors.
    - For each capacity, the average percentage of units that distributors sold that met a specific efficiency level, and the total percent of all sold units that met a specific efficiency level.
    - The percentage of units sold at or above the efficiency threshold that received Mass Save rebates.
    - For distributors who provide partial data, we would extrapolate from other distributors' responses to account for the missing data.
- For the year of interest, with a sample of participating contractors for whom the PAs have rebate data, confirm their rebate counts for the systems of interest, and then ask:
    - the share of the total installations of units of selected equipment types that they installed in the year of interest *without* program incentives.
    - from which distributors they obtained the units (offering a picklist of distributors).
    - the percent of units they obtained from each distributor.

To maximize the likelihood of obtaining the data, the evaluators could use a recruiting approach similar to that of the TXC52 study, which gathered information from distributors via a short web survey, as follows:

1. The program implementers provided the sample frame, which consisted of key HVAC distributors located across Massachusetts.
2. The implementation team kicked off the recruiting. Implementation team staff members made two or three phone calls or emails per contact.
3. After the implementers made the initial introductions, NMR took over recruiting. NMR reached out to each distributor contact at least ten times (at least five emails and five phone calls with a voicemail or personal conversation), or until contacts either completed the survey or clearly qualified as refusals.
4. NMR offered distributor contacts an incentive of $250 to participate. Given the importance of obtaining these data from distributors, and that there would be more than just sales data questions, the PAs may want to consider offering distributors a much larger incentive for participation—e.g. $1,000.

The evaluators could take a similar approach with participating contractors, adjusting the recruiting strategy to account for frequent travel and reducing the incentive to reflect the relatively lower value of contractor data compared to distributor data.

Appendix A Primary Data Collection Methods

The content of this appendix is excerpted verbatim from the *Energy Optimization Fuel Displacement Impact and Process Study* (MA20R24-B-EOEVAL). [28] The numbering of sections and table match those in the MA20R24-B-EOEVAL study.

4.4.1 Program Description

The EO Fuel Displacement measure offerings serve customers of single-family homes through deemed measure savings and incentives. All multifamily fuel displacement projects are currently screened through the custom program. The program helps install HPs to provide space heating more efficiently to their homes, provide an improved cooling amenity, and to reduce reliance on energy and CO2-intensive fuel oil, propane, and electric resistance baseboard heating systems.

Two displacement scenarios are possible through the EO Fuel Displacement measure offerings:

- **Full displacement.** The customer removes or disconnects their existing fossil fuel or electric resistance baseline heating system and replaces all space heating loads with HPs, either for their whole home or for specific heating zones throughout their home.
- **Partial displacement.** The existing delivered fuel-fired system is left in place and either one or multiple HPs are installed. The customer installs an integrated controller, which controls the delivered fuel-fired heating equipment and HP operation to occur during pre-defined outdoor air temperature ranges. The program encourages customers to program an integrated control switchover temperature between 30°F and 40°F as a starting point. Contractors will work with the customer, identify the unique heating and cooling needs of their home, and suggest and program a switchover control setting. The delivered fuel-fired heating systems are prioritized at lower outdoor air temperatures when the HP efficiency is lowest, when the HP cannot meet the full heating loads of the home (e.g., when the heat pump is recovering from a thermostat setback in the morning), or through additional interventions by the customer to meet comfort or other needs. All partial displacement projects included in this evaluation include an integrated control installation.

Both central HPs (ducted) and mini-split HPs (ducted or ductless) are eligible through the program. For the single-family segment in 2019, single-family installations spanned central and mini-split HPs installations with delivered fuel-fired and electric resistance heating baselines. In 2019, all installations within the multifamily segment were full displacements of existing-electric resistance heat with mini-split HPs (impacts determined through custom measure pathway).

The integrated control installation is required to access the energy optimization measure rebates for partial displacement scenarios. In addition, the program provides rebates for standalone

[28] Guidehouse, Inc. 2021. Energy Optimization Fuel Displacement Impact and Process Study (MA20R24-B-EOEVAL). Submitted to the Electric and Gas Program Administrators of Massachusetts, October 13. Accessed from https://fileservice.eea.comacloud.net/FileService.Api/file/FileRoom/14155451.

integrated controllers that are installed at homes with existing delivered fuel-fired furnaces or boilers and ducted central HPs or mini-split HP systems.

In 2019, the PAs offered an incentive of $1,600 per installed ton of HP capacity for customers that displaced delivered fuel-fired heating and installed a mini-split HP. An incentive of $1,000 per ton was offered for customers displacing electric resistance heat with a mini-split HP, or delivered fuel-fired heat with a central HP. For customers that installed an integrated control on an existing HP system with delivered fuel-fired backup heat, PAs offered $500 per heating zone, up to a $1,500 maximum incentive. In the 2020 and 2021 program years, the PAs offered $1,250 per ton for installed central HPs or mini-split HPs partially or fully displacing delivered fuel-fired or electric resistance heat. The same rebate is offered to customers who install an integrated control on existing HP and delivered fuel-fired heating systems ($500 per heating zone, up to $1,500 max incentive per customer).

4.4.2 Contractor and Distributor Interviews

The following sections describe the methodological approaches for completing the contractor and distributor interviews.

4.4.3 Contractor Interviews

The evaluation team interviewed a total of 18 contractors (17 participating, one nonparticipating) over the phone to learn more about the following research areas:

- How contractors discussed HPs and integrated controls with their customers
- The installation process for HPs and integrated controls
- The program participation process for the contractor and customer
- Barriers contractors faced with the fuel displacement technologies

The contractor sample was derived from the Energy Federation Incorporated (EFI) raw dataset for all 2019 downstream rebate programs. The EFI dataset contained a total of 2,605 accounts associated with the fuel optimization offerings. The team was able to match 2,101 accounts in the EFI dataset back to the original EO fuel displacement tracking dataset. Of these 2,101 records, approximately one-third of them did not contain phone numbers and no records contained email addresses or key contact names.

After cleaning the data for duplicate contractor records, a list of 540 unique participating contractors remained, as Table 2-4 outlines.

Table 2-4. Participating Contractor Sample: Data Cleaning Steps

Data Cleaning step	Number of Contractors
EFI raw dataset (original dataset)	2,605
Matched to participant tracking data	2,101
Unique contractor entries (final sample)	540

Source: Evaluation Team Analysis

Participating multifamily contractors. The contractor sample contained five contractors that were associated with installing a multifamily project in 2019. All five of these contractors were contacted for an interview, but either did not respond to the team's outreach attempts or refused to participate.

Nonparticipating contractors. The team defined nonparticipating contractors as contractors who were listed as a qualified MeasureQuick contractor but did not complete a fuel optimization project in 2019. The cleaned participating contractor list was compared against the list of MeasureQuick contractors, leaving a sample of 19 nonparticipating contractors. These contractors likely participated in other program offerings but had not yet participated in the fuel displacement rebate offerings. The evaluation team only achieved one nonparticipating contractor interview due to the small sample size and hard-to-reach nature of this group.

To confirm the perspectives of those contractors who installed the most projects were represented, the team's sample approach prioritized interviews with high volume participating contractors, while also allowing for broad representation of contractors that install different system types and project volume levels. Table 2-5 shows how the 2019 contractor population varies by volume of accounts served and details the number of interviews the team completed within each group.

Table 2-5. Contractor Groups and Completed Interviews

Group	Volume of 2019 Accounts*	Number of Contractors	Number of Accounts Served	Percent of Total Accounts	Completed Interviews
1	40 or more	5	357	17%	3
2	10 to 39	10	765	36%	7
3	2 to 9	53	701	33%	3
4	1	298	298	14%	3
5	0	19	0	0%	1
	Total Contractors	**559**	**2,121**	**100%**	**18**

*Proxy for number of projects completed (or homes served) in 2019
Source: Evaluation Team Analysis

An incentive of $200 was offered to contractors who agreed to participate in an interview. The team contacted 112 contractors and completed 18 interviews, achieving a 16% response rate. The contractors interviewed work primarily in single-family residential homes. Although almost all contractors (n=17) interviewed noted working in multifamily buildings, they said that this was a small portion of their overall work. Five contractors noted they also worked on small commercial buildings, and none served affordable housing.

4.4.4 Distributor Interviews

The evaluation team completed four phone interviews with HVAC distributors serving the MA residential market. These interviews explored market trends for HP systems and integrated controls, how distributors support contractors in the selling and installation of fuel displacement technologies, and potential market barriers.

The team obtained a program-provided list of distributor store locations, including 529 individual contacts with 120 unique distributors. The list did not include key contact names or emails addresses, and about half of the records had no phone number listed.

Table 2-6. HVAC Distributor Sample

Data Cleaning Step	Number of Records
ICF raw dataset: Number of contacts	529
Unique distributor companies	120

Source: Evaluation Team Analysis

The evaluation team prioritized interviews with HVAC distributors that had multiple store locations across the state to ensure broader market representation. The team called ten distributors and completed four interviews, achieving a 40% response rate. All four distributors interviewed stated that they primarily served the residential sector, with some small commercial work.

4.4.5 Customer Survey and Interviews

4.4.5.1 Single-Family Customer Survey

The evaluation team surveyed 328 customers who participated in the 2019 EO Fuel Displacement measure offerings. The team administered the survey online using Qualtrics software, and included questions to explore the following areas:

- Customer awareness and motivations.
- Previous heating and cooling equipment installed, what other equipment they considered aside from the program-eligible HP, and what equipment types they would have installed if they did not install the HP they did (informs baseline weightings applied in gross impact analysis)
- Interactions with the equipment and integrated controls
- Experience with the program and their contractor

Net-to-gross and market effects questions were also included in the customer survey to inform other ongoing MA studies.

The evaluation team used PA-provided program tracking data to identify a sample for the participant survey. First, the team tagged each customer with a survey variable name which allowed the team to ask separate questions and modules for customers that installed either a central HP or mini-split HP, either as full displacement or as partial displacement with an integrated controller. Table 2-7 shows the number of customers in the EO fuel displacement dataset for each measure category, the number of customers tagged as do not contact in the utility program data, the number of available customers to field the survey, the number of customers with email addresses, and the number of customers who completed the survey. Each of the 1,452 available customers had a mailing address and 1,029 of those customers also had an email address. The team sent up to two postcard invitations and reminders to all customers,

and up to three email invitations and reminders to customers with a valid email address. A $20 incentive was also offered to respondents.

Table 2-7. Customer Survey Sample Disposition

Survey Measure Type	Number of Unique Customers	Do Not Contact Count	Survey Sample Remaining	Has Email	Survey Started	Survey Complete
Central HP (full displacement, delivered fuel baseline)	4	-	4	4	1	1
Central HP with integrated controls (partial displacement, delivered fuel baseline)	569	224	345	293	101	98
Mini-split HP displacing electric heat	729	297	432	275	91	85
Mini-split HP with integrated controls (partial displacement, delivered fuel baseline)	1,199	537	662	452	147	143
Integrated controls installation on existing mini-split HP	14	5	9	5	1	1
Total	**2,515**	**1,063**	**1,452**	**1,029**	**341**	**328**

Source: Evaluation Team Analysis

The team achieved 328 completed survey responses and a 23% response rate for the customer survey.

Appendix B Participant Survey

Below we list the customer survey questions discussed in Section 3. The full customer survey can be found in Appendix B of the *Energy Optimization Fuel Displacement Impact and Process* (MA20R24-B-EOEVAL).[29]

B.1 Interview Guide

B.1.1 Introduction

Thank you for taking this survey for the Mass Save Heating and Cooling rebate program. Your feedback will help Mass Save understand your experience and make improvements in the future.

There are no right or wrong answers; we want your honest feedback. This survey will take about 20 minutes of your time. To thank you for your feedback, you will receive a $20 e-gift card after you have completed the survey, redeemable at numerous retailers or for charitable donation through Rewards Genius and Tango Card.

To start, please enter your customer PIN number. This is the number printed on the postcard you received in the mail (as shown in the image below) or in the body of the email you may have received.

B.1.2 Module B: Baseline Questions

B12. How does this heating system function today? (Select only one response)

1. The heating system functions as a back-up or supplemental system to the new heat pump

2. The heating system and the new heat pump run together at all times

3. The system runs as the primary heating system. The new heat pump is used as a supplemental heating system only when needed.

4. The system runs as the primary heating system. The new heat pump is only used for cooling.

5. The system is used in the coldest winter months, and the heat pump is used in more mild weather in the spring and fall.

97. Other, please specify [TEXT BOX]

98. Don't Know

[ASK IF B3 = 2 or 3]

[29] Guidehouse, Inc. 2021. Energy Optimization Fuel Displacement Impact and Process (MA20R24-B-EOEVAL). Accessed from https://ma-eeac.org/wp-content/uploads/MA20R24-B-EOEval_Fuel-Displacement-Report_2021-10-13_Final.pdf. Report submitted to the Electric and Gas Program Administrators of Massachusetts, October 13.

B13. Do you use your new mini-split heat pump system for all (or most) of your heating needs? [SINGLE RESPONSE]

1. Yes

2. No

98. Don't know

[ASK IF EQUIPMENT = MINI SPLIT HEAT PUMP, AND B13=1]

B13a. Using a scale of 1-5, with 1 meaning "not at all agree" and 5 meaning "strongly agree", how much do you agree with the following statement? "Even on the coldest winter days, my heat pump is able to keep up and provide the heat needed for my home."

[ASK IF B13a <= 3]

B13b. Why did you rate it this way? Please provide details or examples of a time when your heat pump could not keep up. [OPEN END]

[ASK IF B13=2)

B14. What is the reason for not using your new heat pump for all (or most) of your heating needs? [Open-ended text].

[ASK IF B3 = 1 or 3]

B18. Do you use your new heat pump system for all (or most) of your cooling needs? [SINGLE RESPONSE]

1. Yes

2. No

98. Don't know

[ASK IF B18=2)

B19. What is the reason for not using your new heat pump for all (or most) of your cooling needs? [Open-ended text].

B.1.3 Module D: Customer Experience and Interactions with Heating/Cooling Systems and Controls

[ASK IF EQUIPMENT= MINI-SPLIT HEAT PUMP WITH INTEGRATED CONTROLS, CENTRAL HEAT PUMP WITH INTEGRATED CONTROLS, OR INTEGRATED CONTROLS INSTALLATION ON EXISTING MINI-SPLIT HEAT PUMP]

For the following questions we want to learn more about your experience with the integrated controls that were installed to manage your heat pump.

D1. According to our records, an integrated control was installed to manage your heat pump system. The control is designed to automatically switch between your heat pump system and your fuel-fired heating system when the outdoor temperature drops below a certain point. Are you aware that your system has this control?

1. Yes

2. No (CONTINUE TO E1)

98. Don't know

[ASK IF EQUIPMENT= MINI_SPLIT w/INTEGRATED CONTROLS, CENTRAL HEAT PUMP w/ INTEGRATED CONTROLS, OR INTEGRATED CONTROLS ONLY]

D3. Is the integrated control still installed and working?

1. Yes

2. No

98. Don't know

[ASK IF D3=2]

D5. Why is the integrated control not installed/working? [Open-ended text]

[ASK IF D3=1]

D6. When you are heating with your heat pump system, do you rely on the integrated control to automatically switch between the heat pump and your other fuel-fired heating system?

1. Yes

2. No

98. I don't know

[ASK IF D6=2 or D3=2]

D7. What do you do instead to manage your heat pump and fuel-fired heating systems?

[SINGLE RESPONSE]

1. I use my heat pump until it gets to be a certain temperature OUTSIDE, below which I switch to the existing fuel-fired system manually and turn off the heat pump

2. I use my heat pump until it gets to be a certain temperature OUTSIDE, below which I also turn on the existing fuel-fired system manually, keeping the heat pump on as well

3. I use two thermostats to control the existing fuel-fired system and heat pump systems and set them both to the same temperature

4. I use two thermostats to control the existing fuel-fired system and heat pump system, and set the heat pump to a higher temperature

5. I use two thermostats to control the existing fuel-fired system and heat pump system, and set the fuel-fired system to a higher temperature

6. I only use my heat pump to supplement the existing fuel-fired system (i.e. to make specific rooms more comfortable)

7. I use my heat pump for cooling only

8. I only use the heat pump to heat my home and do not use the fuel-fired heating system

97. Other, please specify [TEXT BOX]

D10. Did the contractor that installed the new heat pump explain how to operate the integrated control?

1. Yes

2. No

99. Don't know

[ASK IF D10=1]

D11. What instructions did the contractor give you about how to use the integrated control? [Open-ended text]

Appendix C Distributor Interview Guide

Below we list the distributor interview questions discussed in Section 3. The full distributor interview guide can be found in Appendix E of the *Energy Optimization Fuel Displacement Impact and Process* (MA20R24-B-EOEVAL).[30]

C.1 Interview Guide

C.1.1 Introduction

Hi, thank you so much for speaking with us today. We are conducting this research on behalf of Mass Save about their Fuel Optimization rebates offered through the Heating and Cooling program and Multifamily programs *(Note: The fuel optimization rebates include heat pumps and integrated controls, with a rebate amount of $1,250 per ton for central heat pumps and $500 for each integrated control).*

The purpose of this research is to understand your experience with the adoption of these technologies.

We are interested in learning more about the decisions that contractors like you make when selling and installing heating systems such as mini-split heat pumps and central heat pumps, including integrated controls for dual-fuel systems. More specifically, we are interested in learning about how and when you recommend these products and your experiences working with these technologies.

To be clear, we are not trying to make any assessment or judgement of how well you do your job. There are no right or wrong answers. We are mainly interested in hearing about your experiences to help us understand how to make the program more effective in the future.

We would like to record our conversation for note-taking purposes. Everything you say will be kept confidential and we will report our findings in aggregate only. We will not attach your name or any other identifying information to any of our results or findings. Is it ok if we record this conversation?

Do you have any questions before we begin?

(Internal note: questions in blue font are also Market Effects questions)

C.1.2 Business Characteristics and Introduction

We will be starting off with a few general questions about your company:

1. To get started, please tell me a little bit about yourself and your company

[30] Guidehouse, Inc. 2021. Energy Optimization Fuel Displacement Impact and Process (MA20R24-B-EOEVAL). Accessed from https://ma-eeac.org/wp-content/uploads/MA20R24-B-EOEval_Fuel-Displacement-Report_2021-10-13_Final.pdf. Report submitted to the Electric and Gas Program Administrators of Massachusetts, October 13.

a. What is your role within the company?

b. How long has the company been in operation? About how many full-time employees work at the company? What services does the company provide (HVAC, Plumbing, Electric, etc.)?

c. What geographical areas does your company serve? [IF NEEDED, what states or counties?]

d. How many locations does your company have? Of these, how may routinely install ductless mini-split heat pumps in Massachusetts?

4. Thank you for sending me your company's heat pump installation numbers for 2019 ahead of time.

C.1.3 Heat Pump Systems Residential Market

(NOTE: Question 1 will be sent to distributors prior to the interview)

The next set of questions are designed to understand the residential market of heat pump systems (both centrally ducted and ductless mini splits) and integrated controls in Massachusetts.

For reference, when we say, "integrated control", we mean a control that is designed to automatically switch a customer's heating from their heat pump system to their other heating system (for example, propane or oil furnace or boiler) when the outdoor temperature drops below a certain point.

1. Thank you for sending me your company's heat pump installation numbers for 2019 ahead of time.

*(*Interviewer note: if they did NOT provide ahead of time, walk through the questions below on the call: We have some questions about your company's sales for 2019 that we have sent you by email, did you receive this? Would you be able to share this information with us now? Ok. Thank you, to start, …*)*

Table 2. Heat Pump System Types Sold in 2019

	Ductless Mini-Split Heat Pump	Centrally Ducted Heat Pump
a) Roughly what percent of the total Massachusetts market for residential heat pump systems would you say your company's sales represented in 2019 (by heat pump type)?	%	%
b) Thinking about the heat pump systems your company sold in 2019 that were intended for use in Massachusetts, about what percent of these were cold-climate systems? (For DMSHPs: SEER of at least 18 and HSPF of at least 10. For centrally ducted: SEER of at least 16 and HSPF of at least 9.5 with a capacity ratio of 67%))	%	%

c) Thinking about all the heat pump systems your company sold in 2019 that were intended for use in Massachusetts, not just cold-climate systems, what percent of these did you sell with integrated controls?	%	%
d) What percent of the cold-climate heat pump systems did you sell with integrated controls?	%	%
e) Thinking just about your locations that routinely sell heat pump systems intended for use in Massachusetts: In 2019, about how many residential heat pump systems were sold for use in Massachusetts?	n =	n =
f) Thinking about just your locations that routinely sell heat pump systems that are installed in Massachusetts, did these locations stock or sell integrated controls for use with heat pumps in 2019?	Yes or No	N/A

2. I have a couple follow-up questions on the numbers you provided.

a. How did you come up with the numbers?

(For internal coding, choose one based on response:

1. A guess, meaning they did not rely on actual sales records

2. Somewhat accurate, meaning they relied on some sales records but made a few inferences from them

3. Highly accurate, meaning that they relied on actual sales records.)

b. How did sales change in 2020 as compared to 2019? Did sales of heat pumps and/or integrated controls increase/decrease? Why do you think this was?

c. How have prices of integrated controls for ductless Minisplit Heat Pumps changed since your company first began to offer them?

C.1.4 Distributor's Experience with Integrated Controls

3. When talking with contractors about heating retrofits with ductless mini-split heat pumps, would you say that you recommend integrated controls…

(For internal coding, choose one based on response)

1. All of the time

2. About 75% of the time

3. About 50% of the time

4. About 25% of the time

5. Less than 25% of the time

6. Never

C.1.5 Conclusion

These are all the questions I have today. We really appreciate you taking the time to share your valuable insights in this industry. As I stated before, we would like to give you a $200 gift card as a thank you for your time. Can I confirm your email address? Note that it may take 6-8 weeks for the gift card to arrive.

[Interviewer record and confirm contact information for sending the incentive.]

Thank you again for your participation in this interview!

Appendix D Contractor Interview Guide

Below we list the contractor interview questions discussed in Section 3. The full contractor interview guide can be found in Appendix D of the *Heat Pump Fuel Displacement Process and Impact Study* (MA20R24-B-HPFD).[31]

D.1 Interview Guide

D.1.1 Introduction

Hi, thank you so much for speaking with us today. We are conducting this research on behalf of Mass Save about their Fuel Optimization rebates offered through the Heating and Cooling program and Multifamily programs *(Note: The fuel optimization rebates include heat pumps and integrated controls, with a rebate amount of $1,250 per ton for central heat pumps and $500 for each integrated control).*

The purpose of this research is to understand your experience with the adoption of these technologies.

We are interested in learning more about the decisions that contractors like you make when selling and installing heating systems such as mini-split heat pumps and central heat pumps, including integrated controls for dual-fuel systems. More specifically, we are interested in learning about how and when you recommend these products and your experiences working with these technologies.

To be clear, we are not trying to make any assessment or judgement of how well you do your job. There are no right or wrong answers. We are mainly interested in hearing about your experiences to help us understand how to make the program more effective in the future.

We would like to record our conversation for note-taking purposes. Everything you say will be kept confidential and we will report our findings in aggregate only. We will not attach your name or any other identifying information to any of our results or findings. Is it ok if we record this conversation?

Do you have any questions before we begin?

(Internal note: questions in blue font are also Market Effects questions)

We will be starting off with a few general questions about your company:

1. To get started, please tell me a little bit about yourself and your company a. What is your role within the company?

[31] Guidehouse, Inc. 2021. Energy Optimization Fuel Displacement Impact and Process (MA20R24-B-EOEVAL). Accessed from https://ma-eeac.org/wp-content/uploads/MA20R24-B-EOEval_Fuel-Displacement-Report_2021-10-13_Final.pdf. Report submitted to the Electric and Gas Program Administrators of Massachusetts, October 13.

b. How long has the company been in operation? About how many full-time employees work at the company? What services does the company provide (HVAC, Plumbing, Electric, etc.)?

c. What geographical areas does your company serve? [IF NEEDED, what states or counties?]

d. How many locations does your company have? Of these, how may routinely install ductless mini-split heat pumps in Massachusetts?

2. We'd like to get a sense of what your business does. What portion of the company's residential work (including multi-family) is focused on: (1) installations in existing homes/buildings, (2) installations in new homes/buildings, and (3) service/maintenance work?

3. Thinking of all residential work again (including multi-family), what portion of your business serves detached single-family homes, 2–4-unit buildings, and 5+ unit multifamily buildings? a. Of those multi-family (5+ unit) homes, what percent do you think are qualified as affordable housing?

4. Thank you for sending me your company's heat pump installation numbers for 2019 ahead of time.

(Interviewer note: if they did NOT provide ahead of time, walk through the questions below on the call: We have some questions about your company's number of installations for 2019 that we have sent you by email, did you receive this? Would you be able to share this information with us now? Ok. Thank you, to start, …)

Table 2. Ductless Mini-split Heat Pump System Types Installed in 2019

Question	Ductless Mini-Split Heat Pump
a) How many heat pumps did you and your company install in homes in Massachusetts in 2019, by system type? (your best estimate is ok)	n =
b) Of total 2019 installs, what % included integrated controls?	%
c) Of total 2019 installs, about what % received a rebate through the Mass Save Fuel Optimization offerings (a rebate of $1,250/ton)?	%
d) What % of heat pumps with integrated controls were cold climate heat pumps? (i.e. for DMSHPs, a SEER of at least 18 and HSPF of at least 10; for central HPs, a SEER of at least 16 and HSPF of at least 9.5 with a capacity ratio of 67%)	%
e) Of the cold climate heat pumps with integrated controls, about what % received a rebate through Mass Save?	%

5. I have a couple follow-up questions on the numbers you provided. a. How did you come up with the numbers?

(For internal coding, choose one based on response: (1) A guess, meaning they did not rely on actual sales records; (2) Somewhat accurate, meaning they relied on some sales records but made a few inferences from them; or (3) Highly accurate, meaning that they relied on actual sales records.

D.1.2 Contractor Recommendations/Sales Approach (PARTICIPANTS AND NONPARTICIPANTS)

5. How often do you recommend integrated controls for ductless mini-split heat pump systems?

a. Would you say all the time, about 75% of the time, about 50% of the time, about 25% of the time, or never?

D.1.3 Installation and Programming of Equipment (PARTICIPANTS AND NONPARTICIPANTS)

5. In your experience, how well do integrated controls work?

a. How reliable are they? [NOTE for back-coding: How confident are you in the effectiveness of ductless mini-split heat pump integrated controls? Would you say you are… a. Very confident

b. Somewhat confident

c. Not at all confident?

a. In your opinion, how effective are they in optimizing fuel use?

6. What feedback have you heard from customers using these systems? Did the system they install meet their expectations? If NOT, how was it different from their expectations?

a. Have any customers told you that they intend to disable or uninstall the integrated controls? About what percent?

i. Does this vary by system type?

7. How have prices of integrated controls changed since your company first began to offer them?