



Project 10 Task 6.2 HVAC Market Characterization and Penetration Analysis – Final Report

Massachusetts Energy Efficiency Programs in Large
Commercial & Industrial Evaluation Contractor (LCIEC)

Prepared for: Massachusetts Energy Efficiency Program Administrators and the
Energy Efficiency Advisory Council (EEAC)

Submitted to: National Grid

Prepared by DNV KEMA Inc and NMR Group

Madison, Wisconsin, July 10, 2012



Table of Contents

1. Executive Summary	1-1
1.1 Findings	1-1
1.1.1 Market Penetration	1-1
1.1.2 Market Characterization.....	1-8
1.1.3 Recommendations.....	1-9
2. Introduction and Methodology.....	2-10
2.1 Background	2-10
2.2 Research Objectives	2-12
2.3 Interviewing	2-12
2.3.1 Screening.....	2-13
2.3.2 Market Penetration	2-13
2.3.3 Market Characterization.....	2-15
2.3.4 Other Survey Topics	2-16
3. Sample Disposition and Population Estimate	3-18
3.1.1 Disposition of Sample	3-19
3.1.2 Refining the Population Estimate.....	3-23
3.1.3 Final Population Estimate	3-25



Table of Contents

3.2	Sampling Error.....	3-25
3.2.1	Sampling Error by Equipment Type.....	3-27
3.3	Weighting.....	3-28
3.3.1	Adjustments to Number of Employees	3-28
3.3.2	Weights.....	3-30
4.	Survey Results.....	4-31
4.1	Respondent & Firm Characterization	4-31
4.2	Market Penetration	4-34
4.2.1	Threats to Validity	4-35
4.2.2	Interpretation of Results.....	4-36
4.2.3	Self-reported Error Band.....	4-38
4.2.4	Air-cooled Unitary Air-Conditioning and Split Systems.....	4-38
4.2.5	Natural Gas Furnaces.....	4-46
4.2.6	Condensing Gas Boilers	4-49
4.2.7	Dual Enthalpy Economizers.....	4-52
4.2.8	Demand Control Ventilation.....	4-53
4.2.9	ECM Fan Motors.....	4-55



Table of Contents

4.2.10	7-day Programmable Thermostats	4-58
4.2.11	Opportunities for New Measures	4-60
4.3	Market Characterization	4-61
4.3.1	Role of Manufacturers	4-61
4.3.2	Emergency Replacements.....	4-62
Appendix A:	Program Staff Interview Guide	A-1



Table of Contents

List of Exhibits:

Table 1-1: Market Penetration for Air-Cooled Unitary AC and Split Systems	1-4
Table 1-2: Market Penetration for Natural Gas Furnaces up to 150 MBH	1-5
Table 1-4: Market Penetration for Controls	1-7
Table 2-1: Equipment Type and Efficiency Level.....	2-15
Table 2-2: Original Estimates of Population and Interview Targets	3-19
Table 2-3: Revised Estimates of Population	3-21
Table 2-4: Adjustments for Low C&I and Non-HVAC Related Businesses.....	3-24
Table 3-4: Revised Estimates of Population	3-25
Table 2-6: Number of Completed Interviews and Sampling Error.....	3-26
Table 2-7: Number of Completed Interviews and Sampling Error by Equipment Type.....	3-27
Table 2-8: Participating Contractors Employee Adjustments.....	3-28
Table 2-9: Number of Employees: Population vs. Sample	3-29
Table 2-10: Contractor Sample Weights	3-30
Table 3-1: Title or Position of Respondents	4-31
Table 3-2: Responsibilities of Respondents.....	4-32
Table 3-3: Number of Employees	4-32



Table of Contents

Table 3-4: Percent C&I Work.....	4-33
Table 3-5: Percent of C&I Business by End Use Sector.....	4-33
Table 3-6: Percent of C&I Business by Type of Work.....	4-34
Table 3-7: Self-Reported Error Band	4-38
Table 3-8: Market Penetration for Rooftop AC Systems < 5.4 tons	4-40
Table 3-9: Market Penetration for Rooftop AC Systems ≥ 5.4 to < 20 tons	4-42
Table 3-10: Market Penetration for Rooftop AC Systems ≥ 20 tons	4-44
Table 3-11: Reasons Qualifying Rooftop AC Systems Did Not Receive a Program Incentive ...	4-45
Table 3-12: Market Penetration for 94% AFUE Natural Gas Furnaces with ECM Motor.....	4-47
Table 3-13: Market Penetration for 96% AFUE Natural Gas Furnaces with ECM motor.....	4-48
Table 3-14: Reasons Qualifying Gas Furnaces Did Not Receive a Program Incentive	4-48
Table 3-15: Market Penetration for Natural Gas Condensing Boilers Up To 300MBH	4-50
Table 3-16: Market Penetration for Natural Gas Condensing Boilers Greater Than 300MBH	4-51
Table 3-17: Reasons Qualifying Gas Condensing Boilers Did Not Receive a Program Incentive	4-51
Table 3-18: Market Penetration for Dual Enthalpy Economizers	4-53
Table 3-19: Market Penetration for Demand Control Ventilation	4-55



Table of Contents

Table 3-20: Market Penetration for ECM Fan Motors	4-57
Table 3-21: Market Penetration for 7-day Programmable Thermostats	4-59
Table 3-22: Technologies Suggested for Rebate	4-60
Table 3-23: Contractor Purchases by Source	4-61
Table 3-24: Planned vs. Emergency Replacements	4-62
Table 3-25: Emergency Replacement Turnaround Time	4-63
Table 3-26: Factor Affecting Flexibility of Turnaround Time ¹	4-64
Table 3-27: Important Factors When Selecting New Equipment ¹	4-65
Table 3-28: Influence Over Equipment Selection in Emergency Replacement Situations.....	4-66
Table 3-29: Reasons for Influence ¹	4-67
Table 3-30: Suggestions to Increase the Likelihood Efficient Equipment is Installed	4-68

1. Executive Summary

This report is the deliverable of Research Task 6.2 HVAC Market Penetration and Characterization, which is part of the 2011-2012 Process Evaluation of the large Commercial and Industrial (C&I) energy efficiency programs in Massachusetts (Project 10). This research is sponsored by the Program Administrators (PAs) and the Energy Efficiency Advisory Council (EEAC). This research was designed to estimate the market penetration of energy-efficient equipment in the Massachusetts commercial HVAC market, gauge the level of large C&I program influence on market penetration, and characterize the market for emergency replacement. In order to address these objectives, NMR conducted a total of 51 telephone interviews with commercial HVAC contractors and distributors in Massachusetts. The initial evaluation plan targeted 80 completed interviews but we were unable to achieve that goal in the allocated timeframe because many firms either did not sell enough C&I HVAC equipment to qualify for the study or did not respond despite repeated attempts.¹

1.1 Findings

In this section we present a summary of findings from the in-depth interviews with distributors and contractors.

1.1.1 Market Penetration

Our key findings concerning the market penetration of energy efficient commercial HVAC equipment are discussed here. First, however, we briefly discuss the analysis approach, the threats to validity, and interpretation of results.

Each respondent was asked to estimate the market penetration for their firm. This figure was then rolled up to estimate market penetration for the entire market, using a weighting scheme described in section 3.3.2.

¹ See Section 3.1.1 for details.

1.1.1.1 Threats to Validity

Studies that are based upon self-reported data collected through surveys face a variety of threats to validity, as discussed below. See section 4.2.1 for more details.

- **Reporting Error.** Because respondents answered our sales and market share questions without consulting their records, there is the possibility of reporting error. On average distributors and contractors self-reported an error band of 8 percent and 12 percent, respectively. While these figures may suggest the scale of reporting error, we have no evidence to indicate that this reporting error would bias the market share estimates in any one direction.
- **Self-Selection Bias.** It is possible that vendors who are more interested in energy efficiency may be more likely to respond to the survey; these respondents may be more likely to sell a higher proportion of energy efficient units, which may inflate the market share estimates. Overall, we believe that self-selection bias could be an issue for contractors, particularly for nonparticipants, but is probably not an issue for distributors.
- **Sampling Error.** For contractors, sampling error at the 90 percent confidence level ranges from 20 percent to 34 percent depending on the type of equipment. For distributors, the sampling error ranges from 32 percent to 81 percent.

1.1.1.2 Interpretation of Results

Because some of the interviewed contractors may purchase equipment from some of the interviewed distributors, we do not think it is reasonable to combine the distributor estimates and contractor estimates into a single set of market penetration estimates. Therefore, we present the results separately.

However, this approach poses an issue when the market penetration estimates provided by distributors differ from those provided by contractors. In addition, we have two potential estimates of baseline energy efficient sales for contractors – those estimates provided by participants in the absence of program incentives and those provided by nonparticipants.

Distributor and Contractor Divergence. In our discussion of the results, we have more confidence in, and therefore place more emphasis on, market penetration results where the estimates from both distributors and contractors converge. In cases where the market

penetration estimates provided by distributors and contractors diverge, we have less confidence in the results and therefore place less emphasis on the results because it is unclear which estimates are more accurate. See section 4.2.2 for more details.

Baseline Market Penetration Estimates. Distributors generally do not fill out rebate application forms and are therefore removed from direct program participation. Therefore, the distributor respondents were not able to estimate the percent of program-qualifying equipment that would have been sold in the absence of the program incentives. Thus, the contractors provide the sole source of estimates regarding baseline market penetration.

We have more confidence in, and therefore place more emphasis on, baseline market penetration results where the estimates from both participating and nonparticipating contractors converge. In cases where the market penetration estimates diverge, we have less confidence in the results and therefore place less emphasis on the results. Our assessment indicates that participants may tend to underestimate the program baseline but that nonparticipants may tend to overestimate the baseline. Therefore, in cases where the estimates diverge, we recommend that the two estimates may represent a lower-bound estimate and upper-bound estimate of baseline market penetration. See section 4.2.2 for more details.

1.1.1.3 Market Penetration Results

Air-cooled Unitary Air-Conditioning and Split Systems. Results from contractors and distributors suggest that the market penetration of energy efficient 'rooftop' AC units <20 tons in size is approximately 55 percent to 64 percent (Table 1-1). However, the contractors (63%) provided substantially higher market penetration estimates for units >20 tons than did distributors (27%). In addition, the results indicate different degrees of program impact on market penetration depending on equipment size.

- For the units < 5.4 tons in size, the results suggest the program has a clear impact on market penetration. Participating contractors reported a substantially higher market penetration (80%) than did the nonparticipants (35%), which is similar to the market penetration estimated by participants (36%) in the absence of program incentives. In addition, a similar proportion of units sold outside the program (39%) are estimated to be energy efficient.
- For the units sized 5.4 tons or larger, the impact of the program on market penetration is less evident. The nonparticipants reported somewhat higher levels of market penetration

than did participants: 69 percent vs. 51 percent for units 5.4 to 20 tons in size and 65 percent vs. 59 percent for units 20 tons or larger. However, the participants estimated lower levels of market penetration in the absence of the programs (15% and 32%, respectively). The market penetration of efficient models among units sold outside the program is about one-half.

About one-half of the <5.4 efficient units are estimated to receive program incentives, compared to about one-quarter to one-third of the >5.4 ton efficient units.

**Table 1-1:
Market Penetration for Air-Cooled Unitary AC and Split Systems**

Equipment Type; Efficiency	Market Penetration				Market Penetration in absence of Program Incentives	Percent of Outside Program Sales that are Efficient	Percent of Efficient Units that Received Program Incentives
	Overall Vendor Estimates		Contractor-Only Estimates				
	Contractors	Distributors	Participant	Non-participant	Participating Contractors	All Contractors	All Contractors
< 5.4 tons; 14 SEER, 12 EER	57%	64%	80%	35%	36%	39%	52%
≥ 5.4 to < 20 tons; 11.5 EER	55%	62%	51%	69%	15%	46%	31%
≥ 20 tons; 10.2 EER	63%	27%	59%	65%	32%	55%	28%
# Respondents	17 – 32	4 - 6	12 – 23	5 - 9	12 – 23	17 – 32	17 – 32

Natural Gas Furnaces with ECM Fan Motors. Contractors offer substantially higher estimates of market penetration than do distributors for high efficiency natural gas furnaces with ECM motors. Contractor results suggest that the market penetration for 94% AFUE gas furnaces is approximately 79 percent, whereas distributors estimate 33 percent. In addition, contractors estimate the market penetration for 96% AFUE gas furnaces is approximately 62 percent, compared to 29 percent for distributors (Table 1-2).

The programs' impact on market penetration is unclear as participating contractors reported only slightly higher penetration than the nonparticipants (85% vs. 75%) for 94% AFUE models while the nonparticipants reported higher market penetration than did participants (70% vs. 51%) for 96% AFUE models. In both cases, the participants estimated relatively low market penetration estimates in the absence of program incentives - 47 percent and 33 percent,

respectively. The market penetration among units sold outside the program is estimated to be 70 percent and 53 percent, respectively. The percent of efficient units that received program incentives is estimated to be approximately one-third, regardless of efficiency level.

**Table 1-2:
Market Penetration for Natural Gas Furnaces up to 150 MBH**

Equipment Efficiency	Market Penetration				Market Penetration in absence of Program Incentives	Percent of Outside Program Sales that are Efficient	Percent of Efficient Units that Received Program Incentives
	Overall Vendor Estimates		Contractor-Only Estimates				
	Contractors	Distributors	Participant	Non-participant	Participating Contractors	All Contractors	All Contractors
94% AFUE w/ECM	79%	33%	85%	75%	47%	70%	37%
96% AFUE w/ECM	62%	29%	51%	70%	33%	53%	31%
# Respondents	32	3	23	9	23	32	32

Condensing Gas Boilers. The results from contractors suggest that the market penetration of high-efficiency models among all condensing gas boilers is high: 94 percent for units <300 MBH and 91 percent for units >300 MBH (Table 1-3). In addition, nonparticipants reported higher market penetration than did participants, even though participants estimated low market penetration in the absence of program incentives (25% and 41%). However, the market penetration among units sold outside the program is also high – 85 percent or more. These results do not clearly provide evidence of the programs impact on market penetration. Roughly one-half of efficient units appear to have received program incentives.

**Table 1-3:
Market Penetration for Natural Gas Condensing Boilers**

Equipment Type; Efficiency	Market Penetration				Market Penetration in absence of Program Incentives	Percent of Outside Program Sales that are Efficient	Percent of Efficient Units that Received Program Incentives
	Overall Vendor Estimates		Contractor-Only Estimates				
	Contractors	Distributors	Participant	Non-participant	Participating Contractors	All Contractors	All Contractors
Up to 300 MBH; 90% AFUE	94%	n/a	90%	100%	25%	87%	57%
300 MBH or more; 90% thermal eff.	91%	n/a	84%	99%	41%	85%	45%
# Respondents	24-32	0	19-26	5-6	19-26	24-32	24-32

Controls. Because of the program requirement that controls be installed with new program-qualifying equipment, the controls questions may have been more difficult for respondents to accurately answer.

Dual Enthalpy Economizers. The contractor results suggest that the market penetration of dual enthalpy economizers is about 45 percent, while distributors estimate only 2 percent. Participating contractors reported much lower market penetration than did nonparticipants (12% vs. 80%), though market penetration outside the program is estimated to be 2 percent. These results suggest that the impact of the program on market penetration is unclear. Most of the eligible units (84%) appear to receive program incentives.

Demand Control Ventilation. The contractor results suggest that the market penetration of DCV is about 34 percent, while distributors estimate only 1 percent. Participating contractors reported similar market penetration as nonparticipants (32% vs. 36%). Market penetration outside the program is estimated to be 0 percent. These results suggest that the impact of the program on market penetration is unclear. Almost all of the eligible units (99%) appear to receive program incentives.

ECM Fan Motors. The contractor results suggest that the market penetration of ECM fan motors is about 41 percent, while distributors estimate only 9 percent. Participating contractors reported slightly higher market penetration than did nonparticipants (47% vs. 35%). Market

penetration outside the program is estimated to be 15 percent. These results suggest that the impact of the program on market penetration is unclear. Most of the eligible units (85%) appear to receive program incentives.

7-day Programmable Thermostats. The contractor results suggest that the market penetration of program-eligible 7-day programmable thermostats is about 48 percent, while distributors estimate only 4 percent. Participating contractors reported much lower market penetration than did nonparticipants (23% vs. 71%). Market penetration outside the program is estimated to be 71 percent. These results suggest that the impact of the program on market penetration is unclear. Relatively few of the eligible units (19%) appear to receive program incentives.

**Table 1-4:
Market Penetration for Controls**

Equipment Type	Market Penetration				Percent of Outside Program Sales that are Efficient	Percent of Efficient Units that Received Program Incentives
	Overall Vendor Estimates		Contractor-Only Estimates			
	Contractors	Distributors	Participant	Non-participant	All Contractors	All Contractors
Dual enthalpy economizers	45%	2%	12%	80%	2%	84%
<i># Respondents</i>	19	5	11	8	19	19
Demand control ventilation	34%	1%	32%	36%	0%	99%
<i># Respondents</i>	12	5	8	4	12	12
ECM fan motors	41%	9%	47%	35%	15%	85%
<i># Respondents</i>	14	6	9	5	14	14
7-day programmable thermostats	48%	4%	23%	71%	71%	19%
<i># Respondents</i>	25	4	18	7	25	25

Opportunities for New Measures. Sixteen respondents (31%) believed there are technologies that could be incentivized by the Mass Save programs but are currently not eligible. Measures mentioned include chiller/induction units, geothermal heat pumps, high AFUE furnaces without ECM motors, and more rebates for larger HVAC systems. Some of the measures mentioned—chillers, geothermal heat pumps, and larger systems—are already

covered through the program. This may indicate an opportunity for better communication with vendors regarding the scope of program incentives.

1.1.2 Market Characterization

Our key findings concerning the market characterization include the following:

- *The population of C&I HVAC vendors in Massachusetts is estimated to be about 600.* The original sample drawn from Dun & Bradstreet company data and program tracking databases identified 1,522 potential C&I HVAC vendors in Massachusetts. Based on speaking with 419 vendors, the evaluation team prepared a revised sample population of 586 vendors, including 571 contractors and 15 distributors.
- *Participating contractors comprise 32 percent of the total population of C&I HVAC contractors in Massachusetts.* The evaluation team estimates a total of 571 HVAC contractors provide services to C&I customers in Massachusetts and that 183 directly facilitate participation in the program.
- *Participating distributors comprise about one-third of the total population of C&I HVAC distributors in Massachusetts.* The evaluation team estimates a total of 15 HVAC vendors provide services to C&I customers in Massachusetts and that five directly facilitate participation in the program. It is important to note that while the other ten are not direct participants, some of the equipment they sell likely receives rebates from the program.
- *Interviewed vendors sell and install HVAC equipment to a variety of end use sectors.* Offices rank highest for distributors (35%) and contractors (25%), followed by retail/restaurant (18% each), and institutions (12% distributors, 24% contractors).
- *More than one-half of the C&I HVAC business comes from either new construction or major renovation projects.* Contractors interviewed said that nearly one-half of their business comes from new construction or major renovation projects (47%), compared to 54 percent for distributors. Not surprisingly, contractors reported relatively more business from maintenance and service calls (about 30%) compared with distributors (5%).
- *Although respondents report that the majority of equipment replacements are planned, emergency replacements still account for a significant portion.* Distributors estimate that air conditioning units are most likely to require emergency replacement (42%). However,

contractors said that furnaces and condensing boilers were most likely to require an emergency replacement (31% and 27%, respectively).

- *Customers require quick turnarounds for emergency replacements.* According to respondents, customers generally require a five-day turnaround on equipment replacements in emergency situations.
- *Over one-half of respondents (56%) said that the season or weather conditions affect customer flexibility with emergency replacements.* In addition, 20 percent of respondents said that the degree of malfunction affects customers' flexibility, as customers are less flexible when the equipment in question is completely inoperable versus somewhat functional.
- *Availability (50%) and cost (41%) are the two most frequently-mentioned factors considered when customers select new equipment in an emergency replacement situation.* Efficiency was mentioned by 26 percent of respondents.
- *Contractors believe that they exert a large degree of influence over equipment selection in emergency situations.* The vast majority of contractors (88%) said that they have a large degree of influence over equipment selection and the remaining 12 percent said they have some influence. Contractors said that customers trust their expertise and rely on them to select equipment.
- *Suggestions for increased program role in emergency replacements:* In order to increase the likelihood of installing efficient equipment during emergency replacements, 21 percent of respondents suggested reducing the time required to process rebates or otherwise easing program participation. More than one-tenth of respondents said to ensure the units are in stock (14%), offer higher rebates and incentives (13%), or increase marketing and advertising (13%).

1.1.3 Recommendations

Based on the results of this research, we provide the following recommendations.

Consider raising efficiency levels for condensing gas boilers. Given the high market penetration for high-efficiency condensing gas boilers reported by both participating contractors

(84%-90%) and non-participants (90%-100%), it appears that the program could benefit from raising efficiency levels.

Consider offering stocking incentives to distributors. One-half of respondents believe that availability is an important factor in selecting new equipment in emergency replacement situations. In order to ensure the wide availability of high-efficiency models, consider offering stocking incentives to distributors to maintain an inventory of high-efficiency equipment.

2. Introduction and Methodology

This report is the deliverable of Research Task 6.2 HVAC Market Penetration and Characterization, which is part of the 2011-2012 Process Evaluation of the large Commercial and Industrial (C&I) energy efficiency programs in Massachusetts (Project 10). This research is sponsored by the Program Administrators (PAs) and the Energy Efficiency Advisory Council (EEAC). This research was designed to estimate the market penetration of energy-efficient equipment in the Massachusetts commercial HVAC market, gauge the level of large C&I program influence on market penetration, and characterize the market for emergency replacement. In order to address these objectives, NMR conducted a total of 51 telephone interviews with commercial HVAC vendors in Massachusetts.

The following subsections discuss the background of this study and describe the topics covered by the interviews as well as our sampling approach.

2.1 Background

According to the Final Project 10 Research Plan, several PA representatives were interested in learning what percentage of the sales of energy-efficient HVAC technologies such as energy-efficient rooftop units (RTUs) or demand control ventilation (DCV) equipment were being captured by their C&I programs.² They thought it might be possible to obtain HVAC equipment sales data from the Air-Conditioning Heating and Refrigeration Institute (AHRI) and then

² Final, Revised Research Plan for Project 10: Process Evaluation of the Large Commercial and Industrial Energy Efficiency Programs in Massachusetts. November 1, 2011.

compare the sales levels for particular types of energy-efficient equipment with the number of units being incentivized by the Massachusetts programs. In our summary description of Research Task 6.2 in the Project 10 Research Plan we stated that we would “try to calculate these market penetration ratios for whatever HVAC technologies prove feasible based on a review of the AHRI sales data.”

A January 13, 2012 memorandum described an initial re-scoping of these Task 6.2 research activities, which was necessary due to the unavailability of the AHRI data that was the central component of the original analysis plan.³ After contacting AHRI multiple times, we learned that these data are available to the public only at the national level.⁴ While these data are produced at the state level, it is only available to AHRI members, who must be HVAC manufacturers. Because the AHRI data is not available for Massachusetts, we proposed an alternative approach for measuring the market penetration of energy-efficient HVAC technologies through interviews with HVAC vendors about the types and efficiency level of equipment sold or installed.

The Project 10 research plan included 40 trade ally interviews with participating and non-participating HVAC contractors (Research Task 4). However, these Research Task 4 trade ally interviews were designed to focus mostly on traditional process evaluation topics (e.g. program awareness/knowledge, barriers to participation, program participation experiences, etc). These HVAC trade ally interviews were moved over to Research Task 6.2 but with an emphasis on the objectives described in section 2.2.

Two reviewers of the January 13, 2012 memorandum questioned whether the proposed sample size of 40 HVAC vendors was adequate for the proposed market penetration/characterization task. They suggested an expansion of this sample size which would be based on an understanding of the size of the underlying Massachusetts HVAC

³ Draft Research Plan for Project 10 Task 6.2: HVAC Market Characterization & Penetration Analysis for the Process Evaluation of Large Commercial and Industrial Energy Efficiency Programs in Massachusetts. January 13, 2012.

⁴ <http://www.ahrinet.org/statistics.aspx>

vendor population. A February 3, 2012 memorandum revised the study approach in order to address these concerns and included an estimate of the population size as well as an increase in the number of interviews from 40 to 80.⁵

2.2 Research Objectives

The research objectives of this study are as follows:

- Estimate the market penetration of key energy-efficient equipment in the Massachusetts commercial HVAC market;
- Gauge the level of program influence on the market penetration of energy efficient technologies;
- Characterize the nature of the commercial HVAC market, with particular emphasis on missed opportunities during emergency replacement; and
- Collect key information on program awareness, knowledge, participation, barriers, and financial incentives as originally outlined in Research Task 4 of the Project 10 research plan.

2.3 Interviewing

This section discusses the topics covered by the interview guide. Because the sample sizes for the vendor interviews were relatively small and because we wanted the capability of gathering richer responses and doing follow-up questions, NMR staff conducted in-depth telephone interviews rather than Computer-Aided Telephone Interview (CATI) surveys.

⁵ Revised Draft Research Plan for Project 10 Task 6.2: HVAC Market Characterization & Penetration Analysis for the Process Evaluation Large Commercial and Industrial Energy Efficiency Programs in Massachusetts. February 3, 2012.

In order to ensure that vendors were actively involved in the C&I HVAC market, respondents were screened to ensure that each firm derived at least 20 percent of their business from C&I customers.⁶

The evaluation team initially targeted completing interviews with 80 vendors but due to difficulties recruiting vendors was only able to complete 51 interviews within the timeframe available for interviewing. The evaluation team received responses from 419 unique vendors and made at least four attempts to contact an additional 802 vendors. The disposition of the sample is discussed in greater detail in Section 3.

2.3.1 Screening

In order to ensure the highest quality data, interviewers screened for respondents who identified themselves as the most knowledgeable person at the organization concerning the type and efficiency of equipment sold as well as sales figures. Respondents were also screened out if they said that less than 20 percent of their company's business came from commercial and industrial sales, installations, or service.

2.3.2 Market Penetration

In order to estimate market penetration, the interviewers first asked respondents to estimate the quantity of HVAC equipment sold or installed in Massachusetts in 2011. Respondents were then asked to estimate the percent of units that met program energy efficiency requirements. In addition, respondents were asked to estimate the percent of program-eligible energy-efficient HVAC equipment that received program incentives. If these estimates were less than 100 percent, they also were asked why some of the eligible units did not program incentives.

In order to estimate the degree of program influence on the sales of eligible energy efficient equipment, participants were asked to estimate the percent of their eligible equipment that would have been sold or installed if the program incentives had not been available.

⁶ Originally this criteria was set at 30%, but was later relaxed to 20% due to difficulty finding a sufficient quantity of interviewees who met this 30% threshold.

Initially, we planned to match the interview data, for each program participant, regarding the percent of eligible units that received program incentives to the actual number of units incentivized in 2011 from the program tracking data. This figure would then be scaled up to estimate the number of eligible energy efficient equipment installed or sold, which would then be further scaled up to estimate market level sales or installations.

However, after analyzing the program tracking database, this approach was determined to be infeasible because equipment type and efficiency levels were not consistently provided in the database. In addition, while the identity of the end user was evident, the vendor was not consistently available. These issues made it impossible to conduct the analysis as originally envisioned. Instead, we relied entirely on vendor self-reported interview data regarding the number and efficiency level of equipment sold or installed, as well as the number that received program incentives.

Equipment Types & Efficiency Levels. We selected commercial HVAC equipment types that are commonly incentivized because technologies that are more frequently incentivized may be more likely to exhibit program effects. These equipment types were selected based on a review of program tracking data. In addition, given the emphasis on emergency replacements, equipment was selected where replacement of failed equipment could occur quickly (Table 2-1).

**Table 2-1:
Equipment Type and Efficiency Level**

Equipment Type	Program-Eligible Efficiency Level	Incentive Level
Air-cooled Unitary AC and split systems		
< 5.4 tons	split = 14.0 SEER & 12.0 EER; packaged = 14.0 SEER & 11.6 EER	\$70/ton
≥ 5.4 to < 20 tons	11.5 EER	\$50/ton
≥ 20 tons	20-62 tons = 10.5 EER; ≥63 tons = 10.2 EER	\$30/ton \$50/ton
Natural gas furnaces		
≤ 150 MBH	94% AFUE with ECM motor	\$600
≤ 150 MBH	96% AFUE with ECM motor	\$800
Natural gas condensing boilers		
≤ 300 MBH	90% AFUE	\$1,000
≥ 300 MBH	90% thermal efficiency	\$3,000 - \$15,000 (increases with size)
Demand control ventilation	Installed with new program-qualifying HVAC equipment. Ineligible if required by code – i.e., new construction spaces greater than 500 square feet.	\$200
Dual enthalpy economizers	Installed with new program-qualifying HVAC equipment	\$250
Programmable thermostats	Installed with new program-qualifying HVAC equipment	\$25
ECM fan motors	Installed with new program-qualifying HVAC equipment	\$150

2.3.3 Market Characterization

The interview guide included questions on the following topics regarding market characterization:

- Types of customers served (retail, office, institutional, manufacturing, etc);
- Types of equipment customers purchase directly from manufacturers;
- Percent of equipment for new construction vs. retrofit;
- Percent of planned replacements vs. emergency replacements;

- Turnaround required for emergency replacements;
- Vendor influence on customers' equipment purchase decisions, particularly during emergency replacements; and
- Opportunities to increase the chances that energy-efficient equipment would be installed in emergency replacement situations.

2.3.4 Other Survey Topics

In addition to the market penetration and characterization questions, we asked some of the traditional process evaluation questions outlined in Project 10's Research Task 4 (Trade Ally Interviews). Because of the emphasis on market penetration and characterization, we were unable, due to concerns about respondent fatigue, to ask the full battery of process-evaluation-related questions outlined in Task 4. However, it should be noted that the Research Task 4 team asked the full battery of process evaluation questions to the other targeted trade ally groups (lighting contractors, refrigeration contractors, etc). The results of these questions are presented in the Project 10 Process Evaluation report.

Program participation. We asked key questions about program participation as outlined under Task 4 of the Project 10 work plan. These questions included the following:

- Is energy efficiency included in marketing or sales pitch, and if so, how;
- Do they provide multiple bids including an energy efficient option;
- Do they interact with program staff or PA account representatives,
- What barriers might prevent vendors from participating in these programs;
- Whether they discuss life-cycle costs with customers, and if so, do they factor rebates into their calculation;
- Impact of economic downturn on sales;
- Rating of their level of satisfaction with the program and rationale for the rating; and
- What the programs could do to get them to become more active.



Financial incentives. We asked key questions about their experience with program financial incentives, as outlined under Task 4 of the Project 10 work plan. These questions included the following:

- How/whether they incorporate the program incentives in their sales strategies;
- Whether they thought program rebate levels were adequate to move market demand;
- Whether upstream incentives would further motivate them to promote energy efficient equipment; and
- Whether/how they had promoted the financing mechanisms and, if not, why not.

3. Sample Disposition and Population Estimate

The sample was drawn from Dun & Bradstreet (D&B) company data. Based on this data alone the evaluation team estimated that there were a total of 1,522 HVAC vendors in Massachusetts, including 1,481 contractors and 41 distributors. In order to develop these totals, we started with a list of Massachusetts-based companies that had primary SIC/NAICs codes that identified them as HVAC contractors or distributors. We then reviewed “Line of Business” descriptions in the D&B database to screen out companies that did not appear to be part of the target population. Finally we filtered the D&B records to include only those firms with five or more employees, with the assumption that smaller HVAC vendors would be unlikely to serve C&I customers (a similar filter was used in a 2006 NEEP C&I HVAC market characterization study). The estimated HVAC distributor population of 41 is supported by the Heating, Air-Conditioning, and Refrigeration Distributors International website⁷, which lists 34 members in Massachusetts.

We also analyzed the HVAC trade allies from the 2008-2011 program tracking databases. We then eliminated duplicate participating trade allies from the D&B list so that we had one list of participants and one list of nonparticipants. This analysis indicated that participating HVAC trade allies (384 companies) represent about one-quarter of all vendors in Massachusetts.

For nonparticipants, size was based on the number of employees from D&B data. Because we did not know the number of employees for participants, the level of energy savings from program tracking data was used as a proxy (more details on this sampling approach appear in the Project 10 Process Evaluation Report). Because some vendors, particularly participating contractors, did not have either number of employees or energy savings available, they were categorized as ‘unknown’ size.

In designing this sample plan, we balanced two competing objectives: (1) interviewing a sufficient number of participants in order to provide useful input about their program experience for the process evaluation and (2) interviewing enough nonparticipants for the market penetration/characterization study to adequately represent that segment of the HVAC market

⁷ <http://www.hardinet.org/>

(which may be different than the participant population). Therefore, we planned to allocate 40 of the 80 interviews to participating vendors and 40 to non-participating vendors (Table 3-1).

**Table 3-1:
Original Estimates of Population and Interview Targets**

Vendor Type	Participation Status	Estimated Population	Interview Targets
Contractor	All	1,481	64
	Participant	390	32
	<i>Large</i>	44	12
	<i>Small</i>	232	17
	<i>Unknown</i>	114	3
	Nonparticipant	1,091	32
	<i>Large</i>	145	15
	<i>Small</i>	941	17
	<i>Unknown</i>	5	0
Distributor	All	41	16
	Participant	15	5
	<i>Large</i>	1	--
	<i>Small</i>	14	5
	<i>Unknown</i>	--	--
	Nonparticipant	26	11
	<i>Large</i>	6	3
	<i>Small</i>	17	7
	<i>Unknown</i>	3	1

3.1.1 Disposition of Sample

Once we began contacting vendors it became quickly apparent that additional revisions to the target population would be needed. Interviewers encountered a large number of duplicate vendors, vendors who did not sell HVAC related equipment, and vendors who primarily sold

residential equipment.⁸ Interviewing began on March 14, 2012 and concluded on April 30, 2012. Table 3-2 shows the disposition of the sample based on all of the calls made for the project. We received responses from 419 unique vendors. Of the 419 vendors who responded, 88 percent were screened out or refused to participate in the study,

- 157 operated non-HVAC related businesses,⁹
- 131 refused to participate in the study,
- 80 said that they derived less than 20 percent of their business from commercial and industrial customers,¹⁰ and
- 51 completed interviews.

For the remaining 1,103 vendors in the sample,

- 182 were determined to be duplicates,
- 119 had numbers that were out of service,¹¹ and
- 802 did not respond despite repeated attempts to contact them.¹²

⁸ The team initially sought to complete interviews only with vendors who said at least 30% of their business came from the C&I sector. This threshold was later decreased to 20% in an attempt to increase the number of completions.

⁹ These vendors were generally plumbers or specialty contractors, such as fire suppression or sheet metal vendors.

¹⁰ The vast majority of vendors with a low incidence of C&I business reported very low C&I sales, less than 10%.

¹¹ For vendors with numbers out of service the evaluation team attempted to identify updated numbers based on web searches.

¹² The evaluation team made at least four attempts to contact each vendor in the sample.

It is important to note that we have characterized distributors as participants and non-participants based on their direct involvement with program processes. All of the distributors we spoke with were aware of the program and it is highly likely that at least some of the energy-efficient equipment they sell is rebated by the program. However, distributors generally do not fill out application forms and are at least one level removed, and in many cases two, from direct program participation. Distributors who reported being directly involved in the programs are listed as participants.

**Table 3-2:
Revised Estimates of Population**

Vendor Type	Participation Status	Original Estimated Population	Duplicate Records	Non-HVAC Related Business	Low % of C&I Work	Estimated Population After Interviews
Contractor	All	1,481	169	147	77	1,088
	Participant	390	89	5	37	259
	<i>Large</i>	44	20	1	--	23
	<i>Small</i>	232	69	2	19	142
	<i>Unknown</i>	114	--	2	18	94
	Nonparticipant	1,091	80	142	40	829
	<i>Large</i>	145	23	41	6	75
	<i>Small</i>	941	52	101	34	754
	<i>Unknown</i>	5	5	--	--	--
Distributor	All	41	13	10	3	15
	Participant	15	9	1	--	5
	<i>Large</i>	1	--	--	--	1
	<i>Small</i>	14	9	1	--	4
	<i>Unknown</i>	--	--	--	--	--
	Nonparticipant	26	4	9	3	10
	<i>Large</i>	6	1	1	--	4
	<i>Small</i>	17	--	8	3	6
	<i>Unknown</i>	3	3	--	--	--

3.1.1.1 Attempts to Increase Response Rate

As it became clear that the goal of interviewing 80 vendors would be more difficult than initially expected, the evaluation team implemented several changes to its plan in order to increase the total number of interviews completed.

- The team asked for, and received, approval to offer a \$50 incentive to respondents.
- The team lowered the threshold of commercial sales activity from 30 percent to 20 percent.
- The team added additional interviewers and two additional weeks to the interviewing schedule.

Unfortunately, these efforts had little impact on the total number of interviews completed. Only one vendor was persuaded by the \$50 incentive and the vast majority of vendors who were screened out due to low commercial sales were below even the 20 percent threshold.

As stated earlier, nearly nine out of ten (88%) vendors reached by the team were either screened out of the study or refused participate.

3.1.2 Refining the Population Estimate

In order to further refine the estimate of the population of commercial HVAC vendors in Massachusetts, we examined the proportion of vendors that screened out of the sample based on a low percentage of business from the commercial sector and vendors operating non-HVAC related businesses. Below we breakdown the adjustments made in order to estimate the final population by vendor type and size category. Table 3-3 presents a summary of the inputs and adjustments.

3.1.2.1 Participating Contractors

We spoke with ten large participating contractors. Of these ten contractors, only one was screened out as a non-HVAC business. Based on this we made no additional changes to the estimated population of large participating contractors.

We spoke with 54 small participating contractors. Of these 54 contractors, 21 (39%) were screened out: 19 were screened out for low C&I sales and two were determined to be non-HVAC related vendors. We used the proportion of vendors screened out to reduce the remaining population of vendors that we were unable to reach by 39 percent — from 109 to 67. This yields a revised population of 100 for small participating contractors.

We spoke with 42 ‘unknown’ size participating contractors. Of these 42 contractors, 20 (48%) were screened out: 18 were screened out for low C&I sales and two were determined to be non-HVAC related vendors. We used the proportion of vendors screened out to reduce the remaining population estimate by 48 percent — from 72 to 38. This yields a revised population of 60 for the ‘unknown’ size participating contractors.

3.1.2.2 Non-Participating Contractors

We spoke with 59 large non-participating contractors. Of these 59 contractors, 47 (80%) were screened out—six were screened out for low C&I sales and 41 were determined to be non-HVAC related vendors. We used the proportion of vendors screened out to reduce the remaining population estimate by 80 percent from 63 to 13. This yields a revised population of 25 for large non-participating contractors.

We spoke with 228 small non-participating contractors. Of these 228 contractors, 135 (59%) were screened out—34 were screened out for low C&I sales and 101 were determined

to be non-HVAC related vendors. We used the proportion of vendors screened out to reduce the remaining population estimate by 59 percent from 661 to 270. This yields a revised population of 363 for small participating contractors.

All of the unknown size non-participating contractors were determined to be duplicate vendors. Based on this no further adjustments were needed to the population of unknown size non-participating contractors.

3.1.2.3 Distributors

Since we spoke with all 15 distributors it was unnecessary to make further adjustments to the population based on the proportion of vendors that screened out (Table 3-3).

**Table 3-3:
Adjustments for Low C&I and Non-HVAC Related Businesses**

Vendor Type	Participation Status	Reached	Low C&I or Non-HVAC Related	% Of Those Reached	No Response	Removed from Population
Contractor	All	393	237	60%	906	517
	Participant	106	55	52%	182	76
	<i>Large</i>	10	1	10%	14	--
	<i>Small</i>	54	21	39%	109	42
	<i>Unknown</i>	42	20	48%	72	34
	Nonparticipant	287	182	63%	724	441
	<i>Large</i>	59	47	80%	63	50
	<i>Small</i>	228	135	59%	661	391
	<i>Unknown</i>	--	--	--	--	--

3.1.3 Final Population Estimate

Table 3-4 presents our final estimate of the population of commercial HVAC vendors in Massachusetts based on the revisions discussed earlier. For reference, the table also includes the original estimated population and the estimated population after completion of the interviews.

**Table 3-4:
Revised Estimates of Population**

Vendor Type	Participation Status	Original Estimated Population	Population After Interviews	Revised Estimated Population
Contractor	All	1,481	1,088	571
	Participant	390	259	183
	<i>Large</i>	44	23	23
	<i>Small</i>	232	142	100
	<i>Unknown</i>	114	94	60
	Nonparticipant	1,091	829	388
	<i>Large</i>	145	75	25
	<i>Small</i>	941	754	363
	<i>Unknown</i>	5	--	--
Distributor	All	41	15	15
	Participant	15	5	5
	<i>Large</i>	1	1	1
	<i>Small</i>	14	4	4
	<i>Unknown</i>	--	--	--
	Nonparticipant	26	10	10
	<i>Large</i>	6	4	4
	<i>Small</i>	17	6	6
	<i>Unknown</i>	3	--	--

3.2 Sampling Error

Table 3-5 shows the final estimated population, the interviews completed and the sampling error at the 90 percent confidence level. For contractors we achieved a sampling error of 16 percent and for distributors we achieved a sampling error of 32 percent. These sampling errors

assume that 50 percent of respondents answer “yes” to a question and therefore presents a worst-case scenario for calculating sampling error.

It should be noted that the original sample plan called for 80 completed interviews, 64 interviews with contractors and 16 with distributors, yielding sampling errors of 11.5 percent and 16.9 percent, respectively. Unfortunately, due to difficulty recruiting vendors to participate in the study the evaluation team was unable to complete all 80 interviews. As discussed in-depth in section 3.1.1, the team made every effort to increase completions in order to reach the desired sample size.

**Table 3-5:
Number of Completed Interviews and Sampling Error**

Vendor Type	Participation Status	Revised Estimated Population	Interviews Completed	Sampling Error at 90% Confidence Level
Contractor	All	571	45	16%
	Participant	183	32	13%
	<i>Large</i>	23	5	<i>n/a</i>
	<i>Small</i>	100	26	<i>n/a</i>
	<i>Unknown</i>	60	1	<i>n/a</i>
	Nonparticipant	388	13	23%
	<i>Large</i>	25	3	<i>n/a</i>
	<i>Small</i>	363	10	<i>n/a</i>
	<i>Unknown</i>	--	--	<i>n/a</i>
Distributor	All	15	6	32%
	Participant	5	2	37%
	<i>Large</i>	1	1	<i>n/a</i>
	<i>Small</i>	4	1	<i>n/a</i>
	<i>Unknown</i>	--	--	<i>n/a</i>
	Nonparticipant	10	4	64%
	<i>Large</i>	4	3	<i>n/a</i>
	<i>Small</i>	6	1	<i>n/a</i>
	<i>Unknown</i>	--	--	<i>n/a</i>

3.2.1 Sampling Error by Equipment Type

Each respondent did not sell every type of equipment; therefore the sampling error varies significantly for the market penetration estimates presented in section 4.2. Table 3-6 provides the estimated sampling error for distributors and contractors by equipment type. For contractors, sampling error ranges from 20 percent to 34 percent based on equipment type. For distributors, sampling error ranges from 32 percent to 81 percent.

**Table 3-6:
Number of Completed Interviews and Sampling Error by Equipment Type**

Vendor Type	Equipment Type	Participant Interviews	Non-Participant Interviews	Total Interviews	Sampling Error at 90% Confidence Level
Contractor	Air-Cooled Unitary Systems <5.4 tons	23	9	32	20%
	Air-Cooled Unitary Systems ≥ 5.4 to < 20 tons	17	7	24	23%
	Air-Cooled Unitary Systems ≥ 20 tons	12	5	17	29%
	Natural Gas Furnaces 94% AFUE	23	9	32	20%
	Natural Gas Furnaces 96% AFUE	23	9	32	20%
	Condensing Gas Boilers Up to 300 MBH	26	6	32	25%
	Condensing Gas Boilers > 300 MBH	19	5	24	28%
	Dual Enthalpy Economizers	11	8	19	22%
	Demand Control Ventilation	8	4	12	34%
	ECM Fan Motors	23	9	32	20%
	Thermostats	18	7	25	23%
Distributor	Air-Cooled Unitary Systems <5.4 tons	2	4	6	32%
	Air-Cooled Unitary Systems ≥ 5.4 to < 20 tons	2	3	5	39%
	Air-Cooled Unitary Systems ≥ 20 tons	1	3	4	53%
	Natural Gas Furnaces 94% AFUE	1	2	3	81%
	Natural Gas Furnaces 96% AFUE	1	2	3	81%
	Condensing Gas Boilers Up to 300 MBH	--	--	--	N/A
	Condensing Gas Boilers > 300 MBH	--	--	--	N/A
	Dual Enthalpy Economizers	2	3	5	39%
	Demand Control Ventilation	2	3	5	39%
	ECM Fan Motors	2	1	3	80%
	Thermostats	2	2	4	79%

3.3 Weighting

3.3.1 Adjustments to Number of Employees

The number of employees for the vast majority of contractors and all of the vendors was estimated based on information obtained from Dun & Bradstreet or directly obtained through completed interviews. After the completion of interviews, only 69 participating contractors were missing an estimate of number employees—eight large contractors, 34 small contractors and 27 unknown contractors. In order to calculate weights for these contractors with missing employee counts we assigned these records employee counts based on the average number for their size category. For large participating contractors we averaged the number of employees for 15 large participating contractors and 75 large non-participating contractors. For small participating contractors we averaged the number of employees for 66 small participating contractors and 796 non-participating contractors. For ‘unknown’ size participating contractors we calculated a weighted average number of employees based on the proportion of large and small contractors in the sample. The resulting averages are presented in Table 3-7.

**Table 3-7:
Participating Contractors Employee Adjustments**

Size	Number of Records	Number Missing Employee Count	Average Number of Employees
All	183	69	n/a
<i>Large</i>	23	8	45
<i>Small</i>	100	34	8
<i>Unknown</i>	60	27	11

Table 3-8 shows the proportion of the population and sample of distributors, participating contractors, and non-participating by number of employees.

**Table 3-8:
Number of Employees: Population vs. Sample**

# of Employees	Distributors		Participating Contractors		Non-Participating Contractors	
	Population	Sample	Population	Sample	Population	Sample
1 to 10	60%	34%	64%	53%	77%	77%
11 to 20	--	--	17%	25%	19%	8%
21 to 30	7%	17%	7%	6%	3%	--
31 to 40	7%	17%	1%	--	1%	8%
41 to 50	--	--	7%	6%	1%	--
51 to 60	--	--	1%	--	--	--
61 to 70	--	--	1%	--	--	--
71 to 80	14%	34%	1%	--	<1%	8%
81 to 90	--	--	--	--	--	--
91 to 100	--	--	--	--	--	--
100 or more	14%	--	3%	9%	--	--
Number of Firms	15	6	183	32	388	13

3.3.2 Weights

Because of the relatively small population of distributors (15), and the fact that we only completed six interviews with distributors, we elected to present all distributor results unweighted. For contractors we calculated two sets of weights (1) a participant and nonparticipant weight and (2) an overall weight. The participant weights are applied when presenting results only for participants; likewise for nonparticipants. The overall weights are applied when presenting results for all contractors.

For each employee size segment, the weights were calculated by dividing the proportion of the population by the proportion of the sample. Table 3-9 shows the weights applied for tables that present weighted results.

**Table 3-9:
Contractor Sample Weights**

Participation Status	Number of Employees	Population	Sample	Participant / Nonparticipant Weight	Overall Weight
Participants	All	183	32	n/a	n/a
	1 to 10	117	17	1.203	0.542
	11 to 20	36	8	0.787	0.355
	21 to 100	26	4	1.137	0.512
	101 or more	4	3	0.233	0.105
Nonparticipants	All	388	13	n/a	n/a
	1 to 20	371	11	1.130	2.658
	21 or more	17	2	0.285	0.670

4. Survey Results

This section presents the results of the vendor interviews in three sections: respondent & firm characterization, market penetration, and market characterization.

4.1 Respondent & Firm Characterization

As Table 4-1 shows, the vast majority of respondents (81%) act in a management capacity at their company—59 percent are either the owner or president of their respective companies and 22 percent are managers. In keeping with their positions, their responsibilities consist primarily of management duties (31%), varied responsibilities (26%), and office work (20%) (Table 4-2). These positions and responsibilities are in keeping with the small size of most companies (Table 4-3); for the most part, the responding firms were smaller companies so it is likely that employees have multiple responsibilities.

**Table 4-1:
Title or Position of Respondents**

Position	Distributors (unweighted)	Contractors (unweighted)	All Respondents (unweighted)
Owner/President	33%	62%	59%
VP/Manager	50%	18%	22%
Sales/Business Development	17%	2%	4%
Engineering/Operations/Project Management		13%	12%
Secretary/Office Manager		4%	4%
Number of Respondents	6	45	51

**Table 4-2:
Responsibilities of Respondents**

Responsibilities	Respondents (unweighted)
Project/personnel management	31%
Many responsibilities	26%
Office work	20%
Office and Fieldwork	6%
Sales and business development	6%
Operations	4%
Estimating/scheduling	2%
Design and build	2%
No answer	4%
Number of Respondents	51

As Table 4-3 shows, the number of employees varies widely among respondents. On average, non-participating contractors are relatively smaller compared to participating contractors. The differences are driven largely by three very large participating contractors. These three participating contractors have 265, 270 and 320 employees. In comparison, the largest non-participating contractor interviewed has 75 employees. It should be noted that the differences in number of employees is consistent with the population of contractors as presented in Table 3-8 in section 3.3.

**Table 4-3:
Number of Employees**

Number of Employees	Distributors (unweighted)	Contractors (unweighted)		
		Participants	Nonparticipants	Overall
Average	36.2	37.8	13.5	30.8
Median	27.5	9.5	7.0	8.0
Minimum	6.0	2.0	2.0	2.0
Maximum	74.0	320.0	75.0	320.0
Number of Respondents	6	32	13	45

Table 4-4 displays the percent of business that is in the C&I sector, as opposed to the residential sector. The average C&I percentage is 64 percent for contractors, and 49 percent

for distributors. Because respondents were screened out who had less than 20 percent C&I work, the minimum value is 20 percent.

**Table 4-4:
Percent C&I Work**

Number of Employees	Distributors (unweighted)	Contractors (unweighted)		
		Participants	Nonparticipants	Overall
Average	49%	64%	62%	64%
Median	33%	60%	60%	60%
Minimum	25%	20%	20%	20%
Maximum	97%	100%	100%	100%
Number of Respondents	6	32	13	45

Interviewed vendors sell and install HVAC equipment to a variety of end use sectors. Offices rank highest for distributors (35%) and contractors (25%), followed by retail/restaurant (18% each), and institutions (12% distributors, 24% contractors). When contractor results are weighted, the relative proportion of sales by sector remains similar (Table 4-5).

**Table 4-5:
Percent of C&I Business by End Use Sector**

Sector	Distributors (unweighted)	Contractors	
		Unweighted	Weighted
Office	35%	25%	24%
Retail/restaurant	18%	18%	14%
Hotel/motel	13%	9%	4%
School/hospital/institutional	12%	24%	29%
Industrial/manufacturing	8%	16%	20%
Other	15%	8%	8%
Number of Respondents	6	45	45

Distributors interviewed said that slightly more than one-half of their C&I business comes from either new construction or major renovation projects (54%). Similarly, contractors interviewed said that nearly one-half of their business comes from new construction or major renovation projects (47%). Not surprisingly, contractors reported relatively more business from maintenance and service calls (about 30%) compared with distributors (5%). The proportion of

sales by type of work remains relatively unchanged when contractor responses are weighted (Table 4-6).

**Table 4-6:
Percent of C&I Business by Type of Work**

Type of Work	Distributors (unweighted)	Contractors	
		Unweighted	Weighted
Replacement of existing HVAC equipment	41%	22%	22%
New construction	32%	17%	15%
Major renovation and remodeling projects	22%	30%	34%
Maintenance and service calls	5%	31%	29%
Number of Respondents	6	45	45

4.2 Market Penetration

In order to estimate the market penetration of energy efficient HVAC equipment, respondents were asked a nested series of questions for each technology. Each respondent was first asked to estimate the volume of HVAC equipment sold (for distributors) or installed (for contractors) in Massachusetts in 2011. Respondents were then asked to estimate the percent of units that met or exceeded program energy efficiency requirements. In addition, participating respondents were asked to estimate the percent of program-eligible energy efficient equipment that received program incentives. In order to assess the degree of program influence on the sales or installation of eligible energy efficient equipment, participants were also asked to estimate the percent of eligible equipment that would have been sold or installed if the program incentives had not been available.

While all six distributor respondents reported estimates of market penetration, only three were willing to provide the volume of sales for their company. Because this is key information for the analysis, we assumed all six distributors sold an equal number of units based on the average number of sales for the three distributors who did provide sales numbers.

In contrast, all 45 of the contractors provided estimates of sales volume. Therefore, when calculating the market penetration for all contractors, we take into account, for each contractor, the number of units installed as well as the market penetration of energy-efficient models.

4.2.1 Threats to Validity

Studies that are based upon self-reported data collected through surveys face a variety of threats to validity. In this section, we discuss these threats and assess how they may affect the results of this study.

- **Reporting Error.** Because respondents answered our sales and market share questions without consulting their records, there is the possibility of reporting error. This might be more evident for contractors than distributors, as several reviewers believe that distributors maintain better records than contractors and therefore may provide more accurate figures. However, we believe that respondents who over-estimate sales figures are likely counterbalanced by those who under-estimate sales figures, leading to overall results that should be relatively free of reporting error. This counterbalancing effect is more likely among contractors than distributors, because we interviewed relatively few distributors. Without the ability to cross-check responses with actual sales records it is not possible to definitively estimate the degree of reporting error. In anticipation of this issue, we asked all respondents to estimate an error band surrounding their sales figures. As presented in section 4.2.3, on average distributors and contractors estimated an error band of 8 percent and 12 percent, respectively. While this may suggest the scale of reporting error, we have no evidence to indicate that this reporting error would bias the market share estimates in any one direction.
- **Self-Selection Bias.** Vendors who elected to respond to our survey may be inherently different than those vendors who did not respond. It is possible that vendors who are more interested in energy efficiency (among all respondents) or are more invested in the MassSave program (among participants) may be more likely to respond. These respondents may be more likely to sell a higher proportion of energy efficient units, which may inflate the market share estimates. Because of a high rate of both refusals and non-response, the interview completion rate was low - about 5 percent overall. However, we completed interviews with six of the estimated fifteen distributors (40%) that sell C&I HVAC equipment in Massachusetts. In contrast, we completed interviews with 32 of the estimated 183 participating C&I HVAC contractors (18%) and 13 of the estimated 388 nonparticipating C&I HVAC contractors (4%). These factors indicate that self-selection bias could be an issue for contractors, particularly for nonparticipants, but is probably not an issue for distributors.

- **Sampling Error.** In section 3.2, we provide the estimates of sampling errors. Because each respondent did not sell every type of equipment, the sampling error varies by equipment type. For contractors, sampling error at the 90% confidence level ranges from 20 percent to 34 percent. For distributors, sampling error ranges from 32 percent to 81 percent.

4.2.2 Interpretation of Results

In this section we present a summary of our approach in interpreting the results of the market share estimates. Because some of the interviewed contractors may purchase equipment from some of the interviewed distributors, we do not think it is reasonable to combine the distributor estimates and contractor estimates into a single set of market penetration estimates.

Therefore, we present the results separately.

However, this approach poses an issue when the market penetration estimates provided by distributors differ from those provided by contractors. In addition, we have two potential estimates of baseline energy efficient sales for contractors – those estimates provided by participants in the absence of program incentives and those provided by nonparticipants. We delve into each of these issues in more detail in this section.

4.2.2.1 Distributor and Contractor Divergence

In our discussion of the results, we have more confidence in, and therefore place more emphasis on, market penetration results where the estimates from both distributors and contractors converge. In cases where the market penetration estimates provided by distributors and contractors diverge, we have less confidence in the results and therefore place less emphasis on the results because it is unclear which estimates are more accurate. There are reasons to believe the contractor results are more accurate, but also reasons to believe the distributor results are more accurate.

First we discuss the arguments in favor of the contractor results. As noted in section 4.2.1, the sampling error for the contractor interviews is lower than for distributors for all equipment types. In addition, because all of the contractors were willing to provide sales figures, our analysis of market penetration for contractors takes into account their differing sales volumes. In contrast, only three of the six distributors were willing to provide sales figures, although all six provided estimates of market penetration. Therefore in order to calculate market share, we assumed

each distributor sold an equal number of units based on the three distributors who did provide sales figures.

However, there are also several arguments in favor of the distributor results. While there were far fewer distributor respondents (6) than contractor respondents (45), we estimate that these six distributors represent 40 percent of the C&I HVAC distributor population in Massachusetts. In addition, because distributors typically serve many contractors, each respondent represents a much larger share of the market. In addition, as several reviewers pointed out, it is possible that distributors, who by necessity must closely monitor demand to provide adequate stock, may maintain more accurate records than do contractors.

In cases where the market penetration estimates provided by the distributors and contractors diverge, we do not have sufficient evidence to clearly state which estimate is likely more accurate. In these cases, we simply recommend interpreting the results that diverge with less confidence than the results that converge.

4.2.2.2 Baseline Market Penetration Estimates

As discussed in section 3.1.1, distributors generally do not fill out rebate application forms and are therefore removed from direct program participation. Therefore, the distributor respondents were not able to estimate the percent of program-qualifying equipment that would have been sold in the absence of the program incentives. Thus, the contractors provide the sole source of estimates regarding baseline market penetration.

We have two estimates of baseline market penetration from contractors. Participating contractors were asked to estimate the percent of program-qualifying equipment that would have been sold in the absence of program incentives. In addition, nonparticipating contractors were asked to estimate the percent of program-qualifying equipment that they sold.

We employ a similar approach as described in section 4.2.2.1. We have more confidence in, and therefore place more emphasis on, baseline market penetration results where the estimates from both participating and nonparticipating contractors converge. In cases where the market penetration estimates diverge, we have less confidence in the results and therefore place less emphasis on the results because it is unclear which estimates are more accurate.

While the participating contractors may have a good sense of the effect of program rebates on sales, they also may have an incentive to “game” their response by under-estimating baseline

market penetration in order to overstate program influence. In contrast, as discussed in section 4.2.1, nonparticipating contractors could suffer from self-selection bias, which may result in inflated estimates of baseline market penetration. In addition, there is the possibility that that the programs have influenced nonparticipants to sell a higher share of energy efficient equipment than otherwise would have occurred because their competitors and customers have all shifted towards energy efficiency (i.e. nonparticipant spillover). In this case the market penetration estimates may not reflect the actual baseline in the absence of the program.

Overall, these issues indicate that participants may tend to under-estimate the program baseline but that nonparticipants may tend to over-estimate the baseline. Therefore, in cases where the estimates diverge, we recommend that the two estimates may represent a lower-bound estimate and upper-bound estimate of baseline market penetration.

4.2.3 Self-reported Error Band

Because, for the most part, the respondents answered detailed sales questions without consulting actual sales records, they were first asked to estimate the error band surrounding their sales figures (Table 4-7). On average, distributors estimated an error band of 8 percent and contractors 12 percent; the median value for both groups was 10 percent. Given the types of questions being asked, this seems to be a reasonable level of accuracy.

**Table 4-7:
Self-Reported Error Band**

	Distributors (unweighted)	Contractors (unweighted)		
		Participants	Nonparticipants	Overall
Average	8%	12%	12%	12%
Median	10%	10%	11%	10%
Minimum	0%	5%	5%	5%
Maximum	15%	50%	20%	50%
Number of Respondents	6	32	13	45

4.2.4 Air-cooled Unitary Air-Conditioning and Split Systems

Table 4-8 displays the results for “rooftop” air-conditioning (AC) units <5.4 tons in size sold or installed by respondents in Massachusetts in 2011. Note that only 32 of the 45 contractors

reported installing these <5.4 ton rooftop units. Due to different weighting schemes (see section 3.3.2) employed for the participating contractors, the nonparticipating contractors, and all contractors together, the number of rooftop units sold by all contractors shown in Table 4-8 does not equal the sum of units sold by participating contractors and nonparticipating contractors.

Overall, contractors reported that 57 percent of AC units met program efficiency requirements, which is similar to the 64 percent figure provided by distributors. In addition, the 23 participating contractors reported a substantially higher market penetration (80%) than did the nine nonparticipating contractors (35%). This 35 percent figure is supported by the fact that participating contractors estimated the market penetration would have been 36 percent without any program incentives. In addition, we calculate that 39 percent of the units sold outside the program (i.e., without program incentives) by all contractors met program efficiency requirements¹³. This figure lends further credence to the notion that the baseline market penetration estimate is about 35 percent to 39 percent.

Lastly, participating contractors estimated that about three-quarters (76%) of eligible units received program incentives. Overall, it appears that about one-half of all eligible units (52%) sold by both participating and nonparticipating contractors received program incentives. As discussed earlier, because distributors typically do not deal directly with customers, they were unable to consistently estimate the percent of eligible units that received a program incentive.

These results suggest that the overall market penetration of energy efficient rooftop AC units <5.4 tons is approximately 57 percent to 64 percent, and that the program does appear to increase market penetration from about 35 to 39 percent to 80 percent for participants.

¹³ The 39% figure was calculated by dividing (1) the number of program-qualifying units sold that did not receive a program incentive by (2) the number of total units sold excluding those that received a program incentive. A similar approach was used for other measures in this report.

**Table 4-8:
Market Penetration for Rooftop AC Systems < 5.4 tons**

	Distributors (unweighted)	Contractors (weighted)		
		Participants	Nonparticipants	Overall
Number of ≤ 5.4 ton systems sold in 2011	11,400	586	117	539
Percent of ≤ 5.4 ton systems at or above 14 SEER & 12 EER ¹	64%	80%	35%	57%
Number of Respondents	6	23	9	32
Estimated percent of ≤ 5.4 ton systems that would have been sold at or above 14 SEER & 12 EER ¹ without program incentive	n/a*	36%	35%	36%
Percent of ≤ 5.4 ton systems at or above 14 SEER & 12 EER ¹ that received program incentive	n/a*	76%	0%	52%
Percent of ≤ 5.4 ton systems sold outside the program at or above 14 SEER & 12 EER ¹	n/a*	49%	35%	39%
Number of Respondents	n/a*	23	9	32

¹ 14 SEER & 12 EER for split systems; 14 SEER & 11.6 EER for packaged systems.

* Distributor respondents were too removed from customers to be able to estimate the percent of units that received a rebate or the market penetration in the absence of the rebates.

Table 4-9 displays the responses for rooftop AC units ≥ 5.4 tons to < 20 tons in size sold or installed by respondents in Massachusetts in 2011. Note that only five of the six distributors and 24 of the 45 contractors reported selling or installing rooftop AC units of this size.

Overall, contractors reported that 55 percent of AC units met program efficiency requirements, which is similar to the 62 percent figure provided by distributors. However, the 17 participating contractors reported a somewhat lower market penetration (51%) than did the seven nonparticipating contractors (69%). In addition, the participating contractors estimated the market penetration would have been 15 percent without any program incentives. Lastly, participating contractors estimated that about one-half (56%) of eligible units received program incentives; overall about one-third (31%) of all eligible units sold by both participating and nonparticipating contractors received program incentives.

These results suggest that the overall market penetration of energy efficient rooftop AC units ≥ 5.4 tons to < 20 tons in size is approximately 55 percent to 62 percent. However, it is unclear to what extent the program increases market penetration, as the nonparticipants reported higher market penetration than did participants (69% vs. 51%) although participants estimated 15 percent market penetration in the absence of program incentives. In addition, we calculate that 46 percent of the units sold outside the program (i.e., without program incentives) by all contractors met program efficiency requirements.



**Table 4-9:
Market Penetration for Rooftop AC Systems ≥ 5.4 to < 20 tons**

	Distributors (unweighted)	Contractors (weighted)		
		Participants	Nonparticipants	Overall
Number of ≥ 5.4 to < 20 ton systems sold in 2011	915	455	54	333
Percent of ≥ 5.4 to < 20 ton systems at or above 11.5 EER	62%	51%	69%	55%
Number of Respondents	5	17	7	24
Estimated percent of ≥ 5.4 to < 20 ton systems that would have been sold at or above 11.5 EER without program incentive	n/a*	15%	69%	36%
Percent of ≥ 5.4 to < 20 ton systems at or above 11.5 EER that received program incentive	n/a*	56%	0%	31%
Percent of ≥ 5.4 to < 20 ton systems sold outside the program at or above 11.5 EER	n/a*	31%	69%	46%
Number of Respondents	n/a*	17	7	24

* Distributor respondents were too removed from customers to be able to estimate the percent of units that received a rebate or the market penetration in the absence of the rebates.

Table 4-10 displays the responses for rooftop AC units ≥ 20 tons in size sold or installed by respondents in Massachusetts in 2011. Note that only four of the six distributors and 23 of the 45 contractors reported selling or installing rooftop AC units of this size.

Overall, contractors reported that 63 percent of AC units met program efficiency requirements, which is substantially greater than the 27 percent figure provided by distributors. Both participating contractors and nonparticipating contractors reported similar market penetration estimates – 59 percent and 65 percent, respectively. Participating contractors estimated the market penetration would have been 32 percent without any program incentives. Lastly, participating contractors estimated that three-quarters of eligible units received program incentives; overall about 28 percent of all eligible units sold by both participating and nonparticipating contractors received program incentives.

The distributor results suggest that overall market penetration of energy efficient rooftop AC units ≥ 20 tons in size is about 27 percent, whereas the contractor results indicate it is approximately 63 percent. In addition, it is unclear to what extent the program boosts market penetration, as the participating and nonparticipating contractors reported similar levels of market penetration (59%-65%), although participants reported 32 percent market penetration in the absence of program incentives. In addition, we calculate that 55 percent of the units sold outside the program (i.e., without program incentives) by all contractors met program efficiency requirements.

**Table 4-10:
Market Penetration for Rooftop AC Systems ≥ 20 tons**

	Distributors (unweighted)	Contractors (weighted)		
		Participants	Nonparticipants	Overall
Number of ≥ 20 ton systems sold in 2011	600	170	49	192
Percent of ≥ 20 ton systems at or above 11.5 EER	27%	59%	65%	63%
Number of Respondents	4	14	9	23
Estimated percent of ≥ 20 ton systems that would have been sold at or above 11.5 EER without program incentive	n/a*	32%	65%	52%
Percent of ≥ 20 ton systems at or above 11.5 EER that received program incentive	n/a*	75%	0%	28%
Percent of ≥ 20 ton systems sold outside the program at or above 11.5 EER	n/a*	26%	65%	55%
Number of Respondents	n/a*	14	9	23

* Distributor respondents were too removed from customers to be able to estimate the percent of units that received a rebate or the market penetration in the absence of the rebates.

Table 4-11 displays the reasons why some eligible energy-efficient rooftop units did not receive program incentives. For the most part, participating contractors indicated that it is the customer’s responsibility to complete the paperwork, and therefore vendors may not always know if a program incentive is received. However, according to one participating contractor, knowledge of the program and willingness to fill out the forms can be seen as an advantage to the customer. He went on to say that, “[We] have won contracts because of knowledge of the program and rebates. [We] won a job in 2012 because we filled out the paperwork for the customer.”

In addition, respondents noted that their municipal customers are not eligible (presumably they are served by a municipal utility). Other respondents mentioned that the replacement happens too fast to obtain a rebate or the programs exhausted funding.

**Table 4-11:
Reasons Qualifying Rooftop AC Systems Did Not Receive a Program Incentive**

Reasons	Participants (unweighted)
Customers handle that	2
Customers did not want to do the paperwork	2
Municipalities not eligible	2
Replacement happened too fast to plan to get rebate	1
Utility company was out of money	1
Rooftop systems don’t get incentives	1
Don’t know	4
Number of Respondents	13

4.2.5 Natural Gas Furnaces

Table 4-12 displays the responses for natural gas furnaces sold or installed by respondents in Massachusetts in 2011. Note that only three of the six distributors though 32 of the 45 contractors reported selling or installing natural gas furnaces.

Overall, contractors reported that 79 percent of furnaces met the lower level of program efficiency requirements (94% AFUE with ECM motor), which is much higher than the 33 percent figure provided by distributors. The 23 participating contractors reported a slightly higher market penetration (85%) than did the nine nonparticipating contractors (75%). The participating contractors estimated the market penetration would have been 47 percent without any program incentives. Lastly, participating contractors estimated that most all eligible furnaces (87%) received program incentives; overall about 37 percent of all eligible units sold by both participating and nonparticipating contractors received program incentives.

These distributor results suggest that overall market penetration of 94% AFUE gas furnaces is about 33 percent, whereas the contractor results indicate it is approximately 79 percent. It appears that the programs impact on market penetration is unclear as the participating contractors reported only slightly higher penetration than the nonparticipants (85% vs. 75%), although participants estimated 47 percent market penetration in the absence of program incentives. In addition, we calculate that 70 percent of the units sold outside the program (i.e., without program incentives) by all contractors met program efficiency requirements.

**Table 4-12:
Market Penetration for 94% AFUE Natural Gas Furnaces with ECM Motor**

	Distributors (unweighted)	Contractors (weighted)		
		Participants	Nonparticipants	Overall
Number of natural gas furnaces sold in 2011	1650	480	142	551
Percent of natural gas furnaces at or above 94% AFUE	33%	85%	75%	79%
Number of Respondents	3	23	9	32
Estimated percent of natural gas furnaces that would have been sold at or above 94% AFUE without program incentive	n/a*	47%	75%	64%
Percent of natural gas furnaces at or above 94% AFUE that received program incentive	n/a*	87%	0%	37%
Percent of natural gas furnaces sold outside the program at or above 94% AFUE	n/a*	42%	75%	70%
Number of Respondents	n/a*	22	9	32

* Distributor respondents were too removed from customers to be able to estimate the percent of units that received a rebate or the market penetration in the absence of the rebates.

Overall, contractors reported that 62 percent of natural gas furnaces met the higher level of program efficiency requirements (96% AFUE with ECM motor), which is much higher than the 29 percent figure provided by distributors (Table 4-13). The 23 participating contractors reported a lower market penetration (51%) than did the nine nonparticipating contractors (70%). The participating contractors estimated the market penetration would have been 33 percent without any program incentives. Lastly, participating contractors estimated that nearly all eligible furnaces (96%) received program incentives; overall about 31 percent of all eligible units sold by both participating and nonparticipating contractors received program incentives.

The distributor results suggest that overall market penetration of 96% AFUE gas furnaces is about 29 percent, whereas the contractor results indicate it is approximately 62 percent. It is unclear to what extent the program increases market penetration, as nonparticipating contractors reported higher market penetration than did participants (70% vs. 51%) although participants estimated 33 percent market penetration in the absence of program incentives. In addition, we calculate that 53 percent of the units sold outside the program (i.e., without program incentives) by all contractors met program efficiency requirements.

**Table 4-13:
Market Penetration for 96% AFUE Natural Gas Furnaces with ECM motor**

	Distributors (unweighted)	Contractors (weighted)		
		Participants	Nonparticipants	Overall
Number of natural gas furnaces sold in 2011	1650	480	142	551
Percent of natural gas furnaces at or above 96% AFUE	29%	51%	70%	62%
Number of Respondents	3	23	9	32
Estimated percent of natural gas furnaces that would have been sold at or above 96% AFUE without program incentive	n/a*	33%	70%	55%
Percent of natural gas furnaces at or above 96% AFUE that received program incentive	n/a*	96%	0%	31%
Percent of natural gas furnaces sold outside the program at or above 96% AFUE	n/a*	4%	70%	53%
Number of Respondents	n/a*	23	9	32

* Distributor respondents were too removed from customers to be able to estimate the percent of units that received a rebate or the market penetration in the absence of the rebates.

Table 4-14 displays the reasons why some program eligible energy-efficient gas furnaces did not receive program incentives. For the most part, participating contractors indicated that customers did not follow through and apply for rebates or that the rebates were not worth the extra money to purchase an ECM motor for units that would otherwise qualify.

**Table 4-14:
Reasons Qualifying Gas Furnaces Did Not Receive a Program Incentive**

	Participants (unweighted)
Lack of follow through from customers	3
Administrative problems with the program	1
Number of Respondents	4

4.2.6 Condensing Gas Boilers

Table 4-15 displays the responses for condensing gas boilers <300 MBH in size sold or installed by respondents in Massachusetts in 2011. Note that none of the distributors though 32 of the 45 contractors reported installing condensing gas boilers <300 MBH in size.

Overall, contractors reported that 94 percent of condensing gas boilers met program efficiency requirements (90% AFUE). However, the 26 participating contractors reported a slightly lower market penetration (90%) than did the six nonparticipating contractors (100%). In addition, the participating contractors estimated the market penetration would have been 25 percent without any program incentives. Lastly, participating contractors estimated that most all (88%) of the eligible boilers received program incentives. When these participant sales are combined with the nonparticipant sales, overall about 57 percent of all eligible units sold received program incentives.

These results suggest that overall market penetration of condensing gas boilers <300 MBH is about 94 percent. In addition, the nonparticipants reported higher market penetration than did participants (100% vs. 90%) even though participants estimated 25 percent market penetration in the absence of program incentives. In addition, we calculate that 87 percent of the units sold outside the program (i.e., without program incentives) by all contractors met program efficiency requirements.

**Table 4-15:
Market Penetration for Natural Gas Condensing Boilers Up To 300MBH**

	Distributors (unweighted)	Contractors (weighted)		
		Participants	Nonparticipants	Overall
Number of natural gas condensing boilers sold in 2011	n/a	397	36	264
Percent of boilers at or above 90% AFUE	n/a	90%	100%	94%
Number of Respondents	n/a	26	6	32
Estimated percent of boilers that would have been sold at or above 90% AFUE without program incentive	n/a	25%	100%	49%
Percent of boilers at or above 90% AFUE that received program incentive	n/a	88%	0%	57%
Percent of boilers sold outside the program at or above 90% AFUE	n/a	52%	100%	87%
Number of Respondents	n/a	25	6	32

Table 4-16 displays the responses for condensing gas boilers >300 MBH in size sold or installed by respondents in Massachusetts in 2011. Note that none of the distributors though 24 of the 45 contractors reported installing condensing gas boilers >300 MBH in size.

Overall, contractors reported that 91 percent of condensing gas boilers met program efficiency requirements. However, the 19 participating contractors reported a somewhat lower market penetration (84%) than did the five nonparticipating contractors (99%). In addition, the participating contractors estimated the market penetration would have been 41 percent without any program incentives. Lastly, participating contractors estimated that most all (92%) of the eligible boilers received program incentives; overall about 45 percent of all eligible units sold by both participating and nonparticipating contractors received program incentives.

These results suggest that overall market penetration of condensing gas boilers >300 MBH is about 91 percent. Given the high market penetration and the fact that nonparticipants reported higher market penetration than did participants (99% vs. 84%) it is unclear if the program boosts market penetration, even though participants estimated 41 percent market penetration in the absence of program incentives. In addition, we calculate that 85 percent of the units sold outside the program (i.e., without program incentives) by all contractors met program efficiency requirements.

Table 4-16:

Market Penetration for Natural Gas Condensing Boilers Greater Than 300MBH

	Distributors (unweighted)	Contractors (weighted)		
		Participants	Nonparticipants	Overall
Number of natural gas condensing boilers sold in 2011	n/a	175	29	146
Percent of boilers at or above 90% thermal efficiency	n/a	84%	99%	91%
Number of Respondents	n/a	19	5	24
Estimated percent of boilers that would have been sold at or above 90% thermal efficiency without program incentive	n/a	41%	99%	68%
Percent of boilers at or above 90% thermal efficiency that received program incentive	n/a	92%	0%	45%
Percent of boilers sold outside the program at or above 90% thermal efficiency	n/a	30%	99%	85%
Number of Respondents	n/a	19	5	24

Table 4-17 displays the reasons why some program eligible energy-efficient condensing gas boilers did not receive program incentives. Two participating contractors gave a response to the question. One indicated that the customers were waiting for rebates to be processed and the other reported that the unit was replaced.

Table 4-17:

Reasons Qualifying Gas Condensing Boilers Did Not Receive a Program Incentive

Reasons	Participants (unweighted)
Still waiting for incentive processing	1
Unit was replaced due to customer space constraints	1
Don't know	2
Number of Respondents	4

4.2.7 Dual Enthalpy Economizers

Table 4-18 displays the responses for dual enthalpy economizers sold or installed by respondents in Massachusetts in 2011. Note that five of the six distributors and 19 of the 45 contractors reported selling or installing dual enthalpy economizers. Because of the program requirement that dual enthalpy economizers be installed only with qualifying HVAC equipment, this question series may have been more difficult for respondents to accurately answer. In addition, dual enthalpy economizers are sophisticated equipment and the interviews did not cover commissioning. Therefore we have no information regarding whether or not the units were installed and operating properly.

Overall, contractors reported that 45 percent of rooftop AC units sold or installed included a dual enthalpy economizer. The 11 participating contractors reported a market penetration of 12 percent, compared to 80 percent for the eight nonparticipants. Distributors reported that market penetration was only 2 percent.

According to contractors, nine percent of dual enthalpy economizers met program efficiency requirements, which is much lower than the 52 percent figure provided by distributors. In order to qualify for a program incentive, the economizers must have been installed with new program-qualifying HVAC equipment. The participating contractors estimated that 61 percent of dual enthalpy economizers were program eligible and 43 percent in the absence of program incentives. Lastly, participating contractors estimated that most all of the eligible economizers (89%) received program incentives; overall about 84 percent of all eligible units sold by both participating and nonparticipating contractors received program incentives.

These distributor results suggest that overall market penetration of dual enthalpy economizers is about 2 percent, whereas the contractor results indicate it is about 45 percent. It is unclear whether the program has any impact on market penetration, as the nonparticipating contractors reported substantially higher market penetration than did participants (80% vs. 12%). In addition, we calculate that 2 percent of the units sold outside the program (i.e., without program incentives) by all contractors met program efficiency requirements.

Table 4-18:
Market Penetration for Dual Enthalpy Economizers

	Distributors (unweighted)	Contractors (weighted)		
		Participants	Nonparticipants	Overall
Number of rooftop AC units sold in 2011	12,915	1,211	220	1,064
Number of Respondents	6	23	9	32
Number of dual enthalpy economizers sold in 2011	300	140	175	475
Percent of rooftop AC units with dual enthalpy economizer	2%	12%	80%	45%
Percent of dual enthalpy economizers qualifying for a rebate	52%	61%	1%	9%
Number of Respondents	5	11	8	19
Estimated percent of dual enthalpy economizers that would have been program-qualified without program incentive	n/a*	43%	1%	30%
Percent of eligible dual enthalpy economizers that received program incentive	n/a*	89%	0%	84%
Percent of rooftop AC units with dual enthalpy economizer sold outside the program	n/a*	15%	1%	2%
Number of Respondents	n/a*	11	8	19

* Distributor respondents were too removed from customers to be able to estimate the percent of units that received a rebate or the market penetration in the absence of the rebates.

4.2.8 Demand Control Ventilation

Table 4-19 displays the responses for demand control ventilation (DCV) sold or installed by respondents in Massachusetts in 2011. Note that five of the six distributors but only 12 of the 45 contractors reported selling or installing DCV. Respondents were asked to provide responses for qualifying DCVs installed with new program-qualifying HVAC equipment. In addition, respondents were told that DCV were ineligible for rebates if required by code. Because of these additional caveats this question series may have been confusing to respondents and therefore more difficult for respondents to accurately answer.

Overall, contractors reported that 34 percent of rooftop AC units sold or installed included a DCV. The eight participating contractors reported a market penetration of 32 percent, compared to 36 percent for the four nonparticipants.

Overall, contractors reported that 47 percent of DCV units met program efficiency requirements, which is similar to the 46 percent figure provided by distributors. In order to qualify for a program incentive, the DCV must have been installed with new program-qualifying HVAC equipment. In addition, DCV units are ineligible for rebates if required by code – i.e., new construction spaces greater than 500 square feet. The eight participating contractors reported that 98 percent were program eligible, but estimated this figure would drop to one percent without any program incentives. Lastly, participating contractors estimated that all (100%) of the eligible DCV units received program incentives; overall about 99 percent of all eligible units sold by both participating and nonparticipating contractors received program incentives.

The distributor results suggest that overall market penetration of DCV is about 1 percent, whereas the contractor results indicate it is about 34 percent. It is unclear if the program has impacted market penetration, as the nonparticipating contractors reported slightly higher market penetration than did participants (36% vs. 32%). In addition, we calculate that none of the units sold outside the program (i.e., without program incentives) by all contractors met program efficiency requirements.

**Table 4-19:
Market Penetration for Demand Control Ventilation**

	Distributors (unweighted)	Contractors (weighted)		
		Participants	Nonparticipants	Overall
Number of Rooftop AC unit sold in 2011	12,915	1,211	220	1,064
Number of Respondents	6	23	9	32
Number of demand control ventilation sold in 2011	150	383	80	361
Percent of rooftop AC units with demand control ventilation	1%	32%	36%	34%
Percent of demand control ventilation units qualifying for a rebate	46%	98%	0%	47%
Number of Respondents	5	8	4	12
Estimated percent of demand control ventilation units that would have been program-qualified without program incentive	n/a*	1%	0%	<1%
Percent of eligible demand control ventilation units that received program incentive	n/a*	100%	0%	99%
Percent of rooftop AC units with demand control ventilation sold outside the program	n/a*	0%	0%	0%
Number of Respondents	n/a*	8	4	12

* Distributor respondents were too removed from customers to be able to estimate the percent of units that received a rebate or the market penetration in the absence of the rebates.

4.2.9 ECM Fan Motors

Table 4-20 displays the responses for ECM fan motors sold or installed by respondents in Massachusetts in 2011. Note that all six distributors but only 14 of the 45 contractors reported selling or installing ECM fan motors. Respondents were asked to provide responses for qualifying ECM fan motors installed with new program-qualifying HVAC equipment. Because of the additional requirement that ECM fan motors be installed with qualifying equipment this question series may have been more difficult for respondents to accurately answer.

Overall, contractors reported that 41 percent of rooftop AC units sold or installed included an ECM fan motor. The nine participating contractors reported a market penetration of 47 percent,



compared to 35 percent for the five nonparticipants. The distributors estimated that only 9 percent of rooftop units included an ECM fan motor.

Overall, contractors reported that 54 percent of ECM motors met program efficiency requirements, which is similar to the 58 percent figure provided by distributors. In order to qualify for a program incentive, the ECM motors must have been installed with new program-qualifying HVAC equipment. The nine participating contractors reported that 84 percent were program eligible, but estimated this figure would drop to 34 percent without any program incentives. Lastly, participating contractors estimated that all of the eligible ECM motors received program incentives; overall about 85 percent of all eligible units sold by both participating and nonparticipating contractors received program incentives.

The distributor results suggest that overall market penetration of ECM fan motors is about 9 percent, whereas the contractor results indicate it is about 41 percent. It is unclear if the program has impacted market penetration, as the participating contractors reported slightly higher market penetration than did nonparticipants - 47 percent vs. 35 percent. In addition, we calculate that 15 percent of the units sold outside the program (i.e., without program incentives) by all contractors met program efficiency requirements.

**Table 4-20:
Market Penetration for ECM Fan Motors**

	Distributors (unweighted)	Contractors (weighted)		
		Participants	Nonparticipants	Overall
Number of rooftop AC units sold in 2011	12,915	1,211	220	1,064
Number of Respondents	3	23	9	32
Number of ECM fan motors sold in 2011	1,110	566	76	433
Percent of rooftop AC units with ECM fan motor	9%	47%	35%	41%
Percent of ECM fan motors qualifying for a rebate	58%	84%	12%	54%
Number of Respondents	6	9	5	14
Estimated percent of ECM fan motors that would have been program-qualified without program incentive	n/a*	34%	12%	25%
Percent of eligible ECM fan motors that received program incentive	n/a*	100%	0%	85%
Percent of ECM fan motors qualifying for a rebate sold outside the program	n/a*	0%	12%	15%
Number of Respondents	n/a*	9	5	14

* Distributor respondents were too removed from customers to be able to estimate the percent of units that received a rebate or the market penetration in the absence of the rebates.

4.2.10 7-day Programmable Thermostats

Table 4-21 displays the responses for 7-day programmable thermostats sold or installed by respondents in Massachusetts in 2011. Note that four of the six distributors and 25 of the 45 contractors reported selling or installing 7-day programmable thermostats. Respondents were asked to provide responses for qualifying 7-day programmable thermostats installed with new program-qualifying HVAC equipment. In addition, as one reviewer pointed out, thermostats are not applicable in buildings with central control systems; however our interviews did not delve into this issue. Because of these additional complexities this question series may have been more difficult for respondents to accurately answer.

Overall, contractors reported that 48 percent of HVAC systems sold or installed included a 7-day programmable thermostat. The 18 participating contractors reported a market penetration of 23 percent, compared to 71 percent for the seven nonparticipants. The distributors estimated that only 4 percent of HVAC systems included a 7-day programmable thermostat.

Overall, contractors reported that 75 percent of 7-day programmable thermostats met program efficiency requirements, which is higher than the 39 percent figure provided by distributors. In order to qualify for a program incentive, the thermostats must have been installed with new program-qualifying HVAC equipment. The 18 participating contractors reported that 82 percent were program eligible, but estimated this figure would drop to 70 percent without any program incentives. Lastly, participating contractors estimated that 75 percent of the eligible 7-day programmable thermostats received program incentives; overall about 19 percent of all eligible units sold by both participating and nonparticipating contractors received program incentives.

The distributor results suggest that overall market penetration of 7-day programmable thermostats is about 4 percent, whereas the contractor results indicate it is about 48 percent. It is unclear if the program has an impact on market penetration, as the participants reported much lower market penetration than did nonparticipants (23% vs. 71%). In addition, we calculate that 71 percent of the units sold outside the program (i.e., without program incentives) by all contractors met program efficiency requirements.

**Table 4-21:
Market Penetration for 7-day Programmable Thermostats**

	Distributors (unweighted)	Contractors (weighted)		
		Participants	Nonparticipants	Overall
Number of commercial HVAC systems sold in 2011	16,215	2,743	569	2,576
Number of 7-day programmable thermostats sold in 2011	600	631	404	1,235
Percent of HVAC systems with 7-day programmable thermostat	4%	23%	71%	48%
Percent of 7-day programmable thermostats qualifying for a rebate	39%	82%	73%	75%
Number of Respondents	4	18	7	25
Estimated percent of 7-day programmable thermostats that would have been program-qualified without program incentive	n/a*	70%	73%	72%
Percent of eligible 7-day programmable thermostats that received program incentive	n/a*	75%	0%	19%
Percent of 7-day programmable thermostats qualifying for a rebate sold outside the program	n/a*	53%	73%	71%
Number of Respondents	n/a*	18	7	25

* Distributor respondents were too removed from customers to be able to estimate the percent of units that received a rebate or the market penetration in the absence of the rebates.

Of the four participating contractors who reported that eligible dual enthalpy economizers or 7-day programmable thermostats did not receive program incentives, one said that customers handle the paperwork, two said the programmable thermostat rebate is not worth the effort, and a fourth said the 7-day programmable thermostats are required for commercial installations.

4.2.11 Opportunities for New Measures

Sixteen respondents (31%) believe there are technologies that could be incentivized by the Mass Save programs but are currently not eligible. Measures mentioned include chiller/induction units, geothermal heat pumps, insulation or air sealing, high AFUE furnaces without ECM motors, and more rebates for larger HVAC systems (Table 4-22). Interestingly, three of the measures mentioned—chillers, geothermal heat pumps, and larger systems—are already covered through the program. This may indicate an opportunity for better communication with vendors regarding the scope of program incentives. In addition, two of the measures mentioned—insulation and air sealing and co-generation boilers—are not directly related to HVAC measures and outside the scope of this evaluation.

**Table 4-22:
Technologies Suggested for Rebate**

Technology	Respondents (unweighted)
Chillers/induction units	2
Geothermal heat pumps	2
Insulation or sealing	2
High-AFUE furnaces without ECM fan motor	2
More rebates for larger systems	2
Ductless mini-splits	1
Communicating A/C systems	1
Co-generation boilers	1
Oil to gas conversion	1
Smart thermostats/mobile technology	1
Number of Respondents	15

4.3 Market Characterization

In order to gain a better understanding of market opportunities, particularly regarding emergency replacements, respondents were asked a series of market characterization questions. This section presents an overview of the responses to these questions.

4.3.1 Role of Manufacturers

Contractors interviewed said they purchase the majority (87%) of their commercial HVAC equipment from distributors versus directly from manufacturers (Table 4-23). While contractors were relatively more likely to purchase A/C units and controls from manufacturers than other types of equipment, they still reported purchasing about three-quarters of all equipment through distributors.

**Table 4-23:
Contractor Purchases by Source**

Equipment Type	Purchase from Distributor (weighted)				Number of Respondents
	Average	Median	Minimum	Maximum	
All equipment	87%	100%	0%	100%	45
A/C units	72%	100%	0%	100%	33
Gas furnaces	93%	100%	0%	100%	33
Condensing boilers	92%	100%	0%	100%	27
Controls	80%	100%	0%	100%	31
Programmable thermostats	97%	100%	0%	100%	25

Contractors were also asked how many, if any, of their customers (end users) purchase equipment directly from manufacturers. One-quarter of contractors said that some of their customers purchase equipment directly from manufacturers. When asked about the types of equipment customers purchase directly from manufacturers, eight mentioned rooftop units, two mentioned air handlers, and one each mentioned boilers, condensing gas boilers, or chillers.

4.3.2 Emergency Replacements

In order to gain a better understanding of the effect of emergency replacement situations on equipment selection, the interviews included a set of questions concerning customer requirements in emergency replacement conditions. For the purposes of the interviews, emergency replacements were defined as a situation where HVAC equipment must be replaced due to failure and where that failure might be a threat to occupant comfort, safety, and/or productivity.

4.3.2.1 Frequency

According to distributors and contractors, the majority of equipment replacements are planned versus emergency. Distributors estimate that air conditioning units are the most likely to require emergency replacement (42%) and programmable thermostats are the least likely (8%). Contractors said that furnaces and condensing boilers were relatively more likely to require an emergency replacement (31% and 27%, respectively) and that controls and programmable thermostats were relatively less likely to require an emergency replacement (Table 4-24).

**Table 4-24:
Planned vs. Emergency Replacements**

Equipment Type	Distributors (unweighted)		Contractors (weighted)	
	Planned	Emergency	Planned	Emergency
Air conditioning units	58%	42%	79%	21%
Natural gas furnaces	77%	23%	69%	31%
Natural gas condensing boilers	93%	7%	73%	27%
Controls	68%	32%	87%	13%
7-day programmable thermostats	92%	8%	84%	16%
Number of Respondents	6		45	

4.3.2.2 Turnaround Required

Table 4-25 shows the required turnaround time end-users typically require for emergency replacements, as reported by all respondents. When asked about equipment in general, respondents estimated that end-users require a five-day turnaround on equipment replacements. When asked to provide estimates for specific equipment types, respondents estimated end-users expected turnarounds ranging from one to three days.

**Table 4-25:
Emergency Replacement Turnaround Time**

Equipment Type	All Respondents (unweighted)				Number of Respondents
	Average (hours)	Median (hours)	Minimum (hours)	Maximum (weeks)	
All equipment	120	24	0	8-9 weeks	47
A/C units	72	24	0	4 weeks	43
Gas furnaces	34	24	0	1 week	47
Condensing boilers	70	24	0	4 weeks	47
Controls	50	24	0	4 weeks	42
Programmable thermostats	29	24	0	1 week	43

When asked what affects the flexibility of customers regarding turnaround time for emergency replacements, slightly more than one-half said that the season or weather conditions affect flexibility. The degree of malfunction was the next most frequently mentioned factor with 20 percent of respondents indicating that customers are less flexible when the equipment in question is completely inoperable versus somewhat functional. Another 20 percent of respondents indicated that customers are not flexible and request replacement immediately (Table 4-26).

**Table 4-26:
Factor Affecting Flexibility of Turnaround Time¹**

Factors	Respondents (unweighted)
Season or weather	56%
Inoperable/operable equipment	20%
Availability of equipment	8%
Cost is the most important/only factor	7%
Willing to wait for high-efficiency/rebated units	2%
Not flexible/want it ASAP	20%
Nothing/Don't know	2%
Number of Respondents	46

¹ Multiple responses.

4.3.2.3 Important Factors Considered during Emergency Replacements

As Table 4-27 shows, when asked what factors were most important when customers select equipment in emergency replacement situations, one-half mentioned the availability of equipment (50%), two-fifths mentioned cost (41%), and one-quarter mentioned efficiency level (26%). Quality or brand name (13%), availability of rebates (11%), payback period (7%), physical properties (7%), and ease of retrofit (7%) were mentioned by relatively few respondents.

Of the 46 respondents who answered questions about emergency replacements, 12 said that efficiency was an important factor when selecting equipment in emergency replacement situations. Respondents who did not mention efficiency as a factor in selecting equipment in an emergency replacement situation were directly asked if efficiency is an important factor in emergency replacement situations. Less than one-half of these respondents (14) said that efficiency is an important factor in emergency situations. One vendor who said that efficiency is an important factor stated that, “*efficiency is only a factor because the rebates available bring down the costs.*” Another vendor went on to add that while “*efficiency is more important than it used to be, cost is still more important.*”

Table 4-27:
Important Factors When Selecting New Equipment¹

Factors	Respondents (unweighted)
Availability	50%
Cost	41%
Efficiency level	26%
Equipment quality or brand name	13%
Available rebates	11%
Payback period	7%
Size/physical properties	7%
Ease of retrofit	7%
Number of Respondents	46

¹ Multiple response.

4.3.2.4 Vendor Influence for Emergency Replacements

When asked to characterize the degree of influence they have over equipment selection in emergency situations, three of the six distributors said they have little influence, two said they have some influence and one said they have a large degree of influence. In contrast, the vast majority (88%) of contractors said they have a large degree of influence over equipment selection. This difference may reflect the fact the contractors typically interact directly with end users, while distributors may not.

**Table 4-28:
Influence Over Equipment Selection in Emergency Replacement Situations**

	Distributors (unweighted)	Contractors (unweighted)
A large degree of influence	1	88%
Some influence	2	12%
Little influence	3	-
No influence	-	-
Number of Respondents	6	41

When asked to explain the extent of their influence over customer decisions in emergency replacement situations, 23 respondents said that customers trust their expertise and rely on them to select their equipment. The comments of these respondents are perhaps best summed up by one vendor who said, “*We [contractors] are the experts. We know what we have in stock. Most customers aren’t knowledgeable.*” However, even respondents who reported a high degree of influence concede that the final decision rests with the customer. As one vendor mentioned, “*We [contractors] give them options and recommendations, but customers always have final say.*” The next most frequently mentioned reason, mentioned by seven respondents, was that customers are not knowledgeable enough to select equipment on their own. Other reasons mentioned include relationships built with customers (6), cost (5), availability (5), efficiency (3), Internet research (2), and timing (1) (Table 4-29).

Table 4-29:
Reasons for Influence¹

Reasons	All Respondents (unweighted)		
	A large degree of influence	Some influence	Little influence
Customers trust our competence	22	-	1
Customers are not knowledgeable enough to make decisions	6	1	-
Familiarity/relationship with customers	5	1	-
Cost is also a factor	3	2	-
Availability is also a factor	2	1	2
Customers are looking for efficient equipment	2	1	-
Our influence is less because of internet/other research	2	-	-
Timing/budget determines what gets installed	-	-	1
Number of Respondents	36	5	3

¹ Multiple response.

4.3.2.5 Suggestions to Increase Efficient Replacements in Emergency Situations

Respondents were asked to provide suggestions to increase the likelihood that efficient equipment is installed in emergency replacement situations. About one-fifth (21%) of the respondents suggested reducing the time required to process rebates or otherwise easing program participation. More than one-tenth of respondents said to ensure the units are in stock (14%), offer higher rebates and incentives (13%), or increase marketing and advertising (13%). Other suggestions mentioned less frequently included a rebate targeted at installers (5%), adoption of policies to encourage quality maintenance and installation (4%), or offering rebates for only the most efficient units (2%) (Table 4-30).

**Table 4-30:
Suggestions to Increase the Likelihood Efficient Equipment is Installed**

	All Respondents (unweighted) ¹
Faster/easier process	21%
Ensure units are in stock	14%
Higher rebates	13%
Education/advertising/marketing	13%
Installer rebate	5%
Encourage quality maintenance/installation	4%
Only rebate most efficient units	2%
No suggestions	29%
Number of Respondents	49

¹ Multiple response.



Appendix A: Program Staff Interview Guide

The HVAC MARKET PENETRATION VENDOR INTERVIEW GUIDE

MASSACHUSETTS LCIEC EVALUATION – MARCH 2012

REVISED DRAFT

Name _____

Organization _____

Phone _____

Date _____

Sample Information (highlight appropriate item)

Vendor Type	Participant Type	Size
Contractor	Participant	Small
Distributor	Non-participant	Large
		Unknown

[NOTE: THE QUESTIONS IN THIS INTERVIEW GUIDE WILL NOT NECESSARILY BE READ VERBATIM BUT MAY BE MODIFIED TO SUIT THE INTERVIEW. IN ADDITION, THE INTERVIEWERS MAY SKIP QUESTIONS THAT ARE LESS RELEVANT TO A PARTICULAR INTERVIEW]

Hi, my name is _____ calling from NMR on behalf of National Grid, NSTAR, and other electricity and gas providers in Massachusetts and the Massachusetts Energy Efficiency Advisory Council. [If



asked, say: We are working directly for National Grid, NSTAR, Western Mass Electric, Unitil, Cape Light Compact, Berkshire Gas, New England Gas, and Columbia Gas.] We are conducting research to better understand the market penetration of energy efficient equipment in the Massachusetts commercial and industrial HVAC market. As part of this research we are interviewing HVAC contractors and distributors operating in Massachusetts.

[IF NECESSARY] The objective of these interviews is to help estimate market penetration, gauge the level of LCIEC program influence on the market penetration of energy efficient technologies, as well as collect other information about the programs offered by the Massachusetts electric and gas providers and program administrators.

[IF ASKED] We anticipate this interview will last about 30 to 40 minutes. Any information you provide will be treated as confidential.

[IF ASKED] NMR is an independent contractor hired to do this research. You can verify the legitimacy of this research by calling Wendy Todd of National Grid at 781-907-2232.

SCREENING (3 minutes)

SC1. Are you the person who is most knowledgeable about the type and efficiency level of HVAC equipment sold or installed in Massachusetts by [company name]?

SC2. **[IF NO]** We would like to talk to the person who is the most knowledgeable about the type and efficiency level of HVAC equipment sold or installed in Massachusetts by [company name]?

Name: _____

Telephone #: _____

(Note: Thank and terminate call. Schedule interview with best contact.)

SC3. Approximately what percentage of your company's business comes from: **[NOTE: MAKE SURE THE TOTAL % = 100%]**

- 1) Residential equipment sales, installations, or service?
- 2) Commercial and industrial sales, installations, or service?

[If residential >70% of total business, THANK AND TERMINATE]



SC4. Before today, had you heard of the Mass Save program that provides rebates and other financial incentives to commercial and industrial customers for installing energy-efficient HVAC equipment? This program is sponsored by the electric and gas providers from Massachusetts.

- 1) Yes [ASK SC5]
- 2) No [CONTINUE SURVEY ONLY IF QUOTA OF NONPARTICIPANTS HAS NOT BEEN REACHED. TREAT RESPONDENT AS NONPARTICIPANT. SKIP TO IN2]
- 3) Don't Know [CONTINUE SURVEY ONLY IF QUOTA OF NONPARTICIPANTS HAS NOT BEEN REACHED. TREAT RESPONDENT AS NONPARTICIPANT. SKIP TO IN2]

SC5. In 2011, did your company sell or install commercial HVAC equipment that received rebates from the Mass Save program or any of the electric or gas providers from Massachusetts?

- 1) Yes [CONTINUE SURVEY ONLY IF QUOTA OF PARTICIPANTS HAS NOT BEEN REACHED. TREAT RESPONDENT AS PARTICIPANT. OTHERWISE THANK & TERMINATE PER BELOW SCRIPT]
- 2) No [CONTINUE SURVEY ONLY IF QUOTA OF NONPARTICIPANTS HAS NOT BEEN REACHED. TREAT RESPONDENT AS NONPARTICIPANT. OTHERWISE THANK & TERMINATE PER BELOW SCRIPT]
- 3) DON'T KNOW [CONTINUE SURVEY ONLY IF QUOTA OF NONPARTICIPANTS HAS NOT BEEN REACHED. TREAT RESPONDENT AS NONPARTICIPANT. OTHERWISE THANK & TERMINATE PER BELOW SCRIPT]
- 4) REFUSED [THANK & TERMINATE]

THANK & TERMINATE SCRIPT: "I'm sorry, but we've been asked to interview contractors and distributors that have [not] participated in the Mass Save Program. Thank you for your time."



Participant Characterization (5 minutes)

First I would like to get some background information about you and your company.

IN2. What is your title or position in the company?

IN3. Which of the following best describes your firm?

- 1) HVAC installation contractor
- 2) HVAC equipment distributor

IN4. What are your responsibilities in your organization?

IN5. About how many full-time equivalent employees work for your company in Massachusetts?
[Probe for best estimate]

IN6. Approximately what percentage of your company's C&I business comes from the following end use sectors? [SHOULD ADD TO 100%]

- 1) Retail/restaurant
- 2) Hotel/motel
- 3) Office
- 4) Institutional (school, hospital, etc)
- 5) Industrial/Manufacturing
- 6) Other?

IN7. Approximately what percentage of your company's C&I business occurs in the following areas? [SHOULD ADD TO 100%]

- 1) New construction [RECORD %]
- 2) Major renovation and remodeling projects [RECORD %]
- 3) Replacement of existing HVAC equipment [RECORD %]
- 4) [CONTRACTORS ONLY] Maintenance and service calls for existing HVAC equipment [RECORD %]



MARKET PENETRATION (10 - 15 minutes)

Now, I would like to ask you some questions about the type, efficiency level, and number of HVAC equipment that your company sold or installed in Massachusetts in 2011. We'll be asking about air-cooled unitary HVAC systems, natural gas furnaces, natural gas condensing boilers, economizers, demand control ventilation, ECM motors, and programmable thermostats.

MR1. When you estimate the number of commercial HVAC equipment your company sold or installed in Massachusetts in 2011, what do you think is the error band around your numbers - is it $\pm 5\%$, $\pm 10\%$, $\pm 25\%$, etc? [PROBE FOR BEST ESTIMATE]



First, I would like to ask you about the air-cooled unitary AC and split systems you may have sold or installed in 2011. **[NOTE TO INTERVIEWERS: USE TABLE BELOW FOR QUESTIONS MP1-MP4]**

MP1. In 2011, about how many of the [unit size] systems did your company sell or install in Massachusetts? **[IF THEY DID NOT SELL ANY UNITS, SKIP TO THE NEXT SECTION]**

MP2. In 2011, about what percentage of the [unit size] systems sold or installed were at or above [required efficiency]? **[If necessary, these units would have qualified for an incentive through the programs.]**

MP3. **[PARTICIPANTS ONLY]** In 2011, about what percentage of [unit size] systems above [required efficiency] sold or installed received an incentive through the Mass Save C&I programs?

MP3A. **[PARTICIPANTS ONLY]** You said that [% from their response to MP2] of [unit size] systems that you sold or installed in 2011 were at or above [required efficiency]. What do you estimate this percentage would have been if these Mass Save C&I incentives were not available?

MP4. **[IF MP3 NOT 100%]** Why did some of your high efficiency units not receive incentives? **[Probe if necessary: In general, what factors prevented you or your customers from taking advantage of the rebates?]**

Air-cooled Unitary AC and Split Systems						
Unit Size	Required Efficiency	MP1	MP2	MP3	MP3A	MP4: Why Not?
< 5.4 tons	split = 14.0 SEER & 12.0 EER; packaged = 14.0 SEER & 11.6 EER		__%	__%	__%	
≥ 5.4 to < 20 tons	11.5 EER		__%	__%	__%	
≥ 20 tons	20-62 = 10.5 EER; ≥63 = 10.2 EER		__%	__%	__%	



Now, I would like to ask you about the natural gas furnaces that you may have sold or installed in 2011. **[NOTE TO INTERVIEWERS: USE TABLE BELOW FOR QUESTIONS MP5-MP8]**

MP5. In 2011, how many of the gas furnaces up to 150 MBH did your company sell or install in Massachusetts? **[IF THEY DID NOT SELL ANY UNITS, SKIP TO THE NEXT SECTION]**

MP6. In 2011, what percentage of these gas furnaces sold or installed were at or above [required efficiency]? **[If necessary, these units would have qualified for an incentive through the programs.]**

MP7. **[PARTICIPANTS ONLY]** In 2011, what percentage of [unit size] gas furnaces above [required efficiency] sold or installed received an incentive through the Mass Save C&I programs?

MP7A. **[PARTICIPANTS ONLY]** You said that [% from their response to MP6] of [unit size] systems that you sold or installed in 2011 were at or above [required efficiency]. What do you estimate this percentage would have been if these Mass Save C&I incentives were not available?

MP8. **[IF MP7 NOT 100%]** Why did some of your high efficiency units not receive incentives? **[Probe if necessary: In general, what factors prevented you or your customers from taking advantage of the rebates?]**

Natural Gas Furnaces						
Unit Size	Required Efficiency	MP5	MP6	MP7	MP7A	MP8: Why not?
Up to 150 MBH	94% AFUE with ECM motor		__%	__%	__%	
Up to 150 MBH	96% AFUE with ECM motor	n/a	__%	__%	__%	



Now, I would like to ask you about the natural gas condensing boilers that you may have sold or installed in 2011. **[NOTE TO INTERVIEWERS: USE TABLE BELOW FOR QUESTIONS MP9-MP10]**

MP9. In 2011, about how many of the [unit size] gas condensing boilers did your company sell or install in Massachusetts? **[IF THEY DID NOT SELL ANY UNITS, SKIP TO THE NEXT SECTION]**

MP10. In 2011, about what percentage of the [unit size] gas condensing boilers sold or installed were at or above [required efficiency]? **[If necessary, these units would have qualified for an incentive through the programs.]**

MP11. **[PARTICIPANTS ONLY]** In 2011, about what percentage of [unit size] gas condensing boilers above [required efficiency] sold or installed received an incentive through the Mass Save C&I programs?

MP11A. **[PARTICIPANTS ONLY]** You said that [% from their response to MP10] of [unit size] systems that you sold or installed in 2011 were at or above [required efficiency]. What do you estimate this percentage would have been if these Mass Save C&I incentives were not available?

MP12. **[IF MP11 NOT 100%]** Why did some of your high efficiency units not receive rebates? **[Probe if necessary: In general, what factors prevented you or your customers from taking advantage of the rebates?]**

Natural Gas Condensing Boilers						
Unit Size	Required Efficiency	MP9	MP10	MP11	MP11A	MP12: Why Not?
Up to 300 MBH	90% AFUE		___%	___%	___%	
More than 300 MBH	90% thermal efficiency		___%	___%	___%	

Now, I would like to ask you about the controls and ECM fan motors you may have sold or installed in 2011. **[NOTE TO INTERVIEWERS: USE TABLE BELOW FOR QUESTIONS MP13-MP16]**

MP13. In 2011, how many [equipment] did your company sell or install in Massachusetts? **[IF THEY DID NOT SELL ANY UNITS, SKIP TO THE NEXT EQUIPMENT TYPE IN THE TABLE]**

MP14. In 2011, about what percentage of [equipment] sold or installed qualified for a rebate? Please note, that in order to qualify for rebates, the economizers, demand control ventilation,



and ECM fan motors must have been installed with new program-qualifying HVAC equipment. This includes HVAC equipment meeting the efficiency levels that I asked about in earlier questions. In addition, demand control ventilation are ineligible for rebates if required by code – i.e., new construction spaces greater than 500 square feet.

MP15. **[PARTICIPANTS ONLY]** In 2011, what percentage of [equipment] sold or installed received an incentive through the Mass Save C&I Programs?

MP15A. **[PARTICIPANTS ONLY]** You said that [% from their response to MP14] of [unit size] systems that you sold or installed in 2011 were at or above [required efficiency]. What do you estimate this percentage would have been if these Mass Save C&I incentives were not available?

MP16. **[IF NOT 100%]** Why did some of the [equipment] not receive incentives? **[Probe if necessary: In general, what factors prevented you or your customers from taking advantage of the rebates?]**

Equipment Type	MP13	MP14	MP15	MP15A	MP16: Why not?
Dual Enthalpy Economizer		__%	__%	__%	
Demand Control Ventilation		__%	__%	__%	
ECM Fan Motors		__%	__%	__%	
ENERGY STAR or 7-day programmable thermostats		__%	__%	__%	

MP17. Are there any energy-efficient HVAC technologies which you don't think the Mass Save is currently rebating and which you think they should be rebating?

MP18. [IF YES] Which technologies?



MARKET CHARACTERIZATION (15 minutes)

The following questions are designed to help us gain a better understanding of the commercial HVAC market in Massachusetts.

MC1. **[CONTRACTORS ONLY]** About what percent of the commercial HVAC equipment that you install is purchased from distributors vs. directly from manufacturers?

- 1) Does this percentage split vary by the type of equipment? **[Probe by HVAC system type, controls, etc]**
- 2) Which equipment are you more likely to purchase directly from manufacturers?

MC2. Approximately what percentage of the unitary/split systems replaced in existing buildings are planned vs. emergency replacements? **[IF NECESSARY, emergency replacement means a situation where HVAC equipment must be replaced due to failure and where that failure might be a threat to occupant comfort, safety, and/or productivity.]**

- 1) What about for gas furnaces?
- 2) And condensing gas boilers?
- 3) And for demand control ventilation, economizers, and ECM motors?
- 4) And programmable thermostats?

MC3. For emergency replacements, how quick of a turnaround do the end use customers typically require? **[Probe for average number of days]**

- 1) How does this vary by the type of equipment? **[Probe by HVAC system type, controls, etc]**
- 2) What affects how flexible the customers are regarding the turnaround time? **[Probe season, operable vs. inoperable equipment, etc]**

MC4. For emergency replacement situations, which factors are most important when selecting new equipment? **[Probe equipment availability, cost, payback, efficiency, etc]**

- 1) **[IF NOT ALREADY MENTIONED]** Is the efficiency level of the equipment important in these kinds of emergency replacement situations?

MC5. In emergency replacement situations, how much influence do you have regarding equipment selection - do you have no influence, little influence, some influence, or a large degree of influence?

- 1) Why do you say that?



MC6. The Mass Save program would like to increase the likelihood that the most energy efficient units are installed when equipment breaks down in an emergency replacement situation. What suggestions do you have on how they could accomplish this?

MC7. Do any of your end use customers in Massachusetts purchase HVAC equipment directly from manufacturers?

MC8. **[IF MC7 = YES]** What type of equipment do they tend to purchase directly from manufacturers?

I would like to ask you some questions about your company’s standard practices when it comes to energy efficient equipment.

MC9. When you promote the equipment you install or sell to your customers, do you ever mention energy efficiency as part of your marketing or sales pitch?

MC10. **[IF MC9= YES]** How do you do this?

MC11. **[IF NOT MENTIONED IN MC10]** When you provide customers with price bids for the equipment you sell or install, do you ever provide them with multiple price bids for equipment with various levels of energy efficiency?

MC12. **[IF MC11=YES]** For what sorts of equipment do you provide these multiple bids?

MC13. Do you discuss life cycle costs when presenting equipment options to customers? **[IF THEY ASK WHAT LIFE CYCLE COSTS ARE, SAY: “LIFE CYCLE COSTS INCLUDE ALL COSTS INCURRED FOR EQUIPMENT DURING ITS ENTIRE LIFETIME. THESE INCLUDE INITIAL COST, FUEL COST, AND MAINTENANCE COSTS.”]**

1) **[SKIP IF DO NOT PARTICIPATE IN PROGRAMS]** Do you factor program rebates or incentives into those calculations?

MC14. What factors, if any, make it difficult for your customers to purchase the highest efficiency models of the equipment you sell?

MC15. What effects has the recent economic downturn had on your sales?

[DO NOT READ. ACCEPT MULTIPLE ANSWERS]

[Increased standard efficiency sales]	1
[Decreased standard efficiency sales].....	2
[Increased high efficiency sales]	3
[Decreased high efficiency sales]	4
[Increased maintenance jobs]	5
[Decreased maintenance jobs]	6
[Other (Specify)].....	77



PROGRAM AWARENESS (5 - 10 minutes)

Now I would like to ask you some questions about your knowledge and participation in the Massachusetts energy efficiency programs.

- PA1. What do you know about the Mass Save program?
- PA2. Where did you get that program information?
- PA3. Have you had any contact with program staff or utility account representatives about these programs?
- PA4. **[IF PA3 = YES]** Have program staff been available when you need them?
- PA5. Do you incorporate the Mass Save energy-efficient rebates offered through these programs in any of your sales pitches to your commercial or industrial customers?
- PA6. **[IF PA5 = NO]** Why not?
- PA7. Do you think the current incentive levels offered by Mass Save are adequate to encourage customer demand for qualifying equipment?
- PA8. **[IF PA7 = NO]** Are there any particular types of equipment for which you think the incentives are too low?
- PA9. **[IF PA8 = YES]** Which ones?
- PA10. The Massachusetts energy efficiency programs currently give almost all of their financial incentives to end use customers. If these programs chose instead to give a portion of their rebates to the contractors or vendors selling the equipment in order to reduce the cost to the customer, do you think this would increase your sales of energy efficient equipment over the current system?
- PA11. **[IF PA10 = YES]** Why do you say this?
- PA12. Are you aware of the low cost financing available through the Mass Save program and some of the Massachusetts electric and gas providers? **[IF NECESSARY: “THIS PROGRAM PROVIDES LOW OR NO COST FINANCING FOR BUSINESSES TO INSTALL ENERGY EFFICIENT EQUIPMENT. IT IS BRANDED UNDER ‘MASS SAVE.’”]**
- PA13. **[IF PA12= YES]** Do you promote this financing to your customers?
- PA14. **[IF PA13= NO]** Why don't you promote this financing to your customers?
- PA15. **[PARTICIPANTS ONLY]** How satisfied have you been with the program as a whole? Please use a five-point scale where five equals very satisfied and 1 equals not satisfied at all.



PA16. Why do you give that rating?

PA17. What, if anything, could Mass Save do to encourage your company to promote energy efficient equipment or services more often?

WRAP UP (2 minutes)

WU1. **[CONTRACTORS ONLY]** We are also interviewing commercial HVAC distributors in Massachusetts. Can you provide us with the name(s) of the distributors that you most often work with on commercial projects?

WU2. **[DISTRIBUTORS ONLY]** We are also interviewing commercial HVAC contractors in Massachusetts. Can you provide us with the name(s) of the contractors that you most often work with on commercial projects?

Thank you, those are all the questions I have for you. Is there anything else you would like to tell me about the commercial and industrial market for HVAC equipment or about the Mass Save energy efficiency programs that would be useful for our evaluation?

INTERVIEW SUMMARY

[NOTE: THESE ARE TO BE TYPED IN SUMMARY BY THE INTERVIEWER AFTER FINISHING ON PHONE]

General comments/observations/summary:

How much does this Trade Ally know about the program(s)?

How much does this Trade Ally participate in the program(s)? What barriers does the respondent or their customers face?

What impact has the program had on sales of high efficiency equipment? What opportunities have been missed?