Massachusetts Electric and Gas Program Administrators

Recommended Methods for Assessing Market Effects of HVAC Programs

Final Version

November 25, 2014
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1. INTRODUCTION

This document is one of a series of work products addressing consistent methodologies for the measurement of market effects from cross-cutting\(^1\) energy efficiency programs run by the Massachusetts Program Administrators (PAs). It focuses specifically on the effects of three residential HVAC programs or subprograms and one commercial HVAC program on the markets for unitary HVAC equipment and controls and for residential Central Air Conditioning (CAC), gas heating, and ductless mini-split heat pumps. The objectives of this document are to outline appropriate methods for evaluating the programs’ effects on these markets based on the range of methods available for measuring market effects. This includes methods for establishing qualitative evidence of the programs’ effects on markets and quantifying the effects, which incorporate spillover, as well as estimating net savings.

This research was conducted in stages. The body of this document, which was prepared in spring and early summer 2014, proposes that the PAs develop certain market effects data sources and described these sources. In summer and fall 2014, the study team conducted additional research to assess the prospects for the proposed data sources, as proposed in Section 3.3 of the main body of this document. The findings and recommendations from this additional research are reported in Appendix A. **Appendix A adds to, clarifies, and in some cases supersedes information offered in Section 3.3.**

This final document replaces the interim version of August 11, 2014. It differs from the interim version as follows:

- Tables 2-1, 2-2, 2-4 and 2-5 have been replaced with more comprehensive versions that reflect the market effects data sources proposed in Appendix A.

- Appendix A, Findings & Recommendations Regarding HVAC Market Effects Data, has been added to the document. The appendix describes the HVAC data that are available to the PAs, assesses the suitability of data to meet the needs described in Section 3.3 of the main body of this document, and recommends the PAs consider pursuing five activities to help obtain the HVAC market share data described in Section 3.3.

The Cross-Cutting evaluation team is tasked with developing methodologically consistent approaches for assessing market effects within markets identified by PAs as most likely to be affected by their programs. At a series of workshops held in February 2014, the PAs identified the following HVAC sub-markets as high-priority and warranting expedited market effects evaluations: the markets for unitary HVAC equipment and controls typically used in commercial installations; and the markets for CAC, gas heating, and ductless mini-split heat pumps destined for residential installations. Hence, the Cross-Cutting evaluation team has focused this market-specific methods document on these submarkets. Related work products include a document describing the full range of methods available for measuring market effects, with some general guidance about when each is most appropriate\(^2\) and forthcoming market-specific methods documents for the commercial new construction market and selected submarkets of the commercial lighting and controls market. Based on these documents, the Residential and

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1 Residential and commercial/industrial.
Commercial & Industrial (C&I) evaluation teams will be responsible for developing work plans for market effects studies for these sectors and then executing those plans, while the Cross-Cutting team will be responsible for tasks that overlap the two sectors.

Four PA programs are expected to affect the HVAC sub-markets addressed in this document: the C&I Upstream HVAC & Heat Pump Initiative, the residential CAC portion of the Cool Smart Program, the High-Efficiency Heating and Water Heating Equipment (HEHE) program, and the ductless mini-split portion of the Cool Smart Program. Two of the PAs’ HVAC programs and subprograms are ongoing, and therefore are amenable to retrospective market effects evaluations. The other two are newly established, and hence are more appropriate for prospective market effects evaluations—that is, establishing baselines to facilitate assessment of market effects in the future. The relevant markets, sectors, programs, and subprograms, as well as the suggested prospective or retrospective\(^3\) focuses are shown in Table 1-1. Detailed descriptions of the HVAC sub-markets addressed in this document can be found in the market models shown in Figure 2-1 and Figure 2-3.

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\(^3\) A market effects study with a retrospective focus looks at the effects of a program after the activities have taken place, and applies the findings to adjust net savings estimates after the fact. This could include previously uncounted spillover as well as free-ridership and program effects. A market effects study with a prospective focus generally means an effort to lay the groundwork for later assessing and documenting market effects—for example, by quantifying the current state of market indicators in the program area and a comparison area, with the intent of later coming back and looking at the difference of differences.
Table 1-1. HVAC Markets and Related Programs to Be Addressed

<table>
<thead>
<tr>
<th>Market</th>
<th>Program</th>
<th>Sector</th>
<th>Relevant Equipment &amp; Services Addressed by Program</th>
<th>Electric or Gas</th>
<th>Prospective or Retrospective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial cooling &amp; heat pumps &amp; related controls</td>
<td>Upstream C&amp;I HVAC Incentives</td>
<td>Commercial</td>
<td>Unitary and Split Systems Up to 63 Tons and Heat Pumps Up to 20 Tons, and Related Controls</td>
<td>Electric</td>
<td>Prospective</td>
</tr>
<tr>
<td>Residential CAC</td>
<td>Residential Central Air Conditioning (CAC) Portion of the Cool Smart Program</td>
<td>Residential</td>
<td>CAC and Ducted Heat Pumps; CAC Installation Practices</td>
<td>Electric</td>
<td>Retrospective</td>
</tr>
<tr>
<td>Residential gas heating &amp; quality installation</td>
<td>High-Efficiency Heating and Water Heating Equipment (HEHE)</td>
<td>Residential</td>
<td>Furnaces and Boilers; Installation practices</td>
<td>Gas</td>
<td>Retrospective</td>
</tr>
<tr>
<td>Mini-split heat pumps</td>
<td>Ductless Mini-Split Portion of the Cool Smart Program</td>
<td>Residential</td>
<td>Ductless Mini-Split Heat Pumps</td>
<td>Electric</td>
<td>Prospective</td>
</tr>
</tbody>
</table>
1. Introduction…

The approaches described in this document leverage several of the PAs’ ongoing efforts and complementary evaluation studies. These include the following:

1. Implementers’ C&I Upstream HVAC Program Assessment. The PA implementers have been working with HVAC distributors and manufacturers to find ways to improve the C&I Upstream HVAC Incentive Program, including through a workshop and individual interviews. The PA implementers have also been collecting some sales data for qualifying equipment from distributors and manufacturers. Because the implementers have greater access than evaluators to key market actors, their efforts could be the vehicle for collecting some of the most important evaluation data. Leveraging these efforts is a high priority activity and is discussed in Section 3.3.1.

2. Heating, Air Conditioning and Refrigeration Distributors International (HARDI) data. The PAs are acquiring residential and small commercial HVAC shipment data for 2013 in MA, NY, CT, and PA. Data for the 2013 year, by quarter, became available in May.

3. Characterization of Supply-side Population Study. The Stage 3 work plan for this study focusing on the C&I HVAC market has been approved. The first task is to mine Dun & Bradstreet data to help characterize the HVAC market, followed by interviews with manufacturers and distributors. The latter will include exploratory questions to guide the development of one of the data collection activities proposed in Section 3.3.1: developing a panel of manufacturers and distributors to supply Massachusetts market share data.

4. Residential Trade Ally Panel Study. The work plan for this study is in development, but again, presumably any further contact with market actors—beyond the already approved interviews for the Characterization of Supply Side Population Study—could be deferred until the market effects work plans are developed.

5. Process Evaluation of C&I Upstream HVAC Program. This study has been deferred because of concerns about contacting the same market actors multiple times, but some aspects may go forward, and other questions could perhaps be accommodated through other studies.

6. Upstream Branding Study (Cross-Cutting). This study is nearing completion.

7. 2012 Residential Heating, Water Heating, and Cooling Equipment Evaluation: Net to Gross, Market Effects, and Equipment Replacement Timing. This study is complete, so it should help inform the current market effects study, but will not require any additional coordination other than being sensitive about re-contacting the same market actors.

8. DNV GL market characterization study of the Massachusetts C&I natural gas boiler market. This study was not yet available at the time this document was drafted. It includes in-depth interviews with manufacturers, distributors, and trade associations.

There are two primary methodological components recommended for the market effects studies proposed in this document. The first is theory-based evaluation, described in Section 2. This

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4 Also known as “market penetration,” or the percentage of all sales of a particular type of equipment that is high efficiency equipment.

5 Navigant et al., 2013. Prepared for the Electric and Gas Program Administrators of Massachusetts.
1. Introduction…

A qualitative approach identifies how program activities are expected to lead to market effects and measuring the associated indicators periodically.

The second component is quantifying market effects and the associated net energy savings using two different methodological approaches: cross-sectional analysis and supply-side market actor counterfactual self-reporting. We emphasize that it is difficult to make a credible case for any quantitative estimate of market effects if a credible qualitative case—through theory-based evaluation—cannot be made; hence, both components are necessary. The quantification component is described in Section 3.
2. THEORY-BASED EVALUATION

Theory-based evaluation ideally begins with the development of a market model depicting how the market functions and an associated program logic model showing how program interventions are expected to affect the market. The program logic model should include expected short-, intermediate-, and long-term outcomes stemming from program activities. In turn, the evaluators should operationalize these outcomes so they can be measured and conduct periodic research to track them. For retrospective studies—i.e., residential CAC and residential gas heating—insofar as these outcomes occur more or less in the order predicted by the program logic model and are logically linked to program activities, then a reasonable qualitative case can be made for market effects. For prospective studies—the commercial HVAC market and the ductless mini-split sub-market—the point is to establish an initial baseline of key indicators so that later retrospective studies can assess attribution through changes in the key indicators.

2.1 MARKET MODELS AND PROGRAM LOGIC MODELS

Figure 2-1 through Figure 2-6 show preliminary market models and associated program logic models for commercial cooling and heat pumps, and residential HVAC (including CAC, ductless mini-split heat pumps, and gas heating). These models are based on interviews with PA program staff and have since been reviewed by PA program staff, PA evaluation staff, EEAC program staff, and EEAC evaluation staff. Note that there is a program logic model for the Ductless Mini-split Heat Pump portion of the Cool Smart Program that is separate from the logic model for the CAC portion of the Cool Smart Program because quality installation verification (QIV) is addressed in the latter but not in the former. We recommend that the Residential and C&I Evaluation teams refine these market and program logic models once they begin conducting the market effects evaluations.
Figure 2-1. Market Model—Commercial Cooling & Heat Pumps & Related Controls
Figure 2-2. Logic Model—C&I Upstream HVAC Program
Figure 2-3. Market Model—Residential HVAC
Figure 2-4. Logic Model—Cool Smart Program (Except Ductless Mini-Split Heat Pumps)\(^6\)

Figure 2-5. Logic Model—HEHE Program

2. Theory-Based Evaluation…

Figure 2-6. Logic Model—Ductless Mini-Split Heat Pumps (Part of Cool Smart Program)\(^8\)

2.2 INDICATOR TRACKING

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2. Theory-Based Evaluation…

We suggest operationalizing the expected outcomes shown in these program logic models using the indicators shown in Table 2-1 through Table 2-5 below. These tables also show the recommended data source, timing, and responsible party for measuring the indicators. We recommend that the C&I and residential evaluation contractors carry out the sector-specific market effects evaluation activities in order to leverage current and future sector evaluation efforts. The Cross-Cutting evaluation team would be assigned responsibility for activities that involve both the residential and C&I sectors.

Indicators listed on these tables as having been collected previously are from the study *2012 Residential Heating, Water Heating, and Cooling Equipment Evaluation: Net to Gross, Market Effects, and Equipment Replacement Timing*.9

Table 2-1, Table 2-2, Table 2-4, and Table 2-5 have been revised since the Interim version of this document. The new tables reflect additional information and refined data collection activities described in Appendix A of this document.

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### Table 2-1. Outcomes and Indicators for C&I Upstream HVAC Program—Prospective (Baseline), Revised November 7, 2014

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Indicators</th>
<th>Data Source</th>
<th>Timing</th>
<th>Responsible Party (recommended)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distributors become aware of program and are willing to participate</td>
<td>Distributors say they are aware of program</td>
<td>Distributor survey</td>
<td>Annually beginning Q1 2015</td>
<td>Data collection: Cross-cutting, working with PA program staff; Analysis: C&amp;I Evaluation Team</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Phone calls, emails, and site visits</td>
<td>April 2013-present</td>
<td>Program Implementer</td>
</tr>
<tr>
<td></td>
<td>Distributors say they are interested in participating</td>
<td>Distributor survey</td>
<td>Annually beginning Q1 2015</td>
<td>Data collection: Cross-cutting, working with PA program staff; Analysis: C&amp;I Evaluation Team</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Program Implementer</td>
</tr>
<tr>
<td></td>
<td>Distributors sign up for program</td>
<td>Program records</td>
<td>Quarterly beginning Q1 2014</td>
<td>Program Implementer</td>
</tr>
</tbody>
</table>

| Distributors’ sales forces trained in program                            | Number of distributor staff members trained in program (1)                | Program records, possibly supplemented by Distributor survey              | Quarterly beginning Q1 2014                 | Program implementer (records); Distributor data collection: Cross-cutting, working with PA program staff; Analysis: C&I Evaluation Team |
|                                                                          | Number of distributors whose staff are trained in program (1)             | Program records, possibly supplemented by Distributor survey              | Quarterly beginning Q1 2014                 | Program implementer (records); Distributor data collection: Cross-cutting, working with PA program staff; Analysis: C&I Evaluation Team |

| Greater emphasis by distributors on selling qualifying equipment due to opportunity for higher project margin from incentives | Emphasis on energy efficiency and qualified equipment in distributors’ sales efforts | Distributor survey                                                        | Annually beginning Q1 2015                   | Data collection: Cross-cutting, working with PA program staff; Analysis: C&I Evaluation Team |

| Greater effort by distributors’ sales staff to sell qualifying equipment | Distributors say their sales staff is increasing efforts to sell qualifying equipment | Distributor survey                                                        | Annually beginning Q1 2015                   | Data collection: Cross-cutting, working with PA program staff; Analysis: C&I Evaluation Team |

| Increased sales of qualified product under program auspices              | Program-supported sales                                                     | Program records                                                            | Monthly                                      | Program Implementer                                                |

| Reduced first cost of qualifying equipment to customers when some portion of incentive used for this purpose | Distributors say they are passing on some portion of incentive to customers | Distributor survey                                                        | Annually beginning Q1 2015                   | Cross-cutting Evaluation Team                                      |

| Increase in program participation as program encourages competition for sales among distributors | Distributors sign up for program                                             | Program records                                                            | Quarterly beginning Q1 2014                 | Program Implementer                                                |

| Greater stocking of efficient equipment by distributors                  | Counts and %s of qualifying and non-qualifying equipment in stock (3)        | Qualitative HVAC panel                                                     | Quarterly beginning Q2 2015                 | Cross-cutting Team, working with PA program staff, C&I Evaluation Team to incorporate into broader evaluation |

| Increased market penetration of EE equipment                             | Counts and %s of qualifying and non-qualifying equipment sold                | Manufacturer panel                                                         | Quarterly beginning Q1 2015                 | Cross-cutting Team, working with PA program staff, C&I Evaluation Team to incorporate into broader evaluation |
|                                                                          |                                                                          | HARDI data                                                                 | Quarterly data beginning Q1 2013            | Cross-cutting Team, working with PA program staff, C&I Evaluation Team to incorporate into broader evaluation |

| Energy and demand savings, environmental benefits, other non-energy benefits | Quantification of savings stemming from market effects                      | See Section 3 of this document for description                            | 2017 (retrospective)                        | C&I Evaluation Team                                                |

| Sustainable market for EE equipment                                       | Sustainability assessment                                                   | Multiple sources                                                           | 2017 (retrospective)                        | C&I Evaluation Team                                                |

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(1) Program Implementers track outreach activities by number of events, but they do not track number of participants.

(2) Program records currently include counts of qualifying equipment through the program. Assumes program begins requiring participating distributors to provide sales of non-program RTUs, most likely by model number, and that collection of these additional data is quarterly or annual.
2. Theory-Based Evaluation…

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Indicators</th>
<th>Data Source</th>
<th>Timing</th>
<th>Past Measurements</th>
<th>Responsible Party (recommended)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced cost barriers</td>
<td>Number and amounts of incentives paid to customers</td>
<td>Program records</td>
<td>Quarterly beginning Q1 2014</td>
<td></td>
<td>Program Administrators</td>
</tr>
<tr>
<td></td>
<td>Participating customers say they were motivated by incentive</td>
<td>Participant survey</td>
<td>Q1 2015</td>
<td></td>
<td>Residential Evaluation Team</td>
</tr>
<tr>
<td>Increased awareness of program and equipment among contractors and end-users</td>
<td>Non-participating customers say they are aware of the availability of efficient equipment and can define it</td>
<td>Non-participating customer survey</td>
<td>Q1 2015</td>
<td></td>
<td>Residential Evaluation Team</td>
</tr>
<tr>
<td></td>
<td>Non-participating contractors say they are aware of the program; non-participating contractors are aware of availability of high efficiency equipment and can define it</td>
<td>Non-participating contractor survey</td>
<td>Q1 2015</td>
<td></td>
<td>Residential Evaluation Team</td>
</tr>
<tr>
<td>Trained HVAC technicians</td>
<td>Number of trained HVAC technicians</td>
<td>Program records</td>
<td>Quarterly beginning Q1 2014</td>
<td></td>
<td>Program Administrators</td>
</tr>
<tr>
<td>Trained HVAC technicians successfully complete initial installations of energy-efficient equipment (1)</td>
<td>Completion of initial installations of qualifying equipment in each service territory by trained technicians</td>
<td>Program records</td>
<td>Quarterly beginning Q1 2014</td>
<td>2012</td>
<td>Residential Evaluation Team</td>
</tr>
<tr>
<td>Increased stocking and supply of EE equipment (2)</td>
<td>Qualitative assessment of qualifying and non-qualifying equipment in stock</td>
<td>Qualitative HVAC panel</td>
<td>Quarterly beginning Q2 2015, with data beginning earlier</td>
<td>Distributor survey Q1 2013; Contractor survey Q2-Q3 2013</td>
<td>Cross-cutting Team, working with PA program staff; Res Evaluation Team to incorporate into broader evaluation</td>
</tr>
<tr>
<td>Increased demand for EE equipment</td>
<td>Participating and non-participating customers say they would seek out EE equipment</td>
<td>Participating and non-participating customer survey</td>
<td>Q1 2015</td>
<td></td>
<td>Residential Evaluation Team</td>
</tr>
<tr>
<td></td>
<td>Contractors increasingly report customer interest in qualifying equipment (3)</td>
<td>Participating and non-participating contractor survey</td>
<td>Q1 2015</td>
<td>Distributor survey Q1 2013</td>
<td>Residential Evaluation Team</td>
</tr>
<tr>
<td></td>
<td>Qualifying equipment becomes an increasing proportion of distributor’s equipment stock (4)</td>
<td>Qualitative HVAC panel and/or distributor interviews</td>
<td>Quarterly beginning Q2 2015, with data beginning earlier</td>
<td>Distributor survey Q1 2013; Contractor survey Q2-Q3 2013</td>
<td>Cross-cutting Team, working with PA program staff; Res Evaluation Team to incorporate into broader evaluation</td>
</tr>
<tr>
<td>Customers expect energy efficiency from cooling equipment purchases and installation</td>
<td>Contractors increasingly report customer requirements for energy-efficiency equipment (3)</td>
<td>Participating and non-participating contractor survey</td>
<td>Q4 2014</td>
<td>Contractor survey Q2-Q3 2013</td>
<td>Residential Evaluation Team</td>
</tr>
<tr>
<td>Increased market penetration of EE equipment</td>
<td>Counts and %s of qualifying and non-qualifying equipment sold</td>
<td>HARDI data</td>
<td>Quarterly data beginning Q1 2013</td>
<td>Cross-cutting Team, working with PA program staff; Res Evaluation Team to incorporate into broader evaluation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Manufacturer panel to supplement HARDI data</td>
<td>Quarterly beginning Q1 2015</td>
<td>Cross-cutting Team, working with PA program staff; Res Evaluation Team to incorporate into broader evaluation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy and demand savings, environmental benefits, other non-energy benefits</td>
<td>Quantification of savings stemming from market effects</td>
<td>See Section 3 of this document for description (5)</td>
<td>Q2 2015</td>
<td>Residential Evaluation Team</td>
<td></td>
</tr>
<tr>
<td>Sustainable market for EE products and services</td>
<td>Sustainability assessment</td>
<td>Multiple sources</td>
<td>Q2 2015</td>
<td></td>
<td>Residential Evaluation Team</td>
</tr>
</tbody>
</table>

(1) Subsumes the following two outcomes identified and operationalized in the 2012 study: "Contractors install qualifying equipment as a regular practice without obtaining a rebate," "Distributors supply qualifying products for installation," and "Distributors change their stocking practices to supply the increased installation of qualifying equipment." All were operationalized as counts and percents of equipment stock, measured via surveys of distributors and contractors.

(2) Measurements attempted in the 2012 study based on surveys of distributors and contractors; limited success via this data collection method.

(3) Previous study gathered data via distributor survey.

(4) Previous study gathered data via distributor and contractor surveys.

(5) To avoid possible double-counting, analysis will take into account any savings from market effects that may have been assessed through CoolSmart evaluation(s) during the same time period.
<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Indicators</th>
<th>Data Source</th>
<th>Timing</th>
<th>Past Measurements</th>
<th>Responsible Party (recommended)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased customer awareness of QIV</td>
<td>Contractors increasingly report increased customer awareness of QIV techniques</td>
<td>Survey of contractors, including those that took part in QIV training; participant survey</td>
<td>Not recommended; see Section 3.2</td>
<td>Contractors Q2-3 2012; QIV Q1 2013; participants Q4 2012</td>
<td>Residential Evaluation Team</td>
</tr>
<tr>
<td>Increased demand for quality installation</td>
<td>Participating and non-participating customers say they would seek out quality installations</td>
<td>Participating and non-participating customer survey</td>
<td>Not recommended; see Section 3.2</td>
<td></td>
<td>Residential Evaluation Team</td>
</tr>
<tr>
<td>QIV becomes standard practice for all installations whether incented or not</td>
<td>Installations of non-participating equipment meet program standards</td>
<td>Field assessments of installation quality of non-participating equipment</td>
<td>Not recommended; see Section 3.2</td>
<td></td>
<td>Residential Evaluation Team</td>
</tr>
<tr>
<td>HVAC contractors alter sales and marketing to regularly include QIV</td>
<td>Contractors say they have changed sales and marketing to emphasize QIV</td>
<td>Participating and non-participating contractor survey</td>
<td>Not recommended; see Section 3.2</td>
<td></td>
<td>Residential Evaluation Team</td>
</tr>
<tr>
<td>Participating contractors after their sales and marketing to include QIV on a regular basis</td>
<td>Contractors (say they have) introduced (and maintain) energy efficiency as part of their marketing messages</td>
<td>Participating and non-participating contractor survey</td>
<td>Not recommended; see Section 3.2</td>
<td>Q2-3 2012; QIV Q1 2013</td>
<td>Residential Evaluation Team</td>
</tr>
</tbody>
</table>

(5) Previous study gathered data for this indicator via contractor survey.
Table 2-4. Outcomes and Indicators for HEHE Program—Retrospective, Revised November 7, 2014

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Indicators</th>
<th>Data Source</th>
<th>Timing</th>
<th>Past Measurements</th>
<th>Responsible Party (recommended)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced cost barriers</td>
<td>Number and amounts of incentives paid to customers</td>
<td>Program records</td>
<td>Quarterly beginning Q1 2014</td>
<td></td>
<td>Program Administrators</td>
</tr>
<tr>
<td></td>
<td>Participating customers say they were motivated by incentive</td>
<td>Participant survey</td>
<td>Q1 2015</td>
<td>Residential Evaluation Team</td>
<td></td>
</tr>
<tr>
<td>Trained HVAC technicians successfully complete initial installations of energy-efficient equipment</td>
<td>Completion of initial installations of qualifying equipment in each service territory by trained technicians</td>
<td>Program records</td>
<td>Quarterly beginning Q1 2014</td>
<td>2012</td>
<td>Residential Evaluation Team</td>
</tr>
<tr>
<td>Increased awareness of program and equipment among contractors and end users</td>
<td>Non-participating customers say they are aware of the availability of efficient equipment and can define it</td>
<td>Non-participating customer survey</td>
<td>Q1 2015</td>
<td>Residential Evaluation Team</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Non-participating contractors say they are aware of the program; non-participating contractors are aware of availability of high efficiency equipment and can define it</td>
<td>Non-participating contractor survey</td>
<td>Q1 2015</td>
<td>Residential Evaluation Team</td>
<td></td>
</tr>
<tr>
<td>Increased stocking and supply of EE equipment (1)</td>
<td>Qualitative assessment of qualifying and non-qualifying equipment in stock (2)</td>
<td>Qualitative HVAC panel</td>
<td>Quarterly beginning Q2 2015, with data earlier</td>
<td>Distributor survey Q1 2013; Contractor survey Q2-Q3 2013</td>
<td>Cross-cutting Team, working with PA program staff; Res Evaluation Team to incorporate into broader evaluation</td>
</tr>
<tr>
<td>Increased demand for EE equipment</td>
<td>Participating and non-participating customers say they would seek out EE equipment</td>
<td>Participating and non-participating customer survey</td>
<td>Q4 2014</td>
<td>Residential Evaluation Team</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Contractors increasingly report customer interest in qualifying equipment (3)</td>
<td>Distributor interviews and participating and non-participating contractor survey</td>
<td>Q4 2014; Q2-Q3 2012</td>
<td>Residential Evaluation Team</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Qualifying equipment becomes an increasing proportion of distributor's equipment stock (4)</td>
<td>Qualitative HVAC panel and/or distributor interviews</td>
<td>Quarterly beginning Q2 2015, with data earlier</td>
<td>Distributor survey Q1 2013; Contractor survey Q2-Q3 2013</td>
<td>Cross-cutting Team, working with PA program staff; Res Evaluation Team to incorporate into broader evaluation</td>
</tr>
<tr>
<td>Increased market penetration of EE equipment</td>
<td>Counts and %s of qualifying and non-qualifying equipment sold</td>
<td>HARDI data</td>
<td>Quarterly data beginning Q1 2013</td>
<td>Cross-cutting Team, working with PA program staff; Res Evaluation Team to incorporate into broader evaluation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Manufacturer panel to supplement HARDI data</td>
<td>Manufacturer panel to supplement HARDI data</td>
<td>Quarterly beginning Q1 2015</td>
<td>Cross-cutting Team, working with PA program staff; Res Evaluation Team to incorporate into broader evaluation</td>
<td></td>
</tr>
<tr>
<td>Energy and demand savings, environmental benefits, other non-energy benefits</td>
<td>Quantification of savings stemming from market effects</td>
<td>See Section 3 of this document for description (5)</td>
<td>Q3 2015</td>
<td>Residential Evaluation Team</td>
<td></td>
</tr>
<tr>
<td>Sustainable market for EE products and services</td>
<td>Sustainability assessment</td>
<td>Multiple sources</td>
<td>Q3 2015</td>
<td>Residential Evaluation Team</td>
<td></td>
</tr>
</tbody>
</table>

(1) Subsumes the following two outcomes identified and operationalized in the 2012 study: "Contractors install qualifying equipment as a regular practice without obtaining a rebate." "Distributors supply qualifying products for installation," and "Distributors change their stocking practices to supply the increased installation of qualifying equipment." All were operationalized as counts and percents of equipment stock, measured via surveys of distributors and contractors.

(2) Measurements attempted in the 2012 study based on surveys of distributors and contractors; limited success via this data collection method.

(3) Previous study gathered data via distributor survey.

(4) Previous study gathered data via distributor and contractor surveys.

(5) To avoid possible double-counting, analysis will take into account any savings from market effects that may have been assessed through HEHE evaluation(s) during the same time period.
### Table 2-5. Outcomes and Indicators for Ductless Mini-Split Heat Pumps (Cool Smart)—Prospective (Baseline), Revised November 7, 2014

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Indicators</th>
<th>Data Source</th>
<th>Timing</th>
<th>Past Measurements</th>
<th>Responsible Party (recommended)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced cost barriers</td>
<td>Number and amounts of incentives paid to customers</td>
<td>Program records</td>
<td>Quarterly beginning Q1 2014</td>
<td></td>
<td>Program Administrators</td>
</tr>
<tr>
<td></td>
<td>Participating customers say they were motivated by incentive</td>
<td>Participant survey</td>
<td>Annually Beginning Q1 2015</td>
<td></td>
<td>Residential Evaluation Team</td>
</tr>
<tr>
<td>Increased awareness of program and equipment among contractors and end-users</td>
<td>Non-participating customers say they are aware of the availability of efficient equipment and can define it</td>
<td>Non-participating customer survey</td>
<td>Annually Beginning Q1 2015</td>
<td></td>
<td>Residential Evaluation Team</td>
</tr>
<tr>
<td></td>
<td>Non-participating contractors say they are aware of the program; non-participating contractors are aware of availability of high efficiency equipment and can define it</td>
<td>Non-participating contractor survey</td>
<td>Annually Beginning Q1 2015</td>
<td></td>
<td>Residential Evaluation Team</td>
</tr>
<tr>
<td>Trained HVAC technicians successfully complete initial installations of energy efficient equipment</td>
<td>Completion of initial installations of qualifying equipment in each service territory by trained technicians</td>
<td>Program records</td>
<td>Quarterly beginning Q1 2014</td>
<td>2012</td>
<td>Residential Evaluation Team</td>
</tr>
<tr>
<td>Increased stocking and supply of EE equipment (1)</td>
<td>Qualitative assessment of qualifying and non-qualifying equipment in stock (2)</td>
<td>Qualitative HVAC panel</td>
<td>Quarterly beginning Q2 2015, with data beginning earlier</td>
<td>Distributor survey Q1 2013; Contractor survey Q2-Q3 2013</td>
<td>Cross-cutting Team, working with PA program staff; Res Evaluation Team to incorporate into broader evaluation</td>
</tr>
<tr>
<td>Increased demand for EE equipment</td>
<td>Participating and non-participating customers say they would seek out EE equipment</td>
<td>Participating and non-participating customer survey</td>
<td>Q4 2014</td>
<td></td>
<td>Residential Evaluation Team</td>
</tr>
<tr>
<td></td>
<td>Contractors increasingly report customer interest in qualifying equipment (3)</td>
<td>Participating and non-participating contractor survey</td>
<td>Q4 2014</td>
<td>Distributor survey Q1 2013</td>
<td>Residential Evaluation Team</td>
</tr>
<tr>
<td></td>
<td>Qualifying equipment becomes an increasing proportion of distributors’ equipment stock (4)</td>
<td>Qualitative HVAC panel and/or distributor interviews</td>
<td>Quarterly beginning Q2 2015, with data beginning earlier</td>
<td>Distributor survey Q1 2013; Contractor survey Q2-Q3 2013</td>
<td>Cross-cutting Team, working with PA program staff; Res Evaluation Team to incorporate into broader evaluation</td>
</tr>
<tr>
<td>Increased market penetration of EE equipment</td>
<td>Counts and % of qualifying and non-qualifying equipment sold</td>
<td>HARDI data</td>
<td>Quarterly data beginning Q1 2013</td>
<td></td>
<td>Cross-cutting Team, working with PA program staff; Res Evaluation Team to incorporate into broader evaluation</td>
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<td></td>
<td>Manufacturer panel to supplement HARDI data</td>
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<td>Quarterly data beginning Q1 2015</td>
<td></td>
<td>Cross-cutting Team, working with PA program staff; Res Evaluation Team to incorporate into broader evaluation</td>
</tr>
<tr>
<td>Energy and demand savings, environmental benefits, other non-energy benefits</td>
<td>Quantification of savings stemming from changes in system efficiency</td>
<td>See Section 3 of this document for description (5)</td>
<td>2017 (retrospective)</td>
<td></td>
<td>Residential Evaluation Team</td>
</tr>
<tr>
<td>Sustainable market for EE products and services</td>
<td>Sustainability assessment</td>
<td>Multiple sources</td>
<td>2017 (retrospective)</td>
<td></td>
<td>Residential Evaluation Team</td>
</tr>
</tbody>
</table>

1. Subsumes the following two outcomes identified and operationalized in the 2012 study: "Contractors install qualifying equipment as a regular practice without obtaining a rebate," "Distributors supply qualifying products for installation," and "Distributors change their stocking practices to supply the increased installation of qualifying equipment." All were operationalized as counts and percents of equipment stock, measured via surveys of distributors and contractors.

2. Measurements attempted in the 2012 study based on surveys of distributors and contractors; limited success via this data collection method.

3. Previous study gathered data via distributor survey.

4. Previous study gathered data via distributor and contractor surveys.

5. To avoid possible double-counting, analysis will take into account any savings from other measures that may have been assessed through impact evaluation(s) during the same time period.

3. QUANTIFICATION OF MARKET EFFECTS

3.1 OVERVIEW OF METHODS FOR QUANTIFYING MARKET EFFECTS

Within the HVAC markets to be addressed by these studies, there are two general categories of market effects that could be quantified—(1) the effects of the PAs’ programs on sales of efficient HVAC equipment and (2) for CAC only, the effects of the Cool Smart Program on quality installations. Note that, because of questions about the effectiveness of quality installation, we suggest deferring quantification of the effects of the Cool Smart Program on quality installation of central air conditioning equipment. (See Section 3.4 below for a discussion of the rationale for this recommendation.)

There are four basic choices for methods that can quantify market effects:

1. Supply-side market actor self-reported counterfactual analysis. This involves surveys or in-depth interviews asking about free-ridership and spillover.

2. Cross-sectional analysis. This involves identifying one or more comparison groups that will be tracked along with the program area and will serve as the “baseline” for the program area.

3. Forecasting or retrocasting the non-intervention baseline. With this approach, evaluators develop a model to estimate how the market would behave over time without the intervention of the program and compare the estimate with the actual behavior of the market with the intervention. The estimate can be for a future date (forecasting) or a date that has already passed (retrocasting).

4. Structured expert judgment. This approach is typically implemented as a Delphi panel. With this method, evaluators identify a team of experts who review information on the market for the energy-efficient product or service and then go through a structured series of steps to converge on a single baseline estimate.

3.2 METHODS FOR QUANTIFYING EFFECTS OF PROGRAMS ON HVAC MARKETS

We propose using both of the first two methods described above, supply-side market actor self-reporting and cross-sectional analysis, to quantify the effects of the PAs’ programs on sales of efficient equipment and other aspects of HVAC markets. Cross-sectional analysis, given the availability of data from comparison areas, is a powerful analytical tool, and such data from outside of Massachusetts are available through HARDI.

Table 3-1 shows the market effects measurement and attribution methods used in three recent studies of HVAC market effects, with the methods proposed in this document in the last row. As the table shows, the three previous studies all used self-reported counterfactual analysis as a quantitative assessment method and historical tracing or theory-based

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3. Quantification of Market Effects…

evaluation as a qualitative method. These are two of the methods recommended here. Two of
the three studies also used cross-sectional comparison, the third method recommended here.

Table 3-1. Market Effects & Attribution Assessment Methods of Recent Studies

<table>
<thead>
<tr>
<th>Method</th>
<th>Quantitative</th>
<th>Qualitative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Focus on Energy Evaluation Business Programs: Supply-side Evaluation (2010, WI)</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Baseline Market Characterization Study: Residential and Small Commercial HVAC (CA, forthcoming)</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Methods recommended here for assessing market effects of MA HVAC Programs</td>
<td>x</td>
<td></td>
</tr>
</tbody>
</table>

The third method, forecasting (for prospective studies) or retrocasting (for retrospective studies) the non-intervention baseline, is not recommended to estimate the effects of program on the Massachusetts HVAC markets. In our judgment, there are not enough verified variables available about the HVAC markets to develop a reasonably accurate model to estimate market behavior. The fourth method, quantification through structured expert judgment, is dependent on having comprehensive market data for panelists to review, or possibly multiple estimates derived through other methods, which are currently lacking for these markets.

Program Effects on Sales of Efficient HVAC Equipment. Quantifying market effects and associated savings stemming from increased sales of efficient HVAC equipment that can be attributed to PAs’ programs depends on answering two key research questions. For both prospective and retrospective studies, the first key question is:

1. What are the actual sales of heating and cooling equipment of various levels of efficiency in Massachusetts?

For retrospective studies (HEHE and the CAC portion of the Cool Smart Program), the second key research question is:

2. What is the naturally occurring level of sales—i.e., the sales that would have occurred if the Massachusetts initiative had not existed?

For prospective studies (the Commercial Upstream Incentive Program, and the Ductless Mini-split portion of the Cool Smart Program), the second key research question is actually the same as the first. The Cross-Cutting, C&I, and Residential EM&V teams will coordinate to develop market effects work plans and work with program staff to determine whether there has been enough program activity to warrant an adjustment to the current baseline to account for counterfactual conditions.
3. Quantification of Market Effects…

3.3 QUANTIFYING MARKET EFFECTS OF PA PROGRAMS ON SALES OF EFFICIENT HVAC EQUIPMENT

This section proposes data collection activities that have since been refined in light of further research conducted since it was written. Appendix A, Findings & Recommendations Regarding HVAC Market Effects Data, supplements this section with information and findings from some of the research this is proposed in this section. This includes descriptions of the HVAC data that are available to the PAs, assessments of the suitability of these data to meet the HVAC market share needs described in this section, and recommendations for activities to help obtain these data.

The Massachusetts study 2012 Residential Heating, Water Heating, and Cooling Equipment Evaluation: Net to Gross, Market Effects, and Equipment Replacement Timing addressed market effects mostly qualitatively because of a lack of actual sales data, instead relying on limited sales data augmented by equipment turnover assumptions. Having accurate sales data from which to calculate market share will answer the first key research question: What are the actual sales of heating and cooling equipment of various levels of efficiency in Massachusetts? Going forward, we suggest relying on two sources for sales data: a proposed distributor panel and quarterly data from HARDI, assuming the HARDI data are of sufficient quality.

3.3.1 Distributor sales tracking via a panel

The market share data that would be obtained from a panel of distributors would provide a direct point of comparison against which evaluators can estimate what sales would have been in the absence of the program. This approach would be appropriate for all four of the markets and submarkets on which this document focuses.

A number of important factors would need to be investigated before attempting to establish a panel of distributors to provide the sales data from which to calculate market share. These include the proportions of distributors and sales both within and outside of Massachusetts that are represented in the HARDI data, the willingness of distributors to contribute to both HARDI and a PA panel, and how the two efforts could work together or be combined. Having estimates of sales and market share from both sources would help to ensure the representativeness of the data.

The model that we suggest following to obtain sales data from a distributor panel is the Energy Center of Wisconsin’s (ECW) Furnace and Air Conditioning Tracking System (FACTS), which obtained quarterly data from distributors from 1997 until the discontinuation of the program in 2011. ECW’s experience suggests that significant and steady engagement of program contacts is critical to a successful distributor panel. (The staff member who ran FACTS recently told NMR that the most effective approach for recruiting distributors to participate in such a program is to visit their offices personally, ideally accompanied by the distributor’s contact at the IOU program.)

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12 The relevant market effects indicators measured by this study are included in Table 2-1, Table 2-2, Table 2-3, Table 2-4, and Table 2-5 in Section 2.2.
3. Quantification of Market Effects…

If the PAs decide to move forward with a similar panel to provide market share data for Massachusetts, we would expect both PA implementation staff and evaluation staff to be involved in developing and maintaining the panel. For example, as described in Section 1, the C&I implementers are currently engaged with manufacturers and distributors in the HVAC Upstream Incentive program and already collect sales data from distributors. With the assistance of evaluators, that engagement could be expanded to allow for the development of market share data, possibly for equipment typically destined for residential as well as commercial applications. (Other opportunities to coordinate with or leverage Massachusetts data collection efforts may exist as well.) The PA staff would be essential to leveraging their existing relationships and data collection activities with distributors and manufacturers to facilitate the development of a market share system. This could include encouraging distributors to expand or alter the release of sales data, helping to bring new distributors and manufacturers into the system, and helping to maintain relationships with panel members. Since it is likely that HVAC distributors interact with staff of multiple PAs, it would be important to coordinate among PA staff involved with the panel. The evaluation staff should be involved to help develop and maintain the structure of the system. For example, evaluation staff should identify key data to collect for market effects evaluation, gaps in data, opportunities for improving data collection, and value propositions for distributors. They should be responsible for coordinating the collection of data for different programs and markets, ensuring confidentiality of sensitive market share data, ensuring data quality and comprehensiveness, and providing value-added information back to the participating distributors. Implementers and evaluators would need to view the data gathering and output as a service for the distributors, and seek to meet their needs. Those needs include getting value out of the data as well as absolute assurance of confidentiality to protect their trade secrets.

A. Variables to collect

This proposed market share tracking system would track sales of residential and commercial HVAC (unitary and split systems, heat pumps, and related controls), ductless-mini split systems, and residential gas furnaces and boilers, as follows:

- Number of all packaged and split equipment units sold
- Number of air-cooled three-phase packaged and split units sold by efficiency level\(^{13}\)
- Number of single-phase air-cooled packaged and split equipment units sold by efficiency level
- Number of water source heat pumps and/or water/evaporative cooled air conditioners sold by efficiency level
- Number of ductless mini-split equipment units sold by efficiency level
- Number of residential gas furnaces sold by efficiency level
- Number of residential gas boilers sold by efficiency level.

\(^{13}\) In all cases, efficiency level is broken down into the four tiers qualifying for the HVAC Distributor Incentive Program and non-qualifying equipment. This information can be developed from product model numbers provided by the distributors.
3. Quantification of Market Effects…

Distributors would provide data quarterly. The data provided would include the total quantity of units sold by product code and geographical destination. The data could then be aggregated to regions of interest. While these would depend on the level of geographical detail that distributors could provide—a question that needs exploration—one possibility to consider is:

- Boston and near suburbs
- North Shore
- Metro West
- South Shore
- Cape and Islands
- Central
- West.

While disaggregation is helpful for evaluators, the data must be aggregated to the point that the confidentiality of data is protected. For example, if two distributors dominate a region, then each could figure out the other’s sales. In some cases—e.g., for some types of equipment—it may be necessary to aggregate at a higher geographic level.

Again, in recruiting participants for the panel, it is very important to demonstrate the benefits of a market share tracking system, especially in light of the fact that a number of Massachusetts distributors already supply data to HARDI. The distributors would need to be reassured that their data would be kept confidential and data identifying their individual market shares will not be made public or released to competitors, and that the quarterly reports distributors would receive in return would help them to understand the local market.

Several types of materials need to be prepared before the distributors are approached:

1. The first is a confidentiality agreement in which PAs acknowledge that the relevant data provided by the distributor will contain confidential and proprietary sales information, and that information will be held in strict confidence and not disclosed to any third party without a distributor’s written permission. The confidentiality agreement would also need to state that, without an explicit agreement, the information will not be used for any purpose other than the analyses described; access will be limited to employees directly involved in conducting the analyses; and copies of the information provided will be destroyed upon completion of the research.

2. Another type of material needed is a data collection form. This can be very simple, containing fields for the product model number, the number of units shipped, the date, and geographical information such as zip code to which the units are shipped. Distributors should be able to submit forms online; it would be necessary to have a secure File Transfer Protocol (FTP) site for their use. Such forms were developed as part of the 2012 Residential Heating, Water Heating, and Cooling Equipment Evaluation: Net to Gross, Market Effects, and Equipment Replacement Timing study, and presumably these could be adapted for the panel described here.
3. Finally, it is important to have a mock package of graphs and reports to illustrate to distributors what this project would provide to them in the form of quarterly reports. This package could be individualized for each company. It would show total sales for the state or a particular region\textsuperscript{14} compared to the distributors' own sales or market share. Distributors may already get some sales data through the Air Conditioning, Heating, and Refrigeration Institute (AHRI), but there are no data on sales by efficiency levels. Such data may be quite useful to these companies and it could be a strong selling point for a market share tracking system.

B. Research needed to assess distributor sales tracking for Massachusetts

The decision to develop a distributor sales tracking system to meet the PAs’ needs should be grounded in the reality that some of the data that would be needed for market effects measurement might already be collected through the efforts of the implementation and evaluation teams for the programs in question. For this reason, research will be needed to inform the decision about whether to invest in a Massachusetts-specific distributor panel; under which auspices a panel should be developed (residential, C&I, or cross-cutting); and how to collect the necessary data most efficiently while maintaining relationships that are important to the programs. This research should include:

1. Using interviews with distributors planned for the C&I HVAC Supply-side Actor Study to gather information that could be used to inform panel design (forthcoming).

2. With the indicators listed in Section 2.2 and the variables listed above in mind, developing an asset list for the Massachusetts programs that would support market effects. Assets would not be limited to existing data collection, but would also include relationships, etc. The list should include information about the auspices under which the asset is gathered or maintained (for example, the program for which the data are collected and whether it is collected by the program or evaluation team). For data assets, the list should include details about the variables collected and how the data are sampled. The HARDI data examination described in Section 3.3.2 would be part of this. This research has been conducted and is reported in Appendix A.

3. Examining the overlaps and gaps between the assets and the market effects data needs. This research has been conducted and is reported in Appendix A.

4. Exploring how the existing data collection efforts could be leveraged, and whether they need minor adjustments or more significant changes in order to meet market effects data needs. This research has been conducted and is reported in Appendix A.

The results of the research should be used to develop a plan for Massachusetts that leverages assets; avoids redundancy; and identifies risks, roles, responsibilities, and costs.

3.3.2 HARDI data

As mentioned previously, the PAs are acquiring quarterly residential and small commercial 2013 HVAC shipment data from HARDI for MA, NY, CT, and PA. These data need to be

\textsuperscript{14} Regional data will be provided to the participants only if they do not compromise confidentiality by revealing their competitors’ market shares.
examined to assess a number of factors, including their quality and representativeness; the
degree to which they could meet data needs for measuring cross-cutting HVAC market
effects; the overlap with the sales data currently being collected by the C&I Upstream HVAC
Program and which may be supplemented in the future through a panel of distributors; and
coordinating Massachusetts’ data collection efforts with HARDI. In addition, we recommend
that the HARDI data be grouped for analysis by the same equipment types, efficiency levels,
and regions as described above for the distributor panel data. This would allow for a clear
comparison of HARDI data quality relative to the needs of the market effects evaluation.

For more information about the HARDI data, see Appendix A.

3.3.3 Estimating the counterfactual for sales of efficient equipment

The second key research question to answer in order to quantify market effects is: What is
the naturally occurring level of sales—i.e., the sales that would have occurred if the
Massachusetts initiative had not existed? Another name for this is the counterfactual,
because it has not actually occurred (that is, it is counter to fact). Within the next few months
for the two retrospective studies (HEHE and the CAC portion of the Cool Smart Program) and
in several years for the two prospective studies (C&I Upstream HVAC Incentive Program and
the Ductless Mini-split Heat Pump portion of the Cool Smart Program), we recommend
estimating the counterfactual in two ways:

1. Include questions for the distributor panel to obtain their estimates of sales by
equipment type and efficiency level by year, assuming the program had not existed.
Until comparison area data are readily available for commercial HVAC equipment,
this would be the only estimation of the counterfactual for programs’ effects on the
market for commercial HVAC equipment.

2. For residential and small commercial equipment, also use the sales from comparison
areas to develop a counterfactual estimate. While the PAs have already purchased
HARDI data for NY, CT, and PA, areas without HVAC programs, such as Delaware,
Kansas, and parts of West Virginia, would make for more valid comparisons.
However, it is not clear that the HARDI data are comprehensive enough to justify
additional purchases at this time, especially for Massachusetts. A full exploration of
appropriate comparison states for use with HARDI data should be part of the
development of the HVAC market effects work plans. Since the PAs already own the
HARDI data for NY, CT, and PA, another possibility to consider is using these states’
sales data in a regression model to assess program effect, with the presence and
maturity of the program in each area as an independent variable. However, there
may not be enough variation among the MA, NY, CT and PA programs for a
regression model to pick up an effect.

For both residential and commercial HVAC markets, the distributors’ self-reported
estimates of sales of efficient equipment in the absence of the program would be
compared to actual sales as recorded in the distributor sales tracking panel. The
difference between actual sales of different equipment types and efficiency levels
and suppliers’ estimates of sales in the absence of the program will be considered
the net program effect on sales. The ratio of net sales to program-supported sales
will be the net-to-gross ratio (NTGR).

For the residential and small commercial HVAC market, the HARDI data would be
3. Quantification of Market Effects…

complemented by program-supported sales data from the Massachusetts PAs as well as information on any program-supported sales data obtained directly from PAs in the comparison states, or estimated based on public filings of those programs or other secondary research on the programs. The difference between the market share of incentivized equipment in Massachusetts and the market share in the comparison states of the same equipment and efficiency levels will be considered the net effect of the program on sales. If possible, we recommend adjusting these figures for Massachusetts and comparison states based on the relationship between the HARDI data for Massachusetts and the distributor-reported data for Massachusetts, on the assumption that the latter will be more complete. Again, the ratio of net sales to program-supported sales will be the NTGR.

3.4 ADDRESSING QUALITY INSTALLATIONS FOR CAC

Regulatory compliance among HVAC installations in Massachusetts is, in all likelihood, very limited. Anecdotal evidence indicates that permits for HVAC installations in existing homes in Massachusetts are pulled infrequently or rarely. This may be a symptom of a deeper underlying structural practice in the industry in which price competition is imposing pressure on licensed contractors to compete with large numbers of unlicensed contractors. This has been observed in the HVAC industry in California, and is likely the case nationwide, including in Massachusetts. Thus, a market effects evaluation of the QI component of the Massachusetts Cool Smart program may be of questionable value when the market that the program is operating in may itself be suffering from an endemic lack of regulatory compliance. Additionally, field testing for the evaluation of the QI component of the Massachusetts Cool Smart program is likely to be compromised by flawed protocols for assessing refrigerant charge. A 2012 study conducted at Purdue University15 found that the diagnostic protocols currently used to measure refrigerant charge level are unreliable and have an unacceptably high incidence of false alarms16 and misdiagnoses.17 Recent work in California confirms these findings.

We recommend not trying to quantify savings from a market effects evaluation of the QI component of the Massachusetts Cool Smart program. For this reason, we have not included any QI market effects indicators in the tables in Section 2.2, despite these having been measured as part of the study 2012 Residential Heating, Water Heating, and Cooling Equipment Evaluation: Net to Gross, Market Effects, and Equipment Replacement Timing.18 Instead, we recommend conducting market research to assess the level of regulatory compliance among new HVAC installations, including determining the incidence of HVAC installations by licensed contractors and the incidence of permits being pulled for such installations. With regard to the field testing, we recommend awaiting the development of more reliable diagnostic protocols. The Massachusetts PAs might consider working together with the California PAs, and possibly manufacturers, to develop such protocols.

16 No significant fault is present but the protocol indicates the presence of a fault.
17 A significant fault is present but the protocol misdiagnoses what type of fault it is.
3. Quantification of Market Effects…

3.5 ESTIMATING NET ENERGY SAVINGS

We understand that impact evaluations of the HEHE program and the Ductless Mini-split portion of the Cool Smart Program are planned for 2014, with results expected in early fall for Ductless Mini-Splits and late winter for HEHE. Currently, there are no planned impact evaluations for the C&I Upstream HVAC Program or the CAC portion of the Cool Smart Program.

For the C&I Upstream HVAC Program, we recommend that a prospective market effects evaluation be completed by mid-2015, so an impact evaluation could wait until 2016, just before a retrospective market effects evaluation in 2017. We also suggest 2017 as the timing for a retrospective evaluation of the Ductless Mini-split portion of the Cool Smart Program (which would also have a prospective market effects evaluation in the meantime). We assume that the market effects evaluation could rely on the gross savings estimates from the 2014 impact evaluation of this program.

We recommend that the retrospective market effects evaluations for the CAC portion of the Cool Smart Program be finished by the second quarter of 2015 and by the third quarter of 2015 for HEHE. The HEHE market effects evaluation could rely on the gross impact evaluation to be conducted in late 2014 and early 2015. We recommend that the PAs consider conducting an impact evaluation of the CAC portion of the Cool Smart Program in the summer of 2015.

For the C&I Upstream Incentive Program, the HEHE Program, and the Ductless Mini-split Heat Pump portion of the Cool Smart Program, the NTGR for each program will be applied to the gross savings estimate to produce an estimate of net savings. For the C&I Upstream HVAC Incentive Program and the Ductless Mini-split Heat Pump portion of the Cool Smart Program, since they are new and the imminent studies will be prospective, we recommend that this be completed in 2017 in what will then be retrospective studies, but we suggest annual reports in 2015 and 2016 summarizing the indicators measured to date.
4. SUMMARY OF RECOMMENDED RESEARCH ACTIVITIES

Table 4-1 below summarizes the recommended research activities described in the body of this document. The information in this table has been revised since the Interim version to update timing and reflect the recommendations that appear in Appendix A.
### Table 4-1. Summary of Recommended Research Activities

<table>
<thead>
<tr>
<th>Research Activity</th>
<th>Timing</th>
<th>Responsible Party</th>
<th>Timing</th>
<th>Recommended Responsible Party</th>
<th>Timing</th>
<th>Recommended Responsible Party</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Upstream C&amp;I HVAC Incentives (Prospective)</strong></td>
<td>Q1 2015</td>
<td>C&amp;I Eval Team</td>
<td>Q4 2014</td>
<td>Res Eval Team</td>
<td>Q4 2014</td>
<td>Res Eval Team</td>
</tr>
<tr>
<td><strong>CAC Portion of Cool Smart (Prospective)</strong></td>
<td>Q1 2015</td>
<td>C&amp;I Eval Team</td>
<td>Q1 2015</td>
<td>Res Eval Team</td>
<td>Q1 2015</td>
<td>Res Eval Team</td>
</tr>
<tr>
<td><strong>HEHE (Retrospective)</strong></td>
<td>Q4 2014</td>
<td>Res Eval Team</td>
<td>Q4 2014</td>
<td>Res Eval Team</td>
<td>Q4 2014</td>
<td>Res Eval Team</td>
</tr>
<tr>
<td><strong>Ductless Mini-split Portion of Cool Smart (Prospective)</strong></td>
<td>Q3 2015</td>
<td>C&amp;I Eval Team</td>
<td>Q3 2015</td>
<td>Res Eval Team</td>
<td>Q3 2015</td>
<td>Res Eval Team</td>
</tr>
</tbody>
</table>

* Assumes that distributor RTU sales data collection (Activity 3) does not include sales of RTUs through manufacturer-owned distribution channels.

- **Work Plan**
  - **Timing**: Q1 2015
  - **Recommended Responsible Party**: C&I Eval Team

- **Revision of Market and Program Logic Models**
  - **Timing**: Q1 2015
  - **Recommended Responsible Party**: C&I Eval Team

- **Tracking of Program Records**
  - **Timing**: Quarterly Beginning Q1 2014
  - **Recommended Responsible Party**: PAs

- **Collection and Reporting of Distributor RTU Sales Data (Outcome of Activity 3)**
  - **Timing**: Quarterly Beginning Q1 2015
  - **Recommended Responsible Party**: Program/Implementation Staff & TBD

- **Obtain & analyze HARDI Data (Outcome of Activity 1)**
  - **Timing**: Quarterly Data Beginning Q1 2013
  - **Recommended Responsible Party**: TBD

- **Collection and Reporting of Manufacturer Sales Data for Sales through Manufacturer-owned Distribution Channels**
  - **Timing**: Quarterly Data Beginning Q4 2015 for Q3 2015 data
  - **Recommended Responsible Party**: TBD & Program/Implementation Staff

- **Collection of qualitative and stocking data from panel of manufacturers and distributors (Activity 5)**
  - **Timing**: Annually Beginning Q3 2015
  - **Recommended Responsible Party**: TBD & Program/Implementation Staff

- **Participating & Non-participating Customer Survey**
  - **Timing**: Q4 2014–Q1 2015
  - **Recommended Responsible Party**: Res Eval Team

- **Participating & Non-participating Contractor Survey**
  - **Timing**: Q4 2014–Q1 2015
  - **Recommended Responsible Party**: Res Eval Team

- **Synthesis of Indicators for Theory-based Evaluation**
  - **Timing**: Q3 2015 (prospective), 2017 (retrospective)
  - **Recommended Responsible Party**: C&I Eval Team

- **Impact Evaluation**
  - **Timing**: 2016
  - **Recommended Responsible Party**: C&I Eval Team

- **Quantification of Market Effects and Net Savings**
  - **Timing**: 2017
  - **Recommended Responsible Party**: C&I Eval Team

- **Assessment of Sustainability of Market**
  - **Timing**: 2017
  - **Recommended Responsible Party**: C&I Eval Team
APPENDIX A: FINDINGS & RECOMMENDATIONS REGARDING HVAC MARKET EFFECTS DATA

A.1 BACKGROUND

Section 3.3 of this report discusses the possibility of establishing a panel of distributors to provide sales data needed to calculate market share. This appendix reports on a number of important tasks that need to be completed before determining whether to attempt to establish a panel of distributors. These tasks include understanding the HARDI\textsuperscript{10} data collected by D&R International (D&R), understanding the sales data currently being collected by the C&I Upstream HVAC Program, identifying any other relevant Massachusetts data collection efforts that might provide data needed for cross-cutting HVAC market data needs described in the main body of the report, and comparing the data available to these needs.

The information presented here is based on supplemental research conducted between June and October of 2014. This research included the following activities:

- Examining HARDI data and interviewing representatives of D&R International
- Examining market data collection forms for data collected by the Upstream HVAC Program and interviewing program staff
- Obtaining relevant information about data collection activities that are part of current and planned studies related to the HVAC market and programs affecting it in order to identify any other periodic Massachusetts data collection activities that could supplement the information provided in the main body of the report
- Examining the residential and C&I program tracking databases assembled by the evaluation teams.

This document is organized as follows:

- Section A.2: Summary of recommendations
- Section A.2.1: Brief methodology
- Section A.3.1: General description of each of the sources of HVAC market data we examined
- Section A.3.2: Comparison of key aspects of each data set in a discussion and tables
- Section A.4: Key findings
- Section A.5: Recommendations
- Section A.6: Issues for Consideration

\textsuperscript{10} Heating, Air-conditioning & Refrigeration Distributors International.
In the process of conducting the additional research reported in this Appendix, the study team revised four of the tables of indicators that now appear in Section 2.2 of the main body of this report.

A.2 SUMMARY OF RECOMMENDATIONS

In Section A.5, we describe five activities for the PAs to consider pursuing to obtain the HVAC market share data described in the main body of this document. As Table A-1 shows, each of the activities is designed to address the data need for a particular type of equipment from a particular sales channel. We recommend that the PAs pursue all five activities in order to maximize the representativeness of HVAC market share data in the future. It is important to bear in mind that the sources of data discussed here are in flux, the activities we recommend may not all bear fruit, and the activities will no doubt need to change over time as progress is made and new information comes to light. The activities are as follows:

1. To rely on the HARDI data for residential HVAC market share and partner with D&R to increase participation in the HARDI report by Massachusetts distributors

2. To encourage D&R to obtain and make available for sale HARDI data for commercial equipment

3. To build on the Upstream HVAC Program’s distributor data collection to obtain market share data for commercial RTUs

4. To research the ability of manufacturers to provide meaningful state-level HVAC sales data made through manufacturer distribution networks or directly to customers, and if it appears to be viable, establish a manufacturer panel to collect data for these channels to supplement residential HARDI data and provide some data for commercial equipment other than RTUs

5. To establish a panel of manufacturers and distributors to provide qualitative data in support of market effects and process evaluation and as quality assurance for HARDI data.
A. Findings & Recommendations Regarding HVAC Market Effects Data…

Table A-1. Data Needs Addressed by Each Activity

<table>
<thead>
<tr>
<th>Equipment Type</th>
<th>Recommended Activity to Obtain Data for Equipment Type &amp; Sales Channel</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sales through Independent Distribution Channels</td>
</tr>
<tr>
<td>Residential equipment</td>
<td>1 (HARDI data)</td>
</tr>
<tr>
<td>Commercial equipment, except RTUs</td>
<td>2 (Possible future HARDI data)</td>
</tr>
<tr>
<td>RTUs</td>
<td>3 (Build on Upstream Program data collection for RTU market share)</td>
</tr>
</tbody>
</table>

A.2.1 Methodology

To accomplish this research, the team reached out to PA and consultant evaluation staff and implementation staff in order to identify current and planned HVAC market share data collection efforts. We examined HVAC-related Massachusetts reports available from the EEAC website and drafts of related forthcoming Massachusetts reports, where available, to look for evidence of studies having collected relevant data. We participated in a meeting with Upstream HVAC Program staff to learn about their distributor and manufacturer data collection efforts, obtained and examined the forms used to collect these data, and asked clarifying questions of program staff in an informal interview. We also interviewed staff of D&R, obtained the 2012 HARDI reports purchased by the PAs, and examined these data in accordance with the PAs’ agreement with D&R.

A.3 SUMMARY OF RELEVANT DATA SOURCES

We identified the following six sources of HVAC data:

1. HARDI data collected by D&R and reported quarterly
2. Sales data collected on a monthly basis by the Upstream HVAC Program from participating distributors who sold products through the Program
3. An effort undertaken in 2012 by the Upstream HVAC Program to collect 2011 unit sales data from manufacturers
4. An effort undertaken in 2013 by the Upstream HVAC Program to collect price data from manufacturers
5. Residential HVAC sales data collected for an evaluation of the residential Cool Smart and High-Efficiency Heating and Water Heating Equipment (HEHE) programs in 2012.\(^{20}\)

6. Data collected on small C&I boiler sales from boiler manufacturers for a C&I boiler market characterization study conducted by DNV GL in 2013.\(^{21}\) (While small commercial and industrial boilers were not included among the cross-cutting HVAC market data needs, we have included them here because we understand that the Upstream HVAC Program may add boilers in the future. We learned after completing our research that the addition of chillers is under consideration as well. We did not seek out chiller data as part of this study.)

In this section, we examine the data sources and compare them against the market share data we propose for collection in Section 3.2.2 in the main body of this report.

A.3.1 Descriptions of data sources

a. HVAC equipment destined for residential versus commercial applications

Because the Massachusetts programs address HVAC equipment for both commercial and residential applications, it is important to be able to differentiate sales of HVAC equipment and controls destined for each of these applications. We found that the majority of the HARDI sales data are for units typically installed in residential applications—that is, units of sizes of five tons or less that are appropriate for such applications. The 2012 sales data collected for the Cool Smart and HEHE evaluation were only for residential equipment.

All the data collected under the auspices of the Upstream HVAC Program are for units typically installed in commercial applications. The data collected for the Massachusetts Boiler Market Characterization were for gas boilers installed in the small commercial and industrial sector of this market.

Evaluation contractor staff working on the Supply Side Market Actor Study provided insights to the Market Effects Study team that suggest the relationships among manufacturers, equipment production, and distribution are complex. For example, any individual manufacturer might produce just one type of HVAC equipment for which PAs seek market share data, or they might produce several different types. Distributors may sell equipment made by just one manufacturer, or by a variety of manufacturers. Distributors may focus primarily on equipment for residential applications, or for commercial applications—or they may distribute equipment for both applications. (For example, according to D&R only four of the distributors listed on the web as participating in the Upstream HVAC Program provide residential sales data for the HARDI Report.) Thus, the set of manufacturers and distributors involved in producing and distributing each equipment type varies somewhat by type of equipment.

For the purposes of this study, we will focus on two main types of distributors:


A. Findings & Recommendations Regarding HVAC Market Effects Data…

1. Those that are owned and operated or franchised by a manufacturer and distribute only one manufacturer’s line of equipment (referred to here as “manufacturer distribution networks”)

2. Those that are not owned and operated or franchised by a manufacturer, and may distribute equipment made by a variety of manufacturers (referred to here as “independent distributors”).

b. Residential: Recurring HARDI HVAC reports and one-time Cool Smart and HEHE evaluation data

HARDI reports

In 2014, the Massachusetts Program Administrators purchased 2013 HARDI Unitary HVAC Market Share sales reports from D&R International (D&R). HARDI refers to Heating, Air-conditioning & Refrigeration Distributors International. Its members provide equipment sales data to D&R, and D&R prepares reports with these data under license to HARDI. Here, we refer to these data as the HARDI data.

D&R collects HVAC equipment sales data directly from participating HARDI member distributors and prepares free quarterly market share reports for these members as well as aggregate sales data for HARDI. D&R also provides aggregate sales reports to other interested parties for a fee. Distributors report sales data to D&R on a monthly basis, while the HARDI reports are supplied to purchasers on a quarterly basis. The data are for both energy-efficient equipment and standard equipment. The study team examined these data with the approval of the Massachusetts PAs and interviewed D&R staff in order to better understand the characteristics of the data. Here, we report only underlying characteristics of the HARDI data and how they are collected and prepared for reporting, not the data themselves.

According to D&R staff, HARDI estimates that its members represent 85 percent of sales (as calculated by dollar value) of the national residential market for unitary HVAC equipment. Much of the missing percentage of dollar value sales are those of Lennox, which sells directly through its own distribution branches throughout the country and is not a HARDI member. Other manufacturers who sell directly to end-use customers exclusively are also not included in the population of HARDI members. While D&R is interested in acquiring data from such manufacturers to include in the market share reports, it is not currently collecting these data.

D&R staff estimated that, as of October 2014, the sales of HARDI members reporting data to D&R represented about 25 percent of all residential unitary HVAC sales in Massachusetts. This is an increase from 2013, a period for which D&R staff speculated the sales of reporting HARDI members to be roughly around 15 percent of all unitary HVAC sales in Massachusetts. D&R is actively engaged in recruiting more distributors for this effort.

D&R recruits distributors for the panel at the organizational level. Participating distributors range in size from big national players to “mom-and-pop” organizations. Participation in the reporting effort is voluntary for HARDI members. D&R continually recruits additional participants to increase the percentage of HARDI members who participate.

22 D&R estimated the percentage for this period to be on the low end of a range from 12 to 22 percent. One interviewee speculated, but could not confirm, that the number was around 15 percent.
To reduce noise from changes in participation, D&R includes data only for distributors who have provided one year or more of complete data. It currently requests that new report participants provide data from 2012 and 2013 as well as 2014. D&R runs an internal index to determine increases or decreases in the amount of sales at state, local, and national levels. Future reports will reflect whether D&R believes sales decreases or increases are due to actual changes in the market or to changes in the number of participants reporting.

D&R obtains from distributors the total number of furnaces and boilers, unitary AC, and heat pumps sold by model number and HARDI member branch location. D&R derives unit specifications, including size, efficiency and other characteristics, for each of model from the model numbers.23

The HARDI estimate of units sold in Massachusetts is based on a basic stock replacement model using publicly available data on housing stock, age of equipment, etc., as well as the HARDI data for some of the splits and equipment fuel type. D&R compares its estimates to other data that are reported regarding the size of the HVAC market. According to D&R staff, thus far the data have lined up well with those of other national sources.

Cool Smart and HEHE evaluation data

In 2013, the residential evaluation team collected one-time unit HVAC sales data from 25 Massachusetts distributors as part of an evaluation by Navigant, Opinion Dynamics, and Cadmus that looked at the net market effects of the residential Cool Smart and High-Efficiency Heating and Water Heating Equipment (HEHE) programs in 2012. This study asked a sample of 25 residential HVAC equipment distributors for the number of units of residential HVAC and water heating equipment sold in Massachusetts in 2012 by equipment type and efficiency level. Because of differences in the way the 2013 HARDI data are aggregated compared to the 2012 data collected for the Massachusetts Cool Smart and HEHE evaluation, we have very limited ability to compare these data sets directly. We were able to compare the data sets only for gas boilers (less than 90 AFUE versus 90+ AFUE) and gas furnaces (less than 90 AFUE versus 90+ AFUE for HARDI data, less than 92 AFUE versus 92+ for HEHE data). For both equipment types, the HARDI data report substantially higher sales of less efficient units.24

Commercial: Upstream HVAC Program data and one-time boiler study data

The Upstream HVAC Program implementation team collects unit HVAC sales data for qualifying commercial energy-efficient units and selected HVAC system components on a monthly basis from program participants. Preliminary results of research currently underway as part of the Supply Side Market Actor Study show that 100 percent of distributors that sell unitary commercial rooftop cooling equipment (also known as rooftop units or RTUs) in or to Massachusetts are program participants. These distributors also sell other types of program-qualifying equipment and report sales data for all of these types to the program. While all participating distributors are required to report unit HVAC sales data each month, a relatively small number of distributors account for the majority of sales. Some participating distributors have no sales and thus have not reported data.

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23 D&R noted that typically, about 5 percent of models cannot be classified.
24 HEHE 2012 market share for gas boilers of less than 90% AFUE was between 16% and 27%; for furnaces of less than 92% AFUE, it was between 16% and 20%. It is not possible to report the 2013 HARDI figures due to the PAs' confidentiality agreements with D&R.
The percentage of the market for unitary equipment types other than RTUs that is represented in the Upstream HVAC Program data collected from participating distributors is currently undetermined. While program staff could not provide an estimate of the share of Massachusetts commercial HVAC sales represented by the participating distributors and manufacturers, it is the staff’s belief that “most” distributors of commercial HVAC equipment to Massachusetts participate in the program. As of October 2014, the evaluation team working on the Supply Side Market Actor study had identified a number of non-participating distributor outlets selling other types of commercial HVAC equipment to Massachusetts customers. Adding boilers and chillers to the Program is under consideration. Currently only a small percentage of manufacturers and distributors of boilers and chillers participate in the Program.

In 2012, the implementation team also gathered one-time unit HVAC shipment data for 2011 from three of the five largest RTU manufacturers. In 2013, the implementation team asked these manufacturers for one-time price data. Program staff estimate that the percentage of the RTU market represented by manufacturers responding to the 2012 and 2013 surveys was roughly 50 percent in 2012 and 60 percent in 2013. It is not clear what percentage of the markets for HVAC equipment other than RTUs was represented by these manufacturers.

The 2012 request for 2011 data was for Massachusetts-specific sales data, which in the case of manufacturers means shipments to Massachusetts distributors. In the study team’s experience, it is common for manufacturers to ship products for the mass market or lighter products destined for commercial use—such as lighting—to distributors’ main warehouses, and for distributors to then redistribute the products among their warehouses and outlets. In the case of larger distributors, these warehouses are often scattered across multiple states. Product manufacturers usually do not have access to information about where their products have been redistributed once they are shipped to distributors. For this reason, manufacturer shipment data that has not been redistributed may not be particularly helpful for program administrators to understand market progress in their states. There are some exceptions, however. For example, manufacturers of heavier equipment, such as motors, may ship the product closer to its ultimate destination. In such cases, shipment data that has not been redistributed can still be helpful to programs.

Program staff thought it unlikely that the 2011 shipment data reflected redistribution of equipment across state lines.

d. Gas boiler study data

As part of a characterization of the Massachusetts small commercial and industrial boiler market, the C&I evaluation team requested 2012 sales data from a sample of 26 out of 35 boiler manufacturers identified through research as collectively manufacturing a substantial proportion of the market for high efficiency and standard efficiency boilers sold to Massachusetts C&I customers. Twenty manufacturers supplied sales data that yielded an estimate of gas-only boilers in the 90–2,000 MBH size range sold in 2012 in the Massachusetts small commercial and industrial market. The evaluation team supplemented the sales data with an analysis of gas C&I account billing data and inventory data from commercial building databases to estimate the 2012 market share of high efficiency C&I boilers.
A.3.2 Comparison of data needs with data sources

Table A-2 shows the breakdown of data available for different equipment types and sizes from HARDI and the Upstream HVAC Program, as well as the data collected as part of the Cool Smart and HEHE evaluations and the Massachusetts boiler market characterization study. Table A-3 compares these data sources across a variety of characteristics. Below, we summarize and discuss notable differences between the market effects data needs and the data sources.

a. Types of equipment in each data set

Table A-2 shows the types of HVAC equipment (unitary HVAC equipment and controls and residential CAC, gas heating and ductless mini-split heat pumps) addressed by each data source. Where the data sources examined included data for other equipment types, we have added these to the table for reference.

As Table A-2 shows, the 2013 HARDI Report for Massachusetts provided sales data for four types of primarily residential equipment: central air conditioners (ducted vs. ductless), central heat pumps (ducted vs. ductless), furnaces (by fuel type), and boilers (by fuel type). D&R explained that, since this breakdown is derived from model number information provided by distributors, sorting of units by a set of unit types that better matches program equipment targets could be provided to the PAs upon request.

Distributors participating in the Upstream HVAC Program provide counts for each HVAC unit type included in the Upstream HVAC Program and installed at commercial locations, plus information about other incented HVAC components, including dual enthalpy economizers, demand control ventilation, and ECM motors for HVAC fans. The 2012 manufacturer survey provided information on the number of air conditioning units cross-tabulated by unit capacity and standard versus high efficiency, but not specifically by unit type and not separated by residential versus commercial applications. The 2013 manufacturer data collection provided price data for commercial central air conditioning (AC) and heat pump (HP) units eligible for the Upstream HVAC Program by unit type and efficiency tier, but did not provide sales counts or percentage distribution among efficiency tiers.

Distributors reporting sales for the Cool Smart and HEHE study provided estimates of the total number of central air conditioners, heat pumps, furnaces, boilers, ductless mini-split systems, and residential water heating units by type sold in Massachusetts in 2012. The distributors also estimated the percentages of the sales of each unit type by efficiency level.

Manufacturers and distributors of small C&I boilers reporting sales for the Massachusetts Boiler Market Characterization study provided estimates of both the total number of gas boilers they sold for businesses in Massachusetts in 2012 and the percentage of sales by condensing versus non-condensing, by size, and by AFUE.
Table A-2. Types of Unitary HVAC Equipment & Controls and Residential CAC, Gas Heating & Ductless Mini-split Heat Pumps Addressed by Each Data Source

<table>
<thead>
<tr>
<th>Equipment—All Types</th>
<th>HARDI</th>
<th>Upstream HVAC Program</th>
<th>Evaluation-Specific Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall size range of equipment</td>
<td>Mostly 5 tons or smaller</td>
<td>Either 5 to 25 tons or 5 to 50 tons (unclear)</td>
<td>From 5 to 25 tons</td>
</tr>
<tr>
<td>Equipment Primarily for Residential Use</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air-cooled single-phase packaged units (CAC &amp; HP &lt; 5 T or 5.4 T)</td>
<td>Primary focus</td>
<td>Only if installed in Commercial or Industrial facility</td>
<td>Price only</td>
</tr>
<tr>
<td>Air-cooled single-phase split units (CAC &amp; HP &lt; 5 T or 5.4 T)</td>
<td>Primary focus</td>
<td>Only if installed in Commercial or Industrial facility</td>
<td>Price only</td>
</tr>
<tr>
<td>Ductless mini-split equipment units</td>
<td>Primary focus</td>
<td>Only if installed in Commercial or Industrial facility</td>
<td>Price only</td>
</tr>
<tr>
<td>Residential gas furnaces</td>
<td>Primary focus</td>
<td>-</td>
<td>Primary focus</td>
</tr>
<tr>
<td>Residential gas boilers</td>
<td>Primary focus</td>
<td>-</td>
<td>Primary focus</td>
</tr>
<tr>
<td>Additional Residential Equipment Addressed by Each Data Source</td>
<td>Fuel oil furnaces</td>
<td>Primary focus</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Fuel oil boilers</td>
<td>Primary focus</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Gas Water Heaters, Storage and Tankless</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Equipment Primarily for Small Commercial or Industrial Use</td>
<td>Air-cooled three-phase packaged units (CAC &amp; HP &lt; 5 or 5.4 T)</td>
<td>Not segregated from single-phase in current reports</td>
<td>Primary focus</td>
</tr>
<tr>
<td></td>
<td>Air-cooled three-phase split units (CAC &amp; HP &lt; 5 or 5.4 T)</td>
<td>Not segregated from single-phase in current reports</td>
<td>Primary focus</td>
</tr>
<tr>
<td></td>
<td>Air-cooled units (CAC &amp; HP, ≥ 5 or 5.4 T)</td>
<td>minimal data collected</td>
<td>Primary focus</td>
</tr>
<tr>
<td></td>
<td>Water source heat pumps (&lt;11.25 T)</td>
<td>-</td>
<td>Primary focus</td>
</tr>
<tr>
<td></td>
<td>Water/evaporative cooled air conditioners (&lt; 20 T)</td>
<td>-</td>
<td>Primary focus</td>
</tr>
<tr>
<td></td>
<td>HVAC controls (demand control ventilation, dual enthalpy economizer controls, ECM motors for HVAC fans)</td>
<td>-</td>
<td>Primary focus</td>
</tr>
<tr>
<td>Additional Commercial Equipment Addressed by Each Data Source</td>
<td>Ground Water/Water Source Heat Pump Systems (Open Loop, &lt;11.25 T)</td>
<td>-</td>
<td>Primary focus</td>
</tr>
<tr>
<td></td>
<td>Ground Loop-Water Source Heat Pump Systems (Closed Loop, &lt;11.25 T)</td>
<td>-</td>
<td>Primary focus</td>
</tr>
<tr>
<td></td>
<td>Small C&amp;I boilers (90–2,000 MBH)</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Legend:
- Information for this equipment broken out at this level is primary focus of data source
- Information for this equipment broken out at this level is not primary focus of data source

b. Unit counts and ability to calculate market share
Market share is a ratio that can be reported either in unit counts ([qualifying units]/[all units]) or as a percentage. Unit-level data provide the most flexibility for market effects analysis. Table A-3 shows the degree to which each data source provides market share data and whether unit counts or percentages are reported.

The 2013 HARDI report purchased by the PAs included an estimate of total Massachusetts sales of each general type of HVAC system during the reporting period. It also provided a distribution of the percentage of units sold of each type by the reporting distributors that were high efficiency units. It did not, however, offer an estimate of the percentage of the market represented by the sales of reporting distributors and combine this with the distribution of percentage of high efficiency units sold, which would have resulted in estimated unit sales by efficiency level, or estimated market share. D&R staff noted that the 2014 data set will include an estimate of the share of the market represented by the HARDI data. It is also working to include in future reports the percent distributions of units by type cross-tabulated by capacity and efficiency. This cross-tabulation would enable the PAs to calculate market share of qualified equipment by unit type.

Distributors report monthly sales to the Upstream HVAC Program as unit counts, but only for qualifying HVAC equipment. Distributors participating in the Upstream HVAC Program provide an Air-Conditioning, Heating, and Refrigeration Institute (AHRI) number for each HVAC system submitted for an incentive. This number defines a system’s type, capacity, and efficiency and thus determines system qualification. The 2013 manufacturer survey collected the total number of HVAC units shipped, the number of conventional units shipped, and the number of high-efficiency units shipped, both overall (presumably nationally, but this was not specified) and specifically to Massachusetts.

Responding manufacturers also reported shipment counts of conventional and high efficiency units broken down by unit size. The survey did not ask manufacturers to distinguish between residential and commercial units.

The Cool Smart and HEHE study included an estimate of 2012 Massachusetts sales by the reporting distributors of residential HVAC and water heater equipment. It also provided a distribution of the percentage of units sold of each type by efficiency level. These data were used to estimate the Massachusetts market share of units by efficiency level. The study did not offer an estimate of the percentage of the market represented by the sales of reporting distributors.

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25 Also known as market penetration.
26 The Upstream HVAC Program’s 2013 manufacturer survey data collection instrument included some unclear questions and reporting categories. If the program requests similar information of manufacturers in the future, the instrument should be revised. Because of the issues with the instrument, the 2013 data would mostly likely not be suitable for use as a baseline.
### Table A-3. Comparison of HVAC Sales Data Sources

<table>
<thead>
<tr>
<th>HARDI</th>
<th>Upstream HVAC Program</th>
<th>Evaluation-Specific Data</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Quarterly Reports:</strong> Unitary HVAC Market Share</td>
<td><strong>Monthly Distributor Online Data Collection</strong></td>
<td><strong>One-time Unit Data from Manufacturers (2012)</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Respondents</th>
<th>Participating HARDI distributors</th>
<th>Program participants (distributors &amp; manufacturers)</th>
<th>Sample of mfrs (3 of 5 major manufacturers)</th>
<th>Sample of mfrs (4 of 5 major manufacturers)</th>
<th>Sample of distributors (25 of 176 identified)</th>
<th>Sample of manufacturers (16 of 35 identified)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data collection Frequency</td>
<td>Quarterly</td>
<td>Monthly</td>
<td>One time</td>
<td>One Time</td>
<td>One Time</td>
<td>One Time</td>
</tr>
<tr>
<td>Equipment for residential installation</td>
<td>YES</td>
<td>NO</td>
<td>Not clear</td>
<td>NO</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>% of Residential MA HVAC Market Represented by Source</td>
<td>~25%</td>
<td>Not applicable</td>
<td>Not clear</td>
<td>Not applicable</td>
<td>NO</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Equipment for commercial installation</td>
<td>Some</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>NO</td>
<td>YES</td>
</tr>
<tr>
<td>% of C&amp;I MA HVAC Market Represented by Source</td>
<td>NO</td>
<td>~100% of RTU distributors; Unknown % of distributors of other types of HVAC equipment</td>
<td>~ 50-60% of MA RTU market according to program staff; unknown % of market for other types of HVAC equipment</td>
<td>~ 60% of MA RTU market according to program staff; unknown % of market for other types of HVAC equipment</td>
<td>Unknown</td>
<td></td>
</tr>
<tr>
<td>Market share (counts of all equipment, both qualifying &amp; non-qualifying)</td>
<td>YES</td>
<td>NO</td>
<td>YES</td>
<td>NO</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Count of program-qualifying equipment by type</td>
<td>YES</td>
<td>YES</td>
<td>NO</td>
<td>NO</td>
<td>YES*</td>
<td>YES</td>
</tr>
<tr>
<td>Data are by equipment type</td>
<td>YES</td>
<td>YES</td>
<td>NO</td>
<td>YES</td>
<td>YES**</td>
<td>YES</td>
</tr>
<tr>
<td>Data are by equipment size</td>
<td>YES</td>
<td>YES</td>
<td>NO</td>
<td>YES</td>
<td>NO</td>
<td>YES</td>
</tr>
<tr>
<td>Method by which efficiency and/or qualifying versus non-qualifying equipment identified</td>
<td>Determined from model # (AC condensing unit Model # is proxy for split system efficiency)</td>
<td>Determined from AHRI # (AHRI system efficiency)</td>
<td>EER Tier</td>
<td>SEER, AFUE, or EP (by range) or product type (for tankless water heaters)</td>
<td>AFUE range</td>
<td></td>
</tr>
<tr>
<td>MA representation</td>
<td>Distributor specifies state in which equipment sold</td>
<td>Participants provide installation address</td>
<td>Manufacturer specifies state to which equipment shipped; not clear if data reflect shipment redistribution by distributors</td>
<td>Not applicable</td>
<td>Distributor specifies state in which equipment sold</td>
<td>Manufacturer specifies state to which equipment shipped</td>
</tr>
<tr>
<td>Price data included</td>
<td>Requested from respondents</td>
<td>List price &amp; sales price per unit</td>
<td>Cost and Cost Difference of conventional &amp; high efficiency units by size/EER</td>
<td>Average wholesale price to distributor</td>
<td>Not included</td>
<td>Not included</td>
</tr>
</tbody>
</table>

**Legend:**
- Appears to meet data requirement
- May not meet data requirement
- Does not meet data requirement

**Notes:**
- Unit counts were collected, but not included in report.
- Except split versus packaged AC and HP needed to determine program eligibility.
c. Generalizability to smaller areas within the state

Ideally, the installed location of each HVAC unit sold would be included in a market share tracking database. This would make it possible to identify which units were installed both in Massachusetts PA territories and outside of the PA territories, including outside the state. D&R has been able to obtain the ZIP codes to which sold units are delivered from only a subset of distributors. Current HARDI reports do not make adjustments for units sold outside of Massachusetts by distributors located in Massachusetts, or units sold into Massachusetts by distributors located outside of Massachusetts. In the absence of complete ZIP code data for the destination of sold units, D&R assigns HVAC units to the location of the HARDI branch member reporting the sales. This may not correspond to where the equipment is installed. D&R staff stated that, on request, they could adjust sales for units sold outside of Massachusetts by distributors located in Massachusetts.

D&R staff noted that it is possible to obtain sales reports at levels of aggregation smaller than a state. They added the caveat that, since not all distributors have provided ZIP codes, the smaller the area of aggregation, the harder it is to make the claim that the sample is robust.

The Upstream HVAC distributor sales data includes contractor and end-user mailing address and installation address, but only for qualified units.

Manufacturers that responded to the 2012 unit shipment data request reported data at the state level only—though, as noted above, these data may not accurately reflect state-level sales. Some manufacturers sell selected equipment lines through distributors that they own and operate or franchise (i.e., “manufacturer distribution networks”). It may be possible to obtain ZIP code-level data from manufacturers for units sold through manufacturer distribution networks, but determining this would require further research.

Neither the Cool Smart and HEHE study nor the boiler market characterization study requested data at the ZIP code level.

d. Pricing information

Table A-3 shows per-unit cost information collected. Since the PAs use the pricing data for a purpose other than the sales count data, different parameters, including frequency of a data request, may apply, so simultaneous collection of pricing and sales data may or may not be beneficial. The 2013 Upstream HVAC Manufacturer Price Matrix survey focuses on collecting price data by unit capacity and efficiency for program qualifying and non-qualifying commercial units and does not provide counts of units sold in Massachusetts.

e. Future opportunities

D&R staff noted that the 2013 HARDI report provided to the Massachusetts PAs was designed to meet the Massachusetts data request specified in their agreement. HARDI reports are a new offering for D&R, and they have been evolving since the PAs’ data purchase. D&R is open to adding new product categories to its data collection efforts as it gains momentum with these reports. It is also open to providing other reporting formats, as requested.
A.4 KEY FINDINGS

The Massachusetts sales data sources that could be leveraged to meet at least some of the HVAC market share data needs outlined in Section 3.3.2 include the HARDI data, the monthly sales data collected from distributors by the Upstream HVAC Program, and one-time efforts by the Upstream HVAC Program to collect unit sales and price data from manufacturers. It may also be possible to leverage the contacts who provided one-time residential HVAC sales data for the Cool Smart and HEHE evaluation and one-time small C&I boiler sales data for the Massachusetts Boiler Market Characterization Study to help build or enhance a future effort to obtain market share data.

We found information that is, or will be, collected by a number of current and planned studies not previously examined that could be leveraged for measuring market effects indicators other than market share. We added these to the tables in Appendix B.

A.4.1 Residential equipment

The share of the Massachusetts residential HVAC market represented by distributors reporting data to D&R has grown from around 15 percent in 2013 to about 25 percent in 2014. While 25 percent is not large enough to be a reasonable proxy for the Massachusetts residential HVAC market, the number is heading in the right direction.

D&R continues to recruit new distributors for this effort.

The HARDI data are evolving in a direction that would be more useful for quantifying market effects of PA programs on sales of efficient residential HVAC equipment than the 2013 reports the PAs purchased.

- The HARDI data collection effort is a new one for D&R. As it has gained traction with distributors and grown the data set, it has begun releasing reports with greater detail than the 2013 reports the PAs purchased.
- The HARDI reports can be customized to better meet the PAs’ market effects evaluation needs. For example, D&R could analyze the underlying unit data to report on the percentage of units that do and do not qualify for the Massachusetts programs, with equipment types broken out by size and efficiency as well as subtype.

The HARDI data lacks Lennox equipment. According to D&R staff, Lennox comprises a substantial portion of the 15 percent of the market for residential HVAC equipment nationwide that is represented by non-HARDI members. Lennox distributes equipment through its own network.

A.4.2 Commercial equipment

For commercial equipment other than RTUs, a considerable expansion in both data types and data sources would be required for the data collected by the Upstream HVAC Program to meet market share data needs. The sales data collected from participants by the Upstream HVAC Program are not market share data. To qualify as market share data, sales of standard equipment would also need to be included, the data would need to be collected from non-participating as well as participating distributors, and responding distributors would need to represent a reasonable share of Massachusetts sales. With program participation by 100% of distributors of RTUs to or within Massachusetts, this equipment type is promising in terms of
obtaining market share data because only the data to be requested, and not the number of respondents, would need to expand. The situation is not as clear for the other commercial equipment types, however.

The Upstream HVAC Program has had some success obtaining unit sales data for commercial equipment from manufacturers. This bodes well for the possibility of obtaining commercial HVAC market share data from manufacturers in the future. The Upstream HVAC Program’s 2012 effort to collect sales data from manufacturers included a request for data on sales of both high efficiency and standard efficiency equipment. In 2012, three of five manufacturers responded. In 2013, when the program requested pricing data, four of five responded. The Upstream HVAC Program estimates that the responding manufacturers represent 50 to 60 percent of RTU market sales. The number of HVAC equipment manufacturers is much smaller than the number of distributors. The connections made through the previous manufacturer data collection efforts could be useful in future efforts to obtain commercial HVAC market share data. A key question that remains to be addressed is the extent to which manufacturers need to, or can, report redistributed sales in order to accurately represent sales to Massachusetts customers. If redistribution turns out not to be an issue, another question is the extent to which cross-border sales need to be corrected for. Both of these questions require further research.

Unfortunately, the manufacturer sales data collected by the program in 2012 are not likely to be usable for commercial HVAC market share tracking. While the study team did not have access to these data, it appears from the data collection form that the data were requested in such a way that they would be difficult to interpret.

D&R is considering the possibility of embarking on an effort to collect commercial HVAC data within the next 6 to 12 months. This could eventually yield commercial HVAC market share data for a reasonably large percentage of the Massachusetts market. However, it would miss sales through manufacturers’ distribution networks and large commercial equipment sold directly by manufacturers to customers.

A.5 RECOMMENDATIONS

Based on the information discussed above, we have identified five activities for the PAs to consider pursuing in order to obtain HVAC market share and related data for residential and commercial equipment. We recommend that the PAs undertake all five activities. It is important to bear in mind that the sources of data discussed here are in flux, the activities we recommend may not all bear fruit, and the activities will no doubt need to change over time as progress is made and new information comes to light. The activities include, but are not limited to, a more thoroughly considered version of the distributor sales panel described in Section 3.3.1 of the main body of the report. These activities are summarized in Table A-4.

Table A-5 presents a summary of the strengths, weaknesses, opportunities, and threats or challenges associated with each. In section A.6 we discuss issues and considerations specific to some of these activities.
Table A-4. Summary of Recommended Activities

<table>
<thead>
<tr>
<th>Activity</th>
<th>Sector</th>
<th>Equipment Type</th>
<th>Sales Channel</th>
<th>Data Source</th>
<th>Purpose of Activity is to Obtain:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Rely on the HARDI data for residential HVAC market share, and partner with D&amp;R to increase participation by Massachusetts distributors.</td>
<td>Residential</td>
<td>All listed</td>
<td>Independent distributors</td>
<td>HARDI</td>
<td>●</td>
</tr>
<tr>
<td>2. Encourage D&amp;R to obtain and make available for sale HARDI data for commercial HVAC equipment.</td>
<td>Commercial</td>
<td>All listed</td>
<td>Independent distributors</td>
<td>HARDI</td>
<td>● ●</td>
</tr>
<tr>
<td>3. Build on the Upstream HVAC Program’s distributor data collection to obtain market share data for commercial RTUs.</td>
<td>Commercial</td>
<td>RTUs</td>
<td>Independent distributors</td>
<td>Distributors participating in Upstream HVAC Program</td>
<td>●</td>
</tr>
<tr>
<td>4. Research the ability of manufacturers to provide meaningful state-level HVAC sales data made through manufacturer distribution networks or directly to customers, and if it appears to be viable, establish a manufacturer panel to collect data for these channels to supplement residential HARDI data and provide some data for commercial equipment other than RTUs.</td>
<td>Residential &amp; Commercial</td>
<td>All listed except RTUs</td>
<td>Manufacturer distribution networks &amp; manufacturer direct sales to customer</td>
<td>Manufacturers</td>
<td>● ●</td>
</tr>
<tr>
<td>5. Establish a panel of manufacturers and distributors to provide qualitative data in support of market effects and process evaluation and as quality assurance for HARDI data.</td>
<td>Residential &amp; Commercial</td>
<td>All listed</td>
<td>Independent distributors, manufacturer distribution networks &amp; manufacturer direct sales to customers</td>
<td>Manufacturers &amp; Independent Distributors</td>
<td>●</td>
</tr>
</tbody>
</table>
We recommend the following:

1. **Rely on the HARDI data for residential HVAC market share, and partner with D&R to increase reporting to D&R by Massachusetts distributors of residential HVAC equipment.** In Section 3.1.1 of the main body of the report, we describe the possibility of collecting residential as well as commercial HVAC market share data through a panel of distributors. If the PAs were to attempt to collect sensitive residential HVAC market share data through distributors at this time, it would likely set the PAs in conflict with D&R, which would be attempting to collect the same residential HVAC data—and eventually, perhaps, also the same commercial HVAC data—from many of the same distributors. Attempting to collect residential HVAC market share data from distributors could thus jeopardize both D&R’s efforts and the PAs’ efforts. In addition, the PAs have little leverage with distributors who are not participants in the Upstream HVAC Program.

As we noted earlier, D&R has been collecting residential HVAC market share data from a growing percentage of the Massachusetts market and is working to recruit more distributors. The PAs could develop a mutually agreeable arrangement with D&R in which the PAs would work to help increase HARDI report participation in the state—including among distributors that are not HARDI members—and make plans to purchase future HARDI data for the Massachusetts residential HVAC market. This activity would be subject to D&R confirming that it will be able to supply the PAs with the necessary level of detail in future reports, including sales cross-referenced by unit type, size and efficiency, and single- versus three-phase equipment. It would also be subject to the PAs and D&R working out a mutually satisfactory agreement as to price—given that the PAs would be providing a service to D&R—delivery, and sufficient reporting leeway for the PAs to use the data to meet program evaluation needs. The Upstream HVAC Program and other Massachusetts HVAC programs with contacts among distributors of HVAC equipment would need to be actively involved in encouraging distributors to provide data for the HARDI report. The PAs could also explore the possibility of tying data purchases to performance indicators, such as by achieving a target percentage of reporting for the Massachusetts market by a certain date. If successful, this approach should greatly enhance the representativeness of the HARDI data for Massachusetts.

Working with D&R to improve the HARDI data would not preclude the Upstream HVAC Program from continuing to collect monthly sales data from distributors participating in the program. Indeed, if the approach is successful, the value of these data could be enhanced by obtaining from D&R a separate report of aggregated sales of relevant non-qualified equipment by participating distributors.

2. **Encourage D&R to obtain and make available for sale HARDI data for commercial HVAC equipment.** D&R is considering the possibility of approaching HARDI members to obtain sales data for commercial HVAC equipment within the next 6 to 12 months. In this document, we have identified a number of challenges to obtaining data for commercial equipment other than RTUs. These challenges include the following:
   - Somewhat different channels of manufacturers and distributors for different types of equipment
   - Accurately identifying Massachusetts sales through manufacturers
   - Obtaining sales data for programs that rely on downstream incentives, and thus do not have distributor partners, and for non-partner distributors of upstream programs

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• The amount of time it would likely take for the PAs to convince distributors that they can trust the PAs with sensitive sales data and that releasing these data would be beneficial to the distributors—and to convince enough distributors to obtain data for a reasonable proxy for the market(s) in question.

The PAs could approach D&R about the possibility of D&R obtaining and making available for sale HARDI data for commercial HVAC equipment. An expression of interest by the PAs could help propel D&R to undertake this effort—especially if the PAs were to help with recruiting distributors. The PAs could pursue this avenue at the same time as activity 3. If in the future D&R embarks on an effort to collect commercial HVAC data, the PAs could reassess at that time whether to continue collecting RTU data as described in activity 3.

Part of the research for activities 1 and 2 should be to explore what market information, if any, D&R and/or the PAs could provide to non-HARDI members in return for their data.

3. Build on the Upstream HVAC Program’s distributor data collection to obtain market share data for commercial RTUs. The Upstream HVAC Program appears to have established relationships with all of the distributors of RTUs to or in Massachusetts, and thus is in an excellent position to develop commercial RTU market share estimates for the state. The PAs and commercial evaluation contractors could work with the program staff to incorporate into program reporting or partnership agreements a requirement that distributors supply data on sales of non-qualifying RTUs. This market share data could be reported less often than the program sales data (quarterly rather than monthly). The data request need not be as detailed as for the program sales data—and, indeed, should not be if PAs are to have any realistic expectation of obtaining data for equipment that is sold outside the program. If the non-program sales data request is limited to RTUs, as we suggest, distributors who sell little or no equipment through the program may be willing to share the information. Once providing data for non-qualifying RTUs has become routine for distributors, the PAs could consider requesting non-qualifying sales data for other commercial equipment types from these distributors—that is, if no other reliable sources of market share sales data for other types of commercial HVAC equipment have been established by this time.

4. Research the ability of manufacturers to provide meaningful state-level HVAC sales data made through manufacturer distribution networks or directly to customers, and if it appears to be viable, establish a manufacturer panel to collect data for these channels to supplement residential HARDI data and provide some data for commercial equipment other than RTUs. The Upstream HVAC Program has had some success collecting one-time market data of unit sales or shipments and equipment prices from manufacturers of RTUs. The PAs could build on this experience and the program’s connections to supplement both the residential HARDI data and the RTU market share data described in activity 2 above. By collecting data from manufacturers only for sales made through manufacturer distribution networks or directly to customers—not sales through independent distributors—the PAs avoid the problem of shipment redistribution and are more likely to obtain accurate Massachusetts data. A fairly wide range of manufacturers would need to be recruited for the panel to provide reasonably representative data across the full range of residential and commercial HVAC equipment types for which data are needed. Some of the questions that would need to be studied include the number of manufacturers that sell equipment through manufacturer distribution networks or directly to customers, the percentage of equipment...
sold this way, and how this varies by equipment type. If it is decide that a manufacturer panel is to be established, it should be coordinated with activity 5.

5. **Establish a panel of manufacturers and distributors to provide qualitative data in support of market effects and process evaluation and as quality assurance for HARDI data.** Such a panel could begin with the manufacturers and distributors described in activities 3 and 4, and the data collection for this activity could be made in conjunction with these data requests. Indeed, asking prospective panelists for qualitative data, as described here, could help pave the way for their supplying the quantitative market share data that would be requested as part of activities 3 and 4.

These panelists could be asked to provide qualitative information to accomplish the following:

- Help understand the HVAC market and how it is changing over time
- Provide quality assurance for the data being obtained from D&R, perhaps by asking for percent of efficient sales without unit counts
- Meet market effects indicator tracking needs other than sales data
- Provide feedback on the programs.

These data would be more representative—and, thus, more useful to the program—if the panel included distributors of commercial HVAC equipment that do not participate in the Upstream HVAC Program as well as non-HARDI members. The research being conducted for the Supply Side Market Actors study should be helpful in identifying distributors of each of the types of HVAC equipment of interest to help ensure recruitment of an appropriate range of distributors.

The panel could be pitched as an opportunity for panelists to have input into the PAs' programs. If at a future date the PAs decide to seek market share data from distributors for commercial equipment other than RTUs, the trust previously established among distributors from their participation in the qualitative panel could facilitate obtaining quantitative market share data.
### Table A-5. Summary of Strengths, Weaknesses, Opportunities and Threats or Challenges

<table>
<thead>
<tr>
<th>Activity</th>
<th>Strengths</th>
<th>Weaknesses</th>
<th>Opportunities</th>
<th>Threats or Challenges</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Rely on the HARDI data for residential HVAC market share, and partner with D&amp;R to increase reporting to D&amp;R by Massachusetts distributors of residential HVAC equipment.</td>
<td>1. Would result in data from both participants &amp; nonparticipants</td>
<td>1. Represents only 25% of all residential unitary HVAC sales in MA</td>
<td>1. Leverage relationships and data collection effort already established through Upstream HVAC program</td>
<td>1. Negotiating suitable agreement with D&amp;R</td>
</tr>
<tr>
<td></td>
<td>2. Known share of market represented</td>
<td>2. Involves relying on a third party, D&amp;R, to obtain data</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. If successful, most likely of the options to represent a high proportion of market sales in future</td>
<td>3. Misses sales of manufacturers through their own distribution networks (but this proposed for activity 4)</td>
<td>2. Leverage contacts developed through Cool Smart/HHE Evaluation (if confidentiality agreements allow)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Would result in data from both participants &amp; nonparticipants</td>
<td>1. Likely to take a year or more for D&amp;R to establish this data collection</td>
<td>1. If D&amp;R moves ahead with collecting commercial HVAC market share data, PAs can assess at that time whether to continue with activity 3</td>
<td></td>
</tr>
<tr>
<td>2. Encourage D&amp;R to obtain and make available for sale HARDI data for commercial HVAC equipment.</td>
<td>1. Would result in data from both participants &amp; nonparticipants</td>
<td>1. Likely to take a year or more for D&amp;R to establish this data collection</td>
<td>1. If D&amp;R moves ahead with collecting commercial HVAC market share data, PAs can assess at that time whether to continue with activity 3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Would expect that eventually known share of market would be represented</td>
<td></td>
<td></td>
<td>1. Negotiating suitable agreement with D&amp;R</td>
</tr>
<tr>
<td></td>
<td>2. Existing data collection effort on which to build</td>
<td>2. Same as activity 1, opportunities 1-3</td>
<td></td>
<td>2. D&amp;R may not choose to move forward with commercial HVAC data collection, or may move forward and not obtain a large enough portion of the market to warrant purchasing the data.</td>
</tr>
<tr>
<td></td>
<td>3. If this activity is undertaken and down the line D&amp;R is able to provide commercial market share data for RTUs, the PAs could reassess whether to continue with this effort</td>
<td>3. May create an opportunity to coordinate with D&amp;R and combine efforts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Build on the Upstream HVAC Program’s distributor data collection to obtain market share data for commercial RTUs.</td>
<td>1. 100% of market covered</td>
<td>1. Could come into conflict with similar HARDI efforts for commercial HVAC expansion</td>
<td>1. Leverage relationships and data collection effort already established through Upstream HVAC program</td>
<td>1. The majority of program sales are made by a small number of distributors. Participating distributors who do not make program sales do not report data. It may be difficult to get these distributors to begin reporting.</td>
</tr>
<tr>
<td></td>
<td>2. Existing data collection effort on which to build</td>
<td>2. May create an opportunity to coordinate with D&amp;R and combine efforts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Research the ability of manufacturers to provide meaningful state-level HVAC sales data made through manufacturer distribution networks or directly to customers, and if it appears to be viable, establish a manufacturer panel to collect data for these channels to supplement residential HARDI data and provide some data for commercial equipment other than RTUs.</td>
<td>1. Relatively few market actors to recruit</td>
<td>1. Data granularity may vary by market</td>
<td>1. Leverage relationships and data collection effort already established through Upstream HVAC program</td>
<td>1. Winning trust of targeted individuals and organizations and maintaining confidentiality (as with any sales data collection effort)</td>
</tr>
<tr>
<td></td>
<td>2. Fills data gaps while avoiding conflicting or redundant efforts.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Establish a panel of manufacturers and distributors to provide qualitative data in support of market effects and process evaluation and as quality assurance for HARDI data</td>
<td>1. Should be easier to establish than a panel to provide market share data, since information requested would be less sensitive</td>
<td>1. Would not provide quantitative data to start</td>
<td>1. Same as activity 1</td>
<td>1. Same as activity 4</td>
</tr>
<tr>
<td></td>
<td>2. Could help pave the way for obtaining the quantitative market share data that would be requested as part of activities 3 and 4</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*HVAC Market Effects Methods—Final Version. November 25, 2014*
A.6 ISSUES FOR CONSIDERATION

A.6.1 Activity 1

Ensuring the success of the first activity, relying on the HARDI data for residential HVAC market share and partnering with D&R to increase participation by Massachusetts distributors, would require input from a number of parties. The PAs should designate a team to take the lead in providing input to the PA contracts departments to ensure that the products and services negotiated will meet program needs. This team would also work with D&R to increase participation by distributors selling products to Massachusetts customers. Logical choices for the team include representatives of the Upstream Program, PA program evaluation staff, and the cross-cutting and residential evaluation contractor teams. The work of these parties could include activities such as the following:

- Developing appropriate distributor recruiting strategies
- Prioritizing distributors for outreach and conducting outreach
- Negotiating changes to the HARDI reports to ensure that they meet the PAs’ data needs, including confirming that sufficient information can be shared about the data to enable its use in baseline and NTG research
- Proposing appropriate performance incentives for D&R tied to key milestones such as a target percentage of reporting for the Massachusetts market
- Monitoring progress on recruiting distributors and strategizing on ways to increase participation.

The study team understands that it took many months to complete negotiations and paperwork in order to buy the 2013 HARDI data. D&R staff explained to the study team that the primary reason for this was having to work with multiple PA contracts departments. They noted that securing confidentiality agreements with each PA is particularly time consuming. Having done this once already, there may not be a need to secure new agreements, which would help. However, the first activity would result in a contract or purchase agreement with D&R that could look quite different from the one signed for the 2013 data purchase. The agreement may need to have some elements of a standard evaluation contract, such as milestones, with which D&R may not be familiar or comfortable.

A.6.2 Activities 3 through 5

Activities 3 (building on the Upstream HVAC Program’s distributor data collection to obtain market share data for commercial RTUs), 4 (researching the ability of manufacturers to provide meaningful state-level HVAC sales data made through manufacturer distribution networks or directly to customers, and if it appears to be viable, establishing a manufacturer panel to collect data on sales of HVAC equipment made through manufacturer distribution networks or directly to customers), and 5 (establishing a panel of manufacturers and distributors to provide qualitative data) would also require a number of parties to work together as a team to increase the likelihood of success. Since the Upstream HVAC Program has established important relationships with manufacturers and distributors that would need to be leveraged to establish the proposed panel(s), it will be critical to the success of these activities to secure participation of Upstream HVAC staff, and presumably, also the...
contractor(s) responsible for collecting program data and implementing the program. These parties also have experience selling the programs and program services to manufacturers and distributors, which are necessary skills for this effort.

While the participation of the Upstream Program and its affiliates will be very important to the success of any of the panels, establishing a successful panel for the purposes described in this document requires skill sets other than those offered by the program and its affiliates. Representatives of the C&I evaluation team, market effects evaluation contractors, and residential evaluation contractors would need to work on these efforts as well in order to ensure that the data collected meet market effects evaluation needs and are reasonably representative of the markets of interest. It would also be prudent to have input from staff of other PA HVAC programs. One entity would need to be designated by the PAs to take the lead on this effort and delegate work. The cross-cutting evaluation team might be a logical choice for the activities that include both residential and commercial equipment.

A key question to address for activities 3 and 4 is who would be responsible for the collection, aggregation, quality control, and confidentiality of sensitive sales data. The entity that takes on this responsibility would need to meet contractual, IT, and physical requirements to keep sensitive data confidential. Its staff would need to have sufficient evaluation and data analysis skills to recognize possible issues with the sales data, understand how to aggregate them appropriately to ensure confidentiality, and identify and implement ways to rectify gaps in the data in order to maintain the ability to compare the data over time. They would need to have both the people skills to establish trusting relationships with panelists and a commitment to maintaining these over time. The latter has implications for the contract for this work. The quality of the panel is likely to suffer if the work of maintaining relationships and gathering data is given to a new firm every few years, as is often the case with competitive solicitations.

Once the question of allocation of responsibility for data collection is resolved, members of the team designated to work on this effort should work together to undertake activities such as the following:

- Planning data collection logistics and developing strategies to maximize the response rate
- Providing input into soliciting and selecting an implementation contractor
- Identifying manufacturers and their representativeness for recruitment, and working to secure their participation
- Providing analysis guidance to the data collection contractor, as needed.

A.6.3 Important considerations for collecting HVAC market share data from upstream market actors

During the 1990s, the Energy Center of Wisconsin (ECW) collected market share data for HVAC equipment from a panel of HVAC distributors established by the ECW. A study team member provided support for this panel. This section summarizes keys to success in obtaining data from upstream market actors based on the team member’s experience with the ECW panel and other team members’ experiences with other sales data collection efforts. It would be prudent for the PAs to bear these in mind when considering activities 3 through 5 because all of these involve market share data collection from upstream market actors.
Create a partnership with panelists. Establishing a panel of upstream market actors to provide ongoing sales data, or other information on an ongoing basis, is different from the usual one-time in-depth interview or survey performed as part of a traditional energy efficiency program evaluation. It means sitting down with individuals, learning about their individual and organizational needs and concerns, and trying to reach an agreement to address their needs. It also requires an ongoing effort to develop and maintain relationships and prod laggards to provide periodic data.

Show panelists the value in providing the data. Panelists need to understand the value of providing the data, ideally from more than one perspective. First, they should be provided with the context for the request. A key selling point in Wisconsin was that the data were used to help justify DSM programs, which had a positive impact on the distributors’ bottom line. Panelists also need something of value in exchange for the information they will provide. In the case of Wisconsin, this came in the form of a quarterly report of market share for different regions in the state. For Massachusetts, an example report should be developed to help sell the concept to prospective participants. It will be critical for the PAs and their representatives to engage with prospective panel participants to understand their needs and concerns prior to establishing a panel and as part of the recruitment process.

Engage distributors at the right level. This is most commonly a CEO, president, or other decision maker fairly high in the corporate structure.

Allow distributors some leeway in the reporting format. Distributors participating in the Wisconsin panel reported data in different ways and with different levels of detail. This flexibility helped overcome some distributors’ reluctance to participate—but it did burden the contractor that was hired to reconcile and combine the data.

Panelist trust is paramount. Confidentiality will always be an issue with any effort to collect sensitive market data. Developing an appropriate confidentiality agreement is only part of this. The other part will be developing trust among prospective panelists in the Massachusetts PAs and their data collection contractor.

A.6.4 Support for moving activities forward

Table A-6 describes a set of tasks to help move forward with market effects evaluation of the Massachusetts HVAC programs. These tasks are associated with the activities recommended in Section A.2. The tasks are interrelated and are expected to cut across the several evaluation teams, PAs, and implementers.

For the residential market, market data are expected to come from at least two sources, HARDI and manufacturers. For the C&I markets, manufacturers and distributors are the expected data sources. We expect there to be some overlap between suppliers of C&I equipment and residential market suppliers, since at times residential-sized HVAC equipment may be installed in C&I customers’ facilities. As data collection efforts expand it will be critical to maintain program implementer relationships in order to avoid confusion or otherwise disrupt program delivery. As such, program implementers, and particularly the Upstream HVAC Program for the C&I sector, should be involved with the data collection process and relationship building.

While it is important that activities begin in the near-term to drive market effects evaluations, we recommend that the total set of activities be scoped and staged for the long-term benefit.
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of the Massachusetts programs and their evaluation. Developing the long-term data collection process across sectors and with different market actors will require building and maintaining relationships. The type and nature of data being requested is not typical of most evaluation activities that the market actors may have previously been involved with. We recommend taking a sensitive but focused approach to building the market share data across the market actors. Systems and processes will need to be put in place for this to happen, but more importantly, relationships and trust will need to be built over time.

In addition to the tasks and considerations in Table A-6, which are fairly specific to the recommendations outlined in Section A.2, the PAs should consider these broader key issues as the HVAC market effects work proceeds:

- Whether a central point of market share data collection and review would be helpful
- How to qualify or otherwise vet the data to ensure the data meet quality requirements prior to their use in evaluations of each sector
- Allocating responsibilities for parsing data that may have overlapping sector end uses
- Avoiding the double counting of sales and identifying key data gaps or other issues
- Allocating evaluation team and PA/implementer team responsibilities for establishing and maintaining relationships
- Allocating responsibilities for providing input to or negotiating contracts with different market actors with an eye toward long term value and addressing variations in data quality.
### Table A-6. Tasks and Related Considerations

<table>
<thead>
<tr>
<th>Task</th>
<th>Related Considerations</th>
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<tbody>
<tr>
<td>Develop and execute the market effects evaluation plans for C&amp;I-focused programs (Upstream HVAC).</td>
<td>Carrying out C&amp;I program evaluation is the responsibility of the C&amp;I evaluation team.</td>
</tr>
<tr>
<td>Develop and execute the market effects evaluation plans for residential programs (HEHE and Cool Smart, including DHP)</td>
<td>Carrying out residential program evaluation is the responsibility of the Residential evaluation team.</td>
</tr>
<tr>
<td>Ensure that the next HARDI data purchase negotiated by the PAs results in data that meets the needs discussed here and described in Appendix A, Sections A.5 and A.6.1. (Related to Activity 1.)</td>
<td>While the data in the HARDI report primarily comprise sales of residential equipment, some distributors report sales for commercial equipment as well. As described in Appendix A, there is a possibility that D&amp;R may expand the HARDI report to include commercial sales data in future, and there is some overlap among distributors reporting residential sales data to HARDI and commercial sales data to the Upstream HVAC program.</td>
</tr>
<tr>
<td>Ensure that the request for non-program commercial RTU sales is appropriately worded, and that the entity in charge of housing these data can appropriately address the issues described in Appendix A, Section A.6.2. (Related to Activity 3.)</td>
<td>There is some overlap among distributors participating in the Upstream HVAC program and reporting to HARDI. This work would build on current Upstream HVAC program data collection and Upstream HVAC program and implementation staff know the distributors who would be asked to provide data. Evaluators need substantial involvement to ensure that the sales data collection request meets market effects evaluation needs.</td>
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<tr>
<td>Complete any remaining research needed into the possibility of a panel of manufacturers to provide state-level HVAC sales data made through manufacturer distribution networks or directly to customers. If after further research the panel is determined to be worth pursuing, develop the necessary supporting materials and plans as described in Appendix A, Section A.6.2. (Related to Activity 4.)</td>
<td>Data to be collected would be for both residential and commercial equipment.</td>
</tr>
<tr>
<td>Plan for and collect qualitative data from a panel of manufacturers and distributors. (Related to Activity 5.)</td>
<td>Data to be collected would be for both residential and commercial equipment.</td>
</tr>
<tr>
<td>Identify possible gaps and overlap in reporting among data sources and recommend analytical approaches for rectifying overlaps.</td>
<td>Data to be examined would be for both residential and commercial equipment.</td>
</tr>
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</table>