EMI CONSULTING

California HVAC Contractor & Technician Behavior Study, Phase II

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FINAL REPORT

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Executive Summary

For the **California HVAC Contractor and Technician Behavior Study, Phase II**, the research team explored implementation challenges faced by technicians, qualities of contractors' business models that prevent or contribute to ideal field practices, and training/certification needs in order to fully transform the market. The study included multiple phases of data collection: (1) in-depth interviews with contractors, (2) in-depth interviews with market actors, (3) in-depth interviews with implementer staff, and (4) a telephone survey with technicians. In addition, we sought to operationalize and determine the feasibility of measuring the five market transformation indicators (MTIs) indicated by the California Public Utilities Commission (CPUC). Key findings are presented below, grouped by the five research topics/questions included in the study.

Awareness and Use of Industry Standards

While a sizable minority of technicians report they are aware of industry standards, in most cases, the standards do not appear to be "top-of-mind." When asked in an unprompted question what codes or standards they use, only 9% of technicians indicated that they use Quality Installation, Quality Maintenance, or ACCA/ASHRAE standards. City and state codes appear to be much more salient, with 60% of technicians mentioning city/municipal codes, and 51% mentioning state code, state building code, or Title 24.

Only 9% of technicians mentioned a QI/QM standard (unprompted) as one of the standards they follow on a typical job.

However when prompted...

41% of technicians asked about installation work indicated they were aware of ACCA Standard 5 (prompted).

34% of technicians asked about residential maintenance work indicated they were aware of ACCA Standard 4 (prompted).

49% of technicians asked about commercial maintenance work indicated they were aware of ACCA/ASHRAE 180 (prompted).

Terminology: Standards and Program Names

Out of all technicians performing **installation** work, **only 3%** of technicians were both aware of ACCA 5 and correctly associated it with a specific utility program (unaided).

Out of all technicians performing **maintenance**, **only 2%** were both aware of either ACCA 4 or ACCA/ASHRAE 180 and correctly associated it with a specific utility program (unaided).

Technicians generally do not associate the terms "quality installation" and "quality maintenance" with the standards or with utility programs. When asked to define "quality maintenance" or "quality installation," technicians generally think of completing a job "the right way" or having a clean or neat system. Only 1% of respondents associated ACCA Standard 5 with "quality installation" and 1% of respondents associated utility programs with "quality installation." None associated "quality maintenance" with the standards and less than 1% associated it with utility programs.

Quality Contractor Best Practices

Quality contractors emphasize customer service.

Firms already focused on superior customer service are able to incorporate QI/QM standards more easily because the value proposition aligns with their emphasis on service.

Quality contractors understand and internalize the value of QI/QM.

Quality contractors are those who understand and buy in to the value proposition of QI/QM and have the ability to demonstrate the value of QI/QM to customers.

Quality contractors are focused on continuous improvement.

Quality contractors who successfully implement QI/QM are those who undertake and emphasize continuous training, invest in their staff, are open to feedback, and perform QA/QC regularly.

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Executive Summary

Training

A combination of classroom and in-field training is viewed as most effective by contractors and market actors. While on the job training was rated as most effective by technicians (with 90% rating it as "very effective"), this type of training is likely extremely variable, as it is dependent on the knowledge, skills, and efficacy of the trainer.

There appears to be a training need for technicians on the topics of airflow, building science, and HVAC fundamentals. However, nearly one third (32%) of technicians we surveyed indicated there were ***no topics*** on which they could use additional training.

Most technicians play a role in sales and are interested in sales training.

89% of technicians who perform installation work are responsible for selling new HVAC equipment to customers.

85% of technicians who perform maintenance work are responsible for selling HVAC maintenance services to customers.

73% of technicians responsible for sales are interested in sales training.

Market Transformation Indicators

A number of key terms will need to be clearly defined before the MTIs can be operationalized or consistently measured. For example, in order to accurately estimate MTI HVAC-1a (market share of climate appropriate HVAC equipment) and MTI HVAC-1b (market share of climate appropriate energy efficient HVAC equipment), the term "climate appropriate" must be clearly defined and a list of qualifying unit types developed.

Additionally, proximate (or *leading*) indicators may help measure any market transformation that takes place in the near term. For example, proximate changes in *awareness* and *understanding* of the standards, which are necessary for implementing standards-based work, could be tracked in addition to the longer-term market transformation indicators.

Abbreviated Recommendations*

* For full text recommendations, please refer to the Chapter 8 in the report.

1. Include guidelines for *how* to enact the standards when training technicians and contractors on the specifics of the ACCA/ASHRAE standards. These guidelines will provide a necessary foundation for education and training of contractors and technicians.

2. Conduct case studies with technicians to better understand how the standards are currently enacted in the broader marketplace. These case studies could involve either shadowing technicians or conducting covert field observations. Understanding the standard "baseline" practice will help inform where to focus training efforts.

3. Develop a proactive branding strategy. To do this, we recommend that the IOUs develop several potential branding strategies and test these with contractors, technicians, and customers before adopting a strategy. We recommend using program names that can be differentiated from "good" installation or maintenance.

4. Provide sales training to technicians. This is important because they are often the first point of contact with the customer. Sales training should teach contractors, technicians, and sales staff how to speak to customers about sales in a language that customers will understand.

5. Craft QI and QM training so contractors and technicians are well-versed in the value proposition. Buy-in from contractors and from technicians is necessary because if they do not believe in the value, it will be difficult at best to convince customers.

6. Provide tools such as case studies and data that contractors and technicians can use to demonstrate energy savings and reliability to customers. Communicating the value proposition will be much easier if those selling standards-based services can show customers examples of how much other similar customers have saved.

7. Consider pairing Quality Maintenance contracts with financing of new HVAC equipment purchases. Pairing a maintenance contract at the point of purchase, and including that contract in the financing, will help overcome cost barriers and encourage proper maintenance.

8. Educate customers about the training/certification requirements for trade allies to participate in the QI and QM programs. This will allow them to differentiate QI/QM services from standard practice. In turn, customers may begin to demand contractors/technicians with these credentials.

9. Design and teach ways to build QA/QC into contractors' internal processes. This will help contractors sustain quality practices even after the programs end.

1. INTRODUCTION

This chapter first summarizes the impetus for this research and provides an overview of the study. This is followed by a summary of the research questions.

1.1 Study Background and Overview

Understanding how to improve the quality of technicians' HVAC installation and maintenance practices in California is of the utmost importance. In June 2008, the California Energy Commission (CEC) estimated that improper installation and maintenance of cooling systems can result in a 20% to 30% increase in summertime peak electricity needed by such systems. As such, quality installation and quality maintenance have particular strategic importance as demonstrated in the *California Long Term Energy Efficiency Strategic Plan (CLTEESP),* which identifies one of the four HVAC goals as: "Quality Installation and maintenance becomes the industry and market norm. The marketplace understands and values the performance benefits of quality installation and maintenance."[1]

This HVAC Contractor & Technician Behavior Phase II Study builds upon the work the EMI Consulting Team completed in 2012 for the *California HVAC Contractor & Technician Behavior Phase I Study,* which focused on contractors and explored business models, maintenance sales practices, and understanding of HVAC maintenance and industry standards.[2] The Phase II study also builds on the *CQM Rapid Feedback Process Evaluation*, which identified procedural issues with contractor and technician vetting, training, and quality control.[3] Additionally, this study was conducted simultaneously with the HVAC Customer Decision-Making study, which focused on understanding how residential and commercial customers in California make purchasing decisions related to HVAC installation and maintenance.[4]

This Phase II Study, coupled with the HVAC Customer Decision-Making study and aforementioned past studies yields additional insights to moving California closer to the CLTEESP HVAC *Big Bold Energy Efficiency Strategy:* "Heating, Ventilation and Air Conditioning (HVAC) will be transformed to ensure that its energy performance is optimal for California's climate."[5] This research characterizes the opportunities and challenges that HVAC contractors and technicians face in implementing quality installation (QI) and quality maintenance (QM) in line with industry standards that were not addressed in prior studies.

For the purposes of this study, the term "quality Installation" and its initials "QI" refer to ACCA

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[1] California Public Utilities Commission. (2011). *The California Energy Efficiency Strategic Plan*. Available at: http://www.cpuc.ca.gov/PUC/energy/Energy+Efficiency/eesp/.
[2] EMI Consulting. (2012). *California HVAC Contractor and Technician Behavior Study.* CALMAC Study ID SCE0323.01. Available at http://www.calmac.org/publications/ca_hvac_behavior_study_finalreport_2012sept14_final.pdf
[3] EMI Consulting. (2014). *Southern California Edison HVAC Quality Maintenance Program Rapid Feedback Process Evaluation.* CALMAC Study ID SCE0344.01. Available at http://www.calmac.org/publications/EMI_SCE_Rapid_Feedback_CQM_Report_Final_2_3_14.pdf
[4] EMI Consulting. (Forthcoming). *California HVAC Quality Installation/Quality Maintenance Customer Decision-Making Study.*
[5] California Public Utilities Commission. (2011). *The California Energy Efficiency Strategic Plan*. Available at: http://www.cpuc.ca.gov/PUC/energy/Energy+Efficiency/eesp/.

Standard 5. "Quality maintenance" and its initials "QM" refer to ACCA Standard 4 (Residential), and ASHRAE/ACCA Standard 180-2008 (Commercial). The CLTEESP emphasized these industry standards because they are comprehensive in their specifications, whereas the HVAC quality control requirements set forth by Title 24 are optional.[6] Thus, the investor owned utilities' (IOUs') QI and QM programs are based on these standards.

1.2 Research Questions

For this project, the research team explored implementation challenges faced by technicians, qualities of contractors' business models that prevent or contribute to ideal field practices, and training/certification needs to fully transform the market. In addition, we sought to operationalize and determine the feasibility of measuring the five market transformation indicators (MTIs) indicated by the California IOUs and the California Public Utilities Commission (CPUC). The key research questions this study addressed are grouped by topic below:[7]

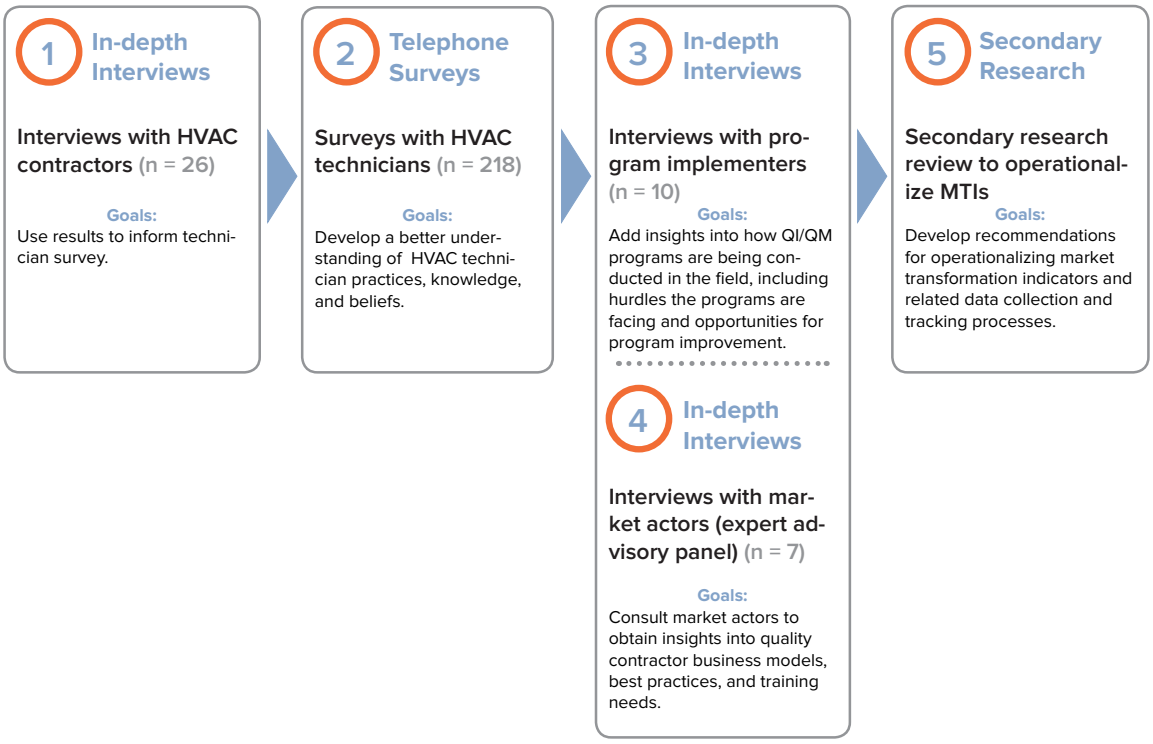
- Awareness and Use of Industry Standards
  - What is the level of technicians' awareness and use of industry standards?
  - How are industry standards communicated to technicians and how do contractors and implementers follow up with technicians to ensure that standards are enacted in the field?
- Terminology: Standards and Program Names
  - Are "quality installation" and "quality maintenance" terms that technicians can readily differentiate from "good" maintenance, as it is regularly understood?
  - What is the level of fluency with which the IOU program names can be linked with standards-based practices?
- Quality Contractor Best Practices
  - What does a quality contractor look like?
  - What are the best practices for organizing a QM and QI HVAC business?
  - What are the best practices for ensuring that technicians are delivering QM and QI in the field?
- Training
  - What is the role and efficacy of various types of technician training and certification?
  - What are the key training needs that exist with respect to technician practices, such as test instrument selection and calibration, protocols, and tasks performed in the field?
  - What are the best practices in sales training processes/approaches specific to HVAC services?
- HVAC Market Transformation Indicators (MTIs)
  - How can the five HVAC MTIs be operationalized for future data collection?

[6] California Public Utilities Commission. (2011). *The California Energy Efficiency Strategic Plan*, p. 55.
[7] Originally, there was one additional research question, but SCE and the project team agreed to remove this question because other ongoing studies were addressing this question in detail, and also to decrease respondent burden inherent with such a large number of research questions. The deleted question was: "What is the rate of Title 24 Code compliance as demonstrated by pulling permits, having Home Energy Rating System (HERS) inspections, and making final the permit?"

2. METHODOLOGY

This chapter summarizes the four primary data collection activities and secondary data review conducted as part of this study. Figure 2-1 shows an overview of the tasks EMI Consulting undertook to conduct this study. The contractor in-depth interviews (#1 in the figure) served to inform the technician survey (#2). The interviews with implementers (#3) and market actors (#4) were undertaken simultaneously. We then conducted a secondary research review (#5).

Figure 2-1. Research Design



While the figure shows the order in which data were collected, the results are reported in a different order to ease comparison of findings; we first present results of the implementer interviews, as this describes the IOU program training and quality assurance/quality control (QA/QC). This is followed by results of the market actor interviews and then the contractor interviews. Then, in the chapter on telephone survey results, we compare and contrast findings with those of the various interview efforts, where applicable. Finally, we report the results of the secondary research review to operationalize the MTIs.

After summarizing the five research methodologies, this chapter concludes with a discussion of the limitations of this research. This chapter is organized accordingly into the following sections:

- Implementer Interview Methodology
- Market Actor Interview Methodology
- Contractor Interview Methodology
- Technician Survey Methodology

- Secondary Research Review to Operationalize MTIs
- Research Limitations

2.1 Implementer Interview Methodology

EMI Consulting conducted interviews with 10 third-party implementers and IOU QI/QM program staff between February and March 2015. Each interview lasted for about one hour. These interviews provided important information and insights into how training and verification processes are structured within the QI/QM programs, as well as the opportunities and challenges for contractors and technicians participating in the programs.

As shown in Table 2-1, EMI Consulting staff conducted interviews with representatives of Southern California Edison (SCE), San Diego Gas & Electric (SDG&E), and Pacific Gas & Electric (PG&E). Although the Southern California Gas Company (SCG) is currently developing QI and QM programs, the utility does not have any participants yet. The SCG programs are being developed following the model of SCE's program, and will use the same implementers as SCE. Thus, we did not interview SCG program staff; however we did ask SCE staff about plans for the SCG programs.

Table 2-1: Implementer and Program Staff Interview Participants

IOU Program	Role
SCE Commercial and Residential Quality Installation/Quality Maintenance	Program Manager
SCE Commercial Quality Maintenance	Implementer with CLEAResult
SCE Residential Quality Installation/Quality Maintenance	Implementer with CSG
SDG&E Commercial Quality Maintenance	Implementer with CSG
SDG&E Residential Quality Installation/Quality Maintenance	Implementer with DNV GL
SDG&E Residential Quality Installation/Quality Maintenance	Program Manager
PG&E Residential Quality Maintenance	Program Manager
PG&E Residential Quality Maintenance	Implementer with Build It Green
PG&E Commercial Quality Maintenance	Program Manager
PG&E Commercial Quality Maintenance	Implementer with Honeywell

2.2 Market Actor Interview Methodology

In February 2015, EMI Consulting conducted seven in-depth interviews with market actors in line with their particular areas of expertise, shown in Table 2-2. Interviews each lasted 60 to 90 minutes. While interviewees were not provided with an incentive specifically for the interview, they were each paid a $1,200 stipend for their ongoing participation in the ongoing research

study.[8] Interviewees provided key insight into where the best opportunities and potential strategies lie for moving the California HVAC market forward.

Table 2-2: Market Actor Interview Participants

Company Type	Role	Years in Industry
1. HVAC Contractor	President	41
2. HVAC Contractor	President	37
3. HVAC Educator	Owner & CEO	37
4. HVAC Industry Association	President	35
5. HVAC Efficiency Consultant	President	30
6. HVAC Quality Assurance Provider	HVAC Industry Consultant	20
7. HVAC Consulting Company	HVAC Industry Consultant	3

2.3 Contractor Interview Methodology

EMI Consulting staff conducted 26 in-depth interviews in July and again in September and October of 2014. Interviewing began in July but was paused due to lack of responsiveness by contractors during the busy cooling season. Recruiting and interviews began again in mid September and were completed in October. Most interviews were approximately 45 minutes long. EMI Consulting provided respondents with a $75 incentive as a thank you for their time.

Interviews were conducted with two types of contractors: (1) experienced participating QI/QM contractors (i.e., contractors that had completed more than the median number of projects through an IOU-sponsored QI or QM program), and (2) contractors that had not participated in any QI/QM programs (i.e., nonparticipants). The objectives for speaking with participating HVAC QI/QM contractors were to understand how their business practices may differ from those of nonparticipants, and to help identify best practices in the industry and how to move the market forward.[9] Speaking with nonparticipants helped inform us about topics such as the current state of the HVAC market place including general awareness and understanding of QI/QM standards, training, field practices, and business models. As shown in Table 2-3, we had originally targeted 40 total interviews with contractors. Due to timing of the interviews and difficulty reaching interview targets during the busy summer cooling season, we ultimately completed 26 interviews. This sample size was judged to be sufficient because the contractor interviews were not designed to be generalizable to the population of contractors, but were rather primarily used to inform the surveys with a much larger sample of technicians.

[8] Each market actor agreed to participate in an "Expert Advisory Panel" for this study. As part of that agreement, they provided input on data collection instruments, helped interpret results of the study, and provided ongoing industry expertise as needed. The stipend amount for one panel member was $600 because this member was recruited after the study was underway.

[9] We realized however, that practices among participating contractors may still need to be improved and may not represent "best practices" or the desired end goal.

Table 2-3: Participant and Nonparticipant Contractor In-Depth Interview Sample Targets and Completes

	Target	Completed Interviews
Nonparticipant Contractors	25	15
Participant Contractors	15	11
Total Contractors	**40**	**26**

Sample Frame Development & Completes - Participating Contractors

EMI Consulting developed the sample frame for the interviews with participating contractors from IOU data. The IOUs provided EMI Consulting with data regarding contractors that participated in the QI and QM programs over the past two years (2012 and 2013). SCE and PG&E provided program data for this purpose; SDG&E provided participating contractor lists. Note that SCG did not have any active QI or QM programs at the time of this study; therefore the data described below is for contractors participating in programs offered by SCE, PG&E, and SDG&E only.

The total number of interviews completed with participating contractors is shown in the two right-most columns of Table 2-4. The number of interviews per IOU was roughly based on the proportion of total participating contractors in the population, shown on the left side of the table. Note that for PG&E, all interviews were completed with QM contractors because there was no QI program in place at the time. We focused the participating contractor interviews on more "experienced" contractors, defined as those who had performed work on a number of units – greater than the median for each program/IOU/sector combination.

Table 2-4: Stratification and Completes for Participating Contractor Interviews

IOU	Population of Participating Contractors		Target Completes for Participating Contractor Interviews			
	Number	Percent	Interviews with QI Contractors	Interviews with QM Contractors	Total Number of Interviews	Total Percent of Interviews
SCE	112	62%	1	5	**6**	**55%**
PG&E	53	29%	-	3	**3**	**27%**
SDG&E	17	9%	1	1	**2**	**18%**
Total	**182**	**100%**	**2**	**9**	**11**	**100%**

Sample Frame Development & Completes - Nonparticipating Contractors

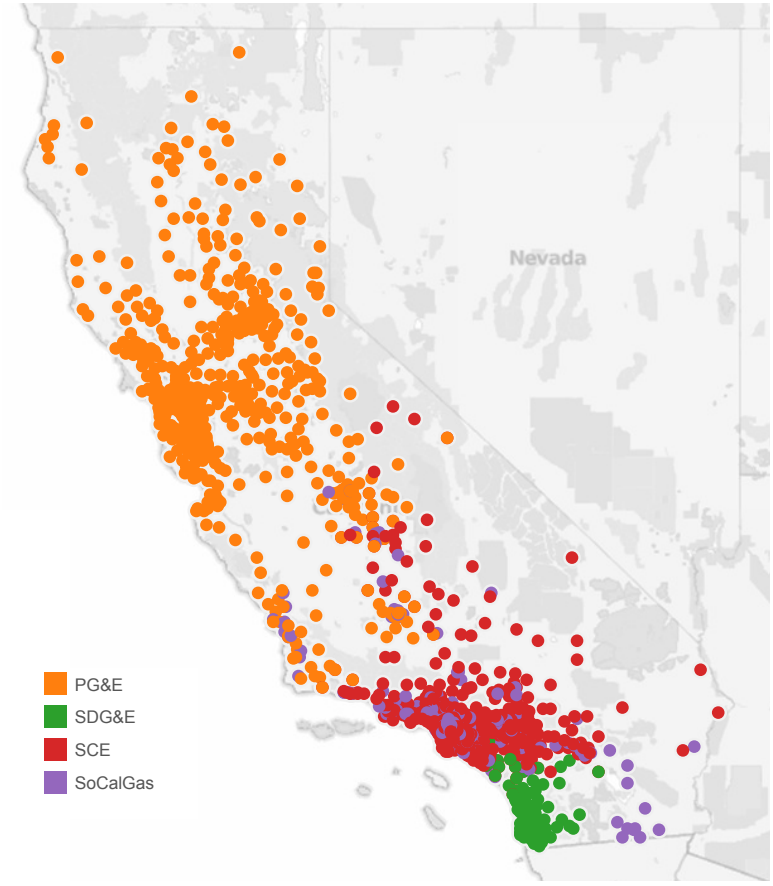
The basis for the sample frame for non-participating contractors was the Phase I sample frame, which EMI Consulting developed in 2012 through consultation with SCE, PG&E, and several other stakeholders. This Phase I sample frame utilized the California State Licensing Board (CSLB) C-20 (Warm-Air Heating, Ventilating and Air-Conditioning Contractor) licensee list, which, after removing duplicates, contained information on 10,486 HVAC C-20 licensees throughout the state.

For this Phase II study, we began with this same sample of 10,486 licensed contractors. To generate an appropriate sample frame for stratification by individual IOU, licensees with mailing zip codes not located in a participating IOU service territory were removed. The remaining sample included 9,678 licensed contractors. The research team then cross-referenced this list

with the *participating* contractors provided separately by each IOU and removed these participating contractors from the licensed contractor list, resulting in 9,516 nonparticipating contractors.

We organized the remaining 9,516 licensees according to their respective service territory designations.[10] Due to the fact that SCE and PG&E service territory boundaries cut across zip codes, 169 cases were unable to be located uniquely in SCE or PG&E territory. For these cases, half were randomly assigned to SCE territory and half were assigned to PG&E territory. As a visual check on the zip code assignments by service territory, cases were mapped by zip code and visually inspected for general conformity with the California IOU service territories. This is shown in Figure 2-2.

Figure 2-2: Location of Nonparticipating Contractors by Zip Code, Classified by IOU Territory



[10] Zip code data for assigning cases to a utility service area were obtained from two sources: (1) CSV files produced by NREL/Ventyx available from: http://en.openei.org/datasets/node/899, and (2) a list of counties served by SCG, including Fresno, Imperial, Kern, Kings, Los Angeles, Orange, Riverside, Santa Barbara, San Bernardino, San Luis Obispo, Tulare, and Ventura counties.

The number of interviews completed with nonparticipating contractor interviews is shown in Table 2-5. The number of interviews per IOU was roughly based on the proportion of total contractors in the population, shown on the left side of the table.

Table 2-5: Stratification and Completes for Nonparticipating Contractor Interviews

IOU	Population		Target Completes for Nonparticipating Contractor Interviews	
	Number	Percent	Total Number of Interviews	Total Percent of Interviews
SCE	4,346	46%	8	53%
PG&E	3,458	36%	3	20%
SDG&E	711	7%	1	7%
SCG	1,001	11%	3	20%
TOTAL	**9,516**	**100%**	**15**	**100%**

Note. There is a great deal of overlap between SCG's service territory and both SCE and PG&E. Of the population of PG&E contractors shown, 19% were also located in SCG territory. Of the SCE contractors shown, 99% were also located in SCG territory. In these cases, for purposes of assigning interview targets, we assigned contractors to the relevant electric utility, because of the larger size of the electric utility programs compared to the gas utility programs. Because contractors in overlapping service areas likely perform work in both, the research team considered these designations useful for stratification purposes, but not restrictive in terms of defining a contractor's work area.

2.4 Technician Survey Methodology

The research team completed surveys with 218 HVAC technicians between November 2014 and January 2015. The survey was offered in two formats: telephone and online. Telephone surveys were administered by CIC Research in close collaboration with EMI Consulting. Online surveys were administered by EMI Consulting. As a thank you for their time, we offered all survey respondents a $50 incentive.

Technician Survey Sample Frame Development

The sample frame for the technician surveys was based on a combination of the participating and nonparticipating contractor sample frames discussed previously, as well as a small number of contacts obtained through the industry group RSES. Technicians were recruited through three means. The vast majority were recruited through one primary method, although we also used two secondary methods:

- Primary: The C-20 nonparticipating contractor sample frame. We located individual technicians by calling the phone numbers in the list and asking if an installation or maintenance technician was available. If not, we asked if we could take down their contact information to call them directly at a more convenient time.
- Secondary: We leveraged the contractor in-depth interviews to recruit for the technician survey by asking contractors for referrals to technicians. Overall, only two surveys (1% of the total 218 surveys) were completed with technicians from participating firms, similar to the proportion of participating contractors in the population (about 2%).
- Secondary: RSES agreed to send out a link to an online version of the survey to their list of approximately 150 technicians in California who perform installation or maintenance of HVAC systems. RSES is a certifying body in the HVAC industry, and they maintain

membership lists that they use for periodic email distribution of newsletters and other industry information.

Survey Completes and Dispositions

The sample design for the technician survey was designed to attain a minimum of +/- 10% relative precision at the 90% level of confidence for the residential, small commercial, and large commercial sectors separately. This resulted in a minimum target of 68 cases per sector. We targeted 70 cases per sector to provide a small buffer against potential missing or questionable data. As shown in Table 2-6, we exceeded the goal of 70 per sector, with 218 total completes. Note that the number of surveys per IOU was based on the proportion of total HVAC contractors in the population, which is also shown in the table. By design, the proportion of technician survey respondents for each IOU was very similar to the proportion of contractors for each IOU in the population.

Table 2-6: Completed Technician Surveys by Sector and IOU

IOU	Population of HVAC Contractors		Technician Survey Completes				
	Population Frequency	Percent of Population	Residential	Small Commercial	Large Commercial	Total Number of Surveys	Total Percent of Surveys
SCE	4,401	46%	29	35	36	**100**	**46%**
PG&E	3,533	36%	27	25	25	**77**	**35%**
SDG&E	727	7%	5	6	6	**17**	**8%**
SCG	1,017	11%	11	5	8	**24**	**11%**
TOTAL	**9,678**	**100%**	**72**	**71**	**75**	**218**	**100%**

Of the 218 surveys, 204 were completed via telephone and the remaining 14 were completed online.[11] Table 2-7 shows the final dispositions for the technician telephone surveys. Surveys were completed with 5% of all numbers dialed. Almost half (47%) were not reached due to an answering machine, while 16% of numbers were noted as either the wrong number, not in service, or a fax machine. The refusal rate was 14%.

[11] The survey was intended primarily as a telephone survey, but we included an online option for technicians who were unable to schedule a time to complete the phone version, or if they simply preferred an online survey as opposed to a phone survey. This was included to ensure we met our target survey completes in a reasonable time frame.

Table 2-7: Technician Survey Call Dispositions

Final Disposition	Frequency	Percent
Completed	204	5%
Answering machine	1,891	47%
Wrong number/not in service/fax	646	16%
Refusal	548	14%
Callback	342	8%
No answer	117	3%
Busy number	89	2%
Prefer to do survey online	72	2%
Over quota - not completed	44	1%
Answering service company	33	1%
Language barrier	26	1%
Blocked number	12	< 1%
Mid-survey terminate by respondent	5	< 1%
No mention of 4 IOUs (Q S6)	1	< 1%
Total	**4,030**	**100%**

Note. Of the 218 total completed surveys, 204 were completed over the telephone. The remaining 14 surveys were completed online.

There were two sources for the sample of technicians who responded to the online version of the survey. One source consisted of technicians who were contacted for the telephone survey but indicated they preferred to take the survey online. The other source was through RSES.

Table 2-8 shows the dispositions and number of completes for each of the two sample sources for the online survey. The completion rate for the online survey contacts obtained through the telephone survey was 21%; this relatively high rate of completion is expected because the contacts had already indicated a willingness to participate. The completion rate for the survey through RSES was 5%, equal to the completion rate for the telephone version of the survey.

Table 2-8: Online Technician Survey Dispositions

Final Disposition	Source: Telephone Survey Contacts		Source: RSES	
	n	Percent	n	Percent
Completed	**6**	**21%**	**8**	**5%**
No response	22	76%	133	89%
Did not complete survey	1	3%	8	5%
Terminated (100% service, Q S5)	0	0%	1	1%
Total	**29**	**100%**	**150**	**100%**

Note. The distribution list for California technicians subscribing to the RSES distribution is dynamic; at the time of the survey, the distribution list contained approximately 150 contacts.

Assigning Survey Respondents to Survey Modules

In Phase I of the Behavior Study, we found that out of the 343 contractors we spoke with, the majority of contractors stated that they perform work in the residential (91%) and small commercial sectors (88%). The number of contractors that work in the large commercial sector was reported as much lower (37%). Given this, for the purposes of assigning respondents to different survey "modules" based on sector, respondents were asked the percentage of jobs that their company completes in each sector. Respondents were assigned to answer questions for one sector based on their responses. We used this same approach for the Phase II technician survey. Thus, for any technicians who indicated that 10% or more of their jobs were in the large commercial sector, they were assigned to answer questions for that sector. Respondents who indicated that large commercial jobs are less than 10% of their work and small commercial jobs comprise 20% or more of their work were assigned to the small commercial sector. The remaining respondents, all of whom conduct work in the residential sector, were assigned to the residential sector for purposes of completing the survey. This strategy ensured a roughly equal distribution of completes for each of the three sectors and accounted for the fact that firms working in the large commercial sector are less common.[12]

Table 2-9 shows the percentage of jobs performed in each of the sectors for respondents assigned to each of the three modules. The standard deviations shown in the table represent the variation in the percentage of jobs worked in each sector by technicians assigned to a single survey module. These values reflect the classification logic used to assign technicians to the survey modules. For example, technicians who reported 10% or more of their work was with large commercial customers were assigned to the large commercial module, meaning they could perform between 10% and 100% of their work with this customer type. See Section 2.4 for more detail.

Table 2-9: Mean Percentage of Jobs in Each Sector, by Survey Module Assignment

Survey Module Assignment	Percentage of Jobs Worked in Each Sector		
	Residential Mean (*SD*)	Small Commercial Mean (*SD*)	Large Commercial Mean (*SD*)
Residential (n = 72)	91% (7%)	8% (6%)	1% (2%)
Small Commercial (n = 71)	59% (22%)	40% (22%)	1% (2%)
Large Commercial (n = 75)	27% (28%)	37% (23%)	36% (26%)
Total	**59% (33%)**	**28% (23%)**	**13% (23%)**

The six online surveys completed through the telephone survey contact source were evenly divided between residential, small commercial, and large commercial respondents. The eight surveys completed through the RSES sample were all assigned to the large commercial module.

[12] This scheme was not meant to imply that any contractor that performs 10% of their jobs with large commercial customers is primarily a "large commercial contractor." However, it is possible that even a small proportion of commercial jobs could represent a majority of a company's revenue, since commercial jobs are typically more costly than residential jobs. Regardless, the classification scheme used was meant to serve as a reasonable strategy for assigning respondents to survey modules that focused on particular customer sectors - not as a way of classifying contractors into distinct groups. In reality, contractors may work with a variety of types of customers.

2.5 Secondary Research Review to Operationalize MTIs

In addition to the four primary data collection activities already discussed, the research team was tasked with operationalizing five market indicators. The CPUC requires (in D. 09-09-047) the Energy Division to develop recommendations for market transformation indicators and related data collection and tracking processes, noting that the purpose of the market transformation indicators and associated market transformation tracking framework is that it will "enable the Commission to track progress on implementation of the Strategic Plan and for specific technologies and measures" (D. 09-09-047 at 94).

The IOUs and the CPUC – Energy Division have defined a series of five market transformation indicators (MTIs) to gauge market change over time. These include the following (note that the first MTI is actually two separate indicators, HVAC-1a and HVAC-1b):

- HVAC-1a (and HVAC 1b): Market share of climate appropriate HVAC equipment (or market share of energy efficient climate appropriate equipment) – Residential and Non-Residential
- HVAC-2: Percentage of California residential HVAC installation contractors using QI guidelines
- HVAC-3: Percentage of California commercial HVAC installation contractors using QI guidelines
- HVAC-4: Percentage of HVAC units serviced in IOU service territory under a Quality Maintenance Service Agreement

As part of this study, EMI examined the feasibility of operationalizing each of these MTIs. We used numerous data sources to operationalize the five MTIs shown above, including: the Expert Advisory Panel members, the Project Team, contractors, technicians, program data, and literature reviews. Each of these sources provided insight into how to best capture the information needed to derive reliable and accurate estimates for these MTIs.

2.6 Research Limitations

All research has limitations. The primary limitations for this study are listed below.

- This research did not address behavior, attitudes, etc. of unlicensed contractors. The population sample frame was based on the list of C-20 licensed contractors. We expected that unlicensed contractors would not volunteer to participate in research studies such as this, and this population is very difficult to identify. The expert panel (market actor interviewees) hypothesized that as much as 50% of the true HVAC contractor population is unlicensed.
- This research did not capture responses from new contractor firms with licenses obtained since December 2011. Updating the list of contacts would have been extremely time consuming, and would have made the two populations for Phase I and Phase II less comparable.
- The contractor interviews were intentionally not designed to be generalizable to the population of contractors. Due to the low sample size of contractor interviews, the results of the interviews cannot be generalized to the entire population of HVAC contractors in California. A large sample of contractors (n = 343) was surveyed as part of the Phase I study. The purpose of the Phase II contractor interviews was to follow up and explore

important themes and provide additional data to support results of the overall study. Findings from the contractor interviews were primarily used to inform surveys with a much larger sample of technicians, which will be generalizable to the population of technicians employed with licensed contractors.

3. IMPLEMENTER INTERVIEW RESULTS

This chapter presents the results of in-depth interviews with ten IOU program staff and third-party implementers in the California IOU QI and QM programs. Results are summarized according to the following topics:[13]

- Opportunities to Improve Training/Testing
- Communicating Industry Standards to Contractors and Technicians
- Ensuring Standards are Enacted in the Field
- Best Practices and Contractor Business Models
- Barriers to QI/QM Program Success
- Key Takeaways from Implementer Interviews

Throughout the chapter, unless otherwise noted, all remarks represent the view of a single interviewee.

3.1 Opportunities to Improve Training/Testing

Training is required to participate in each of the California IOU programs, but slightly different types of training are required for participants in QI versus QM. Interviewees described two types of training offered through the programs: (1) operations training intended for contractors or administrative personnel and intended to introduce them to the operational basics of program participation, and (2) technical training intended to teach technicians how to perform work to meet program standards and how to use program software in the field. Operations training is usually attended by either the firm owner or administrative staff, and covers how to submit forms to the program, as well as sales strategies. Both types of training are required for participating firms in all but the SCE and SDG&E QI programs, which require only one technician from each participating firm to attend a technical training and do not require operations training. That technician is then expected to share the teachings with the rest of the firm. The remainder of this section focuses on technical training, which was the primary focus of the interviews.

Contractors and technicians are both required to have HVAC-industry experience to participate in the programs: for contractors, there are a number of financial requirements as well as the requirement that the contractor holds a C-20 license and that the firm has been in business for at least three years. While technicians are also required to have three years of experience, and are usually required to have obtained formal education or certification; several interviewees described technicians being assessed for participation on a case-by-case basis.

Seven out of the ten interviewees described (unprompted) that the technicians who enter their programs lack the skills necessary to perform QI and QM work to program standards. However, for the most part, interviewees believe that current trainings offered by their programs address

[13] We also asked each of the interviewees to comment on data sources that could be used to operationalize the MTIs. Responses to these questions are not presented in this chapter; rather their feedback was incorporated in the chapter summarizing operationalization of the MTIs.

these skill deficits, and are proactive in improving the trainings if necessary. PG&E's Commercial QM Program Manager described a gap analysis currently being conducted, while SCE's commercial Quality Maintenance implementer described using HVACRedu,[14] an online education organization, to provide technical training after the CPUC Work Order 32[15] outlined deficits in technician's training. Four interviewees described specific skill gaps that the program is not currently addressing in training, and may be useful to include in the future, including: controls, sales training, proper program data entry, and building science fundamentals.

Implementers measure the effectiveness of technical training according to whether technicians pass the test given at the end of training and whether or not technicians are able to pass inspections. Retraining is required if the technician either fails three inspections at one site in a row, or inspections at three different sites. For most of the programs, training does not just happen within the confines of the technical training, and once the technicians pass this training there are many more informal opportunities for them to learn in the field. In fact, SCE's commercial QM implementer described piloting a mentorship program that assigns an experienced technician to work with less experienced technicians to ensure their work is brought up to standard.

> *"Trainings aren't where technicians learn the most, it's through mentorship."*
>
> *-SCE QI/QM Program Manager*

3.2 Communicating Industry Standards to Contractors and Technicians

Industry standards are an essential component of the programs' technical trainings, and according to all of the interviewees, the trainers describe the standards not as simply the "industry" or "program" standards but by specifically using the terms ACCA Standard 4 or 5, or ACCA/ASHRAE Standard 180. Because the standards are so detailed, the hands-on demonstrations that take place during technical trainings are essential to communicating the standards to technicians in a way that can help them perform their daily work. Interviewees described the hands-on part of the training as one of the most important ways they teach technicians about the ACCA/ASHRAE standards.

The programs offer a number of materials as resources to participating contractors and technicians. They provide participants with copies of the manuals (which are also widely available online) as well as software tools and checklists to use in the field. These in-field tools were designed to address the requirements outlined in the standards. There are also opportunities to communicate standards to technicians via the QA/QC process, outlined in the further detail in the next subsection of this chapter.

None of the program staff or implementers interviewed described being involved in how industry standards are communicated among staff at participating firms. The programs do not take a prescriptive role in the contractor/technician relationship, and during the operations trainings

[14] see https://hvacredu.net/
[15] DNV GL (2015). *HVAC Impact Evaluation FINAL Report, WO32 HVAC - Volume 1: Report.* CALMAC Study ID: CPU0100.01. Available at: http://www.calmac.org/publications/FINAL_HVAC_Impact_Evaluation_WO32_Report_28Jan2015_Volume1_Report.pdf

they do not instruct contractors on how to convey or enforce the standards among their technicians. As the operations trainings do not focus on ACCA/ASHRAE standards, and technical trainings are primarily attended by technicians, it is unclear whether or not contractors participating in these programs are instructed on ACCA/ASHRAE standards or how to apply them in the field. PG&E's residential QM implementer described informing contractors of best practices to help technicians complete work to standards, but conveying this information in a conversational rather than instructive manner.

3.3 Ensuring Standards are Enacted in the Field

According to implementers and program staff, the best way to ensure that technicians perform work to standards in the field is to create what SCE's QI/QM program manager called a "continual feedback loop" quality control process. Implementers contribute to this feedback loop by conducting regular field inspections as well as by providing feedback on the data collection forms submitted for each job. Discrepancies and errors in data collection forms allow implementers to determine when contractors or technicians are struggling with understanding the program or the standards, while the inspections enforce the correct application of the standard within the field. This continuous feedback process is included in each of the various IOUs' QI and QM programs.

Each program uses a slightly different process to conduct in-field inspections. Generally for QM, the first few jobs are all inspected, and then a small percentage of subsequent jobs are inspected. This process is similar for QI, although there are more stages involved in the SCE inspection process. The process for each program is described in detail below:

- PG&E's Residential QM program inspects the first five jobs a contractor performs in the program.
    - Once the contractor passes these inspections the program inspects 5% to 10% of contractors' jobs.
- SCE's Residential QM program inspects the first five jobs a contractor performs in the program.
    - Once the contractor passes these inspections the program inspects 10% of the contractors' jobs.
- PG&E's Commercial QM program inspects a contractor's first three jobs in the program.
    - Once these inspections are passed the program inspects 10% of contractors' jobs.
- SCE's Commercial QM program inspects the first two jobs a contractor performs in the program.
    - Once the contractor passes these inspections the program inspects 10% of contractors' jobs.
- SDG&E's Residential and Commercial QM programs use a two-tiered inspection system.
    - At Level 1, the program inspects the first five jobs a contractor performs in the program.
    - Once all five inspections have been passed the contractor ascends to Level 2, and 20% of their program jobs are inspected.
- SDG&E's Residential and Commercial QI programs also use a two-tiered system and are based on the ANSI/ACCA Standard 9 Quality Installation verification protocol to conduct inspections.

    - At Level 1 the contractors' work must pass 3 inspections to ascend to Level 2.
    - At Level 2, 1 in 10 jobs are inspected.
- SCE's Residential and Commercial QI programs, like SDG&E's QI programs, are based on the ANSI/ACCA Standard 9 Quality Installation verification protocols, but uses a four-tiered system.
    - At Level 1 the first five jobs in the program are inspected. Once these inspections are passed, contractors ascend to Level 2.
    - At Level 2, one in three jobs are inspected. If they pass graded inspections (a score of .80), they ascend to Level 3.
    - At Level 3, one in ten jobs are inspected. If the contractor's pass rate is .80 to .89 they ascend to Level 4
    - At Level 4, one in twenty jobs are inspected.

Contractors' internal QA/QC processes, much like contractor/technician communication, is not prescriptively dictated by the program. Three interviewees noted that it is important for contractors to conduct internal QA/QC, and that the contractors in the program who do conduct it are among the more successful program participants. However, they also noted that it can be challenging for smaller firms to build the internal QA/QC processes and best practices that could help them succeed in the program – such as internal QA/QC staff, regular check-in meetings, and site visits – because smaller firms have limited resources.

When asked how the programs' QA/QC process could be improved, many of the interviewees reported that the process did not need improvement. However, there were some suggestions that focused on data quality. Two interviewees mentioned that contractors should put more resources into their internal QA/QC processes, one saying that the program should require contractors to conduct internal QA/QC. Two interviewees suggested that data collection methods should be improved, and that data entry training should be incorporated into the technical training.

3.4 Best Practices and Contractor Business Models

Implementers and program staff described a number of best practices among successful contractors; by far the most frequently mentioned factor was understanding and buying into the value proposition of QI/QM. As SCE's Commercial QM implementer described, the contractors need an "internal champion who is passionate about the goals of the program" to succeed within the program, as the program is often demanding, and the reimbursement provided by rebates frequently does not cover the extra labor and time spent on QI/QM work. A contractor who prioritizes quality work or energy efficiency will usually be more active in the program than a contractor who prioritizes completing as many jobs as possible.

> *"The most successful contractors in the program have 'an internal champion who is passionate about the goals of the program.'"*
>
> *- SCE Commercial QM Implementer*

Other important qualities for contractors in the program include a willingness to change practices, openness to feedback, and investment in developing staff skills. As PG&E's commercial QM program manager reported, many of the contractors entering the program believe they are already performing standards-based work (i.e., work based on ACCA/ASHRAE standards), and it

can be challenging to convince them that their work is not meeting ACCA/ASHRAE standards. The most active contractors are able to accept feedback on the improvements their business may need to make to be part of the program, such as sending technicians to more training, incorporating internal QA/QC, or scheduling technicians enough time to complete QI/QM jobs to standards. And as one implementer described, successful contractors actively engage and offer feedback to implementers about the program.

There are a number of business models that interviewees described as important to contractors' success within the program. Interviewees described the most active contractors as firms that: (1) already have a large customer base; (2) have participated in utility programs before; and (3) have a strong investment in customer service and customer satisfaction. Because of the price-consciousness of most customers, firms with an existing customer base have more luck selling QI/QM work to their existing customers—whom they have already established a relationship with—than firms who attempt to sell QI/QM work to new customers. Firms that have already participated in utility programs tend to work better within the program than firms without this experience, because they have an understanding of the complexity, possibility of change, and possibility of reimbursement delays that can be part of program participation. Finally, firms that already distinguish themselves with superior customer service are able to incorporate QI/QM standards more easily than other firms, because the value proposition of QI/QM is consistent with prioritizing customer satisfaction.

3.5 Barriers to QI/QM Program Success

The barrier most frequently mentioned by interviewees was the difficulty of selling the value proposition of QI/QM in a highly commoditized, price-driven market. Four interviewees described participating contractors being consistently underbid by non-QI/QM contractors. One interviewee said that because many customers do not understand or care why the QI/QM work costs more, these contractors miss out on work. While some contractors are able to successfully convey the value proposition of QI/QM, and win work by selling quality instead of a low price, they are the exception in this competitive marketplace.

Another major barrier to QI/QM program success is that most contractor business models do not include the robust internal processes necessary to consistently perform work to ACCA/ASHRAE standards. All of the implementers and program staff emphasized the essential role QA/QC plays in enforcing standards in the field, and two were particularly enthusiastic about contractors building their own QA/QC processes. However, thorough QA/QC is a significant investment of resources that is often either not prioritized or possible for many contractors. Contractors may be less likely to make the changes necessary to internalize these processes, because it could involve significant changes in how the contractor does business, with little apparent return on investment.

A barrier mentioned by one interviewee was that some contractors have skeptical or resistant attitudes towards the program, and are unwilling to adapt to feedback, which prevents them from internalizing the value proposition of the program. While this barrier may be related to contractors' resource limitations, it is not necessarily only a problem for small or resource-strapped firms. A number of contractors who enter the program believe that they are already doing work to ACCA/ASHRAE standards, and when they are informed that their work does not meet the standard, rather than attempting to improve they become defensive of the quality of their work. These contractors represent a vocal minority who do not perform well in the

programs, because their assumptions about the quality of their work do not allow them to improve and complete work to ACCA/ASHRAE standards.

3.6 Key Takeaways from Implementer Interviews

Key takeaways from the interviews are summarized below:

- **According to implementers, technicians are not performing work to ACCA/ASHRAE standards outside of the program.** Most of the technicians who enter the program, regardless of their previous training, are not currently performing work to ACCA/ASHRAE standards.
- **The training need most frequently described was data entry.** Other key training needs mentioned included the use of controls and the fundamentals of building science.
- **Hands-on training is essential to teaching technicians how to apply standards in the field.** Technical trainings consist of both classroom and hands-on training, and interviewees emphasize the importance of technicians learning how the standards are applied to a real system.
- **Standards are communicated both in the technical training and through the software tools used by technicians.** The standards are also reinforced through the quality control process.
- **The quality contractor business model is defined by investing resources to develop processes and staff.** The most active contractors in the program are committed to continually developing their businesses and are open to receiving feedback on how they conduct business.
- **Aligning business model priorities, training, and industry standards will require efforts from all actors within the market.** Technicians need to understand how the tools they are using relate to the ACCA/ASHRAE standards; contractors must understand best practices and how to communicate/enforce standards with technicians; contractors also need to engage with implementers and provide them with feedback on how the program works for them.
- **Best practices for delivering QI and QM involve continual learning and feedback.** Contractors should develop robust internal QA/QC and continuing educational opportunities, such as mentorship: the program's technical training is really the beginning of learning how to perform work to ACCA/ASHRAE standards, not the end.

4. MARKET ACTOR INTERVIEW RESULTS

EMI Consulting staff conducted seven in-depth interviews with key market actors focusing on their individual areas of expertise in the HVAC industry. The purpose of the interviews was to (1) understand business models that allow contractors to successfully implement QI/QM projects, (2) get a sense of best practices and challenges related to technician field practices, and (3) gather perspectives on the most effective types of sales and technical training.[16]

Results of the interviews are divided into the following topics:

- Contractor Business Models
- Technician Field Practices
- Sales Skills and Technical Training
- Key Takeaways from Market Actor Interviews

Throughout the chapter, unless otherwise noted, all remarks represent the view of a single interviewee.

4.1 Contractor Business Models

We first asked market actor interviewees about the type of business models or practices that allow contractors to be successful at conducting QI/QM, compared to standard installation and maintenance services. Interviewees discussed a broad range of factors that impact the level of participation and ultimate success of HVAC contractors who participate in QI/QM programs. These factors are organized into three categories: (1) business models that contribute to contractor success, (2) challenges or trade offs that contractors make when participating, and (3) factors that contractors consider when deciding to participate in QI/QM programs.

Successful Business Models

When asked, interviewees quickly identified a variety of characteristics of successful participating contracting firms, along with business practices employed by those firms that contribute to their ability to successfully implement QI/QM programs.

Successful Contracting Firm Characteristics

Two interviewees mentioned that successful implementation of QI/QM programs starts with strong contractor leadership support of the value of QI and/or QM. Interviewees explained that success starts at the top. Technicians need support from leadership in the form of time for (1) training on QI/QM processes and the value proposition, and (2) completing all necessary steps required for QI/QM implementation.

[16] We also asked each of the market actors to comment on data sources that could be used to operationalize the MTIs. Responses to these questions are not presented in this chapter; rather their feedback was incorporated in the chapter summarizing operationalization of the MTIs.

A second characteristic among successful contracting firms, described by one respondent, is that sound business operations provide a foundation for success regardless of the new venture. Operation processes common among these firms include a keen understanding of business financials, ability to manage operational assets, and a focus on tracking sales and profitability. Because participation in QI/QM programs increases the cost (through increased labor) of completing installation and maintenance service, having a clear handle on business fundamentals is critical to stay profitable.

A third contracting firm characteristic, presented by two respondents, is that the firms most successful at implementing QI/QM programs are typically larger contracting firms – In terms of number of employees.[17] This is because larger contracting firms tend to have more support staff (e.g., administrative, sales) available who can help manage and complete paperwork required for QI/QM program participation. In addition, these firms are also better able to absorb unexpected labor costs associated with return visits to completed projects, such as costs associated with inspections on a following day. (The impact that the firm size may have on QI/QM program participation is also discussed later in the next section as a challenge.)

Business Practices

All market actor interviewees stated that contracting firms that successfully implement QI/QM programs have the ability to demonstrate the value of QI/QM to customers. This was similarly mentioned by the implementer interviewees. Market actors explained that the value proposition presented depends on the type of customer (e.g., residential, nonresidential) and the type of service (e.g., quality installation, quality maintenance). Because QI/QM is more costly compared to standard installation/maintenance, characteristics of the value proposition typically are not cost-based. Instead, contractors have to sell based on quality, comfort, and HVAC system efficiency. One interview respondent explained that contractors who successfully sell QI/QM services to commercial customers emphasize the impact that QI/QM will have on reducing equipment failures, technician callbacks, and system issues. Commercial customers are especially sensitive to these factors because any downtime of their HVAC system could negatively impact business operations. These findings closely parallel findings from the California HVAC Customer Decision-Making Study, in which both residential and commercial customers placed high value on system reliability.[18]

The second business practice successful QI/QM HVAC contractors rely on, mentioned by five expert panel respondents, is to build and retain good client relationships. Interviewees explained that it is much more difficult for contractors to sell QI/QM to new customers than existing clients. This is because once a contractor has established a relationship with a client or property management firm and earned their trust, those customers are much more receptive to contractor recommendations for future service needs. From the customer perspective, the customer now has someone who they have established rapport, so the need to shop around for future services is greatly reduced.

> *"If you have a good relationship with a customer, then that can help offset if you are one of three contractors they are considering."*
>
> *- HVAC Contractor*

[17] Note: Interviewees identified smaller firms as those that employed 3 to 4 employees and typically were family run, and did not provide specifics about larger firms, except that they were more formally structured.
[18] For more information see: EMI Consulting, (2015). *"California HVAC Customer Decision-Making Study."*

The importance of trust was illustrated during the interviews, when one respondent drew a parallel between customer relationships with HVAC firms and medical professionals such as doctors. This respondent explained that customers are not entirely sure what doctors do, but they know things get better after visiting them; the same holds true for HVAC contractors.

A final business practice employed by successful QI/QM contracting firms, according to five respondents, is an emphasis on continuous training. According to interviewees, successful contractors understand the value and importance of training technicians and office staff on both why and how QI/QM works. The successful firms understand the value of staff training and are willing to invest in it. In addition, one respondent reported that some contracting firms will assess what types of training content and approaches are most effective.[19]

> *"Training is an ongoing process, not a one-time thing."*
>
> *- HVAC Industry Leader*

Challenges and Trade-offs

> *"If you are competing on price, you are never going to make it."*
>
> *- HVAC Contractor*

Interviews with market actor respondents provided insight into challenges and trade-offs participating contractors face when implementing QI/QM projects. All interview respondents reported that additional costs are the most critical challenge to participating in QI/QM programs. Notably, HVAC has now become a commodity (due to many companies providing these services and competing primarily on price) and competing with other contractors who provide low-ball pricing estimates for services is difficult. However, contracting firms successful at implementing QI/QM programs have found ways to differentiate themselves in the competitive market. Below are two examples of approaches discussed by Interview respondents.

- **Build a valued reputation** – One thing contractors do consistently to differentiate themselves in the market place is develop a valued reputation. This does not happen overnight, but once a good industry reputation is established, contractors can rely less on having to compete on cost. Interview respondents added that customer testimonies can greatly help to illustrate value and build a contracting firm's reputation.
- **Develop well-trained technicians** – The best way to deal with questions about the value of QI/QM programs is to have a highly trained crew who understand the benefits of QI/QM and can sell the value of it to customers. Having well-trained technicians will help address potential customer concerns about QI/QM. Training efforts should include staff across all parts of contracting firms, including sales staff and technicians. One respondent specifically mentioned that ongoing training for technicians is needed because "field guys often think they know everything" and may not recognize when they need additional training. The respondent also reported that effective training for technicians

> *"Technicians often need to unlearn rule-of-thumb processes."*
>
> *- HVAC Industry Trainer*

[19] The respondent did not provide additional details regarding how training effectiveness is assessed.

requires helping technicians unlearn common practices such as rules of thumb that are not accurate.

Administrative requirements are another aspect of participation in QI/QM programs that interview respondents reported as challenging. Program participation requires contractors to collect additional data in the field, process additional paperwork, and in some cases provide staff with QI/QM training. The incentives provided through the QI/QM programs help to offset some of these costs, but the margins are still extremely tight. As a result, efficiency in operations is critical and any issues at all with the projects increase the contractor's time and labor expenses. Examples of unanticipated issues include paperwork adjustments due to program changes and repeat visits to completed jobs for inspections (e.g., city inspectors, HERS raters). As mentioned previously, interview respondents explained that larger contracting firms are better able to absorb the additional costs when they arise than smaller firms who may not have the same support staff or staff availability.

Interview respondents also mentioned other challenges to implementing QI/QM programs that are secondary to the cost-related challenges:

- **Inconsistency in utility program naming conventions**. One interviewee explained that it is difficult to discuss the programs when different names are used across utility territories for the same or similar QI/QM offering.
- **Limited recognition for utility account managers** may result in account managers putting minimal effort into promoting the program and increasing participation. To help address this, the interviewee recommended directly incentivizing utility account managers to encourage more active involvement in marketing the programs.
- **Extensive amount of math required** to conduct QI/QM program calculations was initially challenging for many technicians. Interviewees mentioned that a new spreadsheet tool has helped alleviate much of this concern.

Participation Factors Considered

Market actor interview respondents were also asked about what factors contractors consider when deciding to participate in the QI/QM programs. Respondents offered three factors contractors consider: (1) incentive availability, (2) client base expansion, and (3) differentiation from competing contractors. The biggest attraction for contractors considering QI/QM program participation is the availability of incentives. According to interviewees, contractors claim that customers are currently not demanding QI/QM and that incentive programs provided by utilities help to increase the awareness of QI/QM and the desire to participate in those services. The second factor considered by contractors is the potential to grow their business through providing higher quality services. The third, but related factor, is the desire among contractors to differentiate themselves from other contractors. Participation in the QI/QM programs provides contractors with the ability to present additional value to customers through more thorough installation and maintenance processes that will potentially help to improve long-term system efficiency.

4.2 Technician Field Practices

Implementing QI/QM standards in the field can present challenges for HVAC technicians and contracting firms. Interviews with expert panel respondents helped to highlight technician

experiences in implementing QI/QM in the field, including: (1) challenges implementing QI/QM in the field and (2) strategies for addressing those challenges.

Challenges

Market actor interview respondents discussed a variety of challenges that technicians face when implementing QI/QM projects in the field. One of the key challenges expressed by three respondents is that technicians often have a limited understanding of HVAC fundamentals. As a result, one interviewee explained that technicians make decisions on the job based on personal experiences instead of sound HVAC science. Additional training on HVAC fundamentals could help to address the gaps in technicians' HVAC understanding. One of the respondents estimated that more than 50% of the workforce enters the industry without any formal education. This is especially the case among smaller “familial” contracting firms with only 3 to 4 employees.

In addition, respondents reported that even when contracting firms do have high quality installation technicians, the challenge is affording to keep those high quality technicians. This is especially an issue for technicians installing residential systems. Part of the issue is that that average wage rate for installation technicians ranges between $15 to $24 per hour, whereas the average service technician rate can be up to $40 per hour. Technicians who are more skilled will typically transition from installation of HVAC systems to service work, resulting in higher turnover among installation technicians working on residential systems. Contractors do have senior level residential installation technicians, but they typically can only afford to keep one or two on staff.

Market actor respondents also discussed the additional time requirements for QI/QM projects as a challenge for technicians in the field. Specifically, one respondent explained that it is difficult to schedule and provide enough time for technicians to complete quality work, while still being profitable. The primary driver of increased costs is the additional labor required for QI/QM work compared to typical HVAC installation and maintenance, not materials. The increased labor costs include both time for more extensive field procedures and completion of program reporting and paperwork requirements. An example provided by one respondent estimated that a typical “clean and check” of a residential HVAC system usually takes 30 to 40 minutes versus an hour and an half for “quality” HVAC maintenance. The real challenge contractors face is justifying the extra cost to a customer at a rate of $150 per hour.

A few additional challenges were mentioned by respondents. One interview respondent explained that implementing quality maintenance there is not a public perception that maintenance to ACCA standards is better than standard maintenance. In addition, the lack of evidence available to support the claim that QI/QM will save energy or money contributes to the difficulty contractors face when trying to sell either quality maintenance or quality installation. Another respondent commented that it would be very helpful to contractors if utilities could provide evidence of energy and cost savings due to participation in QI/QM to show value to customers.

Respondent Recommendations for Addressing Implementation Challenges

To address QI/QM challenges, interview respondents provided three possible recommendations. The most important thing that contractors can do to help address the challenge is to provide all technicians with HVAC fundamentals training. Two respondents disagreed on the extent to which training alone would address HVAC industry issues, but both agreed that training on HVAC

fundamentals is needed. Another recommendation offered by respondents is the need for greater consistency in enforcement of HVAC standards. One interviewee stated that verification as part of the QI program is helpful, but "unfortunately is not required as part of the QM program." According to one respondent, the industry as a whole lacks the level of verification that is needed. The final recommendation offered by two interview respondents was to better educate contractors and technicians on their impact on energy efficiency. Specifically, inform technicians that they have the most critical role in the installation and maintenance of HVAC units. One respondent added that technicians really need to be informed about why this is important and praised when they get it right.

> *"Verification is key, and the whole HVAC industry really lacks it."*
>
> *- HVAC Industry Leader*

4.3 Sales Skills and Technical Training

We also asked market actor interviewees about the sales skills and technical training required to successfully implement QI/QM programs. According to interview respondents, sales of QI/QM services are most effective when the discussion of program benefits and options begins with the client-facing staff member who interacts with the decision maker. For example, on commercial projects the technician does not always interact with the decision maker. At large firms, the client-facing staff are usually dedicated HVAC sales people, but for smaller firms (with three to four staff members) it is often the owner and occasionally the technician. However, one interview respondent reported that the technician has the most credibility with customers, not sales staff or contracting firm leadership. This is because technicians are typically viewed as a trusted actor whose priorities are to ensure HVAC systems are working in optimal order. Despite this position of trust, interviewees reported that technicians are often the least likely to sell services, although they may be the first to highlight a need for service or new equipment.

The following sections review responses regarding (1) best practices for selling QI/QM services, (2) technician training and testing, and (3) perceptions of HVAC industry standards.

Best Practices for Selling QI/QM

> *"Don't sell; tell and educate."*
>
> *- HVAC Industry Leader*

Market actor respondents provided insight into the best methods for selling QI/QM services to customers and how to overcome barriers to customers' investments in QI/QM. Selling QI/QM begins with the contractor believing in the value, which leads to the opportunity to explain the value to the customer. According to one interview respondent, there are two methods of selling: using charisma, which cannot be taught, and by providing in-depth product knowledge, which can be taught. However, among several other respondents, the consensus was that selling is greatly influenced by the level of trust between the contractor and customer. Not every QI/QM interaction is a "hard sell;" most contractors have existing client relationships through which they can sell QI/QM. In addition, the contracting firms with good reputations can leverage the trust that they have earned with existing customers to help win over new potential customers. A good reputation in the marketplace helps to increase new customer receptiveness to contractor recommendations. One respondent also noted that the key to selling QI/QM is to educate the customer about the benefits, rather than trying to sell a service or product.

Interview respondents also stated that understanding how to best overcome the customer cost barrier is critical for selling QI/QM. Six of the seven respondents emphasized the importance of focusing on the value that customers will receive by participating in QI/QM programs. Interviewees offered three approaches that contractors can use to accomplish this.

- **Start with educating the customer** – Provide customers with a clear understanding of what QI/QM consists of and how it will benefit the life and efficiency of their HVAC system.
- **Provide customers with something they can relate to** – Customers understand the value of QI/QM better when it is put in terms that are familiar to them, which is often related to quality and comfort. A specific recommendation by one respondent was to look for customer "hot buttons" (those items that are most important and relevant to the customer) and balance the investment costs against those important customer factors.
- **For quality maintenance projects, emphasize the additional benefits** – Contracting firms successful at selling QM often also provide customers with additional benefits, including: faster response times due to priority on service calls, reduced service call rates, and discounted pricing on filters.

Technician Training and Testing

Market actor respondents discussed three important aspects of training technicians on QI/QM standards, including (1) best methods for training and training topics, (2) who should provide the training and when it should be provided, and (3) how the effectiveness of training should be tested.

Training Methods and Topics

Two respondents specifically mentioned that the best method for training is to divide the information into manageable segments that allows time to absorb the training. The way to do this is through blended learning that utilizes a combination of both classroom/online instruction and hands-on application. Classroom instruction covers the theory and science, followed by hands-on experience applying the information in the field. One respondent also emphasized that technicians with positive attitudes are easier to train on QI/QM.

Interview respondents, unprompted, also provided recommendations for training topics that should be included in any educational effort. The first recommendation was that effective training has to include building science. Another recommendation, mentioned by two respondents, is that technicians need to be educated on the sales cycle of HVAC systems and understand the stage the customer is at to determine the most appropriate service solutions.

> *"Technicians in California do not know the details [of the standards] and are often unaware of the existence of standards."*
>
> *- HVAC Industry Trainer*

Trainers and Timing

Interview respondents also provided insight into who should provide the QI/QM and sales training, topics that should be included, and when it should be conducted. There was consensus that the organization best suited to conduct training depends on the training topic. For QI/QM

training, utilities and community colleges were mentioned as possible sources. However, for sales training the sources recommended included: manufacturers (e.g., Trane, Carrier), distributors, and private organizations (e.g., MCI). In addition, one respondent emphasized that the best sales trainers are those who specialize in HVAC. One respondent also emphasized the value of bringing in successful contractors to share their own experiences selling QI/QM and examples of how customers have benefited from participation.

Interview respondents also provided recommendations for when sales training sessions should be offered. According to one respondent, sales training offered during more flexible periods that better align with contractor work schedules will be the most successful. This includes class offerings in the evenings and weekends for shorter periods, instead of full eight-hour days. Another recommendation offered was to keep the training content focused and brief.

Types of Testing

Interview respondents were asked about the type of testing that is required to ensure that training is successful, and most interviewees agreed that utilizing pre/post tests is the most effective approach. Pre/post tests are valuable because they can provide evidence that training has resulted in increased technician knowledge of HVAC. One respondent noted that utilities offering HVAC training as part of the requirements to receive QI/QM program incentives are already including testing as part of the model.

One challenge with testing, according to one respondent, will always be that the more time that passes since completing training, the less familiar the specifics become. As a result, conducting QI/QM requires ongoing and continuous training.

Perceptions of HVAC Industry Standards

Interview respondents offered opposing perspectives on the prevalence of HVAC field work that is completed according to ACCA/ASHRAE standards. One respondent, who claims to interpret the standards more broadly, explained that HVAC concepts behind the ASHREA/ACCA standards are not new to the industry. The concepts and best practices have been around for a long time and all that ASHRAE/ACCA has done is to compile the HVAC industry best practices into a single document. According to this respondent, a well-trained HVAC technician is likely aware of the details, but may not know them as a "standard;" instead, they are known as best practices.

This view of the standards is very different from another respondent who felt that only those contractors actively participating in current QI/QM programs are meeting the standard requirements. What both perspectives can agree on is that work to develop a QI/QM user manual could help improve the interpretation of the standards and how they should be implemented in the field.

> *"I can guarantee that contractors cannot do quality installation if they are not participating in the program because they do not have the tools or understand the importance of the number that comes out of the tool."*
>
> *- HVAC Industry Leader*

4.4 Key Takeaways from Market Actor Interviews

Key takeaways from the market actor interviews include:

- **Selling QI and QM programs while maintaining profitability is challenging.** The program requirements can be burdensome (especially for smaller contracting firms). This is because the program requires technician training, resource investments, and administrative requirements, resulting in tight profit margins.
- **Successful contractors establish a value proposition that is not cost-based.** Instead, they communicate to customers the benefits of QI/QM in terms that have meaning to them, and at times offer additional benefits (e.g., priority service, discounted products).
- **There is a need for training on HVAC fundamentals.** Many technicians have not had any formal HVAC education and could benefit greatly from additional training on the theory and science of HVAC systems. This is consistent with a prior study showing that basic HVAC skills are the most pressing training need in the industry.[20]
- **QI and QM training is most effective when a blended approach is used.** Training should consist of either classroom or online instruction on HVAC science followed by hands-on application in the field.
- **Testing and verification are necessary to measure the impacts of QI and QM on energy efficiency.** Ensuring that there is both knowledge transfer for technicians completing QI/QM training, and that QI/QM procedures are implemented correctly in the field, are critical components necessary to demonstrate QI/QM program success.
- **Even among industry experts, there is varied interpretation of standards.** How standards should be interpreted and implemented in the field is still not consistently agreed upon by experts.

[20] EMI Consulting. (2012, October 12). *HVAC Educational Needs Assessment.* Prepared for Southern California Edison.

5. CONTRACTOR INTERVIEW RESULTS

This chapter presents the results of 26 in-depth interviews conducted with HVAC contractors in California. Of the 26 total interviews, 11 were conducted with contractors participating in the Quality Installation/Quality Maintenance (QI/QM) programs and 15 were conducted with non-participating contractors.

The primary purpose of these interviews was to inform the development of technician surveys.[21] Results are summarized according to the following topics: (1) awareness and use of standards, (2) how industry standards are communicated to technicians, (3) importance of training and certifications, (4) sales and sales training, (5) training needs, (6) successful contractor business models, and (7) benefits of program participation. This chapter concludes with a summary of key takeaways.

5.1 Awareness and Use of Standards

Both participating and non-participating contractors were questioned about their awareness of the ACCA/ASHRAE standards. Less than half of participating contractor respondents (5 out of 11) specifically referenced using the ACCA/ASHRAE standards in their work. This is possibly due to the fact that, as described by implementers, technicians are typically the ones attending the technical training provided by the QI/QM programs. Two of the participating contractors who reported incorporating the ACCA/ASHRAE standards into their internal processes specifically described utilizing manuals published by ACCA (Manuals J, D, and S). Among the remaining six participating contractors who did not reference the standards, three described using municipal codes or manufacturers' standards rather than ACCA/ASHRAE, and did not clearly describe how they use the ACCA/ASHRAE standards in their work.

More than half (9 out of 15) of non-participating contractors reported that they base part or all of their work on ACCA/ASHRAE standards, or reported that they perform work to a higher standard (e.g., implement more specific procedures, include additional steps) than ACCA/ASHRAE. The remaining six nonparticipant respondents reported using municipal standards or in-house processes. While non-participating contractors stated that they were familiar with the ACCA/ASHRAE standards, they were generally unable to provide specific examples.

5.2 Communicating Industry Standards to Technicians

We also asked contractors how they communicate industry standards to technicians. Regardless of the level of knowledge contractors expressed of ACCA/ASHRAE standards, none of the participating or nonparticipating contractors described communicating standards to technicians as "ACCA" or "ASHRAE" standards. Instead, four respondents (all participants) reported using the ACCA/ASHRAE standards in their work without referring to these practices by name. Ten respondents reported training technicians through on-the-job training using internal standards (based on, for example, municipal codes or Title 24). Only one contractor (nonparticipating)

[21] Contractors were also asked to comment on MTI HVAC 1a and 1b, and this is reported in the Operationalization of MTIs chapter.

reported hiring technicians who are already acquainted with the standards; this aligns with implementer interview respondents who reported that technicians generally lack the skills needed to perform QI or QM before attending the programs' technical training sessions. Overall, non-participating and participating contractors reported communicating standards to technicians using similar methods. About a third of respondents (8 out of 23 who answered this question) reported using a regular process to communicate the standards. The various processes they described are listed below.

- Use standards-based job checklists (n = 3)
- Conduct weekly meetings (n = 3)
- Checking all jobs and providing feedback to technicians (n = 2)
- Hold regular in-house trainings (n = 2)
- Use preventative maintenance reports (n = 1)

The only notable difference in how participating and nonparticipating contractors reported communicating the standards is that two of the participating contractors reported using multiple methods of communication while the nonparticipating contractors described using only one method of communication. The list of various communication methods reported by contractors was used to populate response options in the technician survey.

> *"If technicians have been in the field, I assume they know these standards, but I often have to reiterate… [so] we have weekly meetings, and we'll talk about the experiences we've had in the last week."*
>
> *-Participating Contractor*

5.3 Training and Certifications

Both participating and nonparticipating contractors were asked about their awareness and the importance of training and certifications. Almost half (10 out of 26) of the contractors we spoke with reported that in-field training is the most effective method for training technicians. An equal number (10 out of 26) of respondents said that they thought technicians were best trained with a combination of classroom and in-field training, but preferred technicians spend more time in the field than in the classroom. This echoes the "blended approach" suggested by market actors, which combines classroom teaching with hands-on training. Overall, most contractors (20 out of 26) agreed that in-field training is more effective than other training methods. However, four respondents described classroom training as the most effective technician training method. Two contractors (both nonparticipating) described hiring technicians with good personalities and work ethics as more effective than training.

> *"If I hired someone with a certification, I would need to see them in the field—it's the best way to train."*
>
> *-Nonparticipating Contractor*

When asked in an unprompted format, nearly all (25 out of 26) of the respondents mentioned looking for NATE (North American Technician Excellence) certifications when hiring new technicians. Among those, two also specifically commented that finding a NATE certified technician was difficult. Ten respondents mentioned looking for EPA (Environmental Protection Agency) certification. In addition, three participating contractors and six nonparticipating contractors described other types of non-NATE or EPA qualifications. These various responses were used to populate response options for the technician survey and are listed below:

- NATE certification (n = 25)
- EPA certification (n = 10)
- National Comfort Institute (NCI) certification (n = 2)
- HERO (Home Energy Renovation Opportunity) certification (n = 2)
- Building Performance Institute (BPI) certification
- National Air Duct Cleaners Association (NADCA) certification
- Union trade certification
- Associates degree
- Vocational school

5.4 Sales and Sales Training

Almost half of contractors (10 out of 23 who answered this question) reported that their technicians perform sales work - with technicians beginning the sales process for both maintenance agreements and new equipment sales. One participant described having technicians educate customers as the best sales approach; similarly one nonparticipant mentioned providing real-world examples and understanding the customers' needs. While contractors described technicians' involvement in sales, they stated that the person ultimately responsible for sales was typically either the president/owner or a dedicated sales manager.

Only two contractors reported providing sales training to technicians. However, just over half of respondents (12 of 23) described being interested in sales training opportunities for their technicians. When asked about the best way to train technicians to sell maintenance agreements or new equipment to customers, contractors offered a variety of responses. Among nonparticipants, one stated that formal sales training is best, one mentioned learning by doing, and two stated that understanding the equipment is the best knowledge to drive sales.

5.5 Training Needs

Both participating and nonparticipating contractors provided details on the types of training that would be beneficial for their technicians. Of the 23 contractors that answered this question, 10 stated that technical training would be beneficial to technicians. Specific technical training topics mentioned by contractors are listed below. Nonparticipants mentioned all of the listed topics, while participants mentioned only three of the topics: airflow measurement, refrigerant charge verification, and electrical training.

- Airflow measurement (n = 3)
- Refrigerant charge verification (n = 2)
- Electrical training (n = 2)
- Test instrument selection
- Controls usage
- Gas fundamentals
- Use of digital gauges and instruments that need recalibration
- Performing proper calculations

In addition to technical training, contractors also offered a variety of other beneficial training topics. About a third of contractors (7 out of 23) described customer service training as potentially beneficial. In addition, one participating contractor described sales training as a need, another participating contractor expressed a desire for more training with the Quality Maintenance program, and one non-participating contractor described a need for more hands-on training opportunities.

Only nonparticipating contractors (3 out of 15) mentioned a desire for training on HVAC fundamentals, with none of the participating contractors describing fundamentals as a training need. Finally, only three respondents said their technicians did not need any training.

5.6 Business Models

Participating contractors also provided examples of business models or approaches that have helped them to successfully implement the QI/QM program. The most frequently described business model was one that focused on service. Specifically, three participating contractors said customer service led to their success in the program and two attributed their success to establishing trust with customers by performing high-quality work. This aligns with the implementer interview respondents, who reported that contractors who are successful at implementing QI/QM are those who have a strong investment in customer service and customer satisfaction. Other responses (each given by one respondent) included: competitive pricing; effective marketing; and efficient staffing practices, which allowed the respondent to devote more time to program jobs.

Almost none of the participating contractors described passing the administrative and scheduling costs of participating in the program on to customers, although only six participating contractors responded to this question. Only one respondent reported passing along 25 to 30% of costs incurred by participating in the program. The remaining five respondents stated that they did not pass along the cost of participating.

5.7 Benefits of Program Participation

Although the participating contractors were not always familiar with the ACCA/ASHRAE standards, they reported that their businesses were affected in other ways by participating in the QI/QM program. Generally, the participating contractors described the advantages and positive impact of the program as outweighing the disadvantages of the program. Specifically, four participating contractors reported that their technicians are better trained as a result of program participation, with one of these stating that the program has “made us a better company.”

Many of the contractors also described positive changes in their relationships with customers as a benefit of participating in the QI/QM program. All six participating contractors who were asked about how the program benefits customers reported that customers receive better service, including more thorough work and preventive maintenance at an accessible price. Meanwhile, when asked about what advantages their business experienced from participating in the program, three reported added value to customers and two said the program helps them educate customers about the importance of preventative maintenance. Three respondents stated that the program sets contractors apart from their competition, and two stated that the program helps bring in extra revenue.

However, not all of the participating contractors described program participation as positively impacting their business. Three contractors described the biggest disadvantage of participating in the program as the administrative costs of processing program paperwork, while others described the extra time involved on jobs (n = 2), or said the rebates are too small to make the work involved in the program worthwhile (n = 1). Three of the eleven participating contractors said there were no major disadvantages.

5.8 Key Takeaways from Contractor Interviews

- **Participating contractors did not always report basing their work on the ACCA/ASHRAE standards.** Three participating contractors reported basing their work on municipal codes or manufacturers' standards. Contrary to expectations, participating contractors did not reference “ACCA/ASHRAE standards” more frequently than nonparticipating contractors in describing how they go about their work.
- **ACCA/ASHRAE standards are communicated with varying degrees of standardization and formality.** While some contractors described a standardized process of communicating standards, via weekly meetings or job checklists, a number only employ informal on-the-job training to communicate tasks included in standards to technicians. None of the participating or nonparticipating contractors used the terms “ACCA” or “ASHRAE” in communicating their standards.
- **Most of the contractors described either a combination of in-field and classroom training, or only in-field training as the most effective way of training technicians.** Nearly all of the respondents described in-field training as a necessity for technicians to successfully conduct their jobs.
- **Participants generally described program participation as having a positive overall effect on their business.** Most of the participating contractors reported that the program has had a positive impact on their business, especially with regard to customer service, providing value to customers, and improved technician training.

6. TECHNICIAN SURVEY RESULTS

As part of this study, EMI Consulting conducted surveys with 218 HVAC technicians to better understand HVAC technician practices, knowledge, and beliefs. As described in the Methodology chapter, we targeted quotas for technicians performing work in each of the residential, small commercial, and large commercial sectors. For questions that were sector-specific, we report results for the three sector-specific survey modules separately.

Results of the surveys are presented for each of the following topics:

- Respondent Characteristics
- Training and Certifications
- Technician Field Experiences
- Awareness and Use of Standards
- Communication of Standards
- Sales and Sales Training

6.1 Respondent Characteristics

In this section, we present information on respondent characteristics, including data on firm size, number of years of experience in the HVAC industry, the type of work (installation, maintenance, or service) performed by technicians in each sector, and a breakdown of respondents by IOU service territory.

Firm Size

As shown in Table 6-1, most respondents reported working for relatively small firms, with just over half of respondents (55%) reporting four or fewer employees in their firm. Overall, 77% of respondents had nine or fewer employees. Only 2% of respondents reported firm sizes greater than 100 employees.[22]

[22] This distribution was generally parallel to the size distribution of firms sampled in the Phase I study, of which 66% had one to four employees, 16% had five to nine employees, and 18% had ten or more employees.

Table 6-1: Number of Employees in Respondents' Firms

Number of Employees in Firm	Respondents in Each Size Category	
	n	Percent
1 to 4	120	55%
5 to 9	48	22%
10 to 24	35	16%
25 to 49	7	3%
50 to 99	3	1%
100 or more	5	2%
TOTAL	**218**	**100%**

Note. This question was unprompted. Responses were recorded as actual numerical values and then binned for ease of comparison to the Phase I study. Numbers do not sum to 100% due to rounding error.

Table 6-2 shows that across all sectors, the average firm size reported by respondents was fairly small, with a mean of 9.2 employees, although there was substantial variation between firms. We note here that throughout this report, we refer to technicians' assigned sectors as "survey modules." While the number of employees in a firm was very similar for technicians assigned to the residential and small commercial survey modules (the median number of employees for both sectors was three), technicians assigned to the large commercial survey module reported a slightly larger firm size (median = seven employees). There was also greater variability in the firm size of technicians assigned to the large commercial module. Overall, the smallest firm had a single employee and the largest firm had 125 employees.

The research team also asked respondents about the number of *technicians* in their firm (as opposed to the number of *employees*). Overall, the number of technicians closely paralleled the number of employees.[23] Across the three assigned survey modules, the ratio of technicians to employees was 0.48; that is, roughly half of the employees are technicians. This ratio was consistent across the different modules (residential = 0.47, small commercial = 0.50, large commercial = 0.48). Summary values for the number of technicians at each firm are also provided in Table 6-2.

Table 6-2: Statistical Summary of Firm Size by Assigned Survey Module

Survey Module	Number of Employees Mean (*SD*)	Number of Employees Median	Number of Employees Minimum	Number of Employees Maximum	Number of Technicians Mean (*SD*)
Residential (n = 72)	5.0 (6.5)	3	1	40	2.3 (1.7)
Small Commercial (n = 71)	5.2 (8.2)	3	1	60	2.6 (2.3)
Large Commercial (n = 75)	17.0 (27.4)	7	1	125	8.2 (14.0)
Overall	**9.2 (17.9)**	**4**	**1**	**125**	**4.4 (8.7)**

Note. Number of employees was unprompted. Survey module (sector) assignment was based on the percent of work performed in each sector (residential, small commercial, or large commercial), as described in the Methodology chapter.

[23] Number of employees and number of technicians showed a statistically significant Pearson correlation, $r = 0.80$, $p < .01$ (two-tailed).

The Importance of Firm Size

The research team considered the size of the firm (in terms of number of employees) to be a potentially important influence on how technicians responded to the survey questions. To account for potential differences related to firm size, we conducted analyses of all survey questions by size, except in cases where only a small subsample of respondents answered the question. To accomplish this task, we first binned technicians into three size groups based on the total number of employees at their firm: (1) one to four employees, (2) five to nine employees, and (3) ten or more employees. The reason for collapsing respondents with 10 or more employees into one bin was to maximize power for finding size differences where they exist. We then consistently compared responses for all questions by size. When significant, we report differences in survey responses by firm size using these bins.

Years of Experience

Survey respondents displayed a wide range of experience levels (overall mean = 22.6 years, *SD* = 11.4 years), although few differences were observed between sectors, as shown in Table 6-3. The minimum number of years of experience was one year; the maximum number of years of experience was 45.

Table 6-3: Statistical Summary of Technicians' Years of HVAC Experience by Assigned Survey Module

Survey Module	Years of Experience Mean (*SD*)	Years of Experience Median	Years of Experience Minimum	Years of Experience Maximum
Residential (n = 71)	22.3 (11.8)	21	3	40
Small Commercial (n = 70)	22.6 (10.0)	20	3	44
Large Commercial (n = 75)	23.1 (12.3)	24	1	45
Overall	**22.6 (11.4)**	**22**	**1**	**45**

Note. This question was unprompted. One residential technician and one small commercial technician did not provide answers to this question. Survey module (sector) assignment was based on the percent of work performed in each category (residential, small commercial, or large commercial).

The distribution of years of experience was generally similar across all three survey (sector) modules, with "20 to 29 years of experience" as the most popular bin for all sectors. Parsing out these results by firm size showed that technicians from larger firms (10 or more employees) had significantly fewer years of experience (mean = 16 years) than technicians from firms with one to four employees (mean = 25 years) or firms with five to nine employees (mean = 22 years).[24] The negative correlation between firm size and years of experience was small but statistically significant.[25]

Work Performed by Sector

Most technicians who responded to the survey reported performing HVAC work in multiple sectors. As shown in Table 6-4, substantial percentages of technicians reported performing work

[24] Significant using a two-proportions z-test, $p < .05$.
[25] The Pearson correlation coefficient between firm size and years of experience was small ($r = -0.15$) but significant, $p < .05$.

in the residential and small commercial sectors (over 90% of technicians did at least some work in one of these two sectors). Fewer technicians (49%) reported performing work in the large commercial sector. As the residential and small commercial markets are similar in terms of the types of HVAC equipment typically employed, it is easy to see how technicians may do work for both residential and small commercial clients. On the other hand, large commercial systems are typically more complex and may require more specialized skill sets.

Table 6-4: Number and Percentage of Technicians Performing Work by Sector

Sector	n	Percent of Total (n = 218)
Residential	198	91%
Small Commercial	204	94%
Large Commercial	106	49%

As shown in Table 6-5, a majority of technicians reported performing service, maintenance, and installation work, with 100% of technicians indicating they performed at least some service work. Across the three assigned survey modules, roughly equal percentages of technicians performed maintenance work (91%) and installation work (90%). Technicians assigned to the large commercial survey module were statistically more likely to perform maintenance work than were technicians in either the residential or small commercial survey modules. There were no significant differences in the percent of technicians performing service or installation work across survey modules.

We also compared these values to the Phase I study and found that the values were generally similar between both studies. However, the percentage of technicians who reported performing service work and maintenance work was somewhat higher than the percentage of contractors who reported this in Phase I, at 95% and 84%, respectively.[26] The percentage of contractors who reported performing installation work in Phase I was nearly identical, at 91%.

Table 6-5: Type of Work Performed by Technicians by Assigned Survey Module

Survey Module	n	Percent who Provide Service	Percent who Provide Maintenance [a]	Percent who Provide Installation [b]
Residential	72	100%	89%	94%
Small Commercial	71	100%	87%	90%
Large Commercial	75	100%	97%	87%
Total	**218**	**100%**	**91%**	**90%**

Note. Survey module (sector) assignment was based on the percent of work performed in each sector (residential, small commercial, or large commercial) using question S4.
[a] Utilizing two proportion z-tests, technicians assigned to the large commercial survey module were statistically more likely to perform maintenance than technicians assigned to the residential or small commercial survey modules ($p < .05$ for each test). There were no significant differences between the residential and small commercial sectors.

[26] *California HVAC Contractor & Technician Behavior Study, Final Report,* p 16. Statistically significant using a two-proportions z-test, $p < .05$.

[b] There were no statistically significant differences found between the proportions of technicians performing installation by assigned survey module.

Service Territories

Just over half (55%) of technicians reported they only perform work in a single service territory, though a third (33%) of respondents reported performing work in two service territories and 12% reported performing work in three or more service territories.[27] Table 6-6 shows that SCE was the most common service territory in which technicians reported doing work (50% of technicians). Smaller proportions of technicians indicated they work in PG&E's service territory (39% of technicians), SCG's service territory (30%), or SDG&E's service territory (14%). It is important to note that these numbers were impacted by the sample stratification design, which assigned firms to IOU service territory by the firm's listed zip code. Hence the distribution shown in Table 6-6 parallels the relative sizes of the IOU service territories, with some minor deviations resulting from the technicians who work in more than one service territory.

Table 6-6: Electric and Gas Utility Service Territories in Which Technicians Performed Work

Service Territory	n	Percent of respondents (n = 216)
Southern California Edison (SCE)	108	50%
Pacific Gas and Electric Company (PG&E)	84	39%
Southern California Gas (SoCalGas or SCG)	64	30%
San Diego Gas and Electric (SDG&E)	31	14%
Los Angeles Department of Water & Power (LADWP)	31	14%
Sacramento Municipal Utility District (SMUD)	11	5%
Southwest Gas	3	1%
Modesto	2	1%
Other	11	5%

Note. Multiple responses were allowed for this question. Two respondents did not provide specific information on the service territories they worked within, though they did confirm that they performed work in at least one of the IOU service territories.

6.2 Training and Certifications

This subsection summarizes responses from technicians about the *types* of HVAC-related training they had received and about the *effectiveness* of those training types. We also asked technicians about the types of certifications they hold, as well as any topics about which they would like to receive additional training.

[27] These percentages were based on n = 216, because two technicians did not specify the number of territories in which they worked.

Types of Training Received

"On-the-job training" was overwhelmingly the most common type of training technicians had received, mentioned by 97% of all technicians. As shown in Table 6-7 below, this type of training was reported with similar frequency by technicians assigned to different survey modules. "Distributor training," training offered by distributors on the equipment they sell, was the second most popular type of training overall (70% of technicians), but was reported with a significantly higher frequency by technicians assigned to the small commercial module (83%) compared to technicians assigned to the residential module (60%).[28] It was also significantly more likely for "technical or trade school" (the third most popular training category overall) to be mentioned by technicians assigned to the small commercial module than by those assigned to the residential module. It was somewhat surprising that 47% of respondents reported receiving utility training; it is unclear if this training included technical skills, utility program logistics, or sales training. Additional comparisons by survey module showed that technicians assigned to the large commercial survey module were significantly more likely to mention participating in "private training institute" training, "online HVAC course training," and "union apprenticeship training" than were technicians assigned to the residential survey module. For "union apprenticeship training," this difference was also significant between large commercial technicians and small commercial technicians.

In addition the prompted categories, technicians mentioned other training categories, including non-union apprenticeship, reading books, and NATE training. Two technicians referenced "employee-provided training," which we interpreted to be more formal training compared to "on-the-job training." Given the small number of responses between these unprompted categories, the research team did not test for statistical differences by survey module.

There were minimal differences in responses to this question between technicians working at different sized firms. Technicians from medium-sized firms with five to nine employees were significantly more likely than smaller firms (one to four employees) to mention "technical or trade school" training and "private training institute" training. Technicians from small firms were significantly less likely to mention attending "utility training" than were technicians from large firms (ten or more employees).[29]

Although one of the market actor interviewees estimated that more than 50% of the workforce enters the industry without any formal education, this does not appear to be the case among the technicians who completed this survey, as 90% of respondents (n = 196) reported receiving some type of formal training (including technical or trade school, community college, IHACI (Institute of Heating & Air Conditioning Industries), private training institute, union training, or NATE). It is possible that technicians who work for firms not contained in the CSLB list (i.e., unlicensed firms) are those who are likely to not have formal training.

[28] Statistically significant using a two-proportions z-test, $p < .05$.
[29] Statistically significant using a two-proportions z-test, $p < .05$.

Table 6-7: Types of Training Received by Technicians

Training Type	Residential (n = 72)	Small Commercial (n = 71)	Large Commercial (n = 75)	Total (n = 218)
Prompted Categories				
On the job training	96%	99%	96%	97%
Distributor training	60%	83% [a]	68%	70%
Technical or trade school training	56%	76% [a]	69%	67%
Manufacturer training	58%	69%	69%	66%
Utility training	47%	46%	47%	47%
Community college training	39%	37%	48%	41%
IHACI training	31%	32%	37%	33%
Private training institute training	21%	34%	44% [b]	33%
Online HVAC course training	18%	30%	35% [b]	28%
Union apprenticeship training	13%	15%	32% [c]	20%
Unprompted Categories				
Non-Union Apprenticeship	0%	3%	1%	1%
Read Books	3%	1%	0%	1%
Military	1%	1%	1%	1%
NATE [f]	1%	1%	1%	1%
HERS Training	1%	1%	0%	1%
Employer-Provided Training	1%	0%	1%	1%
You Tube / Blogs / On-Line HVAC Forums	0%	3%	0%	1%
Correspondence Courses	1%	0%	1%	1%
Other	6%	3%	0%	3%

Note. This question included a number of prompted categories and open-end response questions that were later coded into categories. Except where noted with superscripts, differences in prompted categories were not statistically significant. Unprompted categories were not tested due to the low number of responses.
[a] Statistically significant differences between small commercial and residential technicians using a z-test, $p < .05$.
[b] Statistically significant differences between large commercial and residential technicians using a z-test, $p < .05$.
[c] Statistically significant differences between large commercial and small commercial/residential technicians using a z-test, $p < .05$.
[f] While NATE does not provide training, more than one person provided this as an unprompted response.

Effectiveness of Training Received

For each type of training, we asked those who had received the training to report how effective the training was in teaching them the skills need to perform work with residential, small commercial, or large commercial customers (depending on the survey module assignment).[30] "On-the-job training," the most frequently cited type of training received by technicians, was also deemed to be the most effective training type, as shown in Table 6-8. In general, however, the most common types of training were not necessarily perceived as being the most effective. While

[30] The training types considered to be the most effective by technicians are not necessarily those that teach or emphasize Quality Installation or Quality Maintenance practices.

private training institute[31] (8th most cited) and Institute of Heating & Air Conditioning Industries[32] (IHACI, 7th most cited) were among the least common types of training received, they rank as the second and third most effective types of training (as judged by the percentage of technicians rating each as "very effective" or "effective"). Similarly, while union apprenticeship training was reported as the training least frequently received by technicians, more than half of the technicians (52%) who had received that training rated it as "very effective."[33] And although many respondents received distributor training (70% overall), it was not ranked among the most effective types of trainings, with only 42% of respondents ranking it as "very effective." The research team did not find any statistically significant differences in the ratings of these training types between technicians from different size firms.

Table 6-8: Perceived Effectiveness of Training Categories in Which Technicians Participated

Training Type (all sectors, n = 218)	Very Effective	Effective	Somewhat Effective	Not at all Effective
On the job training (n = 211)	90%	9%	1%	< 1%
Private training institute training (n = 72)	58%	31%	11%	-
IHACI training (n = 73)	58%	26%	14%	3%
Manufacturer training (n = 143)	55%	32%	10%	2%
Union apprenticeship training (n = 44)	52%	25%	20%	2%
Technical or trade school training (n = 146)	49%	26%	24%	1%
Utility training (n = 102)	48%	35%	13%	4%
Distributor training (n = 153)	42%	37%	18%	3%
Community college training (n = 90)	42%	22%	32%	3%
Online HVAC course training (n = 60)	25%	38%	32%	5%

Note. This question included a number of prompted categories and open-ended (unprompted) questions that were later coded into categories. We have included only the prompted questions in this table due to the low number of unprompted responses.

To better understand how technicians working with different types of customers viewed the effectiveness of these different training types, we looked at the percentage of technicians rating each training type as either "effective" or "very effective" by assigned survey module. Table 6-9 presents these results for the prompted training categories included in this question. There were no statistical differences across the three survey modules for this question.

[31] "Private training institute" training was not strictly defined and may include a variety of training topics.
[32] IHACI is a trade association that offers training on a variety of HVAC topics, including Quality Installation and Quality Maintenance. See http://www.ihaci.org/
[33] The low rate of union apprenticeship training is expected, as technicians are required to be union members to receive this training. In the Phase I study, only 8% on contractors indicated that employees at their company were members of a union. See *California HVAC Contractor & Technician Behavior Study, Final Report,* p 22.

Table 6-9: Technician Ratings of Training Effectiveness (Effective or Very Effective) by Assigned Survey Module

Training Type	Residential		Small Commercial		Large Commercial		Total	
	%	n	%	n	%	n	%	n
On the job training	99%	69	97%	70	100%	72	**99%**	**211**
Private training institute training	87%	15	79%	24	97%	33	**89%**	**72**
Manufacturer training	86%	42	82%	49	94%	52	**87%**	**143**
IHACI training	77%	22	96%	23	79%	28	**84%**	**73**
Utility training	85%	34	91%	33	74%	35	**83%**	**102**
Distributor training	79%	43	69%	59	88%	51	**78%**	**153**
Union apprenticeship training	100%	9	64%	11	75%	24	**77%**	**44**
Technical or trade school training	73%	40	76%	54	77%	52	**75%**	**146**
Community college training	64%	28	65%	26	64%	36	**64%**	**90**
Online HVAC course training	69%	13	57%	21	65%	26	**63%**	**60**

Note. This question presents prompted categories only. Several additional open-ended (unprompted) categories were not included in this table due to low number of responses. Group differences were not significant for any of these categories. The n-values shown indicate the number of respondents who indicated they had received that training type, while the percentages indicate the percent who indicated the training was either "effective" or "very effective."

Certifications and Licenses Held by Technicians

Technicians reported holding a wide variety of HVAC-related certifications and licenses. The most commonly reported certifications were the EPA refrigerant license, mentioned by 60% of respondents, and the C-20 license, mentioned by 58% of respondents, as shown in Table 6-10 below. By posing this question without prompted categories, we were able to learn which licenses and certifications technicians would mention *unaided*. However, it is possible that some types of licenses or certifications (for example, the EPA refrigerant license) were underreported because technicians assumed that they did not need to report any such licenses or certifications that are required by law. Only a very small proportion (2%) of technicians reported not possessing any licenses or certifications.

Notably, six of the top ten most frequently mentioned licenses and certifications were either federal or state licenses. This same list included only three types of industry certifications. This includied NATE certifications (15% of respondents), which contractor interviewees reported to be very valuable when hiring technicians. This also included manufacturer-specific certifications (6% of respondents), and RSES (Refrigeration Service Engineers' Society) certifications (3% of respondents). An additional 4% of technicians mentioned an academic degree in response to this question.

The research team tested for group differences in the frequency of certain certifications or licenses held by firms of three sizes: one to four employees, five to nine employees, and ten or more employees. Two important findings emerged from this analysis. First, we found that technicians from firms with ten or more employees were statistically less likely to hold a C-20 license. This may not be surprising, as only one person in a typical firm is required to hold a C-20 license – thus the percentage of technicians holding C-20 licenses likely decreases as firm size increases. Second, we found that technicians from firms with only one to four employees were statistically less likely to hold NATE certification than were technicians from firms with five to nine

or 10 or more employees. We found no other statistically significant differences in the frequency of licenses and certifications held by firms of different sizes.

Table 6-10: Certifications and Licenses Held by Technicians

Certification/License	n	Percent of Respondents (n = 215)
EPA refrigerant license	129	60%
C-20	125	58% [a]
NATE (North American Technician Excellence)	33	15% [b]
Contractor's License/General B/State License	20	9%
C-38 / Refrigeration Contractor License	16	7%
Manufacturer-specific Certification	13	6%
C-36 / Plumbing Contractor License	10	5%
Academic Degree	9	4%
RSES (Refrigeration Service Engineers' Society)	7	3%
C-10 / Electrical Contractor License	6	3%
NCI (National Comfort Institute)	6	3%
R410A	5	2%
HERS Certification	5	2%
HVAC Excellence	5	2%
IOU-associated Certification	4	2%
C-43 / Sheet Metal Contractor License	4	2%
Asbestos Abatement	4	2%
Air Balancing	3	1%
BPI (Buildings Performance Institute)	3	1%
CEC/Title 24	2	1%
ESCO Institute	2	1%
HERO (Home Energy Renovation Opportunity)	2	1%
OSHA-associated Certification	2	1%
Certified Journeyman	1	< 1%
Other	4	2%
I do not hold any certifications or licenses	8	4%

Note. These categories were unprompted. Multiple responses were accepted. Three web respondents did not respond to this question and were not counted in the total.
[a] Firms with one to four employees were significantly more likely to hold a C-20 license than were firms with either five to nine or ten or more employees. Group differences were tested using a two proportions z-test, $p < .05$.
[b] Firms with ten or more employees were significantly more likely to hold NATE certification than were firms with either one to four or five to nine employees. Group differences were tested using a two proportions z-test, $p < .05$.

The majority of technicians mentioned holding either one or two licenses/certifications (32% and 35%, respectively), as shown in Table 6-11. Smaller proportions of technicians reported holding three licenses/certifications (17%) or four licenses/certifications (8%). Overall, very few technicians (less than 3%) reported holding five or more certifications.

Table 6-11: Number of Certifications Held

Number of Certifications	n	Percent (n = 215)
0	9	4%
1	69	32%
2	76	35%
3	37	17%
4	17	8%
5	2	1%
6	2	1%
9	1	< 1%
10	1	< 1%
13	1	< 1%

Note. Three respondents to the online survey skipped this question.

Additional Training Topics

To better understand where targeted training efforts may be most impactful, the research team asked technicians about the specific topics for which they wish they had additional training. This question was posed without any prompted categories. Table 6-12 shows the coded responses to this question. Technicians appeared most interested in learning about new technologies in general (mentioned by 11% of technicians) or learning about specific technologies such as chillers (11% of technicians), controls (8% of technicians), and heat pumps (8% technicians). "Airflow" was also mentioned by 8% of technicians; this was the most common topic mentioned in the contractor interviews. Technicians appeared less interested in learning about "energy consumption/efficiency" (mentioned by 2% of respondents) or "soft skills" such as how to interact with customers (also mentioned by only 1% of respondents). Notably, nearly one-third (32%) of the technicians responding to this question indicated there were *no topics* for which they wanted any additional training.

Technicians from firms with one to four employees were significantly less likely than technicians from firms with five to nine employees to indicate "airflow" as a desired training topic. Other group differences by size were not significant.

Table 6-12: Topics for Which Technicians Wish They Had Additional Training

Topic	Number of Respondents	Percent of Respondents (n = 209)
Staying up to Date / Learning About New Technologies	24	11%
Chillers	22	11%
Controls	17	8%
Heat Pumps	17	8%
Airflow	16	8%
Electrical/wiring	12	6%
Boilers	9	4%
Refrigeration	9	4%
Fundamentals/Basics of HVAC systems	7	3%
Refrigerant charge verification	7	3%
Hydronics	6	3%
Solar HVAC	6	3%
Energy Consumption / Efficiency	5	2%
Large Commercial/Industrial Applications	5	2%
Diagnosis and Troubleshooting	4	2%
Installation protocols	4	2%
Performing proper calculations	4	2%
Economizers	3	1%
Codes and Standards	2	1%
Customer service / how to interact with customers	2	1%
Ductwork	2	1%
Energy Management	2	1%
Maintenance protocols	2	1%
NATE	2	1%
Selecting the right test instrument	1	< 1%
How to use test instruments	1	< 1%
How to calibrate test instruments	1	< 1%
Other	6	2%
None / don't want additional training	67	32%

Note. This question was unprompted.

To better understand the response by some technicians stating that they did not want additional training, we binned the answers according by the years of experience reported by each technician. As shown in Table 6-13, there appears to be a direct relationship between years of experience and the notion that one does not want any additional training. Forty-two percent of technicians with 40 or more years of experience reported there were no topics for which they wanted additional training; for technicians with less than 10 years of experience, this value was only 12%.

Table 6-13: Percent of Technicians Reporting No Training Desired, by Experience Level

Years of HVAC Experience (binned)	Percent (n = 209)
0 to 9	12%
10 to 19	33%
20 to 29	29%
30 to 39	38%
40 to 49	42%

We also analyzed the responses to this question to understand the *number* of topics in which technicians were interested. Among all respondents, half the technicians surveyed (50%) mentioned only one training topic, while 13% of technicians mentioned two topics. Among only those technicians who mentioned they could use some type of additional training, 73% mentioned a single topic, while 20% mentioned two topics. However, the number of topics is not necessarily meaningful, as respondents were not prompted to provide additional topics (i.e., they were free to provide as many topics as they wished but were not specifically asked to provide as many as possible).

Table 6-14: Number of Additional Training Topics Mentioned by Technicians

Number of Topics Mentioned	n	Percent (n = 209)	Percent of Technicians Mentioning at Least One Topic (n = 142)
0	67	32%	n/a
1	104	50%	73%
2	28	13%	20%
3	7	3%	5%
4	2	1%	1%
10	1	< 1%	< 1%

6.3 Technician Field Experiences

In this section, we report the results of a number of questions examining technician field experiences, including the frequency with which they report performing specific tasks during installation and maintenance jobs, their top priorities in the field, and barriers to making a repair.

Specific Tasks Performed During Installation Jobs

We asked technicians who conduct installations to report which of a list of tasks they complete during a typical installation job. As shown in Table 6-15, a majority of technicians reported completing each of the tasks listed. In fact, out of the 27 tasks included in this question, 20 tasks were reportedly performed on a typical installation job by at least 80% of technicians. The proportion of respondents indicating they performed each task ranged from 99% of respondents ("confirm proper levels of refrigerant and airflow") down to 63% of respondents ("inspect all accessible ductwork for moisture or biological growth"). While most tasks were reported by a similar proportion of technicians across the assigned survey module groups, there were several significant differences:

- Technicians were significantly more likely to report showing residential and small commercial customers how to replace air filters, rather than large commercial

customers.[34] This is not surprising given the added complexity of many large commercial systems.

- Technicians were significantly more likely to report inspecting economizers with large commercial customers, rather than small commercial customers.[35] However, this is likely because some small commercial systems may not have economizers (i.e., because they are similar to residential-type systems).
- Technicians were significantly more likely to report inspecting blower motors with large commercial customers, rather than with residential customers.[36]

There were two additional statistically significant differences between technicians from different size firms:

- Technicians from small firms (one to four employees) were more likely than technicians from larger firms (ten or more employees) to report showing the customer how to replace their air filters.[37]
- Technicians from medium-sized firms (five to nine employees) were more likely than technicians from small firms (one to four employees) to report inspecting "all accessible ductwork, including duct strapping, hangers, sections, joints, and seams."[38]

[34] Statistically significant using a two-proportions z-test, $p < .05$.
[35] Statistically significant using a two-proportions z-test, $p < .05$.
[36] Statistically significant using a two-proportions z-test, $p < .05$.
[37] Statistically significant using a two-proportions z-test, $p < .05$.
[38] Statistically significant using a two-proportions z-test, $p < .05$.

Table 6-15: Percent of Technicians Performing Specific Installation Tasks

Task	Residential (n = 68)	Small Commercial (n = 64)	Large Commercial (n = 65)	TOTAL (n = 197)
Confirm proper levels of refrigerant and airflow	100%	100%	98%	**99%**
Make repairs to existing ductwork if necessary	97%	97%	98%	**97%**
Install programmable thermostat, if not already in use	96%	98%	95%	**96%**
Setup programmable thermostat with customer, if not already in use	96%	97%	97%	**96%**
Install a matched indoor coil and outdoor unit, for AC & heat pump only	97%	97%	92%	**95%**
First seal all duct seams (if insulating ducts)	94%	95%	95%	**95%**
Test system controls' modes of operation and control sequences	88%	92%	98%	**93%**
Leave all manuals with customer	97%	91%	88%	**92%**
Inspect air filter housing integrity and air seal	91%	92%	91%	**91%**
Inspect integrity of all accessible ductwork including: duct strapping, hangers, sections, joints, and seams	93%	89%	88%	**90%**
Measure refrigerant charge	90%	86%	94%	**90%**
Inspect condensate drains and traps	87%	92%	91%	**90%**
Inspect integrity of all accessible ductwork insulation	90%	89%	89%	**89%**
Show customer how to replace air filters	100% [a]	94% [a]	71%	**88%**
Inspect all electrical components	79%	89%	91%	**86%**
Inspect economizers	-	78%	91% [b]	**84%**
Inspect accessible refrigerant lines, joints, and coils for oil leaks	84%	84%	85%	**84%**
Inspect cabinet, fasteners, and panels for seals and leaks	76%	83%	89%	**83%**
Consider zoning, with separate temperature controls for different areas	76%	80%	89%	**82%**
Inspect blower motors	71%	83%	91% [c]	**81%**
Test to confirm that duct leakage does not exceed recommended levels	79%	80%	66%	**75%**
Measure airflow across heat exchanger/coil	71%	69%	83%	**74%**
Calculate sizing for equipment using Manual J [d]	72%	-	-	**72%**
Test ductwork to determine maximum system size	69%	67%	77%	**71%**
Install new refrigerant lines, rather than reusing existing lines	66%	66%	66%	**66%**
Provide customer with documentation of installation procedures, including Manual J calculations, AHRI certificate, and records of any measurements or testing	63%	61%	74%	**66%**
Inspect all accessible ductwork for moisture or biological growth	54%	66%	69%	**63%**

Note. The list of tasks shown in this table is the same list used for the Phase I study. The list was based on ACCA Standard 5, but narrowed down based on comments from IOU and CPUC staff with technical HVAC knowledge. This question was only asked of technicians who perform maintenance. All categories were prompted. One large commercial customer answered "Don't know."

[a] Statistically significant using a two-proportions z-test, $p < .05$.

[b] Statistically significant using a two-proportions z-test, $p < .05$.

[c] Statistically significant using a two-proportions z-test, $p < .05$.

[d] This question was also inadvertently asked for respondents in the small and large commercial modules, but we have not included responses in this table. Manual J is meant specifically for residential systems.

Specific Tasks Performed During Maintenance Jobs

Table 6-16 shows the percentage of technicians who indicated performing each of the listed maintenance tasks on a typical maintenance visit. As with installation, a majority of technicians reported completing each of the maintenance tasks listed. Again, rates of performing each task were generally high, ranging from 100% of technicians ("inspect filters and clean/replace as needed") down to 67% of technicians ("measure airflow across heat exchanger/coil"). Among the 18 tasks included in this question, only three tasks were reportedly performed by fewer than 80% of technicians on a typical maintenance job: inspecting integrity of all accessible ductwork, inspecting all accessible ductwork for moisture or biological growth, and measuring airflow. Reported frequencies of task performance were generally similar across the three assigned survey module groups; however, there were several significant group differences:

- Technicians were significantly more likely to report inspecting, cleaning, and adjusting the evaporator coil with small commercial and large commercial customers than with residential customers.[39]
- Technicians were significantly more likely to report inspecting the blower motor with large commercial customers than with residential customers.[40]
- Technicians were significantly more likely to report inspecting integrity of all accessible ductwork, including duct strapping, hangers, sections, joints, and seams with residential customers than with either small or large commercial customers. The higher rate of inspecting accessible ductwork's integrity among residential technicians may be due to the inaccessibility of ductwork in commercial systems, which are typically larger and more complex than residential systems.[41]

There were no statistically significant differences in the responses to this question between technicians of different size firms.

[39] Statistically significant using a two-proportions z-test, $p < .05$.
[40] Statistically significant using a two-proportions z-test, $p < .05$.
[41] Statistically significant using a two-proportions z-test, $p < .05$.

Table 6-16: Percent of Technicians Performing Specific Maintenance Tasks

Task	Residential (n = 64)	Small Commercial (n = 62)	Large Commercial (n = 73)	TOTAL (n = 199)
Inspect filters and clean/replace as needed	100%	100%	100%	**100%**
Inspect condensing coil and clean/adjust as needed	98%	98%	99%	**98%**
Inspect all electrical components during a typical visit	97%	98%	96%	**97%**
Test system controls' modes of operation and control sequences	97%	94%	99%	**96%**
Inspect evaporator coil and clean/adjust as needed	86%	100% [a]	100% [a]	**95%**
Inspect blower motors	91%	97%	99% [b]	**95%**
Inspect condensate drains and traps	92%	98%	96%	**95%**
Visually inspect heat exchanger for signs of corrosion, dirt, or structural problems	94%	95%	96%	**95%**
Inspect economizers	-	92%	97%	**95%**
Inspect accessible refrigerant lines, joints, and coils for oil leaks	98%	92%	89%	**93%**
Inspect air filter housing integrity and air seal	91%	90%	92%	**91%**
Inspect cabinet, fasteners, and panels for seals and leaks	89%	87%	88%	**88%**
Inspect grilles, registers and diffusers for dirt	91%	81%	90%	**87%**
Measure refrigerant charge	91%	90%	82%	**87%**
Inspect integrity of all accessible ductwork insulation	84%	84%	78%	**82%**
Inspect integrity of all accessible ductwork including: duct strapping, hangers, sections, joints, and seams	88% [c]	74%	62%	**74%**
Inspect all accessible ductwork for moisture or biological growth	70%	73%	74%	**72%**
Measure airflow across heat exchanger/coil	70%	63%	68%	**67%**

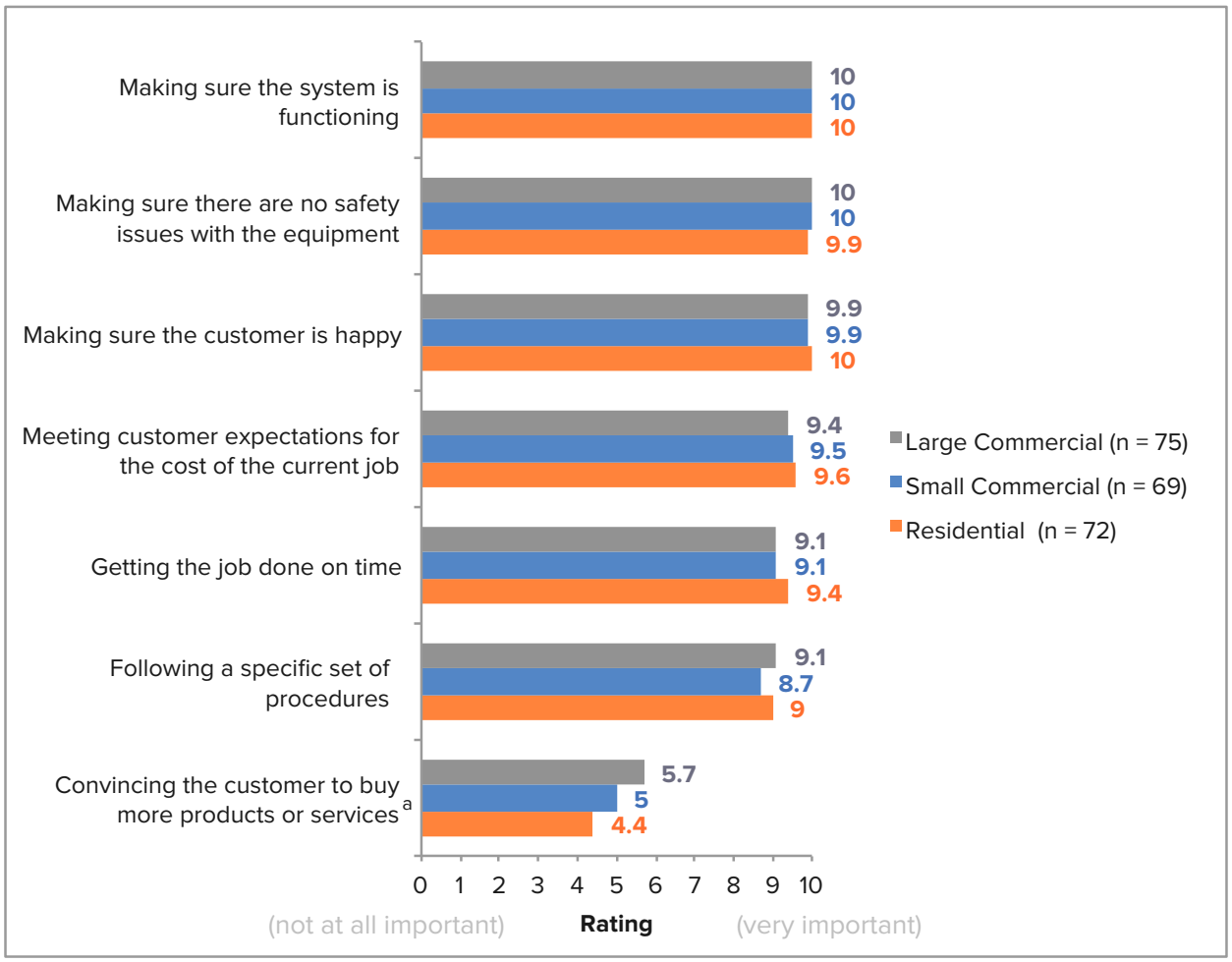
Note. The list of tasks shown in this table is the same list used for the Phase I study. The list was based on ACCA Standard 4 and ACCA/ASHRAE Standard 180, but narrowed down based on comments from IOU and CPUC staff with technical HVAC knowledge. This question was only asked of technicians who perform maintenance. All categories were prompted.
[a] Statistically significant using a two-proportions z-test, $p < .05$.
[b] Statistically significant using a two-proportions z-test, $p < .05$.
[c] Statistically significant using a two-proportions z-test, $p < .05$.

Technicians' Top Priorities Onsite

We asked technician respondents to rate several possible considerations when completing a job. As shown in Figure 6-1, technicians gave the highest ratings to (1) ensuring the system was functional, (2) making sure the system was safe, and (3) making sure the customer was happy. However, there were minimal differences between six of the seven considerations prompted. Only one consideration – convincing the customer to buy more products or services – received a substantially lower rating compared to the other considerations. Significant group differences were found for this category only; this was a higher priority for jobs with large commercial customers compared to those with residential customers. Note that while respondents rated "following a specific set of procedures" as a high priority, it is unclear which procedures technicians specifically had in mind when responding to this question.

For this question, technicians from medium-sized firms (five to nine employees, mean rating of 5.9) were significantly more likely than technicians from small firms (one to four employees, mean rating of 4.6) to give higher ratings to "convincing the customer to buy more products or services."[42]

Figure 6-1: Technicians' Ratings of Priorities Onsite During a Typical Job



Note. Responses were missing for two small commercial respondents.
[a] A one-way ANOVA test showed statistical differences between groups, F (2, 214) = 3.848, p = 0.023. A Tukey post-hoc test showed significant differences between the residential and large commercial sector, $p < .05$; other group differences were not significant.

Although technicians exhibited limited discrimination between considerations in the rating task, a slightly more nuanced picture emerged when they were asked to rank their first, second, and third priorities from this same list. As shown in Table 6-17, "making sure there are no safety issues with the equipment" was most frequently ranked as the number one priority (cited by 63% of technicians overall). Overall, 20% of technicians cited "making sure the customer is happy," and 11% of technicians cited "making sure the system is functioning" as their top priorities. This result may suggest that while functionality and safety are both important to technicians, ultimately a

[42] Group differences were statistically significant using a t-test, $p < .05$.

system's safety is their most important consideration on the job. "Convincing the customer to buy more products or services" was cited by less than 1% of technicians as their top priority – a result that is closely in line with the low ratings shown in Figure 6-1. There were no significant differences among the survey module groups for the top three categories; statistical tests were not performed on the remaining categories due to the small number of responses. Differences between firms of different sizes were minimal – technicians from large firms were significantly more likely to mention "following a specific set of procedures" (mentioned by 16% of technicians from large firms) than were technicians from medium-size firms (2%) as their most important tertiary priority onsite.[43]

Table 6-17: Technicians' Rankings of Top Priority Onsite

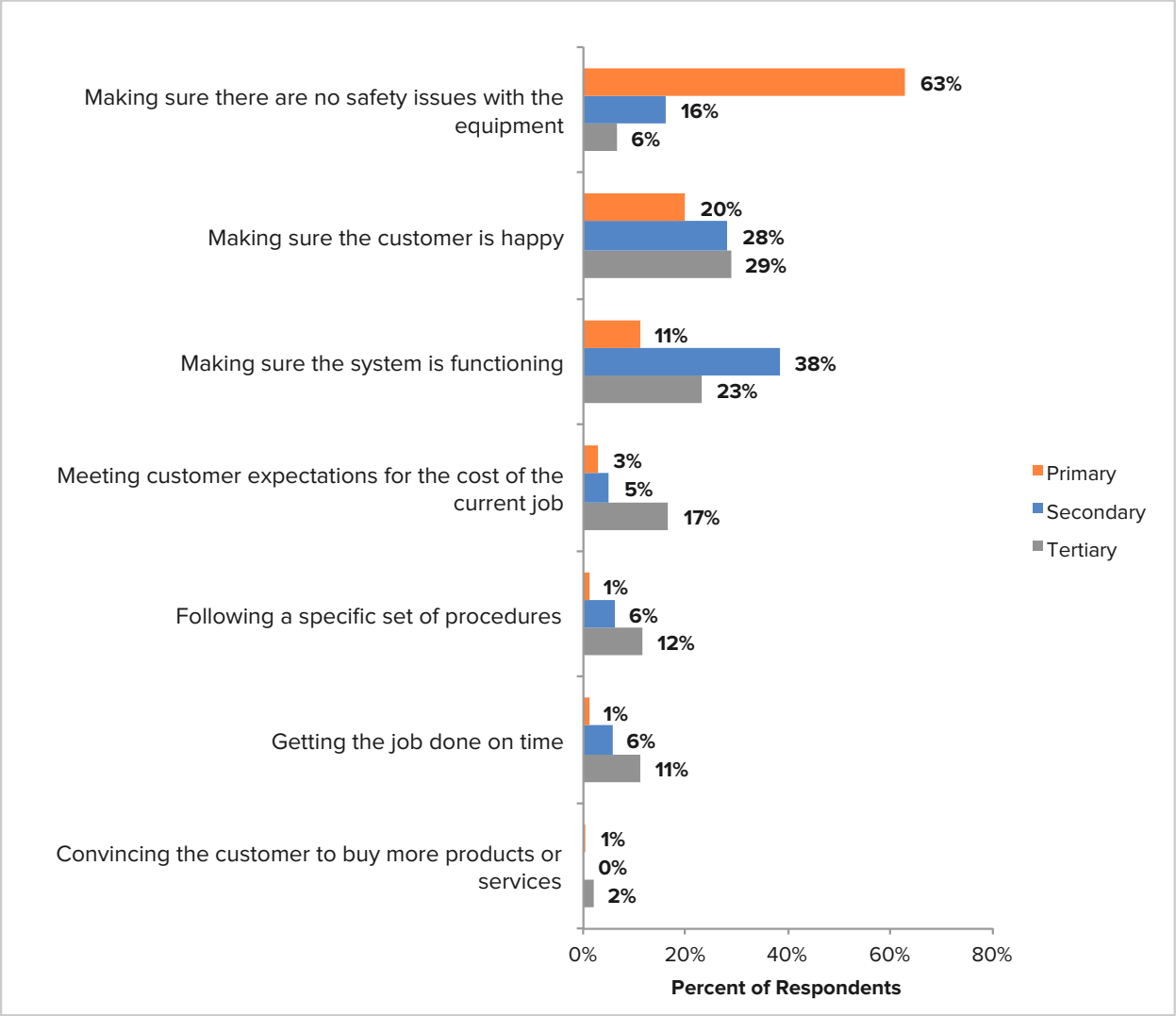
Priority	Residential (n = 72)	Small Commercial (n = 71)	Large Commercial (n = 73)	Total (n = 216)
Making sure there are no safety issues with the equipment [(a)]	64%	68%	58%	**63%**
Making sure the customer is happy [a]	24%	14%	22%	**20%**
Making sure the system is functioning [a]	8%	14%	11%	**11%**
Meeting customer expectations for the cost of the current job	3%	1%	4%	**3%**
Getting the job done on time	-	-	4%	**1%**
Following a specific set of procedures	1%	1%	-	**1%**
Convincing the customer to buy more products or services	-	1%	-	**< 1%**
Cannot rank – All are equally important	-	-	1%	**< 1%**

Note. Responses were missing for two large commercial respondents. Group differences were not tested except where noted due to the small number of responses.
[a] Group differences not significant.

In addition to looking at technicians' top priority onsite, the research team also examined the most common second and third (tertiary) priorities. Figure 6-2 displays the percentage of technicians who cited each prompted category as their primary, secondary, and tertiary priorities while onsite. As reported previously, "making sure there are no safety issues with the equipment" was the most popular primary priority (cited by 63% of technicians). "Making sure the system is functioning" was the most popular secondary priority (cited by 38% of technicians), and "making sure the customer is happy" was the most popular tertiary priority (cited by 29% of technicians).

[43] Group differences were significant using a Fisher exact test, $p < .05$.

Figure 6-2: Technicians Primary, Secondary, and Tertiary Priorities Onsite (n = 216)



Note. The categories in this question were prompted based on technicians' previous ratings to question C4a. The response category "Cannot rank – all equally important" was not included in this graphic.

Barriers to Making Repairs Onsite

To better understand factors that might prevent technicians from spending more time on a jobsite to perform extra work, we asked them to imagine that they were onsite performing a maintenance visit and that they identified a necessary repair that could be fixed in 30 minutes. We then asked them to report any barriers that might prevent them from making the repair (Table 6-18). Respondents were most likely to report customer cost concerns (48% of respondents), not having the necessary parts on hand (33% of respondents), or customer approval (14% of respondents) as barriers. While only 11% of technicians reported time constraints as an issue preventing necessary repairs, this percentage may increase if the additional time required were greater than 30 minutes. Notably, nearly one in ten technicians (9%) said there were no barriers to making such a repair.

There were minimal differences between technicians from different size firms for this question, with technicians from small firms (one to four employees) significantly less likely than technicians from larger firms (ten or more employees) to mention “needing permission from a supervisor” as a barrier (mentioned by 6% of technicians from small firms and 23% of technicians from large firms).[44] Other group differences by firm size were not statistically significant.

Table 6-18: Barriers to Making a Necessary Repair Requiring an Additional 30 Minutes Onsite

Response	n	Percent (n = 197)
Customer's cost concerns	95	48%
Not having the necessary parts or equipment on hand	65	33%
Customer approval	27	14%
Needing permission from a supervisor	22	11%
Time constraints	22	11%
Safety Concerns	2	1%
Other	4	2%
Nothing	18	9%

Note. Multiple responses accepted. This question was unprompted.

6.4 Awareness and Use of Standards

While technician awareness and use of industry standards has been studied previously in the Phase I study, those results were derived from a small field study of observed technicians. A primary purpose of the Phase II study was to validate these findings with a large sample of technicians. The technician survey included several questions designed to understand respondents' awareness of the ACCA/ASHRAE industry standards, as well as their use of these standards. In this section, we first summarize their responses to an unprompted question regarding their use of any codes or standards on the job. We then summarize how technicians define “quality installation” and “quality maintenance.” Finally, we present results of prompted questions asking about awareness and use of the installation standard, and then awareness and use of the maintenance standards.

Codes and Standards - Unprompted

To determine if technicians report using the ACCA/ASHRAE standards without being specifically prompted with the names of the standards, we asked technicians if they follow any specific codes or standards while on a typical job. The majority of technicians (96%) reported following specific codes and standards while on the job, regardless of which type of work they performed (this included 97% of residential technicians, 93% of small commercial technicians, and 97% of large commercial technicians).

Technicians were then asked to report which codes or standards they follow. As shown in Table 6-19, technicians were most likely to report following city/municipal codes (60% of respondents) or state code/state building code/Title 24 (51% of respondents). The next most frequent response

[44] Group differences were statistically significant using a Fisher exact test, $p < .05$.

was the technician's firm's own procedures/company checklist (19% of respondents). It is possible that these include tasks based on the ACCA/ASHRAE standards; one market actor interviewee had remarked that HVAC technicians may not know them as a "standard" but rather, they are often known simply as "best practices."[45] Nine percent of technicians mentioned Quality Maintenance, Quality Installation, or ACCA/ASHRAE standards. While this percentage is relatively low, there was an indication from the contractor interviews performed as part if this study that in some cases, technicians may be following internal firm processes that are *based on the standard* although the technicians may not necessarily be aware of this association.

There were no statistical differences between technicians from different assigned survey modules for the categories "city / municipal code" or "state code / state building code / Title 24." Technicians were significantly less likely to mention using "OSHA / Safety Standards / Trade Safety Standards" when working with residential customers rather than when working with large commercial customers.[46] Technicians were also significantly less likely to mention using "SMACNA (Sheet Metal & Air Conditioning Contractors National Association) standards" when working with residential customers compared to when working with large commercial customers.[47] Other differences were not statistically significant.

Technicians from small firms (one to four employees) were significantly more likely than technicians from larger firms (ten or more employees) to mention "state code / state building code / Title 24" in their responses to this question (mentioned by 58% of technicians from small firms and 37% of technicians from large firms).[48] Conversely, technicians from larger firms were more likely than technicians from medium-size firms to mention "our firm's own procedures / company checklist" (mentioned by 33% of technicians from large firms and 8% of technicians from medium-size firms).[49] Other group differences by firm size were not significant.

[45] It is important to note that the results shown here provide no information on the *extent* to which technicians adhere to these codes and standards.
[46] Group differences were significant using a Fisher exact test, $p < .05$.
[47] Group differences were significant using a Fisher exact test, $p < .05$.
[48] Group differences were significant using a Fisher exact test, $p < .05$.
[49] Group differences were significant using a Fisher exact test, $p < .05$.

Table 6-19: Codes or Standards Followed on a Typical Job

Response	Residential (n = 70)	Small Commercial (n = 63)	Large Commercial (n = 70)	Total (n = 203)
City / municipal code	66%	64%	50%	**60%**
State code / state building code/ Title 24	60%	43%	49%	**51%**
Our firm's own procedures / Company checklist	21%	16%	20%	**19%**
UMC (Uniform Mechanical Codes)	10%	13%	9%	**10%**
Quality Installation / Quality Maintenance standards / ACCA/ASHRAE standards	7%	9%	11%	**9%**
OSHA / Safety Standards / Trade Safety Standards	1%	8%	14% [a]	**8%**
Manufacturers' standards	3%	11%	10%	**8%**
SMACNA (Sheet Metal & Air Conditioning Contractors National Association) standards	1%	6%	11% [b]	**6%**
National Electric Codes	6%	5%	6%	**5%**
EPA / ARB / SCAQMD	4%	5%	6%	**5%**
HERS (Home Energy Rating System) requirements	6%	3%	1%	**3%**
National Plumbing Code	1%	2%	3%	**2%**
Other	9%	6%	11%	**9%**

Note. This question was unprompted. Seven respondents said they did not follow any codes, two respondents were not sure, and three web respondents did not answer this question. An additional three respondents said they followed codes but didn't know which ones. These respondents are not included in this table.
[a] Group differences were significant using a Fisher exact test, $p < .05$.
[b] Group differences were significant using a Fisher exact test, $p < .05$.

The research team also examined the *number* of codes or standards mentioned by each technician. Roughly a third of technicians mentioned following only one code or standard (34% of respondents), while 39% of respondents mentioned following two codes or standards. Seventeen percent of technicians mentioned following three codes or standards. Less than 7% of respondents mentioned following four or more standards. However, it should be noted that while respondents were free to provide as many codes or standards as they wished, they were not specifically asked to provide an exhaustive list.

Technician Definitions of Quality Installation and Quality Maintenance

Technicians who perform installation work were asked how they define "quality installation." As shown in Table 6-20, technicians most frequently mentioned doing a job that is complete, proper, or done "the right way" (44% of respondents). Respondents also frequently mentioned a system that looks clean or neat (22%), being in compliance with city or state codes (21%), and having a satisfied customer (21%). Four percent mentioned using a checklist, while 1% of technicians mentioned utility programs. Only 1% mentioned the ACCA Standard, although ACCA Standard 5 is titled "HVAC Quality Installation Specification." These results suggest that the vast majority of technicians do not appear to associate the term "quality installation" with any specific organization or standards.

There were several significant differences between technicians assigned to different survey modules in their responses to this question. Technicians performing work for residential customers were significantly less likely than technicians working for either small commercial or large commercial customers to mention "manufacturer specifications" (mentioned by 8%, 24%, and 31% of technicians, respectively). Technicians performing work for residential customers

were also significantly less likely than technicians working for small commercial customers to mention “safety” (mentioned by 2% and 16% of technicians, respectively).[50]

There were also significant differences between technicians from different size firms. Technicians from medium-size firms were significantly more likely (13% of technicians) than technicians from small firms (1% of technicians) to mention “using a checklist” in their definition of “quality installation.”[51] Other differences by firm size were not significant.

Comparing responses of technicians to those of the contractors in the Phase I study, the definitions given for "quality installation" are similar, although there are two marked differences.[52] The most common response from technicians was "complete or proper - doing a job the right way," mentioned by 44% of technicians, but only 8% of contractors. The second most common response from technicians was "a clean or neat looking system," mentioned by 22% of technicians, but only 9% of contractors in Phase I.

Table 6-20: Technicians’ Unprompted Definitions of the Term “Quality Installation”

Definition	n	Percent (n = 192)
Complete or Proper - doing a job the "Right Way"	84	44%
A Clean looking or "Neat" system	43	22%
In compliance with city/state Codes (e.g., California Title 24)	41	21%
Customer is Satisfied	41	21%
Peak/Optimum Performance	39	20%
Manufacturer Specifications	39)	20%
Duct Sealing	28	15%
"Correct" system and duct Sizing	25	13%
Safety	18	9%
The System Works / Works Properly / is Effective	15	8%
Energy Efficient	13	7%
General Mention of Tested / Checked	10	5%
Using a Checklist	7	4%
Explained to Customer / Customer Understanding	7	4%
Quality Equipment / Parts	6	3%
Finished on Time	6	3%
Within Budget	5	3%
It is level	3	2%
Utility Programs	2	1%
ACCA Standard / ACCA Standard 5	2	1%
Other	9	5%

Note. The categories were all unprompted. This question was only asked of technicians who perform installation work. Five web respondents who perform installation work did not answer this question.

[50] Group differences were significant using a Fisher exact test, $p < .05$.
[51] Group differences were significant using a Fisher exact test, $p < .05$.
[52] *California HVAC Contractor & Technician Behavior Study, Final Report,* p 69.

Similarly, when asked to define the term “quality maintenance,” technicians provided a wide range of answers – though not one technician mentioned ACCA/ASHRAE or any industry standards. As shown in Table 6-21, one-third (33%) of technicians mentioned doing a “complete or proper job,” or “doing a job the ‘right way’.” The next three most popular responses were reported at approximately equal rates: “cleaning the system” (23%), “peak/optimum performance” (21%), and “general inspections/testing” (20%). Thirteen percent mentioned using a checklist. While it is possible that at least in some cases these checklists could be based on industry standards, overall, these results suggest that most technicians do not currently associate the term “quality maintenance” with any particular organization (i.e., ACCA or ASHRAE) or set of standards. Furthermore, technicians do not appear to associate this term with utility programs.

There was a significant difference in the percentage of technicians who mentioned “manufacturer specifications” in response to this question, with 2% of residential technicians and 13% of small commercial technicians making this reference.[53] Minor differences between technicians from different size firms also existed in the responses to this question, with technicians from small firms (one to four employees) significantly less likely than either medium-size or large firms to mention the category “using a checklist” (6%, 20%, and 23% of technicians, respectively).[54] Other differences by firm size were not significant.

Comparing responses of technicians to those of the contractors in the Phase I study, the definitions for "quality maintenance" look very similar.[55] One marked difference is the second most common response from technicians was "cleaning the system," whereas the contractors in Phase I did not mention this.

[53] Group differences were significant using a Fisher exact test, $p < .05$.
[54] Group differences were significant using a Fisher exact test, $p < .05$.
[55] *California HVAC Contractor & Technician Behavior Study, Final Report,* p 34.

Table 6-21: Technicians' Unprompted Definitions of the Term "Quality Maintenance"

Definition	n	Percent (n = 196)
Complete or Proper - doing a job the "Right Way"	65	33%
Cleaning the System	46	23%
Peak/Optimum Performance	41	21%
General Mention of Inspections/Testing	39	20%
Inspecting Air Filters	27	14%
Using a Checklist	26	13%
Customer is Satisfied	24	12%
Communicating Findings to the Customer	18	9%
Inspecting Condensing Coil	17	9%
Manufacturer Specifications	17	9%
Energy Efficient	17	9%
Regular / Preventative Maintenance	16	8%
General Mention of Safety	16	8%
Inspecting Electrical Components	15	8%
Checking Refrigerant Charge	12	6%
Making Sure the System is Running Properly	10	5%
Inspecting Ductwork	9	5%
Catching Problems Before They Happen	6	3%
No Unnecessary Recommendations	3	2%
Quality Parts / Original Parts	2	1%
Above and Beyond	2	1%
Utility Programs	1	< 1%
Other	21	11%

Note. The categories were all unprompted. This question was only asked of technicians who perform maintenance work. Three web respondents who perform maintenance did not answer this question. One "Other" respondent did not know.

Awareness of Installation Standard (ACCA 5) – Prompted

In addition to asking technicians about codes and standards in an unprompted manner, the research team also asked installation technicians specifically about the ACCA/ASHRAE standards. Table 6-22 shows awareness of ACCA Standard 5 among technicians who perform installation work. Less than half of installation technicians (41%) reported that they were aware of ACCA Standard 5. While awareness was lowest among technicians assigned to the residential module (34%) and highest among technicians assigned to the small commercial module (48%), these group differences were not statistically significant. Additionally, there were no significant differences between technicians from different size firms. Overall, the percentage of technicians aware of ACCA 5 (41%) was no different from the percentage of contractors who indicated they were aware of the standards in the Phase I study (39%).[56]

[56] *California HVAC Contractor & Technician Behavior Study, Final Report,* p 68. Group differences were not significant using a two-proportions z-test.

Table 6-22: Awareness of ACCA Standard 5 by Technicians Who Do Installation Work

Survey Module	n	Percent Aware (n = 195)
Residential (n = 68)	23	34%
Small Commercial (n = 63)	30	48%
Large Commercial (n = 64)	26	41%
Total	**79**	**41%**

Note. This question was prompted.

Those who were aware of ACCA Standard 5 were asked what portion of the standards' specifications they typically follow.[57] In total, 95% of respondents who were familiar with the standard said they follow either the majority or all of the specifications on a typical job. As shown in Table 6-23, technicians were most likely (58%) to report following a *majority* of the specifications on a typical installation job, as opposed to *none*, *some*, or *all* of the specifications. Respondents were more likely to report following the majority of the specifications with small commercial customers (80%) compared to residential (41%) or large commercial (48%) customers. Meanwhile, technicians were less likely to report following *all* of the specifications with small commercial customers (17%) than with residential customers (50%) or large commercial customers (48%).[58] There were no significant differences between technicians from different size firms.

Technicians who were aware of the standard were significantly more likely to report using the majority or all of ACCA 5 (95%) compared to the contractors in the Phase I study (83%).[59]

Table 6-23: Portion of Installation Standard Followed on Typical Installation Job by Survey Module

Portion Followed	ACCA 5 Residential (n = 22)	ACCA 5 Small Commercial (n = 30)	ACCA 5 Large Commercial (n = 25)	Total (n = 77)
None	0%	0%	0%	**0%**
Some	9%	3%	4%	**5%**
Majority	41%	80%	48%	**58%**
All	50%	17%	48%	**36%**

Note. One residential respondent and one large commercial respondent answered "Don't Know."

Of the technicians who reported awareness, 47% indicated they associated the ACCA 5 Standard with any utility-sponsored program or programs. There were no significant differences between technicians from different size firms.

[57] This question did not distinguish between technical and non-technical tasks (e.g., providing documentation to the customer).
[58] Group differences were significant using a Fisher exact test, $p < .05$.
[59] *California HVAC Contractor & Technician Behavior Study, Final Report,* p 68. Group differences were significant using a two-proportions z-test, $p < .05$.

Table 6-24: Do You Associate This Installation Standard with Any Utility-Sponsored Programs?

Answer	n	Percent (n = 79)
Yes	37	47%
No	36	46%
Don't know	6	8%

Table 6-25 shows that the technicians who are both aware of ACCA Standard 5 and associate it with a utility-sponsored program do not strongly associate the standard with any one specific program. Most technicians simply cited the IOU itself, such as SCE (24% of respondents) or PG&E (21% of respondents) without mentioning any specific program names. Due to a low number of respondents, the research team did not test for statistical differences between firm size for this question.

Table 6-25: Utility-Sponsored Program(s) with which Technicians Associate ACCA Standard 5

Program	n	Percent (n = 29)
SCE (program not specified)	7	24%
PG&E (program not specified)	6	21%
Southwest Gas (program not specified)	2	7%
Edison CA Quality Renovation*	1	3%
SCE Early Retirement program*	1	3%
SCE Quality Installation*	1	3%
SCE HVAC Optimization*	1	3%
Quality Install program*	1	3%
Edison Cash for Clunkers	1	3%
SCE Energy Upgrade California	1	3%
SDG&E and SCE IHACI	1	3%
PG&E Upgrade California	1	3%
SMUD, PG&E, don't know name of program	1	3%
SoCalGas	1	3%
“Last one was for Economizers, High Efficiency and Install Swamp Cooler.”	1	3%
“The Green Building”	1	3%
“City sometimes”	1	3%

Note: This question was unprompted. This question was asked only of technicians who had indicated they associated ACCA 5 with a specific utility-sponsored program.
* Denotes utility-sponsored programs that utilize ACCA Standard 5 as part of their participation requirements. A total of 17% of technicians named a utility-sponsored program that utilizes ACCA Standard 5.

Awareness of Maintenance Standard (ACCA 4, ACCA/ASHRAE 180) – Prompted

ACCA Standard 4 addresses residential maintenance and ACCA/ASHRAE Standard 180 addresses commercial maintenance. Thus, technicians assigned to the residential module were asked whether or not they were aware of ACCA Standard 4, while technicians assigned to the

small and large commercial modules were asked about their awareness of ACCA/ASHRAE Standard 180. As shown in Table 6-26, about one-third of technicians assigned to the residential module (34%) said they were aware of ACCA Standard 4. This is significantly lower than the proportion of contractors who indicated awareness of the standard in the Phase I study (45%).[60] For the commercial maintenance standard, technicians assigned to the large commercial module were more frequently aware of ACCA/ASHRAE 180 (56%) than technicians assigned to the small commercial module (40%); however, this difference was not statistically significant.[61] Additionally, there was not a significant difference in awareness of ACCA/ASHRAE 180 between the technician survey in Phase II (49%) and the contractor survey in Phase II (45%).[62]

Technicians from larger firms (ten or more employees) were significantly more likely than technicians from small firms (one to four employees) to report awareness of ACCA 4 (70% of technicians from large firms reported being aware, while only 21% of technicians from small firms reported awareness).[63] There were no significant differences found between technicians of different size firms for awareness of ACCA/ASHRAE 180.

Table 6-26: Awareness of Maintenance Standards by Technician Respondents Who Conduct Maintenance

Sector	ACCA 4 (n = 64)	ACCA/ASHRAE 180 (n = 66)
Residential (n = 64)	34%	N/A
Small Commercial (n = 62)	N/A	40%
Large Commercial (n = 73)	N/A	56%
Total	**34%**	**49%**

Note. This question was prompted.

Despite the lower rates of awareness among residential technicians, these technicians were most likely to report following *all* of the relevant standard in a typical maintenance job. As demonstrated in Table 6-27 below, technicians appeared more likely to report following *all* of Standard 4 with residential customers (43% of respondents), compared to following all of ACCA/ASHRAE 180 with large commercial customers (23% of respondents) or small commercial customers (28% of respondents); however, these differences were not statistically significant. There were also no significant differences between technicians from different size firms in their responses to this question.

Overall, 87% of respondents who were aware of ACCA 4 or ACCA/ASHRAE 180 stated that they use the majority or all of the standards on a typical maintenance job. Technicians who were aware of the standard were significantly more likely to report using the majority or all of ACCA/ASHRAE 180 (88%) compared to the contractors in the Phase I study (75%).[64] There was a

[60] *California HVAC Contractor & Technician Behavior Study, Final Report,* p 32. Group differences were significant using a two-proportions z-test, $p < .05$.
[61] Group differences were not significant using a two-proportions z-test.
[62] Group differences were not significant using a two-proportions z-test.
[63] Group differences were significant using a two-proportions z-test, $p < .05$.
[64] *California HVAC Contractor & Technician Behavior Study, Final Report,* p 33. Group differences were significant using a two-proportions z-test, $p < .05$.

marginally significant difference between technicians' and contractors' use of ACCA 4, with 86% of technicians indicating they use the majority or all of the specifications, and 65% of contractors in the Phase II study indicating they use the majority or all of the specifications.[65]

Table 6-27: Portion of Installation Standard Followed on Typical Maintenance Job by Survey Module

Portion Followed	ACCA 4 Residential (n = 21)	ACCA/ASHRAE 180 Small Commercial (n = 25)	ACCA/ASHRAE 180 Large Commercial (n = 40)	ACCA/ASHRAE 180 Commercial Total (n = 65)	Overall Total (n = 86)
None	0%	0%	0%	0%	0%
Some	14%	16%	10%	12%	13%
Majority	43%	56%	68%	63%	58%
All	43%	28%	23%	25%	29%

Note. One residential respondent and one large commercial respondent answered "Don't Know."

As shown in Table 6-28, only 35% of technicians who were aware of the relevant maintenance standard associated it with a utility-sponsored program. More than half (57%) of the technicians who were aware of ACCA 4 or ACCA/ASHRAE 180 did *not* associate the standard with any utility-sponsored programs. There were no significant differences between technicians from different size firms in their responses to this question.

Table 6-28: Do You Associate This Maintenance Standard with Any Utility-Sponsored Programs?

Answer	n	Percent (n = 88)
Yes	31	35%
No	50	57%
Don't know	7	8%

Most of the technicians who associated maintenance standards with a utility-sponsored program did not associate the standards with any *particular* program, but instead with a utility in general (Table 6-29). Roughly 42% of technicians associated the standards with either SCE (21%) or PG&E (21%) but did not name any specific programs.

[65] This difference was marginally significant, p =.08.

Table 6-29: Utility-Sponsored Program(s) with which Technicians Associate ACCA 4, ACCA/ASHRAE 180

Association	n	Percent (n = 24)
SCE (program not specified)	5	21%
PG&E (program not specified)	5	21%
SCE Energy Star	1	4%
Quality Tune-up program*	1	4%
SCE HVAC Optimization Program*	1	4%
SCE Quality Installation*	1	4%
SCE Early retirement program*	1	4%
SCE or SCG (program not specified)	1	4%
SCE and Pasadena Power: "energy conservation program"	1	4%
SCE Energy Upgrade California	1	4%
LADWP (program not specified)	1	4%
"Depends on what city"	1	4%
HERO	1	4%
LEED	1	4%
“What is available at that time”	1	4%
“Our company quality assurance maintenance / inspection program.”	1	4%

Note. This question was unprompted. This question was asked only of technicians who had indicated they associated ACCA 4 or ACCA/ASHRAE 180 with a specific utility-sponsored program.
*Denotes utility-sponsored programs that utilize one of these standards as part of their participation requirements. In total, 16% of technicians associated the maintenance standards with an actual QM-related utility-sponsored program.

6.5 Communication of Standards

In this section, we discuss the ways in which industry standards are communicated to technicians, including the sources from which technicians first learned about the standard(s) and what, if anything, their supervisor does to make sure proper procedures are followed in the field.

Sources of Awareness of Industry Standards

Respondents who reported being aware of ACC5, ACCA 4, or ACCA/ASHRAE 180 were asked to report how they first became aware of the standard. As shown in Table 6-30, technicians were most likely to report becoming aware of installation or maintenance standards from one of three sources: IHACI training (16% of respondents), trade publications (14% of respondents), or another technician/supervisor (12%). There were no significant differences between technicians from different size firms in their responses to this question.

Table 6-30: How Technicians First Became Aware of Standards

Source	n	Percent (n = 99)
IHACI training	16	16%
Trade publications	14	14%
Supervisor or another technician	12	12%
Utility training	8	8%
'On the job experience'	7	7%
Distributor training	5	5%
Manufacturer training	5	5%
You Tube / Blogs / Online HVAC Forums	5	5%
Union apprenticeship	5	5%
Technical or Trade School	4	4%
Community college	3	3%
Private training institute	1	1%
NATE	1	1%
HERO Program	1	1%
Other	12	12%
Total	**99**	**100%**

Note. This question was unprompted and was asked only of technicians who were aware of the relevant standard for their assigned sector/module. Fifteen respondents answered "Don't Know" and were not included in these numbers.

Ensuring Standards are Enacted in the Field

Table 6-31 details the ways in which supervisors make sure that proper installation and maintenance procedures are being followed in the field. The majority of technicians (67%) reported that their supervisors visit job sites to inspect their work. About one-fifth of technicians (22%) reported their supervisors conduct regular meetings to review work/procedures. An equal number of technicians reported their supervisors conduct regular trainings (14%) and provide job checklists to follow (14%), although the technicians did not provide details about what *type* of information was presented in the checklists or the trainings. The research team also examined this question only for technicians who had indicated awareness of the relevant ACCA or ACCA/ASHRAE standards. Results were generally similar between this subgroup and the overall sample of technicians, with minor (though not statistically significant differences) between technicians who are aware of the standards and technicians who are not aware of any standards.

Technicians from larger firms (ten or more employees) were significantly more likely than technicians from small firms (one to four employees) to mention the following categories: “reviews paperwork or notes,” “conducts regular meetings to review work / procedures,” and “conducts regular trainings.”[66] Technicians from medium-size firms (five to nine employees) were also significantly more likely than technicians from small firms to mention “conducts regular meetings to review work / procedures.”[67] Interpretation of these differences should be tempered by the fact that these questions were not applicable to many technicians from smaller firms.

[66] Group differences were significant using a two-proportions z-test, $p < .05$.
[67] Group differences were significant using a two-proportions z-test, $p < .05$.

Table 6-31: What Does Supervisor do to Ensure Proper Procedures are Followed in Field?

Response	All Technicians		Technicians Aware of Standards	
	n	Percent (n = 169)	n	Percent (n = 97)
Visits job sites to inspect the work	100	67%	59	61%
Conducts regular meetings to review work/procedures	32	21%	21	22%
Conducts regular trainings	21	14%	15	15%
Provides job checklist to follow	21	14%	12	12%
Reviews paperwork or field notes	11	7%	8	8%
Seeks feedback from customers	9	6%	6	6%
A Working Supervisor Onsite	7	5%	6	6%
Nothing	3	2%	2	2%
Go to Utility Classes / Read Installation Manuals	2	1%	1	1%
Other	2	1%	0	0%

Note. This question was unprompted and asked only of technicians from firms with at least two employees. Multiple responses were accepted. A total of 19 responses were not applicable, mainly because the respondent *was* the supervisor, and were not included in this tally. There were no statistically significant differences found between technicians who are aware of standards and those who are not.

6.6 Sales and Sales Training

A critical component to the success of QI/QM programs is the ability of contractors and technicians to sell installation and maintenance services that may be more expensive than "typical" services. In this section, we present findings on the prevalence of technicians selling *installation* services, as well as barriers to selling standards-based installation services. Next, we present findings on the prevalence of technicians selling *maintenance* services, as well as barriers to selling standards-based maintenance services. Last, we present results showing the types of sales training technicians have received.

Selling Standards-based Installation Services

As shown in Table 6-32, overall, the vast majority of technicians (89%) reported being responsible for selling new HVAC equipment as part of their job. This proportion was highest for technicians working with residential customers (93%) and lowest for technicians working with large commercial customers (83%); however, this difference was not statistically significant. This finding is interesting in light of the fact that technicians rated "selling new equipment" as a significantly higher priority when working with large commercial customers than when working with residential customers, as shown previously in Figure 6-1. A possible explanation for this is a greater degree of job specialization among technicians working with large commercial customers – since fewer technicians working with large commercial customers are responsible for selling these services, the technicians who *do* sell such services may be more devoted to this task and thus more likely to rate it as a higher priority. Technicians from small firms (one to four employees) were significantly more likely than firms of any other size to report that they were responsible for selling new HVAC equipment to their customers.

Table 6-32: Percent of Technicians Responsible for Selling New HVAC Equipment

Survey Module	n	Percent Who Sell New HVAC Equipment
Residential (n = 68)	63	93%
Small Commercial (n = 64)	58	91%
Large Commercial (n = 65)	54	83%
Total (n = 197)	**175**	**89%**

Note. This question was only asked of technicians who perform installation.

Those who were responsible for selling new equipment and also aware of ACCA 4 were asked what they see as the primary barrier to selling installation services based on the standard. As shown in Table 6-33, the most common response was that customers do not want to pay extra money for the service (43%). This figure was somewhat lower for technicians working with large commercial customers, compared to those working with small commercial or residential customers, though the differences are not statistically significant. However, this trend is expected because large commercial customers likely have greater financial resources than small commercial or residential customers, whose decisions are frequently motivated more by price than by quality.[68] The second most common response, mentioned by 8% of respondents, was that customers do not understand the value of standards-based maintenance. There were no statistical differences found between technicians from different size firms.

It is interesting to note that 31% of technicians who were asked this question indicated there are *no* barriers to selling standards-based installation services. This "no barriers" trend across assigned survey modules was the exact reverse of the trend for customers' unwillingness to pay extra money, with a greater percentage of technicians reporting there are no barriers when selling to large commercial customers and a smaller percentage reporting no barriers when selling to small commercial or residential customers. However, these group differences were not statistically significant.

[68] EMI Consulting. (2015). *CA HVAC Customer Decision-Making Study*.

Table 6-33: Primary Barrier to Selling Installation Services Based on Standards

Barrier to Selling Installation Services	Residential (n = 19)	Small Commercial (n = 25)	Large Commercial (n = 17)	Total (n = 61)
Customers do not want to pay extra money for standards-based installation [a]	42%	48%	35%	**43%**
Customers do not understand the value of standards-based installation	11%	4%	12%	**8%**
Customers cannot afford standards-based installation	5%	8%	-	**5%**
I do not believe there is any value in doing standards-based installation	-	4%	6%	**3%**
I do not have the skills needed to perform standards-based installation	-	4%	-	**2%**
I have a hard time communicating the value of standards-based installation to customers	-	4%	-	**2%**
We don't make enough money on standards-based installation jobs	-	4%	-	**2%**
Other	11%	-	6%	**5%**
No barriers [a]	32%	24%	41%	**31%**

Note. This question was unprompted. Only one response was accepted from each respondent. One residential respondent, one small commercial respondent, and two large commercial respondents answered "Don't Know." Except where indicated, statistical tests were not conducted between groups due to low number of responses.
[a] Group differences not significant using a two-proportions z-test or Fisher exact test.

Selling Standards-based Maintenance Services

Table 6-34 shows that across all survey modules, a similar proportion of technicians reported being responsible for selling maintenance agreements (85%) as for selling new HVAC equipment (89%). There was not a significant difference between technicians working with different types of customers. There were, however, differences by firm size, with a higher percentage of technicians from small firms (92%) responsible for selling maintenance agreements than technicians from large firms (67%).[69] One possible explanation for this difference is the increased probability that a technician from a small firm is the contractor (i.e., the C-20 license holder).[70] This interpretation is supported by the finding that a higher proportion of respondents from small firms reported holding C-20 licenses (see Table 6-10, table note). It is also possible that larger firms have increased rates of specialization (i.e., dedicated sales staff).

[69] Group differences were significant using a Fisher exact test, $p < .05$.
[70] C-20 license holders were significantly more likely to report being responsible for selling new HVAC equipment (96% of C-20 holders vs. 80% of technicians without a C-20 license) as well as selling maintenance services (91% of C-20 holders vs. 77% of technicians without a C-20 license). Both differences were significant using a two-proportions z-test, $p < .05$.

In the Phase I contractor survey, 53% of surveyed contractors stated that they rely on their technicians to sell maintenance services directly to residential customers,[71] which is very similar to the roughly half of contractors interviewed for this study who indicated that their technicians performs sales work. However, broadening the sales definition to include making recommendations but ultimately referring the customer to a sales person, 90% of contractors in the Phase I study stated that their technicians play a role in sales of maintenance services. This is not significantly different from the 85% of technicians who said they are responsible for selling maintenance agreements.[72]

Table 6-34: Percent of Technicians Responsible for Selling Maintenance Agreements

Survey Module	n	Percent
Residential (n = 64)	57	89%
Small Commercial (n = 61)	53	87%
Large Commercial (n = 73)	58	79%
Total (n = 198)	**168**	**85%**

Note. Group differences were not significant. One small commercial respondent indicated "Don't Know."

Meanwhile, the most commonly reported barriers to selling standards-based maintenance services, shown in Table 6-35, are similar to barriers to selling standards-based installation services. Again, technicians frequently cited customers' unwillingness to pay any extra money for standards-based maintenance as the top barrier (cited by 35% of technicians overall). Similar to installation, about one-third of technicians who were asked this question indicated there are *no* barriers to selling standards-based installation services. This percentage is somewhat higher than that reported by contractors in the Phase I study, for which 14% of contractors said there were no barriers to selling HVAC maintenance services.[73] There were no significant group differences between technicians from different size firms in their responses to this question.

[71] *California HVAC Contractor & Technician Behavior Study, Final Report,* p 53.
[72] Group differences were not significant using a two-proportions z-test.
[73] *California HVAC Contractor & Technician Behavior Study, Final Report,* p 49.

Table 6-35: Primary Barrier to Selling Maintenance Services

Barrier to Selling Maintenance Services	Residential (n = 20)	Small Commercial (n = 23)	Large Commercial (n = 31)	Total (n = 74)
Customers do not want to pay extra money for standards-based maintenance [a]	25%	48%	32%	**35%**
Customers do not understand the value of standards-based maintenance	20%	13%	3%	**12%**
Customers cannot afford standards-based maintenance	0%	9%	3%	**4%**
I do not believe there is any value in doing standards-based maintenance	0%	4%	0%	**1%**
Customers are not willing to make long-term commitments	5%	0%	0%	**1%**
We don't make enough money on standards-based maintenance jobs	0%	0%	3%	**1%**
I have a hard time communicating the value of standards-based maintenance services to customers	0%	0%	3%	**1%**
Customer do their own maintenance	0%	0%	3%	**1%**
Other	10%	0%	19%	**11%**
No barriers [a]	40%	28%	31%	**34%**

Note. This question was unprompted and asked only of those technicians who perform maintenance. Three large commercial respondents answered "Don't Know." Except where noted, statistical tests were not performed between groups due to low n-values in some cells.
[a] Group differences were not significant.

Sales Training

Technicians from firms with at least two employees who are responsible for sales were asked if their company had provided any training to them regarding how to sell or recommend new equipment or maintenance contracts to customers. As shown in Table 6-36, roughly half of technicians reported receiving sales training from their employers.

Table 6-36: Did Your Company Provide Any Training to You Regarding How To Sell or Recommend New Equipment Or Maintenance Contracts To Customers?

Response	n	Percent
Yes	78	54%
No	64	44%
Don't know	3	2%
Total	**145**	**100%**

Note. This question was inadvertently not asked of five respondents.

Table 6-37 reveals that a majority of those who received sales training from their employer said that it was either “effective” (46% of respondents) or “very effective” (36% of respondents), with only one technician reporting that this training was “not at all effective.”

Table 6-37: Effectiveness of Employer-Provided Sales Training

Response	n	Percent
Very effective	28	36%
Effective	36	46%
Slightly effective	13	17%
Not at all effective	1	1%
Total	**78**	**100%**

Note. This question was only asked of technicians who indicated they had received training from their employers. This question was prompted.

Results suggest that technicians generally value sales training, and that most technicians would be interested in receiving sales training or additional sales training. Overall, three-quarters of technicians (75%) reported that they thought sales training (or additional sales training) would be helpful, as shown in Table 6-38. Notably, technicians who had previously received sales training were *more likely* to say additional sales training would be helpful; however, this difference was not statistically significant. There were no significant differences between responses from technicians of different size firms for this question.

Table 6-38: Do You Think Sales / Additional Sales Training Would Be Helpful?

Response	Employer had Provided Training (n = 78)		Employer had not Provided Training (n = 64)		Total (n = 142)	
	%	n	%	n	%	n
Yes	81%	63	69%	44	75%	107
No	19%	15	31%	20	25%	35
Total	**100%**	**78**	**100%**	**64**	**100%**	**142**

Note. This question was not asked of 5 respondents who were inadvertently not asked the question shown in Table 6-36. The 3 respondents who were not sure whether or not their employer had provided training were not included in this tally.

Additionally, among technicians from single-employee firms (n = 38) for whom it was not applicable to ask about whether or not their employer had provided them with sales training, 63% indicated sales training would be helpful while 37% indicated it would not be helpful.[74]

6.7 Key Takeaways from Technician Surveys

Key takeaways from the technician surveys are distilled below.

- **It is possible that technicians use the ACCA/ASHRAE industry standards but do not know them by name.** Although a sizeable minority of technicians stated that they use most or all of the specifications on the job in prompted questions, very few (9%) spontaneously reported using the standards when asked in an open-ended question. This may not be that surprising, as the ACCA/ASHRAE industry standards were developed from best practices in the field. Furthermore, while the majority of technicians

[74] This question was inadvertently not asked of six technicians from single-employee firms. One technician was not sure if training would be helpful or not and was not included in this tally.

indicated they complete most of the maintenance or installation tasks specified in the standards on a typical job, it is unclear exactly *how* technicians are performing these tasks.

- **While some technicians reported learning about the standards from their supervisors/contractors or another technician (12%), it is more common for technicians to learn about the standards through other means.** Technicians most commonly learned about the standards through IHACI training (16%) or trade publications (14%). Eight percent of technicians indicated that they learned about the standards from utility-associated training.
- **When contractors do follow up with technicians about implementing the standards, it is usually by visiting job sites.** Other ways contractors follow up is by conducting regular meetings, conducting regular trainings, and providing job checklists. There are some differences between firm size, with technicians from smaller firms less likely to report that their supervisor performs tasks like “conduct regular meetings to review work / procedures.”
- **Technicians generally do not associate the terms "quality installation" and "quality maintenance" with ACCA/ASHRAE standards.** When asked to define "quality maintenance" or "quality installation," technicians generally think of a completing a job "the right way" or having a clean or neat system. After being asked directly if they were aware of the relevant ACCA or ACCA/ASHRAE standard, less than 20% of technicians who were aware of the standards could link the standard to the name of an actual QI or QM program. Out of all respondents, 3% (5 out of 195) were aware of the installation standard and associated it with a specific utility program name that they could correctly recall. Only 2% (4 out of 199) were aware of Standard 4 or 180 and associated it with a specific utility program name that they could correctly recall.
- **Technicians may not know "what they don't know."** When asked what topics they would like to receive training on, there were no individual topics mentioned by more than 11% of technician respondents. The most commonly mentioned topics included: staying up to date/learning about new technologies, chillers, airflow, controls, and heat pumps. Overall, nearly one-third of technicians (32%) stated that they did not want any additional training. Those with more years of industry experience were more likely to state that they did not want any additional training, compared to those with fewer years of experience.
- **The vast majority of technicians reported being involved in sales.** Eighty-nine percent of technicians who perform installation said they were responsible for selling new equipment, and 85% of technicians who perform maintenance said they were responsible for selling maintenance agreements.
- **The top barrier for technicians selling standards-based installation and maintenance services was the perception that customers do not want to pay extra money for standards-based services.** This is in alignment with findings from the Customer Decision-Making study showing that customers cited cost as very important to their HVAC installation and maintenance decisions.[75] However, about one-third of respondents stated that there are no barriers to selling standards-based services.
- **On the job technical training was rated very highly by technicians, with 90% rating it as "very effective."** Technicians also reported the following training types as being either

[75] EMI Consulting. (2015). *California HVAC QI/QM Customer Decision-Making Study*.

effective or very effective: private training institute training, IHACI training, and manufacturer training. Technicians were least likely to rate “online HVAC course training” as very effective.

- **Technicians are also interested in sales training.** Eighty percent of those technicians who had received sales training through their employer thought additional sales training would be helpful, while 66% of those who had not received training were interested. Of technicians who had received sales training through their employer, 83% reported that they training was either effective or very effective. Additionally, among technicians working alone as solo-practice firms, 63% indicated they thought sales training would be helpful.
- **There were some notable differences by firm size:**
    - Technicians from small firms were more likely to report that they were responsible for selling both new HVAC equipment and maintenance agreements to their customers, compared to technicians from larger firms. They were also more likely than technicians from larger firms to mention using “state code / state building code / Title 24.” However, they were less likely than either medium-size or large firms to define "quality maintenance" as "using a checklist" and were also less likely to report having NATE certification.
    - Technicians from medium-sized firms (5 to 9 employees) were more likely than technicians from smaller firms to mention receiving “technical or trade school" or “private training institute" training. When asked to define "quality installation," they were more likely than technicians from small firms to mention “using a checklist.”
    - Technicians from larger firms (10 or more employees) tended to have less experience and were less likely to hold a C-20 license, compared to technicians from smaller firms. However, technicians from larger firms were more likely to have attended utility training, and reported a higher rate of awareness of ACCA 4. They were also more likely than medium-sized firms (5 to 9 employees) to mention “our firm’s own procedures / company checklist” as a code or standard followed on a typical job.
- **There were also notable differences by sector:**
    - In defining "quality installation," technicians were less likely to mention “manufacturer specifications” when defining "quality installation" with residential customers than with either small commercial or large commercial customers. Technicians were less likely to report inspecting, cleaning, and adjusting the evaporator coil with residential customers than with commercial customers. However, they were more likely to report inspecting the integrity of all accessible ductwork with residential customers. This may be due to the inaccessibility of ductwork in commercial systems, which are typically larger and more complex than residential systems.
    - Technicians assigned to the small commercial module were more likely to report distributor training and technical or trade school training compared to those assigned to the residential module. When asked to define "quality maintenance," technicians were more likely to report “manufacturer specifications” when working with small commercial customers, compared to residential customers. Technicians were also significantly more likely to mention "safety" when defining "quality installation" with small commercial customers compared to residential customers. They were also less likely to report following *all* of the ACCA 5 specifications with

small commercial customers compared to either residential customers or large commercial customers. It is unclear why this is the case.

- Technicians assigned to the large commercial module were more likely to report that they perform maintenance work compared to those assigned to the other two sectors. These technicians were also more likely to mention participating in "private training institute" training, "online HVAC course training," and "union apprenticeship training" than were technicians assigned to the residential survey module (for "union apprenticeship training," this difference was also significant between large commercial technicians and small commercial technicians). Technicians were significantly more likely to report inspecting blower motors with large commercial customers, compared to jobs with residential customers. Finally, convincing the customer to buy more products or services was a higher priority for jobs with large commercial customers compared to those with residential customers.

7. OPERATIONALIZATION OF MARKET TRANSFORMATION INDICATORS

In this chapter we assess the operationalization and feasibility of measuring the four market transformation indicators (MTIs) associated with QI and QM.[76] We begin by discussing several higher-level methodological considerations regarding the design, use, and interpretation of these MTIs, including concerns of long-term comparability and cost-effectiveness of data collection efforts. We then provide an individual assessment of operationalizing each MTI in separate subsections.

When assessing the operationalization and feasibility of these MTIs, our considerations include, but are not limited to:

- How these MTIs can be computed to facilitate comparability over time
- Whether these MTIs can be computed today in a way that can provide useful baselines for future comparison
- What sources of reliable and accurate data may exist
- Where the greatest areas of uncertainty may exist in the estimates.

7.1 Methodological Considerations

In this section, we present a brief discussion of several methodological considerations that should be kept in mind as we discuss the feasibility of operationalizing the MTIs. We first review the difference between proximate and ultimate indicators. We then discuss the importance of long-term comparability and cost-effectiveness of measuring the MTIs over time.

Proximate versus Ultimate Indicators

Market transformation indicators can be roughly divided into two groups: (1) short term, or *proximate* indicators and (2) long term, or *ultimate* indicators. As their names imply, *proximate* indicators measure more immediate outcomes resulting from a specific program or activity, and are generally considered to be necessary preconditions for longer-term effects.[77] Examples of proximate indicators include general awareness or knowledge of a product or program, attitudes or beliefs regarding a product or program, or availability of a certain type of product or service (e.g., a specific technology stocked on store shelves).[78] While proximate indicators serve an important function (namely, as bellwethers of broader market trends), they cannot typically be used to claim energy savings. This function is instead the domain of *ultimate* indicators, which are used to track deeper, more structural changes in the market. Common examples of ultimate

[76] The CPUC requires (in D. 09-09-047) the Energy Division to develop recommendations for market transformation indicators and related data collection and tracking processes, noting that the purpose of the market transformation indicators and associated market transformation tracking framework is that it will "enable the Commission to track on implementation of the Strategic Plan and for specific technologies and measures" (D. 09-09-047 at 94).
[77] Rosenberg and Hoefgen. (2009). "Market Effects and Market Transformation: Their Role in Energy Efficiency Program Design and Evaluation" Available at: http://uc-ciee.org/downloads/mrkt_effts_wp.pdf
[78] Ibid.

indicators include market share, product saturation, updates to codes and standards, and changes in other common practices.[79]

Another way to understand the distinction between proximate and ultimate indicators is to consider proximate indicators as *leading indicators*, which give an earlier view into changes in the market. Ultimate indicators, or *long-term indicators*, will confirm the changes detected by the leading indicators. It has been argued that it is important to have a mix of both leading (proximate) and long-term (ultimate) indicators to get a better, more nuanced view of market change.[80]

In our assessment of the five MTIs addressed by this study, we reference this classification to make clear that in many cases, it is advisable to make sure that the MTIs are supported by the appropriate proximate indicators.

Long Term Comparability and Cost-effectiveness

Because the MTIs are designed to provide meaningful estimates of changes in the market *over time*, it is important to operationalize them in a way that allows for *consistent and direct comparison* of data points from different time periods. This means that any methods used to collect, process, or calculate values for the MTIs should be simple and relatively easy to reproduce. This is particularly important because different firms/parties may be collecting the data and/or performing the calculations in different years.

Methods for calculating the MTIs also need to be *cost-effective,* as they will need to be repeated periodically. Thus, minimizing the costs associated with data collection and processing should be an important factor in determining how the MTIs are operationalized. Where possible, we point out ways in which multiple data collection efforts may be combined for maximum cost-effectiveness.

Lastly, it is critical to note that once an MTI has been defined, it is extremely difficult — if not impossible — to modify the definition without losing the ability to make valid comparisons to earlier values. Thus, to the extent possible, operationalization of the MTIs should rely on data sources that are expected to be available in future time periods.

7.2 MTI HVAC-1a and HVAC-1b

MTIs HVAC-1a and HVAC-1b have been defined by the IOUs and CPUC – ED as:

> *HVAC-1a (and HVAC 1b): Market share of climate appropriate HVAC equipment (or market share of energy efficient climate appropriate equipment) – Residential and Non-Residential*

[79] Decision Approving 2010 to 2012 Energy Efficiency Portfolios and Budgets. Available: http://docs.cpuc.ca.gov/PUBLISHED/AGENDA_DECISION/107378.htm
[80] Prahl and Keating, "Building a Policy Framework to Support Energy Efficiency Market Transformation in California" (2014).

Because this MTI is associated specifically with new construction and retrofit projects,[81] the research team understood "market share" to refer only to *new sales* of climate appropriate and energy efficient climate appropriate HVAC equipment, and not to include existing equipment in the market (i.e., the installed base).[82] In this case, these MTIs may be operationalized by the following formulae:

$$HVAC-1a_{i,j,s} = \frac{Sales\ of\ climate\ appropriate\ HVAC\ units_{i,j,s}}{Total\ sales\ of\ HVAC\ units_{i,j,s}}$$

$$HVAC-1b_{i,j,s} = \frac{Sales\ of\ energy\ efficient\ climate\ appropriate\ HVAC\ units_{i,j,s}}{Total\ sales\ of\ HVAC\ units_{i,j,s}}$$

where "i" is a geographic area,[83] "j" is a specified time period, and "s" is the sector.

Considerations for Operationalizing HVAC-1a and HVAC-1b

The research team believes there is a great deal of complexity associated with the operationalization of these two MTIs. We discuss several considerations below:

- The term "climate appropriate" does not currently have a consistent or commonly understood technical definition in the industry.[84] It will be necessary to formulate a definition for the purpose of computing these MTIs that varies based on climate zone. For example, equipment that may be considered climate appropriate in coastal zones will not always be considered climate appropriate in hotter, more arid inland climate zones. However, based on our experiences conducting interviews with HVAC contractors in California, even a clear definition of the term "climate appropriate" may be interpreted in slightly different ways by contractors and other stakeholders, resulting in a large range of possible values and impairing the indicator's precision/reliability.[85]
- The level of geographic specificity must be carefully considered. At a minimum, there should be two geographical categories: coastal and inland (arid). Fewer geographic categories will facilitate the computation of the MTIs (since there will be less effort required to collect and analyze data from the different areas).
- The definition of the term "energy efficient" will change with time. A unit that is "energy efficient" in the year 2015 may not be "energy efficient" in the year 2020 as technological advancements and new standards improve the overall efficiency of

[81] CPUC, "2013-2014 Energy Division – Investor Owned Utility Energy Efficiency Evaluation, Measurement and Verification Plan Version 2." (p. 50) Available: http://www.cpuc.ca.gov/NR/rdonlyres/B6D32B87-249E-44BB-8083-7139EC4D3B3A/0/20132014_EnergyDivisionEMV_Workplan_v2.pdf

[82] The focus on new climate-appropriate HVAC technologies is from the California Long-Term Energy Efficiency Strategic Plan, which states that, "The federal standards use a single, national air conditioning metric that does not robustly measure — never mind promote — the performance of air conditioners in hot, dry conditions such as California." (p. 54)

[83] The definition of this geographic area would depend on climate zone or aggregated climate zone – see bullet #2 under "Considerations for Operationalizing HVAC-1a and HVAC-1b."

[84] One recent study used Tier 1 from the 2010-2012 SCE Qualifying Minimum Equipment Efficiencies & Incentive Levels for Commercial Air Conditioners as a proxy indicator of "climate appropriate" equipment. These tiers are based on minimum SEER, EER, or IEER ratings, which vary by type and capacity. For more information, see NMR Group, "Baseline Market Characterization Study: Residential and Small Commercial HVAC," CALMAC Study ID CPU0102.01 (2015).

[85] Even after the term "climate appropriate" was described to contractors during interviews we conducted, there was substantial variability in the resulting answers.

equipment in the market. This poses methodological challenges for an indicator measuring this dimension over time. In addition to simply tracking whether or not equipment is "energy efficient," it may be worthwhile to track the *distribution* of units by energy efficiency rating (for example, by SEER or EER ratings). This will help mitigate potential concerns regarding the dynamic definition of "energy efficient" and provide a fuller picture of the market's movement toward efficiency.

- The classification of energy efficient equipment should align with new U.S. Department of Energy (US DOE) Seasonal Energy Efficiency Ratio (SEER) standards that took effect for air conditioners and heat pumps installed after January 1st, 2015. For the first time, these standards are region-specific, and will vary slightly based on the region of the country in which the equipment is installed.[86]
- In the in-depth interviews conducted with contractors, we asked them to provide some estimates regarding the prevalence of "climate appropriate" and "energy efficient climate appropriate" HVAC systems. There was substantial variation among estimates, revealing a possible lack of consensus in contractor knowledge regarding what constitutes a climate appropriate or energy efficient system, and suggesting that these terms must be more clearly defined in order to provide meaningful estimates.
    - **Climate appropriate equipment:** Neither participating contractors nor non-participating contractors gave consistent estimates regarding the percentage of residential and commercial systems that are climate appropriate.
    - **Energy efficient climate appropriate equipment:** Participating contractors' responses regarding how many of their residential and commercial customers' systems were both climate appropriate and energy efficient ranged from 10-40% for residential systems[87], while reports of commercial systems ranged from 15-40%[88]. However, this range excludes one outlier respondent that said "pretty much all" of residential and commercial systems were both climate appropriate and energy efficient. Responses from non-participating contractors regarding rates of climate appropriate and energy efficient systems were so wildly divergent that they did not reveal any pattern.
- Using program-tracking data would not be useful in estimating the number of "climate appropriate" or "energy efficient climate appropriate" units since this data would not capture sales of equipment *outside* the programs. This sentiment was echoed by results of the implementer interviews conducted as part of this study.

[86] There is an 18-month grace period before enforcement of the new standards begins. See also: http://www.acca.org/new-doe-energy-conservation-standards-go-effect-soon/

[87] Responses from participating contractors were as follows for residential systems: 10%, 15%, 18%, 25%, 40%, 100%, 1 did not perform residential work, 1 was not asked due to time constraints, and 1 did not understand the question.

[88] Responses from participating contractors were as follows for commercial systems: 2 responded 15-20%, 2 responded 30%, 1 responded 25-30%, 1 responded 30-40%, 1 responded 100%, 1 did not perform commercial work, 1 was not asked due to time constraints, and 1 did not understand the question.

Recommendations for Operationalizing HVAC-1a and HVAC-1b

In this section, we discuss two possible recommendations for operationalizing MTI HVAC-1a and HVAC-1b.

Recommendation 1: If possible, utilize existing sales data. If access to sales data can be obtained, this is a preferred method to operationalization. In our market actor interviews, we asked experts about possible sources of this data. All interviewees mentioned Heating, Air-Conditioning, and Refrigeration Distributors International (HARDI), which collects data on HVAC equipment sales from a number of distributors across the country. However, obtaining these datasets is expensive. It is also unclear as to whether these data could be obtained in a format that allows for easy computation of the MTIs by service territory, climate zone, or other geographical area, as distributors generally sell equipment to contractors, and contractors are not necessarily located in the area where the equipment is being installed. As discussed above, it is advisable to know how much geographic specificity is required before pursuing this path. Work is currently underway to develop a distributor-based market share tracking system for HVAC units;[89] such a system might be able to easily provide the data needed for this MTI once it is developed.

It is also important to note that even if sales data are obtainable, a critical first step would be to compile a comprehensive list of the types of equipment that are considered to be climate appropriate and/or climate appropriate and energy efficient. This would likely require substantial effort, given the large number and wide variety of equipment types, makes, and models.

Recommendation 2: Perform web-based surveys with contractors, retailers, distributors, and/or trade associations. A panel approach is preferred. If it is determined that existing sales data are not obtainable (and assuming that a market share tracking system is not already in place), conducting periodic web surveys with knowledgeable representatives from these groups could provide data (in the form of estimates of equipment sales) used to calculate MTI HVAC-1a and 1b.. However, this approach must first be piloted with a small number of market actors to ensure the viability of this method and to produce a more informed estimate of what will be required for a larger scale effort.[90] As previously discussed, the terms “climate appropriate” and “energy efficient” must be strictly defined. If at all possible, in the long term we recommend forming a *panel* of market actors who will commit to providing data on an annual or bi-annual basis. Not only would a panel approach improve the long-term comparability of this indicator, it would also streamline the data collection and minimize associated collection costs. While the research team believes this is the best approach to operationalizing MTI HVAC-1a and HVAC-1b, there are several methodological limitations that must be considered. First, the quality of the sales estimates provided by market actors may vary widely, meaning that it is not necessarily possible to obtain highly precise values for the MTIs. Additionally, because retailers, distributors, and trade associations do not always know the exact location in which their equipment is installed, this

[89] This work is currently being scoped for the CPUC Energy Division under Work Order # ED_D_HVAC_1.
[90] HVAC equipment sales were tracked as part of the CA Residential Market Share Tracking project, which monitored the market penetration of energy efficient products in California beginning in 1999. Ultimately this study stopped tracking HVAC sales due to difficulties with obtaining reliable data. However it may offer useful insights into future operationalization efforts for MTIs related to market share. See Itron. (2005). *“California Residential Efficiency Market Share Tracking, HVAC.”*

approach is also susceptible to some degree of geographic uncertainty.[91] Finally, getting retailers, distributors and/or trade associations to share sensitive sales data will likely be a hurdle, and great care will need to be put into recruiting participants.

7.3 MTI HVAC-2 and HVAC-3

MTI HVAC-2 and HVAC-3 have been defined by the IOUs and CPUC – Energy Division as:

> *HVAC-2: Percentage of California residential HVAC installation contractors using QI guidelines*
>
> *HVAC-3: Percentage of California commercial HVAC installation contractors using QI guidelines*

In their current form, these MTIs may be represented by the following formulae:

$$HVAC-2 = \frac{Total\ number\ of\ residential\ HVAC\ contractors\ using\ QI\ guidelines}{Total\ number\ of\ residential\ contractors}$$

$$HVAC-3 = \frac{Total\ number\ of\ commercial\ contractors\ using\ QI\ guidelines}{Total\ number\ of\ commercial\ contractors}$$

In this subsection, we first discuss several considerations related to operationalizing this MTI. We then present our recommendations.

Considerations for Operationalizing HVAC-2 and HVAC-3

In the research team's assessment, operationalizing these MTIs is very difficult when the following information is considered:

- The definition of "using QI guidelines" should be clarified to mean adhering to 100% of the QI standard on all jobs. This is important, since the results of interviews we conducted with contractors revealed a wide variety of interpretations of the concept "using QI/ACCA 5 guidelines," with some contractors indicating that they follow the guidelines – but being unable to provide specific examples. Additionally, the definition must be clear as to whether or not contractors following the standard but not participating in a program are in fact "using QI guidelines." Based on the research team's interviews with program implementer staff, many contractors come into the program saying they *already use the standards* – although without a more specific definition, it is difficult to know exactly what this means.
- Many contractors perform work in both the residential and nonresidential sectors. It is possible that a contractor uses QI or QM standards in one sector but not the other. Thus contractors who work in multiple sectors would need to either be assigned to just one

[91] If there are only two geographic zones for which the MTI is tracked separately, this is less of an issue. However, as the number of geographic zones increases, the difficulty of obtaining sufficiently specific sales estimates also increases.

sector, or else information would need to be collected regarding their work in both sectors.

- Within a sector (i.e., residential or commercial), does this apply to *all* jobs or only *some* jobs? How many jobs within a sector must a contractor do using the QI guidelines to qualify? For example, if a residential contractor performs 50% of residential installation jobs according to the QI guidelines, into which category is he assigned?
- Both implementer interviewees and market actor interviewees agreed that program tracking data may be useful in determining how many contractors are participating in the programs, but it is not useful in determining how many contractors are using QI guidelines outside the programs. Market actor interviewees expressed limited confidence that these figures could be measured, and not one was aware of currently available data that could be referenced. One interviewee specifically commented that it was not even possible for contractors to conduct QI or QM without participating in the program(s).

Given these considerations, the research team believes that MTIs HVAC-2 and HVAC-3 need significant refinement before they can be operationalized. Much of this difficulty comes from the notion that these MTIs are considered *ultimate* rather than *proximate* indicators of market transformation.[92] In order for an ultimate indicator to be useful, it requires that certain proximate measures have already achieved some measurable level of success – which in this case is not certain. Examples of proximate indicators might include "awareness of QI guidelines" or "understanding of QI guidelines."

Recommendations for Operationalizing HVAC-2 and HVAC-3

If the CPUC and IOUs determine that they want to keep MTI HVAC-2 and HVAC-3 in their current form, the research team identified a single approach to operationalizing them (described in Recommendation #1 below). We also recommend the inclusion of several proximate (or secondary) indicators as part of these efforts (Recommendation #2 below).

Recommendation 1: Utilize web-based surveys using a panel of contractors. Using this approach, web-based surveys could be conducted periodically using a panel of contractors licensed to perform HVAC work in California (i.e., recruited through the California State License Board C-20 list). Making sure the panel represents the overall contractor population in terms of geographic location[93] and sector (residential vs. commercial) is recommended. We also recommend that this data collection effort should be integrated with data collection efforts for MTI HVAC-4 (see section 7.4) to minimize costs and avoid concerns of "survey fatigue" among this population.

Several considerations would need to be addressed before such surveys commenced:

- Contractors who perform both residential and commercial work should provide estimates separately for each sector.

[92] See the first section in this chapter for a discussion of proximate and ultimate indicators.
[93] The exact stratification framework for geographical area may be as simple as using IOU service territories, though information on climate zone may also be considered important.

- The term "using QI guidelines" would need to be clearly defined, including direction on what percent of jobs must be performed as QI by an individual contractor in order to qualify for this category.

A panel approach would be valuable for several reasons. The research team is aware of recent concern by the CPUC and IOUs that HVAC contractors in California are heavily burdened with interview and survey requests. Also, based on our own research experience, we fully recognize the difficulty in recruiting busy contractors to participate in research studies. Development of a panel would involve significant effort up-front, with resources and attention allocated to gaining participation with this hard-to-reach group (and it is likely that incentives will be needed to gain participation for each iteration of the survey). However, the panel structure would reduce the need to recruit these contractors time-and-time again for subsequent waves of the survey.[94] Using a panel approach, a clear understanding would be established up-front that the surveys will be an on-going effort. However, and notably, using a web-based format would reduce the burden on the contractors, as they would be able to complete the surveys at their convenience. Another benefit to a contractor panel is that it could be leveraged for estimating multiple MTIs (see Section 7.4). Further, the contractor panel could also be leveraged for other research needs outside of just estimating MTIs, as an established relationship would be developed with participating contractors. It is not clear who would lead the development and implementation of such a panel research effort, though oversight and management from the CPUC may be most appropriate.

Recommendation 2: Include proximate (secondary) indicators in data collection activities. Because our own research has suggested that current levels of contractors' awareness of QI are relatively low, we also recommend incorporating questions to develop and gauge more *proximate* indicators of market change into the web-based contractor data collection efforts recommended above. These proximate indicators represent necessary precursor changes that would need to occur *before* the ultimate MTIs would show change. As such, including these proximate indicators would provide much greater insight and understanding into the evolution of the market over time. If the CPUC and IOUs are amenable to using additional indicators, the research team suggests including the secondary indicators for QI (SIQI) proposed in a recent report submitted to the CPUC[95] (see Table 7-1).

[94] That said, it is likely new contractors would need to be added to the panel periodically to account for attrition.
[95] NMR Group, "Baseline Market Characterization Study: Residential and Small Commercial HVAC," CALMAC Study ID CPU0102.01 (2015).

Table 7-1. Recommended Secondary Indicators for Quality Installation (SIQI) for MTIs HVAC-2 and HVAC-3

Indicator [a]	Operationalization
SIQI-1: Contractor awareness of QI/ACCA standard	• This could be obtained by including general questions of awareness in a web survey
SIQI-2: Contractor level of understanding of QI/ACCA standard	• While awareness is important, it is also important to develop a closer understanding of the depth of understanding • This could be obtained by including standards-specific questions, such as tasks performed
SIQI-3: Percent of contractors currently participating in QI programs	• This could be obtained using program tracking data
SIQI-4: Number of technicians with training in QI	• May be possible to derive using IOU training data or other sources

Note. These indicators closely parallel secondary indicators recommended by NMR Group in "Baseline Market Characterization Study: Residential and Small Commercial HVAC," CALMAC Study ID CPU0102.01 (2015)
[a] The secondary indicators expressed as percentages refer to numerators only. Denominator estimates will be based on the overall population, which could be defined using the California State License Board (CSLB) C-20 license list for contractors. This process would require a substantial amount of data processing, including steps to ensure there are no duplicates included in the lists.

7.4 MTI HVAC-4

MTI HVAC-4 has been defined by the IOUs and CPUC – ED as:

> *HVAC-4: Percentage of HVAC units serviced in IOU service territory under a Quality Maintenance Service Agreement*

In this form, the MTI may be represented by the formula:

$$HVAC-4_{i,s} = \frac{Total\ number\ of\ HVAC\ units\ covered\ by\ QM\ Service\ Agreement_{i,s}}{Total\ number\ of\ HVAC\ units_{i,s}}$$

where "i" is an IOU service territory and "s" is the sector.

In this subsection, we first discuss several considerations for operationalizing this MTI. We then discuss our recommendations.

Considerations for Operationalizing HVAC-4

There are a number of considerations to take into account during the operationalization process for MTI HVAC-4:

- The market for QM services in California is in its infancy. If stakeholders are willing to accept the assumption that QM services are currently not being offered outside of IOU-sponsored programs at any measurable level, it is possible to compute a baseline for MTI HVAC-4 from IOU program tracking data. However, there is an issue with doing so. Given the intent is to transform the market, the number of non-program QM-contracted units should increase over time, making program tracking data only one component of the

total QM contracts in the market. Thus, while using program tracking data to establish a baseline may be feasible, it would need to be amended with additional primary data collection (e.g., contractor surveys) in subsequent years in order to capture QM participation *outside* the program.

- It is virtually impossible to ask customers if they have a QM contract and expect accurate responses. Customers simply do not know what a QM contract is (in contrast to a "standard" contract) – so they don't know whether or not they have one. A customer-based approach to data collection is also unlikely to be of much value in the future even if awareness of QM in the customer population increases. Even though a customer may feel they have a QM contract, the reality is that seeing the words "Quality Maintenance" on a contract does not necessarily mean that QM services are being provided.
- Because we expect that very few contractors currently offer QM services, it would be difficult to obtain estimates from this group that could then be extrapolated to the entire population.
- Onsite visits are not a viable approach to obtaining the data necessary to calculate MTI HVAC-4, given that QM-contracted units likely do not look any different than other units, and there are currently no requirements for QM-contracted units to be marked as such. Onsite visits would thus be unable to distinguish between what is QM-contracted and what is not.

Recommendations for Operationalizing HVAC-4

In this section, we recommend an approach for operationalizing MTI HVAC-4 – collecting data by surveying contractors via the web (Recommendation #1 below). We also recommend the inclusion of several proximate or secondary indicators as part of these efforts (Recommendation #2 below).

Recommendation 1: Administer web-based surveys using a panel of contractors. We recommend conducting periodic web surveys with a panel of contractors. If possible, we recommend conducting the contractor panel surveys as described in Recommendation #1 from Section 0 For the purposes of estimating MTI HVAC-4, surveys could probe the following questions: (1) do they offer QM service contracts; (2) if so, how many customers have QM service contracts; and (3) how many units on average do they estimate each QM customer has? It would also be advisable to ask if contractors or technicians perform certain tasks during QM jobs in order to assess how their claims of following QM guidelines compare to specific tasks included in the standard.

Recommendation 2: Include proximate (secondary) indicators in data collection activities. Because our own research has suggested current levels of contractors' awareness of QM are relatively low,[96] the research team also recommends including more *proximate* indicators that would need to change before the ultimate MTI would be affected. If the CPUC and IOUs are amenable to using additional indicators, the research team suggests including several secondary indicators of QM (SIQM) proposed in a recent report submitted to the CPUC[97] (see Table 7-2).

[96] EMI Consulting, "California HVAC Contractor & Technician Behavior Study," CALMAC Study ID SCE0323.01 (2013).
[97] NMR Group, "Baseline Market Characterization Study: Residential and Small Commercial HVAC," CALMAC Study ID CPU0102.01 (2015)

Table 7-2. Recommended Secondary Indicators for QM (SIQM) for MTI HVAC-4

Indicator [a]	Operationalization
SIQM-1: Contractor awareness of QM/ACCA/ASHRAE standards	• This could be obtained by including general questions of awareness in a web survey
SIQM-2: Contractor level of understanding of QM/ACCA/ASHRAE standards	• This could be obtained by including standards-specific questions, such as tasks performed • While awareness is important, it is also important to develop a closer understanding of the depth of understanding
SIQM-3: Percentage of contractors currently participating in QM programs	• This could be obtained using program tracking data
SIQM-4: Number of technicians with training in QM	• May be possible to derive using IOU training data

Note. These secondary indicators closely parallel indicators recommended by NMR Group in "Baseline Market Characterization Study: Residential and Small Commercial HVAC," CALMAC Study ID CPU0102.01 (2015)
[a] The secondary indicators expressed as percentages refer to numerators only. Denominator estimates should be based on the overall population, which could be defined using the California State License Board (CSLB) C-20 license list. This process would require a substantial amount of data processing, including steps to ensure there are no duplicates included in the list.

8. SUMMARY AND RECOMMENDATIONS

In this chapter, we present key findings from this study, and recommendations for moving forward.

8.1 Summary of Key Findings

Key findings are summarized for each of the five overarching research topics below. This is followed by a summary of notable differences across the research topics with respect to firm size and sector.

Awareness, Use, and Communication of Industry Standards

While a sizable minority of technicians report they are aware of industry standards, in most cases, the standards do not appear to be "top-of-mind." When asked in an *unprompted* question what codes or standards they use on a typical job, only 9% of technician respondents indicated that they use Quality Installation, Quality Maintenance, or ACCA/ASHRAE standards. However, when asked in *prompted* questions about their awareness of the standards, 41% said they were aware of ACCA 5 (installation), 34% were aware of ACCA 4 (residential maintenance), and 49% said they were aware of ACCA/ASHRAE 180 (commercial maintenance). City and state codes appear to be much more salient, with 60% of technicians mentioning city/municipal codes, and 51% mentioning state code, state building code, or Title 24.

Technicians are not generally learning about the standards from contractors. The most common ways that technicians reported learning about industry standards were through IHACI training or trade publications. Twelve percent of technicians reported learning of the standards through supervisors/contractors or other technicians. When contractors do share the standards with technicians, they may not always refer to them by name; none of the contractor interviewees described referring to the standards as "ACCA" or "ASHRAE" standards when communicating them to technicians.

Contractors participating in QI or QM programs may not always base their work on the standards. Three participating contractors reported basing their work on municipal codes or manufacturers' standards. Program implementers stated that they communicate the standards primarily through hands-on demonstrations that take place during technical trainings. However, contractors are not always required to attend these trainings, and in some cases one technician per firm attends the training and then shares the information with other technicians in the firm. Less than half of participating contractor interviewees referenced using the ACCA/ASHRAE standards, which could indicate a disconnect between technicians' use of the standards and contractors' awareness of the standards.

Most technicians aware of the industry standards report enacting them in the field, but it is unclear exactly how each of the tasks specified in the standards is being carried out. Of those who are aware of ACCA 5, 95% said they follow the majority or all of the standard's specifications on typical job; thus 39% of all respondents are both aware of the standard and follow the specifications. Of those who were aware of ACCA 4, 86% said they follow the majority or all of the standard's specifications on typical job, meaning 29% of all respondents are both aware of

the standard and follow the specifications. Finally of those who said they were aware of ACCA/ASHRAE 180, 88% said they follow the majority or all of the standard's specifications on typical job, meaning that 43% of technicians are both aware of the standard and follow the specifications. However, outside of the QI and QM Programs, which conduct QA/QC to ensure the standards are enacted in a consistent fashion, it is unclear exactly how the standards are being carried out in the broader marketplace.

When contractors follow up with technicians to ensure standards are enacted in the field, it is primarily by visiting job sites. Other ways contractors follow up is by conducting regular meetings, conducting regular trainings, and providing job checklists.

Terminology: Standards and Program Names

Technicians generally do not associate the terms "quality installation" and "quality maintenance" with the standards or with utility programs. When asked to define "quality maintenance" or "quality installation," technicians generally think of completing a job "the right way" or having a clean or neat system. Only 1% of respondents associated ACCA Standard 5 (titled “HVAC Quality Installation Specification”) with "quality installation," and 1% of respondents associated utility programs with "quality installation." None associated "quality maintenance" with the standards, and less than 1% associated "quality maintenance" with utility programs. The association of quality installation or quality maintenance with work that is "clean" or "neat" is very similar to the associations that customers make.[98] As identified in the Customer and Decision-Making Study, part of the issue appears to be that it is simply difficult to differentiate the term "quality" from the colloquial term meaning “good.”

Less than five percent of technicians associate the standards with a specific QI or QM program. Out of all respondents, only 3% were aware of the installation standard, ACCA 5, and associated it with a specific utility program name that they could correctly recall. For the maintenance standards, ACCA 4 and ACCA/ASHRAE 180, only 2% were aware of one of these standards and associated it with a specific utility program name that they could correctly recall. Part of the challenge may be the fact that the program names differ depending on the IOU.

Quality Contractor Best Practices

Quality contractors emphasize customer service. Implementers stated that successful QI and QM businesses place a strong investment in customer service and customer satisfaction. Similarly, according to market actors, successful QI/QM HVAC contractors build and retain good client relationships. Firms that already distinguish themselves with superior customer service are able to incorporate QI/QM standards more easily than other firms, because the value proposition of QI/QM is consistent with prioritizing customer satisfaction.

Quality contractors understand and internalize the value of QI and QM. Both the implementer and market actor interviews emphasized that quality contractors are those who understand and buy in to the value proposition of QI/QM. In turn, these contractors and the technicians at their firms have the ability to demonstrate the value of QI/QM to customers. One strategy for helping

[98] EMI Consulting (2015). *California HVAC Quality Installation/Quality Maintenance Customer Decision-Making Study.*

technicians sell QI/QM, identified in the market actor interviews, is to empower technicians so they correctly view their role as crucial in installing/maintaining systems that are energy efficient. According to the market actor interviewees, strong contractor leadership support of the value of quality installation and/or quality maintenance is essential, because technicians need support from leadership in the form of time for (1) training on QI/QM processes and the value proposition, and (2) completing all necessary steps required for QI/QM implementation.

Quality contractors are focused on continuous improvement. Market actors noted that contractors who successfully implement QI or QM are those who undertake and emphasize continuous training. The implementer interviewees also reported that successful contractors exhibit a willingness to invest in developing the skills of staff. Implementers also mentioned that a willingness to change practices, or having an openness to feedback, is also important. To ensure that QI/QM is delivered in the field, implementers emphasized that QA/QC must be performed on a regular basis, and that ideally it should be part of the contractor's internal process (not just something performed by an outside party such as a program implementer). Implementers advocated incorporating a continuous feedback loop into the program that allows for continuous learning opportunities between implementers and contractors/technicians.

Successful contractors leverage current customer relationships. Implementers stated that successful contractors tend to already have a large existing customer base. Because of the price-consciousness of most customers, firms with an existing customer base have more luck selling QI/QM work to their existing customers—with whom they have already established a relationship—than firms who attempt to sell QI/QM work to new customers. This may be due to the notion that customers are likely to avoid "switching costs" associated with seeking a new service provider. It may also reflect a need for additional sales training.

Quality contractors have established sound business and management practices. According to market actors, quality contractors have sound business operations, which provide a foundation for success. Operation processes common among these firms include a keen understanding of business financials, the ability to manage operational assets, and a focus on tracking sales and profitability. Because implementing QI or QM can increase the cost of jobs, having a clear handle on business fundamentals is critical in order to stay profitable.

Larger firms may be better equipped to participate in QI and QM programs. According to market actors, larger contracting firms with five or more employees are typically more successful at implementing QI/QM programs than smaller firms. This is because larger contracting firms tend to have more support staff (e.g., administrative, sales) available who can help manage and complete administrative tasks required for QI/QM program participation. In addition, these firms are also able to better absorb unexpected labor costs associated with return visits to job sites. It is unclear if larger firms are better able to implement QI/QM jobs outside of the programs.

Training

A combination of classroom and in-field training is viewed as most effective by contractors and market actors. While on the job training was rated as most effective by technicians (with 90% rating it as "very effective"), this type of training is likely extremely variable, as it is dependent on the knowledge, skills, and efficacy of the trainer.

Online training is consistently ranked as least effective by both contractors and technicians. Only 25% of technicians who had received training through an online source ranked it as "very effective." Only 7% on contractors in the Phase I study rated online HVAC courses as "very effective" for teaching the technical skills required to perform quality maintenance or quality installation.[99] While 38% of technicians rated online training as "effective," (38%) it was the lowest rated type of training overall. To be clear, we did not collect additional information on the source of online training; therefore it is unknown if particular sources of online training may be rated as more effective than others.

NATE certifications are highly valued by contractors. Nearly all of the contractor interviewees (25 out of 26, including participants and nonparticipants) stated that they look for NATE certification when hiring technicians. However, only 15% of technicians reported that they hold a NATE certification. NATE certifications were less common among technicians from smaller firms (one to four employees).

There appears to be a training need for technicians on the topics of airflow, building science, and HVAC fundamentals. When asked what topics technicians would like to receive training on, the most commonly mentioned topics included: staying up to date/learning about new technologies, chillers, airflow, controls, and heat pumps. Both market actor and implementer interviewees mentioned a need for technician training on building science. Both nonparticipating contractors and market actors mentioned a need for training on HVAC fundamentals.

Nearly one-third of technicians (32%) stated that they did not want any additional technical training. Furthermore, there were no topics mentioned by more than 11% of technician respondents. Those with more years of industry experience were more likely to state that they did not want any additional training, compared to those with fewer years of experience. This could be problematic, as it potentially reflects the idea that technicians "don't know what they don't know." A lack of awareness for the need for training is a challenge as it reflects an unwillingness to seek or receive training.

Most technicians play a role in sales and are interested in sales training. The vast majority of technicians reported being responsible for selling new HVAC equipment (89%) or selling maintenance agreements (85%) as part of their job. Overall, 73% of technicians responsible for sales indicated they were interested in sales training.

Market actors suggested educating technicians on the sales cycle of HVAC systems. Newer HVAC units may only require regular maintenance, whereas older systems may require service or even replacement. Being able to understand and convey the different service needs as systems age is important for the sales process.

Market actors suggested that the organizations that are best fit for conducting sales training include manufacturers, distributors, and private organizations. Manufacturers have specialized knowledge about their products, and distributors are experienced with selling specific brands, so these organizations are especially fit to review the technical knowledge component of sales. Private training organizations have professional sales trainers who focus on teaching sales techniques. One interviewee also suggested bringing in successful contractors to share

[99] *California HVAC Contractor & Technician Behavior Study, Final Report,* p. 61 and p. 75.

experiences selling QI and QM and to include examples of how customers have benefited from QI/QM.

Best practices in sales include basing the value proposition on quality, comfort, and efficiency, rather than cost. According to market actor interviewees, a successful value proposition for QI or QM is typically not cost-based. Although customers are highly motivated by cost savings,[100] QI and QM contractors are generally unable to compete solely based on price. Given that customers are unsure of the benefit of QI/QM above-and-beyond typical services,[101] it makes sense to approach the sale as "educating" the customer about the additional benefits, rather than trying to sell a service or product. This includes emphasizing the impact that QI/QM will have on reducing equipment failure and increasing energy efficiency, as long as these claims can be substantiated.

HVAC Market Transformation Indicators (MTIs)

A number of key terms will need to be defined before the MTIs can be operationalized or consistently measured. For MTI HVAC-1a and MTI HVAC-1b, the term climate appropriate must be clearly defined and a list of qualifying unit types developed. To measure MTI HVAC-2 and MTI HVAC-3, the IOUs will first need to define what is meant by a "residential contractor" and a "commercial contractor." Furthermore, a strict definition must be assigned to "using the QI guidelines" so that there is no room for misinterpretation.

Proximate indicators may help measure any market transformation that takes place in the near term. For example, as indicated by a previous study,[102] measuring changes in awareness and understanding would be useful to track, as awareness and understanding of the standards are necessary prior to implementing standards-based work.

Differences by Size and Sector

In addition to key findings particular to each of the five key research topics, there were some findings that spanned multiple topics. In particular, we note some differences across the size of technicians' firms, as well as differences by sector.

There were some notable differences by firm size. Technicians from small firms (one to four employees) appear to be more autonomous, as they are more likely to be responsible for sales and are less likely to need a supervisor's permission before making a repair. However, technicians from small firms were less likely to report holding a NATE certification and were less likely than technicians from larger firms to mention using checklists on the job. Technicians from medium sized firms (5 to 9 employees) were more likely than those from smaller firms to report receiving formal training such as “technical or trade school" or “private training institute" training. Technicians from larger firms (10 or more employees) tended to have less experience and were less likely to hold a C-20 license, compared to technicians from smaller firms. However, technicians from larger firms were more likely to have attended utility training, and reported a higher rate of awareness of ACCA 4.

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[100] EMI Consulting (2015). *California HVAC Quality Installation/Quality Maintenance Customer Decision-Making Study.*
[101] EMI Consulting (2015). *California HVAC Quality Installation/Quality Maintenance Customer Decision-Making Study.*
[102] NMR Group. (2015). *Baseline Market Characterization Study: Residential and Small Commercial HVAC.* CALMAC Study ID CPU0102.01.

There were also some notable differences by sector. Technicians assigned to the residential module were less likely than other technicians to report using manufacturer specifications when defining "quality installation" or "quality maintenance." Technicians assigned to the small commercial module were more likely to report distributor training and technical or trade school training compared to those assigned to the residential module. Technicians assigned to the large commercial module were more likely to report that they perform maintenance work compared to those assigned to the other two modules. These technicians were also more likely to mention participating in “private training institute” training, “online HVAC course training,” and “union apprenticeship training.” Selling new HVAC equipment or maintenance services seems to be a higher priority with large commercial customers compared to residential customers.

8.2 Recommendations

Transforming the HVAC marketplace in California will require ongoing efforts to address multiple gaps across various market actors, including the contractors and technicians who provide Quality Installation and Quality Maintenance services, as well as the customers who will ultimately demand these services. The recommendations below encompass many of these needs, including consistent and appropriate implementation of the ACCA/ASHRAE standards and effective branding and messaging for contractors, technicians, and customers. There is no "silver bullet" to transform the market; rather these recommendation are intended to work together to help move the market forward. Note that recommendations specific to the MTIs are not included here; instead they are included in Chapter 7.

1. Include guidelines for *how* to enact the standards when training technicians and contractors on the specifics of the ACCA/ASHRAE installation and maintenance standards. Specifically, the IOUs should incorporate industry how-to manuals into program trainings. For instance, ACCA publishes a “Technician’s Guide for Quality Installation” that equips practitioners with the knowledge to properly implement all the measurement procedures required in ACCA Standard 5.[103] As of the writing of this report, there is discussion and collaboration among the California utilities, the industry group Western HVAC Performance Alliance (WHPA), and ASHRAE to create a user's manual for Standard 180. This manual will serve to address the performance aspect of the specified maintenance tasks for commercial systems in a manner that will optimize energy efficiency. We also recommend undertaking a similar collaboration with industry organizations to develop how-to manuals where they do not yet exist, such as a user's manual for Standard 4. Together, these manuals will provide a necessary foundation for education and training of contractors and technicians.

2. Conduct case studies with technicians to better understand *how* the standards are currently enacted in the broader marketplace. These case studies could involve either shadowing technicians in their work or conducting covert field observations as in the Phase I study. The advantage of conducting covert observations is that the IOUs will learn how the tasks are typically carried out, without risking changes in behavior due to knowledge of the study (i.e., the Hawthorne effect). Conducting field observations of technicians working outside the programs will provide an in-depth understanding not just of what steps are taken to complete an installation

[103] https://portal.acca.org/onlinestorefront/ViewMerchandiseDetails.aspx?contextID=180ae9f5-00ce-ccb3-8dc6-0b376873e8d3

or maintenance job, but also how the tasks are conducted, which tools were used (if any), and how much time and attention is allotted to each task. Understanding the standard "baseline" practice will help inform where to focus training efforts.

3. Develop a proactive branding strategy. As recommended in the Phase I study, determine how the programs should be branded, and what the primary message should be based upon. To do this, we recommend that the IOUs develop several potential branding strategies and test these with contractors, technicians, and customers before adopting a strategy. We recommend using program names that can be differentiated from "good" installation or maintenance. The programs may choose to leverage the recognition of existing brands such as ENERGY STAR, but again, multiple possibilities should be tested before adopting a strategy. The IOUs should leverage their marketing departments' resources where they exist (e.g., PG&E has a Customer Insights team) in developing and testing the strategies. The strategy should be consistent across the IOUs, as mentioned in the Energy Efficiency Strategic Plan.[104] A proactive branding strategy will help increase customer and contractor/technician awareness of standards-based installation and maintenance. Marketing focused specifically on customers will help increase demand for these services; results of the Customer Decision-Making Study can be used to inform effective marketing messages. Contractors and technicians may also be more likely to recall branding that is distinguishable from "good" maintenance and installation.

4. Provide sales training to technicians. Making sure that technicians are being offered sales training, in addition to contractors and sales staff, is important because they are often the first point of contact with the customer for selling new equipment or maintenance agreements. Sales training should teach contractors, technicians, and sales staff how to speak to customers about sales in a language that customers will understand (e.g., downtime = revenue loss, using analogies such as car maintenance to discuss HVAC maintenance). If the training is provided via webinar, as in the past, effectiveness of the training should be carefully tracked; online training is viewed as least effective by contractors and technicians, and it is unknown if particular sources of online training are viewed as more effective than others.

5. Craft QI and QM training so contractors and technicians are well-versed in the value proposition. While selling to customers on price is important, emphasis on other benefits such as craftsmanship, comfort, reliability, and efficiency is needed. Buy-in from contractors and from technicians is necessary, as they are the ones selling QI and QM to customers, and if they do not believe in the value, it will be difficult at best to convince customers. Strong contractor leadership support will allow room for ongoing feedback and training. Empowering technicians so they correctly view their role as crucial in installing/maintaining systems that are energy efficient is equally important. However, to achieve buy-in from contractors and technicians, it will likely be necessary to show evidence of energy savings achieved by implementing the standards (see Recommendation # 6). Another technique that can be tried is to ask for verbal or written "commitments" by contractors and technicians and to personally involve them in crafting the value proposition that will work for them and their customers.

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[104] See Strategies 2-1 and 2-2 of the *California Long-Term Energy Efficiency Strategic Plan*, p. 57. Available at: http://www.cpuc.ca.gov/NR/rdonlyres/A54B59C2-D571-440D-9477-3363726F573A/0/CAEnergyEfficiencyStrategicPlan_Jan2011.pdf

6. Provide tools such as case studies and data that contractors and technicians can use to demonstrate energy savings and reliability to customers. Because customers' concerns about cost are the primary barrier to selling QI and QM, communicating the value proposition will be much easier if those selling standards-based services can show customers examples of how much other similar customers have saved. Furthermore, if the customers' prior billing data can be accessed, and compared to post-installation or post-maintenance billing data, customers can be provided with tangible feedback of how much they have actually saved. The programs may also be able to use currently available savings estimation tools compiled by the Western HVAC Performance Alliance.[105] This is the kind of information that is needed to transform the marketplace, because evidence of cost effective savings will drive demand among customers. For commercial customers, the Customer Decision-Making Study found that reliability was a common concern. Therefore, reliability should also be emphasized, if evidence of this can be obtained. To convey how reliability is improved by QI and QM, the IOUs could first collect data from participating commercial customers to illustrate "before" and "after" experiences. Another option is for the IOUs and/or program implementers to explore whether any participating contractors keep records on service calls made to commercial customers, and to compare this rate before program participation to after program participation.

7. To help build momentum in the marketplace for QI and QM services, consider pairing Quality Maintenance contracts with financing of new HVAC equipment purchases. Pairing a maintenance contract at the point of purchase, and including that contract in the financing, will help overcome cost barriers while ensuring that new HVAC equipment is properly maintained.

8. Educate customers about the training/certification requirements for trade allies to participate in the QI and QM programs. This should include information on what these certifications signify. The QI/QM programs already require technicians to hold a certification such as North American Technical Excellence (NATE), HVAC Excellence, Refrigeration Service Engineers Society (RSES), UA STAR, or Building Performance Institute (BPI) in order to participate. Educating customers about these requirements and what they mean will allow them to differentiate QI/QM services from standard practice. In turn, customers may begin to demand contractors/technicians with these credentials.

9. Design and teach ways to build QA/QC into contractors' internal processes. In order for market transformation to occur, sound standards-based practices and QA/QC must occur outside of required program processes. Teaching contractors how to build QA/QC into their ongoing processes will help them sustain quality practices even after the programs end.

[105] See http://www.performancealliance.org/SalesTraining/EnergySavingsEstimationTools/tabid/2472/Default.aspx

APPENDIX A: HVAC CONTRACTOR INTERVIEW GUIDE

Section A: Introduction/Screening

A1. Hi, I'm calling on behalf of <insert IOU Name>. If you qualify, we are offering a $75 Amazon.com gift card for your participation in a telephone interview. The goal of the interview is for the utility to better understand contractor experiences and perspectives on the maintenance and installation of HVAC units in California. Please be assured that all of your responses are confidential. Is this a good time (IF NOT, SET UP A CALLBACK)?

Great! I first have a few questions to see if you qualify for the study.

A2. What is your title or role at <Company Name>?

A3. **[If participant:]** Our records show your company is currently participating in the <Program Name> program with <IOU Name>. Is this correct?

- (IF UNAWARE, ASK TO SPEAK TO KNOWLEDGEABLE PERSON. IF "NO," MARK AS NONPARTICIPANT AND ASK "NONPARTICIPANT" RATHER THAN "PARTICIPANT" QUESTIONS THROUGHOUT REMAINDER OF INTERVIEW.)

A4. Is your company currently working in the HVAC industry? (IF NO, THANK AND TERMINATE.)

A5. Do you personally hold a C-20 license in the State of California? Please note that this information is strictly confidential and will not be shared with the state or used to take any negative actions against you or your company. (IF NO, ASK IF ANOTHER PERSON AT THE COMPANY HOLDS THE LICENSE. IF SO, ASK TO SPEAK TO THIS PERSON. IF NO ONE HAS A C-20 LICENSE, THANK AND TERMINATE.)

A6. How many employees, including yourself, work at your company? (IF MULTIPLE LOCATIONS, CLARIFY: "At this location.")

[IN ADDITION TO RESPONDENT, MUST HAVE AT LEAST ONE TECHNICIAN ON STAFF TO CONTINUE. IF ONLY ONE EMPLOYEE, THANK AND TERMINATE.]

A7. You have qualified for the study! The interview should take between 30 and 45 minutes, and if this is not a good time, I can set up an appointment for a later time or date. Are you willing to participate in this study?

____No (**thank and terminate,** or set up appointment/call back if so requested)
____Yes (continue)

Thank you. I am going to begin with some general questions about your company.

A8. Does your company work on residential systems, commercial systems, or both?

- About what percentage of your company's work -- in terms of the number of jobs completed, not revenue -- comes from:

  Residential Customers _____
  Small Commercial Customers _____ (e.g., customers with systems less than 10 tons in capacity)

Large Commercial Customers _____ (e.g., customers with systems that are 10 tons or greater)

A9. Does your company perform service calls? By service calls, we mean appointments that are made to fix a fault in HVAC system that either shuts the system down or inhibits the system's operation to the point that the customer detects a problem.

A10. Does your company perform maintenance visits? By maintenance, we mean checkups to inspect, test, measure, and preserve an HVAC system. (IF NEEDED: Maintenance is more preventative, compared to service.)

A11. Does your company perform new HVAC installations? By installations, we mean projects where the primary purpose is to install new equipment or replace existing equipment.

A12. Which utility service territories does your company operate within? (PROMPT IF NECESSARY.)

1 Pacific Gas and Electric Company
2 San Diego Gas & Electric
3 Southern California Edison
4 Southern California Gas
5 Los Angeles Department of Water & Power
6 Sacramento Municipal Utility District
7 Other _____
8 Other _____

IF TERMINATED DURING SCREENING: "Sorry, you do not qualify for the study. Thank you very much for your time."

Section B: Impacts of QI/QM Program Requirements

[Nonparticipants:]
B1. Some electric utilities offer HVAC programs designed to promote standards-based maintenance practices that improve the efficiency of existing residential and commercial systems, as well as proper installation practices. Has your company ever participated in a maintenance or installation program from a California utility?

- **[If no:]**
  - Have you heard of the <INSERT NAMES OF QI/QM PROGRAMS BASED ON SVC TERRITORY - REFERENCE BOX ON NEXT PAGE> programs prior to this call?
  - If so: Why hasn't your company participated?
  - Were there any particular program requirements (i.e., requirements for particular tools or skill standards that promote technician certifications) that made you decide not to participate? Please explain.
  - Did you anticipate any difficulties in selling the jobs? Why/why not?
- **[If yes, previously:]** Which program(s)?
  - What is the reason that you stopped participating?
  - Were there any particular program requirements (i.e., requirements for skill standards that promote technician certifications) that caused you to end participation? Please explain.
- **[If currently participating:]** Which program(s)? (IF NEEDED, PROMPT WITH NAMES OF QI/QM PROGRAMS BASED ON SVC TERRITORY - REFERENCE BOX ON NEXT PAGE)
  - Approximately how many quality maintenance service agreements has your company processed in the past two years? For which utilities?
  - Approximately how many quality installations has your company completed in the past two years? For which utilities? (IF NEEDED, PROMPT: PG&E, SCE, SDG&E)
  - (MARK AS PARTICIPANT AND ASK "PARTICIPANT" RATHER THAN "NONPARTICIPANT" QUESTIONS THROUGHOUT REMAINDER OF INTERVIEW.)

[QI Participants only:]
B2. In your opinion, what are the advantages of participating in <Name of QI Program>?

B3. Are there any particular program aspects or benefits that influenced you to participate in the program? Please explain.

B4. What are the disadvantages of participating, if any?

B5. Are there any program requirements (i.e., requirements for particular tools or skill standards that promote technician certifications) that have given you pause or that have ever made you consider terminating your participation in the program? Please explain.

B6. Are there any additional financial costs associated with participating in the <Name of QI Program>?

- **[If so:]** Have you found a way to mitigate these costs? Please explain.
    - Do the incentives your company receives help cover the costs? What percentage of the additional costs does the incentive cover?
    - Do customers sign over their rebates to your company? What percentage of the additional costs associated with your participation in the program are covered by having customers sign over their rebates?
    - Do some of the costs get passed on to customers?
- Thinking about the costs you incur as a part of participating in the <Name of QI Program>, what percentage of the cost do you pass on to customers, if any?

B7. What do you see as the benefits to customers of participating in the <Name of QI Program>?

- Are there any non-energy benefits? If so, please explain.

[QM Participants only:]
B8. In your opinion, what are the advantages of participating in <Name of QM Program>?

B9. Are there any particular program aspects or benefits that influenced you to participate in the program? Please explain.

B10. What are the disadvantages of participating, if any?

B11. Are there any program requirements (i.e., requirements for particular tools or skill standards that promote technician certifications) that have given you pause or that have ever made you consider ending your participation in the program? Please explain.

B12. Are there any additional financial costs associated with participating in the <Name of QM Program>?

- **[If so:]** Have you found a way to mitigate these costs? Please explain.
    - Do the incentives your company receives help cover the costs? What percentage of the additional costs does the incentive cover?
    - Do customers sign over their rebates to your company? What percentage of the additional costs associated with your participation in the program are covered by having customers sign over their rebates?
    - Are you passing any of these costs on to customers?
- Thinking about the costs you incur as a part of participating in the <Name of QM Program>, what percentage of the cost do you pass on to customers, if any?

B13. What do you see as the benefits to customers of participating in the <Name of QM Program>?

- Are there any non-energy benefits? If so, please explain.

Section C: Communication of Industry Standards

Next, I have some questions about some industry standards for HVAC work.

Residential Maintenance Standard [based on response to A7 and A9]

[If they perform Maintenance work with Residential Systems:]
C1a. The Air Conditioning Contractors of America, or ACCA, has defined standards for performing maintenance services on residential system. The standards are referred to as “ACCA Standard 4: Quality Maintenance of Residential HVAC Systems.” How do you incorporate these standards in how your company does its work?

[Ask C1b if respondent indicates awareness in C1a; else skip to C5a.]
C1b. How would you characterize your residential field technician’s knowledge of these standards?

[Ask C2 if respondent indicates technician knowledge in C1b; else skip to C5a.]
C2. Is the standard communicated to technicians or do you assume they already have the knowledge when they are hired?

- How is the standard communicated?

C3. How much of the standards' specifications do field technicians adhere to on typical residential maintenance visit: None, Some, the Majority, or All of the specifications?

[If C1b = "not at all knowledgeable" then skip to C5a; otherwise continue.]

C4. Is there any follow-up or QC process (outside of that associated with utility programs) to verify that technicians are adhering to the standards?
[If yes:]

- Please describe the type of follow-up that is conducted.
- Who conducts the follow-up?
- How often is follow-up conducted?

Commercial Maintenance Standard [based on response to A7 and A9]

I have a similar set of questions on commercial maintenance standards.

[If they perform Maintenance work with Commercial Systems:]
C5a. The Air Conditioning Contractors of America, or ACCA, along with the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE), have defined standards for performing maintenance services on commercial systems. The standards are referred to as "ACCA/ASHRAE Standard 180: Inspection and Maintenance of Commercial HVAC Systems." How do you incorporate these standards in how your company does its work? ?

[Ask C5b if respondent indicates awareness in C5a; else skip to C9a.]
C5b. How would you characterize your commercial field technician’s knowledge of these standards?

[Ask C6 if respondent indicates technician knowledge in C5b; else skip to C9a.]

C6. How much of the standards' specifications do field technicians adhere to on typical commercial maintenance visit: None, Some, the Majority, or All of the specifications?

C7. Is the standard communicated to technicians or do you assume they already have the knowledge when they are hired?

- How is the standard communicated?

[If C5b = "not at all knowledgeable" then skip to C9a; otherwise continue.]

C8. Is there any follow-up or QC process (outside of that associated with utility programs) to verify that technicians are adhering to the standards?
[If yes:]

- Please describe the type of follow-up that is conducted.
- Who conducts the follow-up?
- How often is follow-up conducted?

Installation Standard [ask if A9 or A10 = Yes]

Now I have some questions about standards for installation and major repairs.

[If they perform Installation work or perform major repairs:]
C9a. The Air Conditioning Contractors of America, or ACCA, has defined standards for performing HVAC installation as well as major repairs. The standards are referred to as "ACCA Standard 5: HVAC Quality Installation Specification." How do you incorporate these standards in how your company does its work ?

[Ask C9b if respondent indicates awareness in C9a; else skip to D1.]
C9b. How would you characterize your residential field technician's knowledge of these standards?

[Ask C6 if respondent indicates technician knowledge in C5b; else skip to D1.]
C10. How much of the standards' specifications do field technicians adhere to on typical installation job: None, Some, the Majority, or All of the specifications?

- Does this vary by whether it is a residential or commercial customer? **[Probe regarding whether there is difference between small commercial and large commercial, or residential/small commercial.]**
- How much of the specifications do they adhere to for major repairs of existing systems?

C11. Is the standard communicated to technicians or do you assume they already have the knowledge when they are hired?

- How is the standard communicated?

C12. Is there any follow-up or QC process (outside of that associated with utility programs) to verify that technicians are adhering to the standards?
[If yes:]

- Please describe the type of follow-up that is conducted.
- Who conducts the follow-up?
- How often is follow-up conducted?

Section D: Job Scheduling Process

Next, I would like to ask a few questions about scheduling maintenance and installation jobs.

D1. When you schedule a job, how do you determine how much time is allocated?

- **[If Participant:]** Does the amount of time differ for utility program jobs vs. regular jobs?]
- **[All:]** Does the amount of time differ for installation and maintenance jobs? If yes, how so?
- **[All:]** Does the amount of time differ for residential and commercial jobs, assuming you are only working with a single unit? If yes, how so?

D2. What other factors are considered when scheduling a job?

- What determines which technicians get assigned to a particular job?
- How does customer location factor into scheduling?
- Anything else?

D3. How much time is typically allotted for a maintenance visit?

- How about for a service call?
- How does this vary by residential/commercial?

D4. [If Residential:] How much time is typically allotted for a residential AC installation, assuming you are replacing existing equipment?

- **[Small Commercial:]** How about for an installation at a small commercial unit, assuming a capacity of less than 10 tons?
- **[Large Commercial:]** How about a large commercial unit? Assume a packaged rooftop unit serving a single zone -- no packaged VAV (variable air volume) or built-up systems -- and a capacity of between 10 and 50 tons.

D5. In general, do technicians have additional priorities when they are onsite completing a job, such as selling maintenance contracts or other services?

D6. What happens if a technician is unable to perform the required tasks in the time allocated for the appointment?

[Participants Only:]
D7. Are there any aspects of your business that are different because of your participation in <IOU Name>'s HVAC programs?
[If yes:]

- How so?
- Does this impact how you schedule appointments? How so?
- Does participating in the program change how your technicians interact with customers? If so, how?

Section E: Role of Training/Certifications

Next I would like to ask you some questions about technician training and certifications.

E1. How important is technician training to your company? Are there any routine training opportunities provided internally and/or at the time of hire?

- **[If technical training is provided:]** Is this in the classroom? In the field? A mixture of both? Does it include training on the ACCA/ASHRAE standards?

E2. When hiring technicians, do you look for certain types of certifications such as NATE, or previous training?

- **[If so:]** Which ones?
- Why do you prefer this type of training?

E3. Do any of your technicians hold certifications?

- **[If so:]** Which certifications are the most common?
- What particular skills does this/these certification(s) represent?
- In your opinion, how effective is this certification in ensuring that technicians have these skills?
- Are you confident that a technician with this certification meets the skill level specified by the certification? [If no: Why not?]

E4. In your opinion, what training method(s) is/are best at teaching someone the technical skills needed to perform HVAC maintenance?

- How about HVAC installation?
- How is this training best accomplished? Who is the best source of training (in house or external)?

Section F: Technical Training Needs

F1. Thinking about the technicians at your company, do you think additional training would be beneficial, and if so, in what areas?

- Do you think technicians could use additional training in test instrument selection? If so, which type(s) of instrument(s)?
- How about training in the use of test instruments (e.g., sensor placement)?
- How about test instrument calibration? If so, which instrument(s)?
    - How often do you calibrate instruments at your company?
- How about training in maintenance or installation protocols?
- Are there any other particular in-field tasks where training would be beneficial? If so, which task(s)?
- Anything else?

Section G: Sales and Sales Training

[If Maintenance (A10 = Yes)]
G1. Do the field technicians sell HVAC maintenance services directly to customers or is that a different employee's responsibility?

[If Installation: (A11 = Yes)]
G2. Do the field technicians recommend or sell new HVAC equipment directly to customers or is that a different employee's responsibility?

[If G1 or G2 = No (ELSE SKIP TO G5):]
G3. What is the title or role of the person(s) responsible for selling to customers?

G4. Do you think technicians should have a role in selling maintenance agreements or new HVAC systems to customers? If no: Why not?

[If G1 or G2 = Yes (ELSE SKIP TO G5):]
G5. Does your company provide field technicians training on selling new equipment?

- **[If so:]** Please explain.
- **[If not:]** Why not?

[If G4 or G5 = Yes:]
G6. What do you think is the best way to train technicians to sell maintenance agreements or new HVAC systems to customers?

- Do you offer sales incentives or technician recognition programs to encourage active participation in your sales effort?

[All Participants: (SKIP IF ANSWER TO G5 is "educational/marketing materials"]
G7. Are there any particular sales techniques your company has used to help customers understand the benefits of quality maintenance or quality installation?

- **[If yes:]** Please explain.
- Why do you think this has helped sales or increased maintenance agreements?

[All Participants:]
G8. Are there any particular educational or marketing materials that have helped customers understand the benefits of quality maintenance or quality installation?

- **[If yes:]** Please explain.

Section H: QI/QM Business Models

[If C3, C6, or C10 = Majority or All:]
H1. We would like to understand the characteristics of HVAC contractors that enable them to successfully perform a substantial number of quality installation or quality maintenance jobs with their customers. To your knowledge, is there anything particular about your business model or approach that has allowed your technicians to perform a lot of QI/QM jobs with their customers? Anything with respect to:

- time allotted for scheduling appointments
- how appointments are scheduled
- the pricing structure for maintenance agreements
- pricing of installations
- marketing materials
- particular sales pitches
- which technicians are sent to perform QI/QM jobs
- utility programs
- previous relationships with customers
- etc.

[For any mentioned in H1:]
H2. What is it about <X> that has enabled your business to perform the majority or all of your jobs according to ACCA or ASHRAE standards?

[If C3, C6, and C10 = None or Some:]
H3. Is there anything in particular that has prevented your company from performing more quality installation or quality maintenance jobs with your customers? Please explain.

Section J: Information for MTIs

[If they work with Residential systems, else skip to J3.]
J1. Of the HVAC systems you see at your residential customers' homes, what percentage would you say are climate appropriate? "Climate appropriate" means that the equipment meets the temperature, humidity, and ventilation needs of a building in a specific climate. Your best guess is fine. [IF NEEDED: For example, evaporative cooling can be an energy-efficient and cost effective cooling strategy, but will not be able to effectively meet temperature requirements in hot, humid climates. This would not be considered "climate appropriate."]

J2. What percentage of residential customers' systems would you say are both climate appropriate and energy efficient, meaning they exceed Title 24 requirements? Your best guess is fine.

[If they work with Commercial systems, else skip to K1.]
J3. How about your commercial customers' facilities, what percentage would you say are climate appropriate? "Climate appropriate" means that the equipment meets the temperature, humidity, and ventilation needs of a building in a specific climate. Your best guess is fine. [IF NEEDED: For example, evaporative cooling can be an energy-efficient and cost effective cooling strategy, but will not be able to effectively meet temperature requirements in hot, humid climates. This would not be considered "climate appropriate."]

J4. And for those commercial customers what percent would you say are both climate appropriate and energy efficient, meaning they exceed Title 24 requirements? Your best guess is fine.

Section K: Closing

K1. This concludes all the questions I have for you today. I have one last request before I verify your information for the incentive payment. We are conducting an additional survey with field technicians and would like to speak with some of the techs that work for your company. We offer them $50 and provide a flexible interview schedule that would not interfere with their work schedule. We are interested in hearing from technicians with a wide range of experience, including those who are new as well as those who have been in the industry for a while. Could you refer me to the names of individuals at your company that might be willing to complete our survey?

[If yes:] I can take up to two names.

1. Name: _____

Phone Number: _____

2. Name: _____

Phone Number: _____

K2. Thank you. Those are all the questions I have today. So we can email you your $75 Amazon gift card, please verify the spelling of your name and provide the email address where you would like it sent.

Name: _____

Email Address: _____

Your gift card will be sent within 2 weeks.

[**THANK AND TERMINATE**]

APPENDIX B: TECHNICIAN TELEPHONE SURVEY INSTRUMENT

Section S. Screening Questions

S1. Hello, this is <INTERVIEWER> calling on behalf of <IOU>. This is not a sales call. <IOU> is looking for feedback from HVAC technicians regarding their experience in the field. We are offering $50 to those who complete our survey. This information will be used to further the utility's understanding of the industry to assist with future program design. Is there an installation or maintenance technician available?

1. Yes, I am a technician [**CONTINUE TO S2A**]
2. Yes, let me transfer you [**SKIP TO S2B**]
3. No, no technicians are available right now (READ "COMMENT 1" BELOW)
4. No, not interested (READ "COMMENT 2" BELOW)
-8. Don't know (READ "COMMENT 1" BELOW)
-9. Hard Refusal [**THANK AND TERMINATE**]

(DO NOT READ COMMENTS UNLESS DIRECTED)

COMMENT 1: "I can take down their contact information and call them directly if that would be more convenient." (IF RESPONDENT AGREES, RECORD CONTACT INFORMATION FOR UP TO 3 TECHNICIANS, THEN THANK AND TERMINATE. OTHERWISE, MARK AS "CALL BACK.")

COMMENT 2: "I can take down their contact information and call them directly if that would be more convenient." (IF RESPONDENT AGREES, RECORD CONTACT INFORMATION FOR UP TO 3 TECHNICIANS, THEN THANK AND TERMINATE. OTHERWISE, THANK AND TERMINATE AND MARK AS "REFUSAL.")

S2A. [**CONTINUE WITH TECHNICIAN**] The survey should take about 15 minutes. If you are eligible and complete the survey, we will send you a $50 check. Your responses will be kept confidential. May I continue?

1. Yes **[SKIP TO S3]**
2. No, not now (CONFIRM NAME AND PHONE; RECORD DATE AND TIME TO CALL BACK) **[END CALL]**
3. No, not interested **[SKIP TO S8]**
-9. Hard Refusal [**THANK AND TERMINATE**]

S2B. [**ONCE TECHNICIAN IS ON LINE**] Hello, this is <INTERVIEWER> calling on behalf of <IOU>. This is not a sales call. <IOU> is looking for feedback from HVAC technicians regarding their experience in the field. We are offering $50 to those who complete our survey. This information will be used to further the utility's understanding of the industry to assist with future program design. The survey should take about 15 minutes. If you are eligible and complete the survey, we will send you a $50 check. Your responses will be kept confidential. May I continue?

1. Yes **[CONTINUE TO S3]**
2. Yes but not now (CONFIRM NAME AND PHONE; RECORD DATE AND TIME TO CALL BACK) **[END CALL]**
3. No, not interested [**SKIP TO S8**]
-9. Hard Refusal [**THANK AND TERMINATE**]

S3. Before we get started, I have a few questions to see if you qualify for this survey. Do you perform HVAC installation or maintenance fieldwork in the state of California?

1. Yes
2. No [**SKIP TO S9**]
3. Don't Know [**SKIP TO S9**]
-9. Hard Refusal [**THANK AND TERMINATE**]

S4. Based on the number of jobs you have completed, what percent of your work is performed with residential, small commercial, and large commercial customers? For this survey, please consider small commercial customers as those with systems less than 10 tons in capacity and large commercial as 10 tons or greater. What percent of jobs are with…

(IF NEEDED: Please answer based on the number of jobs completed in each sector, and not on revenue.) (IF NEEDED: Your best estimate is fine.)

A. Residential customers____% (RECORD PERCENT 0-100)
B. Small Commercial customers____% (RECORD PERCENT 0-100)
C. Large Commercial customers____% (RECORD PERCENT 0-100)

(VALUES MUST SUM TO 100%)

S5. For this survey, please consider the following definitions:

- By service calls, I mean appointments that are made to fix a fault in HVAC systems that either shuts the system down or inhibits the system's operations to the point that the customer detects a problem.
- By maintenance visits, I mean checkups to inspect, test, measure, and preserve an HVAC system.
- By installation jobs, I mean projects where the primary purpose is to install new equipment or replace existing equipment.

Using the definitions just provided, approximately what percent of your work, based on jobs completed, comes from service calls, maintenance visits, and installation jobs?

(IF NEEDED: Maintenance is more preventative, compared to service.) (IF NEEDED: Your best estimate is fine.)

A. Service calls ____% (RECORD PERCENT 0-100)
B. Maintenance visits____% (RECORD PERCENT 0-100)
C. Installation jobs____% (RECORD PERCENT 0-100)

(VALUES MUST SUM TO 100%)
[**IF S5.B = 0 AND S5.C = 0, SKIP TO S9**]

PROGRAMMING NOTE:
The following logic will be used to determine each technician's sector categorization, and questions will vary based on the sector to which they are assigned (stored as the variable <SECTOR>):

- If tech performs ≥ 10% large commercial work → <SECTOR> = LARGE COMMERCIAL.
- Otherwise, if tech performs ≥ 20% small commercial work → <SECTOR> = SMALL COMMERCIAL.
- Otherwise <SECTOR> = RESIDENTIAL.

S6. Which electric and gas service territories does your company operate within? (DO NOT READ RESPONSES; ACCEPT MULTIPLE RESPONSES)

1. Pacific Gas and Electric Company (PG&E)
2. San Diego Gas and Electric (SDG&E)
3. Southern California Edison (SCE)
4. Southern California Gas (SoCalGas or SCG)
5. Los Angeles Department of Water & Power (LADWP)
6. Sacramento Municipal Utility District (SMUD)
7. Other 1 (RECORD NAME OF UTILITY)
8. Other 2 (RECORD NAME OF UTILITY)
-8. Don't know

(IF THEY DO NOT MENTION ANY OF THE OPTIONS 1 THROUGH 4, PROBE TO CONFIRM: Do you operate within the territory of Pacific Gas and Electric, San Diego Gas and Electric, Southern California Edison, or Southern California Gas? **IF NO: THANK AND TERMINATE.**)

S7. Great! You have qualified for this survey. (IF NEEDED: The survey should take approximately 15 minutes to complete and we will mail you a $50 check within 3 weeks. All of your responses will be kept confidential.) [**SKIP TO A1**]

S8. Are there any other technicians at your firm who perform installation or maintenance work that might be interested in completing the survey in exchange for $50?
1. Yes (ASK TO SPEAK WITH THEM OR OBTAIN NAME AND PHONE NUMBER)
2. No (THANK AND TERMINATE - MARK AS "REFUSAL.")
3. Don't Know (ASK FOR NAME AND PHONE NUMBER FOR UP TO THREE TECHS)

S9. Unfortunately, you do not qualify for this study. Are there any other technicians at your firm who perform installation or maintenance work in California that might be interested in completing the survey in exchange for $50?

1. Yes (ASK TO SPEAK WITH THEM OR OBTAIN NAME AND PHONE NUMBER FOR UP TO THREE TECHS. LOOP TO S2A ONCE A TECH IS ON THE LINE, OR CALL NEW NUMBER AND BEGIN AT S1.)
2. No (THANK AND TERMINATE - MARK AS "DISQUALIFIED.")
3. Don't Know (ASK FOR NAME AND PHONE NUMBER FOR UP TO THREE TECHS. THANK AND TERMINATE.)

Section A. Background Information

First, I have some basic questions for classification purposes only.

A1. Including yourself, how many total employees work at your firm? (IF NEEDED: This would include both technicians and non-technicians.) (IF NEEDED: Your best estimate is fine.)

(RECORD NUMBER)
-8. Don't know

A2. Including yourself, how many of these are technicians? (IF NEEDED: Your best estimate is fine.)

(RECORD NUMBER)
-8. Don't know

A3. For how many years have you been working in the HVAC industry? Your best estimate is fine.

(RECORD NUMBER OF YEARS)
-8. Don't know

Section B. Training and Certifications (including key training needs)

Now I have some questions about training.

B1. I'll read a list of types of HVAC training. For each one I'd like you to tell me first if you received that type of training, and if so, how effective that training was in teaching you the technical skills needed to perform your work with <SECTOR> HVAC systems.. (READ EACH RESPONSE AND RECORD YES/NO; AFTER EACH YES, ASK;) Would you say that training was... (READ CHOICES)

[**RANDOMIZE RESPONSES EXCEPT FOR "OTHER"**]	(2) No	(9) DK	(1) Yes				
			Not at all effective	Somewhat effective	Effective	Very effective	DK
1. Technical or trade school	2	9	1	2	3	4	9
2. Community college							
3. Union apprenticeship							
4. Private training institute							
5. Online HVAC course							
6. Utility training							
7. Distributor training							
8. Manufacturer training							
9. IHACI training (I-HOCKEY)							
10. On the job training							

11. Any other training? (SPECIFY)							

B3. Which, if any, HVAC-related certifications or licenses do you hold? (DO NOT READ RESPONSES; ACCEPT MULTIPLE RESPONSES)

1. NATE (North American Technician Excellence)
2. HVAC Excellence
3. PAHRA/Industry Competency Exam (Partnership for Air-Conditioning, Heating, Refrigeration Accreditation)
4. TABB/ICB (Testing, Adjusting and Balancing Bureau / International Certification Board)
5. RSES (Refrigeration Service Engineers' Society)
6. UA STAR (United Association of Journeymen and Apprentices)
7. NCI (National Comfort Institute)
8. BPI (Buildings Performance Institute)
9. EPA refrigerant license
10. C-20
11. NADCA (National Air Duct Cleaners Association)
12. HERO (Home Energy Renovation Opportunity)
13. Other (SPECIFY)

-9. I do not hold any certifications or licenses

B4. Are there any specific HVAC topics or areas in which you wish you had additional training? (IF YES: Which topics or areas? IF NO: Code as -9) (DO NOT READ RESPONSES; ALLOW MULTIPLE RESPONSES UNLESS CODED AS -9.)

1. Fundamentals/Basics of HVAC systems
2. Performing proper calculations
3. Airflow
4. Controls
5. Electrical/wiring
6. Refrigerant charge verification
7. Selecting the right test instrument
8. How to use test instruments
9. How to calibrate test instruments
10. Installation protocols
11. Maintenance protocols
12. In-field tasks (PROBE: Any particular in-field tasks? USE RESPONSE CODES AS APPROPRIATE OR SPECIFY IN OPTION 15)
13. Customer service / how to interact with customers
14. Sales
15. Other (SPECIFY)

-8. Don't know

-9. None / don't want additional training

Section C. Technician Field Experiences

C0. For the remainder of this survey, I am going to ask you a number of questions about your work as a technician. I would like you to answer these questions specific to your work with <SECTOR> customers.

(NOTE: THE NEXT THREE QUESTIONS ARE VERY LONG - BUT EACH RESPONDENT IS ONLY READ MAINTENANCE TASKS IF THEY DO MAINTENANCE AND INSTALLATION TASKS ONLY IF THEY DO INSTALLATION. IF THEY DO BOTH INSTALLATION AND MAINTENANCE, THEY ARE READ A LIST OF 32 TASKS, WHICH IS TIME-CONSUMING, BUT NECESSARY.)
[RANDOMIZE ORDER OF C1 AND C2 FOR THOSE WHO RECEIVE BOTH SETS]

C1. [**IF THEY CONDUCT MAINTENANCE, S5.B > 0**] Which of the following tasks do you perform during a typical *<SECTOR> maintenance visit*? [**RANDOMIZE RESPONSES**]

(NOTE: KEEP NUMERING OF RESPONSES FOR CONSISTENCY ACROSS C1 - C3)

1. Inspect filters and clean/replace as needed
2. Inspect grilles, registers and diffusers for dirt
3. Visually inspect heat exchanger for signs of corrosion, dirt, or structural problems
4. Inspect condensing coil and clean/adjust as needed
5. Inspect evaporator coil and clean/adjust as needed

(THE TASKS 20 - 32 BELOW APPLY TO BOTH INSTALLATION AND MAINTENANCE)
[INCLUDE THE RESPONSES BELOW IF THEY ONLY DO MAINTENANCE AND DO NOT DO ANY INSTALLATION, S5.C = 0. IF THEY DO BOTH INSTALLATION AND MAINTENANCE, THEY WILL GET ASKED THESE IN C3.] [**RANDOMIZE RESPONSES**]
20. Inspect air filter housing integrity and air seal
21. Inspect all accessible ductwork for moisture or biological growth
22. Inspect integrity of all accessible ductwork insulation
23. Inspect integrity of all accessible ductwork including: duct strapping, hangers, sections, joints, and seams
24. Test system controls' modes of operation and control sequences
25. Measure airflow across heat exchanger/coil
26. Measure refrigerant charge
27. Inspect accessible refrigerant lines, joints, and coils for oil leaks
28. Inspect all electrical components
29. Inspect blower motors
30. Inspect cabinet, fasteners, and panels for seals and leaks
31. Inspect condensate drains and traps

[ONLY INCLUDE RESPONSE 32 BELOW IF SECTOR = SMALL COMMERCIAL OR LARGE COMMERCIAL] [INCLUDE RESPONSE 32 IN RANDOMIZATION WITH RESPONSES ABOVE]
32. Inspect economizers

C2. **[IF THEY DO INSTALLATION, S5.C > 0]** Which of the following tasks do you perform during a typical *<SECTOR> installation*? (READ RESPONSES AND RECORD YES/NO FOR EACH) [**RANDOMIZE RESPONSES**]

(NOTE: KEEP NUMERING OF RESPONSES FOR CONSISTENCY ACROSS C1 - C3)

6. Calculate sizing for equipment using Manual J
7. Install a matched indoor coil and outdoor unit, for AC & heat pump only
8. Test ductwork to determine maximum system size
9. Install new refrigerant lines, rather than reusing existing lines
10. Install programmable thermostat, if not already in use
11. Setup programmable thermostat with customer, if not already in use
12. Consider zoning, with separate temperature controls for different areas
13. Make repairs to existing ductwork if necessary

14. If insulating ducts, first seal all duct seams
15. Test to confirm that duct leakage does not exceed recommended levels
16. Show customer how to replace air filters
17. Leave all manuals with customer
18. Provide customer with documentation of installation procedures, including Manual J calculations, AHRI certificate, and records of any measurements or testing
19. Confirm proper levels of refrigerant and airflow

(THE TASKS 20 - 32 BELOW APPLY TO BOTH INSTALLATION AND MAINTENANCE)
[**INCLUDE THE RESPONSES BELOW IF THEY ONLY DO INSTALLATION AND DO NOT DO ANY MAINTENANCE, S5.B = 0. IF THEY DO BOTH INSTALLATION AND MAINTENANCE, THEY WILL GET ASKED THESE IN C3.**] [**RANDOMIZE RESPONSES**]
20. Inspect air filter housing integrity and air seal
21. Inspect all accessible ductwork for moisture or biological growth
22. Inspect integrity of all accessible ductwork insulation
23. Inspect integrity of all accessible ductwork including: duct strapping, hangers, sections, joints, and seams
24. Test system controls' modes of operation and control sequences
25. Measure airflow across heat exchanger/coil
26. Measure refrigerant charge
27. Inspect accessible refrigerant lines, joints, and coils for oil leaks
28. Inspect all electrical components
29. Inspect blower motors
30. Inspect cabinet, fasteners, and panels for seals and leaks
31. Inspect condensate drains and traps

[**ONLY INCLUDE RESPONSE 32 BELOW IF SECTOR = SMALL COMMERCIAL OR LARGE COMMERCIAL**] [**INCLUDE RESPONSE 32 IN RANDOMIZATION WITH RESPONSES ABOVE**]
32. Inspect economizers

C3. [**ASK IF THEY DO BOTH INSTALLATION AND MAINTENANCE, S5.B > 0 AND S5.C > 0**]
Now I am going to read a list of tasks that you might complete on either an installation job or a maintenance job. I would like you to tell me if you perform any of these tasks during a typical visit for *<SECTOR>* maintenance or *<SECTOR>* installation. You can also say both or neither. (READ RESPONSES AND RECORD IF YES FOR MAINTENANCE, INSTALLATION, BOTH, or NEITHER, FOR EACH) [**RANDOMIZE RESPONSES**]

(THESE TASKS 20 - 32 APPLY TO BOTH INSTALLATION AND MAINTENANCE)
(NOTE: KEEP NUMERING OF RESPONSES FOR CONSISTENCY ACROSS C1 - C3)

20. Inspect air filter housing integrity and air seal
21. Inspect all accessible ductwork for moisture or biological growth
22. Inspect integrity of all accessible ductwork insulation
23. Inspect the integrity of all accessible ductwork including: duct strapping, hangers, sections, joints, and seams
24. Test system controls' modes of operation and control sequences
25. Measure airflow across heat exchanger/coil
26. Measure refrigerant charge
27. Inspect accessible refrigerant lines, joints, and coils for oil leaks
28. Inspect all electrical components
29. Inspect blower motors
30. Inspect cabinet, fasteners, and panels for seals and leaks
31. Inspect condensate drains and traps

[**ONLY INCLUDE RESPONSE 32 BELOW IF SECTOR = SMALL COMMERCIAL OR LARGE COMMERCIAL**] [**INCLUDE RESPONSE 32 IN RANDOMIZATION WITH RESPONSES ABOVE**]
32. Inspect economizers

C4A. I am now going to read a list of considerations you may have when completing a <SECTOR> job. Please rate the extent to which each is a priority for you, using a scale from 0 to 10 -- where 0 is not at all a priority and 10 is very much a priority.
(READ EACH ITEM BELOW AND RECORD RATING)

1. Getting the job done on time
2. Following a specific set of procedures
3. Making sure the customer is happy
4. Making sure there are no safety issues with the equipment
5. Convincing the customer to buy more products or services
6. Making sure the system is functioning
7. Meeting customer expectations for the cost of the current job

[**RANDOMIZE RESPONSES**]

C4B. You rated the following considerations very highly: **[REMIND RESPONDENT OF TOP THREE OR FOUR RANKINGS FROM C4A (E.G., THOSE THEY RATED A "9" OR "10")]** Of those, what would you say are your 1st, 2nd, and 3rd priorities? (RE-READ IF NECESSARY)
(RECORD 1st, 2nd, and 3rd priorities in rank order)

1. Getting the job done on time
2. Following a specific set of procedures
3. Making sure the customer is happy
4. Making sure there are no safety issues with the equipment
5. Convincing the customer to buy more products or services
6. Making sure the system is functioning
7. Meeting customer expectations for the cost of the current job

C5a. **[IF THEY CONDUCT MAINTENANCE, S5.B > 0]** For jobs with <SECTOR> customers, how do you define "quality maintenance"? (DO NOT READ RESPONSES, CHECK ALL THAT APPLY)

1. General mention of Inspections/Testing
2. Complete or Proper - doing a job the "Right Way"
3. Inspecting Air Filters
4. Using a Checklist
5. Communicating Findings to the Customer
6. Peak/Optimum Performance
7. Inspecting Ductwork
8. Checking Refrigerant Charge
9. Customer is Satisfied
10. Inspecting Electrical Components
11. Inspecting Condensing Coil
12. Manufacturer Specifications
13. Cleaning the System
14. Using a Checklist
15. Utility Programs

16. ACCA Standard / ACCA Standard 4 / ACCA-ASHRAE Standard 180
17. Energy Efficient
18. Other (SPECIFY)
-8. Don't know

C5b. **[IF THEY DO INSTALLATION, S5.C > 0]** For jobs with <SECTOR> customers, how do you define "quality installation"? (DO NOT READ RESPONSES, CHECK ALL THAT APPLY)

1. In compliance with city/state Codes (e.g., California Title 24)
2. 'Correct' system and duct Sizing
3. Duct Sealing
4. A Clean looking or 'Neat' system
5. Customer is Satisfied
6. Peak/Optimum Performance
7. Manufacturer Specifications
8. Complete or Proper - doing a job the "Right Way"
9. Commissioning
10. Using a Checklist
11. Utility Programs
12. ACCA Standard / ACCA Standard 5
13. Energy Efficient
14. Other (SPECIFY)
-8. Don't know

C7. **[IF THEY CONDUCT MAINTENANCE, S5.B > 0]** Imagine that while you are onsite performing a maintenance job for a <SECTOR> customer, you identify a necessary repair that can be fixed in 30 minutes. What, if anything, might prevent you from making the repair? (DO NOT READ RESPONSES; ALLOW MULTIPLE RESPONSES)

1. Needing permission from a supervisor
2. Time constraints
3. Customer's cost concerns
4. Not having the necessary parts or equipment on hand
5. Nothing
6. Other (SPECIFY)
-8. Don't know

Section D. Awareness and Use of QI/QM Standards/Terminology/Programs

I am now going to ask some questions about codes and standards.

D1A. Do you follow any specific codes or standards during a typical <SECTOR> job?

1. Yes
2. No [**SKIP TO D2A**]
3. Don't Know [**SKIP TO D2A**]
-9. Refusal [**SKIP TO D2A**]

D1B. Which codes or standards do you follow during a typical <SECTOR> job? (DO NOT READ RESPONSES; ALLOW MULTIPLE RESPONSES)

1. City / municipal code
2. State code / state building code/ Title 24
3. ACCA/ASHRAE standards
4. Quality Installation / Quality Maintenance standards
5. SMACNA (Sheet Metal & Air Conditioning Contractors National Association) standards
6. HERS (Home Energy Rating System) requirements
7. Our firm's own procedures / Company checklist
8. Other 1 (SPECIFY)
9. Other 2 (SPECIFY)

D2A. [**IF THEY DO INSTALLATION, S5.C > 0**] Are you aware of "ACCA Standard 5: HVAC Quality Installation Specification," developed by Air Conditioning Contractors of America (ACCA)?

1. Yes
2. No
-8. Don't know

D2B. [**IF D2A = 1**] On a typical <SECTOR> installation job, what portion of the standards' specifications would you say you typically follow – none, some, the majority, or all of the specifications?

1. None
2. Some
3. Majority
4. All
-8. Don't know

D2C. [**IF D2A = 1**] Do you associate this installation standard with any utility-sponsored programs?

1. Yes
2. No
-8. Don't know

D2D. [**IF D2C = 1**] Which program or programs?

1. (RECORD VERBATIM)
-8. Don't know

D3A. [**IF <SECTOR> = RESIDENTIAL & IF THEY CONDUCT MAINTENANCE, S5.B > 0**] Are you aware of "ACCA Standard 4: HVAC Quality Maintenance of Residential HVAC Systems," developed by Air Conditioning Contractors of America (ACCA)?

1. Yes

2. No
-8. Don't know

D3B. **[IF <SECTOR> = SMALL COMMERCIAL OR LARGE COMMERCIAL & IF THEY CONDUCT MAINTENANCE, S5.B > 0]** Are you aware of "ACCA/ASHRAE Standard 180: Inspection and Maintenance of Commercial HVAC Systems," developed by Air Conditioning Contractors of America (ACCA) and ASHRAE?

1. Yes
2. No
-8. Don't know

D3C. **[IF D3A = 1 or D3B = 1]** On a <SECTOR> maintenance job, what portion of the standards' specifications would you say you typically follow – none, some, the majority, or all of the specifications?

1. None
2. Some
3. Majority
4. All
-8. Don't know

D3D. **[IF D3A = 1 or D3B = 1]** Do you associate this maintenance standard with any utility-sponsored programs?

1. Yes
2. No
-8. Don't know

D3E. **[IF D3D = 1]** Which program or programs?

1. (RECORD VERBATIM)
-8. Don't know

Section E. Communication of Industry Standards

E2. **[IF AWARE OF INSTALLATION STANDARD OR RES OR COMM MAINTENANCE STANDARD, D2A = 1 or D3A = 1 or D3B = 1]** How or from whom did you first become aware of the **[IF D2A = 1 or D3A = 1: "ACCA"; IF D3B = 1: "ACCA/ASHRAE"]** standards? (DO NOT READ RESPONSES; SINGLE RESPONSE ONLY)

1. Community college
2. Union apprenticeship
3. Private training institute
4. Online HVAC course
5. Utility training
6. Distributor training
7. Manufacturer training
8. IHACI training
9. Supervisor or another technician
10. "On the job experience"

11. Other (SPECIFY)
-8. Don't know

E4. [**IF AT LEAST TWO EMPLOYEES, A1 > 1 or A1 = -8**] What, if anything, does your supervisor do on a regular basis to make sure proper procedures are being followed in the field? (DO NOT READ RESPONSES; ALLOW MULTIPLE RESPONSES)

1. Visits job sites to inspect the work
2. Reviews paperwork or field notes
3. Seeks feedback from customers
4. Tracks the number of callbacks from customers
5. Conducts regular meetings to review work/procedures
6. Conducts regular trainings
7. Provides job checklist to follow
8. Other (SPECIFY)
9. Nothing
-7. Not applicable
-8. Don't know

Section F. Sales and Sales Training

I am now going to ask you a few questions about sales.

F1. [**IF THEY DO INSTALLATION, S5.C > 0**] Are you responsible for recommending or selling new HVAC equipment to <SECTOR> customers?

1. Yes
2. No
-8. Don't know

F2. [**IF F1 = 1 and AWARE OF QI STANDARD, D2A = 1**] What do you see as the primary barrier to selling installation services based on the ACCA installation standard to your <SECTOR> customers? (DO NOT READ RESPONSES)

1. I do not believe there is any value in doing standards-based installation
2. Customers do not understand the value of standards-based installation
3. Customers do not want to pay extra money for standards-based installation
4. We don't make enough money on standards-based installation jobs
5. I do not have the skills needed to perform standards-based installation
6. I have a hard time communicating the value of standards-based installation to customers
7. Customers cannot afford standards-based installation
8. No barriers
9. Other (SPECIFY)
-8. Don't know

F3. [**IF THEY CONDUCT MAINTENANCE, S5.B > 0**] Are you responsible for recommending or selling HVAC maintenance services to <SECTOR> customers?

1. Yes
2. No
-8. Don't know

F4. **[IF F3 = 1 and IF AWARE OF QM STANDARD, D3A = 1 or D3B = 1]** What do you see as the primary barrier to selling maintenance services based on the <**IF SECTOR = RESIDENTIAL:** "ACCA residential maintenance"; **IF SECTOR = SMALL COMMERCIAL OR LARGE COMMERCIAL:** "ACCA-ASHRAE commercial maintenance"> standard to your <SECTOR> customers? (DO NOT READ RESPONSES)

1. I do not believe there is any value in doing standards-based maintenance
2. Customers do not understand the value of standards-based maintenance
3. Customers are not willing to make long-term commitments
4. Customers do not want to pay extra money for standards-based maintenance
5. We don't make enough money on standards-based maintenance jobs
6. I do not have the skills needed to perform standards-based maintenance
7. I have a hard time communicating the value of standards-based maintenance services to customers
8. Customer do their own maintenance
9. Customers cannot afford standards-based maintenance
10. No barriers
11. Other (SPECIFY)
-8. Don't know

F5. **[{IF F1=1 or F3 = 1} & IF AT LEAST TWO EMPLOYEES, A1 > 1 or A1 = -8]** Did your company provide any training to you regarding how to sell or recommend new equipment or maintenance contracts to customers?

1. Yes
2. No
-8. Don't know

F6. **[IF F5=1]** How effective was this training? Would you say it was… (READ RESPONSES 1-4)

1. Not at all effective
2. Slightly effective
3. Effective
4. Very effective
-8. Don't know

F7. **[IF A1=1 and {F1=1 or F3=1}: "Do you think sales training would"]**
[IF F5 = 2 or -8: "Do you think sales training would"]
[IF F5 = 1: "Would additional sales training"] be helpful?

1. Yes
2. No
-8. Don't know

Section H: Closing

H1. Thank you. Those are all the questions I have today. So we can mail the $50 check to you, please verify the name and mailing address where you would like us to send it.

NAME (SPECIFY)
ADDRESS (SPECIFY)
STATE (SPECIFY)
ZIP (SPECIFY)

H2. **[IF SURVEYS HAVE NOT ALREADY BEEN COMPLETED WITH 3 TECHS FROM THAT FIRM]** Before I let you go, are there any other technicians at your firm who might be interested in completing the survey in exchange for $50?

1. Yes (ASK TO SPEAK WITH THEM OR OBTAIN NAME AND PHONE NUMBER)
2. No
3. Don't Know (ASK FOR NAME AND PHONE NUMBER FOR UP TO THREE TECHS)

H3. Thank you again. Your check will be sent within 3 weeks.

APPENDIX C: IMPLEMENTER & PROGRAM STAFF INTERVIEW GUIDE

[Note: Questions will be tailored according to whether we are talking to IOU program staff or third-party implementer staff.]

Section A: Introduction

A1. Hello, this is <Interviewer Name> from EMI Consulting. Thank you for your willingness to discuss the <QI/QM> program(s) with us. We're working with the California utilities to understand more about how Quality Installation and Quality Maintenance standards are communicated to contractors and technicians, as well as any program barriers and opportunities for improvement. As a reminder, the interview will last approximately an hour.

Is this still a good time for the interview?

[If not, reschedule.]

A2. What is your title or role at <Company>?

A3. How long have you been in this role?

Section B: Opportunities to Improve Training/Testing Criteria

B1. What credentials are required for contractors to participate in the [Name of Program]? For technicians?

B2. What types of training/testing are currently conducted through the QI/QM program?

- Who are the audiences for each type of training?

B3. For each type of training, when and how often are they conducted (when they join the program, ongoing basis or does something trigger the need for training)?

B4. How is the effectiveness of the current training offerings determined?

B5. Are there existing skill gaps that are not currently addressed by the training?

B6. Are there plans to develop additional training?

B7. How do utilities/third party vendors align with industry technician training initiatives or certification opportunities? With IOU WE&T programs?

Section C: Communicating Industry Standards to Contractors and Technicians

C1. How does your organization communicate ACCA/ASHRAE standards to participating contractors and technicians?

C2. Given that ACCA/ASHRAE standards are task-oriented, only addressing what tasks to complete and in what order to complete them, does your organization provide participating contractors and technicians with training on how to conduct the specified tasks?

- Can you provide me a few examples?

C3. Does your organization provide any materials that support contractors and technicians with applying the standards in their work?

- What kind of materials do you provide?

C3. How do contractors in your QI/QM programs communicate the programs' standards to technicians? Does your program play a role in the communication process (via materials or trainings with technicians)?

Section D: Ensuring Standards are Enacted in the Field

D1. What steps are taken to ensure that technicians are correctly using QI/QM standards in the field?

D2. Do implementers use a standardized Quality Assurance/Quality Control process to check the work of contractors and technicians participating in the QI/QM program?

- If so, what does this process involve? (site visits, phone calls, etc.)?

D3. Can you describe how contractors in the program(s) conduct QA/QC with their technicians?

D4. Could you describe what you consider the "best practices" for ensuring that techs are delivering QI/QM work in the field?

D5. How can quality assurance/quality control practices be improved in order to ensure the consistent application of QI/QM standards?

Section E: Best Practices and Contractor Business Models

E1. What business models or practices allow contractors to be successful at conducting QI/QM compared to standard installation and maintenance services? **[If the respondent takes a narrow view of success, such as "number of jobs," prompt them to consider success more broadly: includes proper application of the standards, in a way that is cost-effective to the business, resulting in customer satisfaction, etc.]**

- What characteristics or practices set the more successful contractors apart from the less successful contractors?
- What barriers exist to prevent QI/QM from becoming standard practice for an HVAC company?

Section F: Barriers to QI/QM Programs' Success

F1. What do you think prevents contractors from participating in QI/QM programs?

- Do you ask contractors who leave the program why they are leaving the program?
- Do you ask contractors who decline to participate why they're not participating?
- Do you ask contractors who stop participating why they've stopped participating?

F2. What, if anything, do you think prevents participating contractors and technicians from consistently performing jobs to QI/QM standards?

Section G: Input into Market Transformation Indicators

We are trying to help the utilities measure the impact of QI/QM programs on the HVAC market, and we are trying to understand how the program tracking data could help measure the market transformation indicators.

G1. Do the program tracking data contain information that could be used to estimate the total number of HVAC units in California?

- What are the benefits and drawbacks of using the tracking data for these purposes?

G2. Do the program tracking data contain information that could be used to estimate the total number of climate appropriate HVAC units? What about the total number of energy efficient and climate appropriate HVAC units?

- What are the benefits and drawbacks of using the tracking data for these purposes?

G3. Do the program tracking data contain the number of contractors who perform Qi/QM?

- What are the benefits and drawbacks of using the tracking data for these purposes?

G4. Do you track contractors who perform work according to the ACCA/ASHRAE standards, but do not participate in the QI/QM programs? (This is needed to measure the percentage of contractors performing QI/QM in California).

- How many are there?
- Who are they?

Section H: Closing

H1. In closing, would you be able to sum up and describe what a "quality contractor" looks like to you?

- Probe for aspects of training, sales, testing, business models, etc.
- What about technicians?

H2. Thank you for taking the time to talk with us and give feedback. Before we finish up, is there anything that we have not discussed that you think would help with our research? [**THANK AND TERMINATE**]

APPENDIX D: MARKET ACTOR INTERVIEW GUIDE

Section A: Introduction

A1. Hi, this is <Interviewer Name> from EMI Consulting. Thank you for your willingness to discuss the HVAC industry and QI/QM programs with us. We're working with the California utilities to understand what has been tried, what has worked (and what has not), and where the best opportunities and potential strategies lie for moving the California HVAC market forward. As a reminder, the interview will last approximately an hour.

Is this still a good time for the interview?

[**If not, reschedule.**]

A2. What is your title or role at <Company>?

A3. How many years of experience do you have in the HVAC industry?

Section B: Contractor Business Model

[**Note: Throughout the remainder of the interview, QI/QM refers to ACCA/ASHRAE standards, not utility programs - unless specified otherwise.**]

B1. What business models or practices allow contractors to be successful at conducting QI/QM, compared to standard installations and maintenance services? [**If the respondent takes a narrow view of success, such as "number of jobs," prompt them to consider success more broadly: includes proper application of the standards, in a way that is cost-effective to the business, resulting in customer satisfaction, etc.**]

- What characteristics or practices set the more successful contractors apart from the less successful contractors?
- Are there contractors that provide both QI/QM services and typical services? Why?

B2. What challenges or trade-offs do contractors face, from a business perspective, when implementing QI/QM projects?

B3. What factors do contractors consider when deciding to participate in the QI/QM programs?

Section C: Technician Field Practices

C1. Are there any unique challenges (e.g., scheduling, time required, logistics, tool requirements) to delivering QI/QM in the field in comparison to typical projects?

C2. What are some things that contractors can do to help address these challenges?

C3. What are best practices for ensuring that techs are delivering QI/QM in the field?

C4. In your experience, is ductwork maintenance generally included in maintenance contracts, or is maintenance of the unit considered separate from maintenance of the ductwork?
- Does this vary by type of customer (e.g., residential vs. large commercial)?
- [If not usually included:] Why not?
- How often is ductwork maintenance recommended to customers?

Section D: Sales Skills & Training

D1. From your experience, who in an HVAC company traditionally sells QI or QM?

D2. From your experience, what are the best methods for selling QI/QM services to customers?
- What is the best way to communicate the value of standards-based installation and maintenance to customers?
- How do you overcome the cost barrier for customers?

D3. What is the most effective way to provide sales training?
- Who should provide this training?
- Can you describe what the sales training might look like?
- What specific topics should be covered?

D4. Are there any particular educational or marketing materials that help customers understand the benefits of quality maintenance or quality installation?

D5. From your experience, what are the best methods for training contractor and technicians on the technical skills required to conduct QI/QM?

D6. What training or certifications should be required for contractors and technicians participating in QI/QM programs?
- What exactly should this training include?
- Should certifications, like NATE, be required?

D7. What type of testing is needed to ensure contractors and technicians participating in programs are able to correctly apply the standards?
- Who should provide this testing?

D8. How might the utilities/third party implementers best align with industry contractor and technician training or certification opportunities?
- Should the utilities have a role in training or certification?

D9. We have heard through some of our interviews that city codes or state codes such as Title 24 are perceived as being more stringent than the ACCA/ASHRAE standards. Do you agree with this?
- Why/why not?

Section E: Input into Market Transformation Indicators

We are trying to help the utilities measure the impact of QI/QM programs on the HVAC market, and we are trying to understand all the data sources that may be available. I have a few more questions to see if you might be aware of any sources that could help measure the market transformation indicators.

E1. Do you know where there is information available about the total number of HVAC units in California? Ideally, the data would be broken down into residential and non-residential types of HVAC units.

E2. Do you know where there is information available about the total number of climate appropriate HVAC units? About the total number of energy efficient and climate appropriate HVAC units?

E3. Do you know of any contractors who perform work according to the ACCA/ASHRAE standards, but do not participate in the QI/QM programs? (This is needed to measure the percentage of contractors performing QI/QM in California).

- How many are there?
- Who are they?

Section F: Closing

F1. In closing, would you be able to sum up and describe what a "quality contractor" looks like to you? A quality technician?

- Probe for aspects of training, sales, testing, business models, etc.
- How does it all fit together to make it work?

F2. Those are all the questions I have for you today. Is there anything else that I have not asked about that you think would be valuable for us to know and consider?

F3. Thank you for your time and insight into the HVAC industry. [**THANK AND TERMINATE**]

APPENDIX E: COMMENTS AND REVISIONS

This appendix includes a list of all significant comments received on the two draft versions of this report and how these comments were addressed in subsequent revisions.

E.1 Comments on the First Draft Report

The table below shows all substantial comments received on the first draft report, submitted April 3, 2015. These comments were received from members of the Project Team, representing the IOUs and the CPUC ED. Also shown is how the research team addressed each of these comments.

Table E-1: Comments Received on First Draft

Comment	How Comment was Addressed
Explain the reasoning for focusing on ASHRAE and ACCA standards.	Added explanation at end of section 1.1.
Did the technician survey sample frame largely exclude participating contractors?	No changes were made to address this comment. This is already explained in section 2.2. (We included participating firms. The proportion of completed surveys with technicians from participating firms was similar to the proportion of participating contractors in the population.)
Define what is considered "multiple projects" for the contractor interviews.	Changed wording from "multiple projects" to "above the median number of projects" in section 2.3.
Explain how you located the individual technicians.	We added an explanation is section 2.4.
Does treating any contractor who does at least 10% of its jobs for large commercial actually *over*state the percentage of contractors who are really focused on large commercial?	Added a footnote in section 2.4 to address this.
Be clear the goal was never to generalize the contractor interviews.	Made this clear in section 2.6.
Define HVACRedu.	This is now defined in section 3.1
Provide a more complete definition of what is meant by 'standards-based' if not already provided.	Added a description in section 3.4
Did you ask if the respondent happened to be the owner/manager of the company? If so, explore whether there were any differences between them and non-owner/managers.	We did not ask this, and thus no additional analyses were conducted.
Make sure selected quotes illustrate the point being made in the text, and make sure they are not too generic.	Replaced quote in section 4.1. Moved quote in section 5.1 to 5.2.
Remove discussion centered on one response unless the response illustrates a broader.	Deleted comment from one implementer regarding the desire to terminate underperforming contractors in section 3.3. Removed a comment from one market actor in section 3.2 regarding slimmer profit margins for QM compared to QI. Removed comment in 4.3 about training being more successful with technicians who grew up with computers. Removed description of one respondent regarding sales incentives in section 5.4.
Draw parallels in contractor results chapter to key findings from the customer decision-making study.	Added findings from the CDM study about customers rating system reliability highly
Note that ED's upstream HVAC impact evaluation work order includes a task to work on a distributor-based sales tracking system.	We have added a reference to this in Chapter 7.
Given the support for NATE in the market, is it possible that getting behind NATE more strongly would be a better strategy to support improved installation and maintenance practices than the current programs?	Several certifications denote competency in QI/QM. Rather than promoting NATE specifically, we added a recommendation to educate customers about the training/certification requirements for trade allies to participate in the QI/QM programs.
Where can we get a foothold to build market momentum? One possibility is tying QI/QM to equipment rebates through some sort of umbrella HVAC branding/programming strategy. The upstream HVAC program might be a good source of leverage.	Because the Upstream Program targets distributors, this may not be feasible. In speaking with the expert panel for this study, we understand that this would be problematic because distributors are not likely to want to play this role. However, we have included a recommendation on pairing QM with financing of new equipment installations.
Define distributor training, private training institute training, and IHACI training.	Added explanation in section 6.2.
Keep in mind that what a technician considers to be effective training may or may not be correlated with energy efficiency/optimization work.	Added a footnote to indicate this in section 6.2.

Comment	How Comment was Addressed
Is it possible there are sector specialization effects? For example, is a commercial job done by a contractor classified as residential different than a commercial job done by a contractor classified as commercial, because of the differing market niches occupied by the contractor?	We are unable to test this because we tailored questions specifically to how we classified the technicians (for example "residential" technicians were only asked about residential jobs).
Did we ask technicians about formal education?	Included a statement in section 6.2 about formal training.
Do we know if the respondent is the contractor?	Added a footnote in section 6.6 explaining that C-20 license holders were more likely to be responsible for sales.
Possible explanation for why technicians at smaller firms are more likely to sell maintenance agreements is that there may be increased specialization in larger firms.	Added this as a possible explanation in section 6.6
Provide an overall summary of differences across contractor size categories and sector.	We added this to section 6.7.
Consider putting the implementer and market expert interviews first, and then in the contractor and technician sections trying to assess the extent to which implementers' and market experts' perceptions of the market appear to be accurate. Add more systematic integration across data sources.	Moved the implementer and market actor chapters first. Added comparisons where relevant throughout the chapters.
Much discussion has centered on the small/medium/large firm segmentation as well as the residential/small commercial/large commercial segmentation scheme. For purposes of program planning, does EMI observe that one of these segmentation strategies offers a more definitive/actionable differentiation? If so, or even if not, could you include a brief discussion? Are there other segmentation schemes EMI thinks would make more sense?	We added a summary of findings across firm size and across sector, in both sections 6.7 and 8.1. There are not other segmentation schemes that we analyzed for this study and thus we have not included a discussion of others. We have not added any recommendations that center on segments. It is possible that there are additional recommendations we could make based on firm size, but we are hesitant to add additional recommendations (there are already 10). We are happy to add a recommendation if the project team feels strongly about this.
What is the significance of sales figures for climate appropriate/efficient HVAC systems?	Added a reference to the Long-Term Energy Efficiency Strategic Plan in section 7.2.
Eliminate passive sentences where possible.	We removed passive voice in many instances in the report.
Delete unnecessarily wordy text.	We have deleted text throughout the report.

E.2 Comments on the Second Draft Report

The table below shows all substantial comments received on the second draft report, submitted April 17, 2015. The table also includes any comments received during the public webinar held April 24, 2015. Also shown is how the research team addressed each of these comments.

Table E-2: Comments Received on the Second Draft

Comment	How Comment was Addressed
Was it clear in this research that QI/QM is associated with ACCA/ASHRAE standards?	We have made no changes, as this is already addressed in the report. As noted on p. 1 of the report, " For the purposes of this study, the term "quality Installation" and its initials "QI" refer to ACCA Standard 5. "Quality maintenance" and its initials "QM" refer to ACCA Standard 4 (Residential), and ASHRAE/ACCA Standard 180-2008 (Commercial)." When we do refer to programs based on these standards, we refer to them as QI/QM *programs*.
Change QI/QM to "QI and QM."	We made this change in bold headings throughout the Key Findings and Recommendations (Chapter 8). For brevity, we have left the phrase "QI/QM" in other places in the report.
Recommendation #1: Clarify what the IOUs are being asked to do.	We have clarified this in the recommendation.
Recommendation #2: Should the observations be covert?	We added and explanation to this recommendation, stating that the observations would ideally be covert.
Recommendation #3: Does it make sense to leverage Energy Star with the proactive branding strategy?	We have added this to Recommendation #3 as a potential strategy to use.
Consider combining recommendations #3 and #4.	We deleted Recommendation #4 and added a sentence to Recommendation #3 regarding differentiating the program names from "good" installation or maintenance.
Make it clear that the source of online training is unknown. The online training currently used by the programs tracks metrics to ensure effectiveness.	We made this clear both in Key Findings (section 8.1) and in Recommendation #4.

APPENDIX F: RECOMMENDATIONS TABLE

Study ID	Study Type	Study Title	Study Manager
SCE0375.01	Market Research	California HVAC Contractor and Technician Behavior Study, Phase II	SCE

Recommend-ation	Program or Database	Summary of Findings	Additional Supporting Information	Recommendation	Recommendation Recipient	Affected Workpaper or DEER
1	Quality Installation/ Quality Maintenance	Although a sizeable minority of technicians stated that they use most or all of the specifications on the job in prompted questions (pp. 61, 64), very few (9%) spontaneously reported using the standards when asked in an open-ended question. (p. 57) This may not be that surprising, as the ACCA/ASHRAE industry standards were developed from best practices in the field. Furthermore, while the majority of technicians indicated they complete most of the maintenance or installation tasks specified in the standards on a typical job, it is unclear exactly *how* technicians are performing these tasks. (p. 17)		Include guidelines for how to enact the standards when training technicians and contractors on the specifics of the ACCA/ASHRAE installation and maintenance standards. Specifically, the IOUs should incorporate industry how-to manuals into program trainings. For instance, ACCA publishes a "Technician's Guide for Quality Installation" that equips practitioners with the knowledge to properly implement all the measurement procedures required in ACCA Standard 5. As of the writing of this report, there is discussion and collaboration among the California IOUs, the industry group Western HVAC Performance Alliance (WHPA), and ASHRAE to create a user's manual for Standard 180. This manual will serve to address the performance aspect of the specified maintenance tasks for commercial systems in a manner that will optimize energy efficiency. We also recommend undertaking a similar collaboration with industry organizations to develop how-to manuals where they do not yet exist, such as a user's manual for Standard 4. Together, these manuals will provide a necessary foundation for education and training of contractors and technicians.	ACCA/ASHRAE with IOU support. IOUs to include guidelines in program training.	
2	Quality Installation/ Quality Maintenance	See #1 above. While QA/QC is performed with contractors and technicians participating in the QI/QM programs, we have no insight into how technicians are performing these tasks outside of the programs. (p. 66)		Conduct case studies with technicians to better understand how the standards are currently enacted in the broader marketplace. These case studies could involve either shadowing technicians in their work or conducting covert field observations as in the Phase I study. The advantage of conducting covert observations is that the IOUs will learn how the tasks are typically carried out, without risking changes in behavior due to knowledge of the study (i.e., the Hawthorne effect). Conducting field observations of technicians working outside the programs will provide an in-depth understanding not just of what steps are taken to complete an installation or maintenance job, but also how the tasks are conducted, which tools were used (if any), and how much time and attention is allotted to each task. Understanding the standard "baseline" practice will help inform where to focus training efforts.	IOUs	
3	Quality Installation/ Quality Maintenance	Technicians generally do not associate the terms "quality installation" and "quality maintenance" with the standards or with utility programs. When asked to define "quality maintenance" or "quality installation," technicians generally think of completing a job "the right way" or having a clean or neat system. (p. 58) Only 1% of respondents associated ACCA Standard 5 with "quality installation" and 1% of respondents associated utility programs with "quality installation." (p. 62) None associated "quality maintenance" with the standards and less than 1% associated "quality maintenance" with utility programs. (p. 65) The association of quality installation or quality maintenance with work that is "clean" or "neat" is very similar to the associations that customers make. (pp. 61, 110) As identified in the Customer and Decision-Making Study, part of the issue appears to be that it is simply difficult to differentiate the term "quality" from the colloquial term meaning "good." (see reference to right) When prompted, less than five percent of technicians associate the standards with a specific QI or QM program. Out of all respondents, only 3% were aware of the installation standard, ACCA 5, and associated it with a specific utility program name that they could correctly recall. (p. 62) For the maintenance standards, ACCA 4 and ACCA/ASHRAE 180, only 2% were aware of one of these standards and associated it with a specific utility program name that they could correctly recall. (p. 65)	EMI Consulting, "California HVAC QI/QM Customer Decision-Making Study." (2015) (pp. 42, 64, 88, 112)	Develop a proactive branding strategy. As recommended in the Phase I study, determine how the programs should be branded, and what the primary message should be based upon. To do this, we recommend that the IOUs develop several potential branding strategies and test these with contractors, technicians, and customers before adopting a strategy. We recommend using program names that can be differentiated from "good" installation or maintenance. The programs may choose to leverage the recognition of existing brands such as ENERGY STAR, but again, multiple possibilities should be tested before adopting a strategy. The IOUs should leverage their marketing departments' resources where they exist (e.g., PG&E has a Customer Insights team) in developing and testing the strategies. The strategy should be consistent across the IOUs, as mentioned in the Energy Efficiency Strategic Plan. A proactive branding strategy will help increase customer and contractor/technician awareness of standards-based installation and maintenance. Marketing focused specifically on customers will help increase demand for these services; results of the Customer Decision-Making Study can be used to inform effective marketing messages. Contractors and technicians may also be more likely to recall branding that is distinguishable from "good" maintenance and installation.	IOUs and CPUC	

Recommend -ation	Program or Database	Summary of Findings	Additional Supporting Information	Recommendation	Recommendation Recipient	Affected Workpaper or DEER
4	Quality Installation/ Quality Maintenance	Most technicians play a role in sales and are interested in sales training. The vast majority of technicians reported being responsible for selling new HVAC equipment (89%) or selling maintenance agreements (85%) as part of their job. Overall, 73% of technicians responsible for sales indicated they were interested in sales training. (pp. 67-70) Market actors suggested that customers understand the value of QI/QM better when it is put in terms that are familiar to them, which is often related to quality and comfort. (p. 27) Technicians were least likely to rate "online HVAC course training" as very effective (although the particular source of online training technicians had received is unknown). (p. 43)		Provide sales training to technicians. Making sure that technicians are being offered sales training, in addition to contractors and sales staff, is important because they are often the first point of contact with the customer for selling new equipment or maintenance agreements. Sales training should teach contractors, technicians, and sales staff how to speak to customers about sales in a language that customers will understand (e.g., downtime = revenue loss, using analogies such as car maintenance to discuss HVAC maintenance). If the training is provided via webinar, as in the past, effectiveness of the training should be carefully tracked; online training is viewed as least effective by contractors and technicians, and it is unknown if particular sources of online training are viewed as more effective than others.	IOUs (utilizing sales trainers)	
5	Quality Installation/ Quality Maintenance	Both the implementer and market actor interviews emphasized that quality contractors are those who understand and buy in to the value proposition of QI/QM. (pp. 18, 21) In turn, these contractors and the technicians at their firms have the ability to demonstrate the value of QI/QM to customers. One strategy for helping technicians sell QI/QM, identified in the market actor interviews, is to empower technicians so they correctly view their role as crucial in installing/maintaining systems that are energy efficient. (p. 88) Although customers are highly motivated by cost savings, QI/QM contractors are generally unable to compete solely based on price. (p. 19, 23) Given that customers are unsure of the benefit of QI/QM above-and-beyond typical services, it makes sense to approach the sale as "educating" the customer about the additional benefits, rather than trying to sell a service or product. (p. 26) This includes emphasizing the impact that QI/QM will have on reducing equipment failure and increasing energy efficiency, as long as these claims can be substantiated. (see reference to right)	EMI Consulting, "California HVAC QI/QM Customer Decision-Making Study." (2015) (pp. 49, 71, 93, 121)	Craft QI and QM training so contractors and technicians are well-versed in the value proposition. While selling to customers on price is important, emphasis on other benefits such as craftsmanship, comfort, reliability, and efficiency is needed. Buy-in from contractors and from technicians is necessary, as they are the ones selling QI and QM to customers, and if they do not believe in the value, it will be difficult at best to convince customers. Strong contractor leadership support will allow room for ongoing feedback and training. Empowering technicians so they correctly view their role as crucial in installing/maintaining systems that are energy efficient is equally important. However, to achieve buy-in from contractors and technicians, it will likely be necessary to show evidence of energy savings achieved by implementing the standards (see Recommendation # 6). Another technique that can be tried is to ask for verbal or written "commitments" by contractors and technicians and to personally involve them in crafting the value proposition that will work for them and their customers.	IOUs, working with industry training organizations (see http://www.performancealliance.org/SalesTraining/SalesTrainers/tabid/2457/Default.aspx)	
6	Quality Installation/ Quality Maintenance	Market actor interview respondents added that customer testimonies can greatly help to illustrate value and build a contracting firm's reputation (p. 23). Another respondent commented that it would be very helpful to contractors if utilities could provide evidence of energy and cost savings due to participation in QI/QM to show value to customers. Best practices in sales include basing the value proposition on craftsmanship, comfort, and efficiency, rather than cost. (pp. 18, 22)	EMI Consulting, "California HVAC QI/QM Customer Decision-Making Study." (2015) (pp. 44, 66, 116)	Provide tools such as case studies and data that contractors and technicians can use to demonstrate energy savings and reliability to customers. Because customers' concerns about cost are the primary barrier to selling QI and QM, communicating the value proposition will be much easier if those selling standards-based services can show customers examples of how much other similar customers have saved. Furthermore, if the customers' prior billing data can be accessed, and compared to post-installation or post-maintenance billing data, customers can be provided with tangible feedback of how much they have actually saved. The programs may also be able to use currently available savings estimation tools compiled by the Western HVAC Performance Alliance. This is the kind of information that is needed to transform the marketplace, because evidence of cost effective savings will drive demand among customers. For commercial customers, the Customer Decision-Making Study found that reliability was a common concern. Therefore, reliability should also be emphasized, if evidence of this can be obtained. To convey how reliability is improved by QI and QM, the IOUs could first collect data from participating commercial customers to illustrate "before" and "after" experiences. Another option is for the IOUs and/or program implementers to explore whether any participating contractors keep records on service calls made to commercial customers, and to compare this rate before program participation to after program participation.	IOUs	
7	Quality Installation/ Quality Maintenance	Those who were responsible for selling new equipment and also aware of ACCA 4 were asked what they see as the primary barrier to selling installation services based on the standard. The most common response was that customers do not want to pay extra money for the service (43%). (p. 68) Responses were similar for barriers to selling standards-based maintenance services. Again, technicians frequently cited customers' unwillingness to pay any extra money for standards-based maintenance as the top barrier (cited by 35% of technicians overall). (p. 71)	EMI Consulting, "California HVAC QI/QM Customer Decision-Making Study." (2015) (pp. 42, 64, 88, 112)	To help build momentum in the marketplace for QI and QM services, consider pairing Quality Maintenance contracts with financing of new HVAC equipment purchases. Pairing a maintenance contract at the point of purchase, and including that contract in the financing, will help overcome cost barriers while ensuring that new HVAC equipment is properly maintained.	IOUs	
8	Quality Installation/ Quality Maintenance	Technicians participating in the programs are usually required to have obtained formal education or certification. (p. 15)	EMI Consulting, "California HVAC QI/QM Customer Decision-Making Study." (2015) (pp. 42, 64, 88, 112)	Educate customers about the training/certification requirements for trade allies to participate in the QI and QM programs. This should include information on what these certifications signify. The QI/QM programs already require technicians to hold a certification such as North American Technical Excellence (NATE), HVAC Excellence, Refrigeration Service Engineers Society (RSES), UA STAR, or Building Performance Institute (BPI) in order to participate. Educating customers about these requirements and what they mean will allow them to differentiate QI/QM services from standard practice. In turn, customers may begin to demand contractors/technicians with these credentials.	Training organizations and/or certifying bodies, with support of IOUs and CPUC. IOUs to include as part of program messaging to customers.	

Recommend -ation	Program or Database	Summary of Findings	Additional Supporting Information	Recommendation	Recommendation Recipient	Affected Workpaper or DEER
9	Quality Installation/ Quality Maintenance	According to the market actor interviewees, strong contractor leadership support of the value of quality installation and/or quality maintenance is essential, because technicians need support from leadership in the form of time for (1) training on QI and QM processes and the value proposition, and (2) completing all necessary steps required for QI and QM implementation. (p. 21) According to implementers, a major barrier to QI and QM programs' success is that most contractors' business models do not include the robust internal processes necessary to consistently perform work to ACCA/ASHRAE standards. (p. 19) All of the third-party implementers and program staff emphasized the essential role QA/QC plays in enforcing standards in the field. (p. 19)		Design and teach ways to build QA/QC into contractors' internal processes. In order for market transformation to occur, sound standards-based practices and QA/QC must occur outside of required program processes. Teaching contractors how to build QA/QC into their ongoing processes will help them sustain quality practices even after the programs end.	Training organizations, ACCA/ASHRAE. IOUs to include training as part of program.	
MTI Recommend -ations	Quality Installation/ Quality Maintenance	A number of key terms will need to be defined before the MTIs can be operationalized or consistently measured. For example, for MTI HVAC-1a and MTI HVAC-1b, the term "climate appropriate" must be clearly defined and a list of qualifying unit types developed. (p. 78) To measure MTI HVAC-2 and MTI HVAC-3, the IOUs will first need to define what is meant by a "residential contractor" and a "commercial contractor." (p. 81) Furthermore, a strict definition must be assigned to "using the QI guidelines" so that there is no room for misinterpretation. (p. 81)		See detailed Considerations and Recommendations in Chapter 7 of the report.	IOUs, CPUC, along with industry collaboration (e.g., ACCA/ASHRAE)	
MTI Recommend -ations	Quality Installation/ Quality Maintenance	Proximate indicators may help measure any market transformation that takes place in the near term. For example, measuring changes in awareness and understanding would be useful to track, as awareness and understanding of the standards are necessary prior to implementing standards-based work. (p. 76)	NMR Group, "Baseline Market Characterization Study: Residential and Small Commercial HVAC," CALMAC Study ID CPU0102.01 (2015) (pp. 70, 91)	See detailed Considerations and Recommendations in Chapter 7 of the report.	IOUs, CPUC	