

Lawrence Berkeley National Laboratory

LBL Publications

Title

A Survey of Direct Heating Equipment Market Actors in California

Permalink

<https://escholarship.org/uc/item/63h55425>

Authors

Blum, Helcio

Franco, Victor H

Price, Sarah K

Publication Date

2023-12-14

Copyright Information

This work is made available under the terms of a Creative Commons Attribution-NonCommercial-NoDerivatives License, available at <https://creativecommons.org/licenses/by-nc-nd/4.0/>

Peer reviewed



Energy Efficiency Department
Energy Analysis and Environmental Impacts Division
Lawrence Berkeley National Laboratory

A Survey of Direct Heating Equipment Market Actors in California

Helcio Blum, Victor Franco, Sarah Price

January 2023



Disclaimer

This document was prepared as an account of work sponsored by the United States Government. While this document is believed to contain correct information, neither the United States Government nor any agency thereof, nor the Regents of the University of California, nor any of their employees, makes any warranty, express or implied, or assumes any legal responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by its trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof, or the Regents of the University of California. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof, or the Regents of the University of California.

Lawrence Berkeley National Laboratory is an equal opportunity employer.

Copyright Notice

This manuscript has been authored by an author at Lawrence Berkeley National Laboratory under Contract No. DE-AC02-05CH11231 with the U.S. Department of Energy. The U.S. Government retains, and the publisher, by accepting the article for publication, acknowledges that the U.S. Government retains a non-exclusive, paid-up, irrevocable, world-wide license to publish or reproduce the published form of this manuscript, or allow others to do so, for U.S. Government purposes.

A Survey of Direct Heating Equipment Market Actors in California

Prepared for the
California Energy Commission
State of California

Principal Authors
Helcio Blum
Victor H. Franco
Sarah K. Price

Lawrence Berkeley National Laboratory

January 2023

Acknowledgements

The work described in this study was conducted at Lawrence Berkeley National Laboratory (LBNL) and supported by the California Energy Commission (CEC) under Grant Agreement No. PIR-18-006 and the U.S. Department of Energy under Contract No. DE-AC02-05CH11231.

The survey described in this report was conducted by TRC Engineers, Inc. (TRC), under the Subcontract No. 7554710. The authors thank Marian Goebes and David Douglass-Jaimes for supporting the development of the survey questionnaires and leading the survey, and Yolanda Beesemyer, Katie Evans, and Antonea Frasier for their support with survey implementation and participant recruitment.

The authors also thank the following experts for their comments and feedback while reviewing this report (affiliations do not imply that those organizations support or endorse this work):

Jackson Thach	California Energy Commission
Alex B. Lekov	Lawrence Berkeley National Laboratory
Louis-Benoit Desroches	Lawrence Berkeley National Laboratory
Mohan Ganeshalingam	Lawrence Berkeley National Laboratory.

Legal Notice

The Lawrence Berkeley National Laboratory is a national laboratory of the United States Department of Energy (DOE) managed by The Regents of the University of California for the U.S. Department of Energy under Contract Number DE-AC02-05CH11231. This report was prepared as an account of work sponsored by the California Energy Commission and pursuant to an M&O Contract with the DOE. The Regents of the University of California, nor the DOE, nor the Sponsor, nor any of their employees, contractors, or subcontractors, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe on privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by The Regents of the University of California, or the DOE, or the Sponsor. The views and opinions of authors expressed herein do not necessarily state or reflect those of The Regents of the University of California, the DOE, or the Sponsor, or any of their employees, or the United States Government, or any agency thereof, or the State of California. This report has not been approved or disapproved by The Regents of the University of California, the DOE, or the Sponsor, nor has The Regents of the University of California, the DOE, or the Sponsor passed upon the accuracy or adequacy of the information in this report.

Table of Contents

Acknowledgements.....	i
Legal Notice.....	ii
Table of Contents.....	iii
Table of Figures.....	iv
List of Tables	v
Executive Summary.....	vi
1. Introduction.....	1
2. DHE Supply Chain	3
3. Interviews with DHE Manufacturers	4
Experience with the DHE Market in California.....	4
High-efficiency DHE and Other Advanced Technologies.....	5
Barriers to and Incentives for Efficient DHE.....	5
4. Interviews with DHE Distributors in California.....	8
Characteristics of DHE Sold	8
Energy Efficient DHE.....	9
Post-Sale Activities and Other Distributors in California.....	10
5. Survey with DHE Contractors in California.....	11
DHE Installations	11
Installation Costs	14
High-Efficiency DHE	15
6. Conclusions.....	16
References	18
Appendix A. Survey Approach.....	19
6.1 Interview Recruitment.....	19
6.2 Survey Recruitment	20

Table of Figures

Figure 1. Alternative Distribution Paths of DHE.....	3
Figure 2. Frequency of DHE Installations in the Last 5 Years.....	13
Figure 3. Estimates of DHE Lifetime.....	14
Figure A.4. Map of California Regions for Contractor Survey.....	22

List of Tables

Table 1. Distribution of Contractors' Revenue	11
Table 2. DHE Services Provided and their Annual Frequency.....	12
Table A.3. Summary of Interview and Survey Dispositions	19
Table A.4. Contractor Survey Recruitment and Disposition	22
Table A.5. Contractor Survey Responses by California Region	23

Executive Summary

Direct Heating Equipment (DHE) is a category of ductless space heating appliances that provide warm air directly to the space where they are installed. We estimate that DHE is the primary or secondary source of space heating in 12.1% of households in California, and that the fleet of DHE in the state is mostly comprised of old, inefficient, and sometimes unsafe units.

We investigated, from the DHE supply chain perspective, what types of DHE are marketed in the state, how they are sold and serviced, and whether any potential barriers to adoption of high-efficiency DHE exist. We interviewed national DHE manufacturers and California-based DHE distributors, and conducted an online survey with DHE contractors in the state to characterize the supply side of the market for DHE in California.

Our investigation highlights several key findings. First, the DHE market in the state is almost exclusively a replacement market with some additional repair and maintenance services. Installing a DHE unit in a new location in an existing building and/or in new constructions are rare.

Second, while the DHE manufacturers interviewed reported that their companies sell high-efficiency DHE models, most contractors report installing baseline models most of the time. Manufacturers recognize that although high-efficiency DHE is safer and provides better comfort to the users, the additional costs associated with high-efficiency DHE are a barrier to its adoption. The manufacturers believe that monetary incentives and/or stringent building codes could help with overcoming this barrier. Contractors cite that the main reasons for not installing high-efficiency DHE are: (a) their customers do not see any value in high-efficiency units, (b) they (contractors) do not believe that high-efficiency DHE is worth the additional cost to their customers, and (c) contractors' companies are not prepared to install high-efficiency DHE. It was also mentioned that their suppliers do not stock high-efficiency DHE. Specifically, concerning condensing DHE, the highest efficiency technology available, contractors cite the complexity of the equipment and the costs associated with installing this equipment as a barrier to adoption.

Third, the majority of contractors purchase DHE from distributors. Therefore, distributors are a key piece of the supply chain that can constrain DHE purchase choice. Distributors do not see a demand for high-efficiency DHE and, hence, do not keep stock of these units. They note that the market is driven mostly by replacements. Since these replacements occur typically in an unplanned way, when the heater breaks and the unit is too old to be repaired, homeowners are unwilling to pay for any additional costs associated with a high-efficiency model. Rather, they usually prefer to replace the failed unit with a new unit that can fit in the same location as the existing unit, with no- or minimal additional replacement costs. They agree that their customers, primarily contractors, are not focused on energy efficiency. Additionally, distributors have concerns that the DHE market will shift towards mini-splits, given the increased demand for air-conditioning in houses where there is currently a DHE installed and due to the electrification trends in the state.

Fourth, whether the lifetime savings of efficient DHE outweigh their increased upfront costs needs to be evaluated both at the level of individual installations and for the California market as a whole. Considering that most DHE purchases are made by contractors, on behalf of their customers, informing contractors (and homeowners) of the cost-effectiveness of efficient DHE could help mitigate some of the barriers to the adoption of high-efficiency DHE in the state. In addition, monetary incentives and more stringent building codes that apply to DHE replacements can contribute to increasing adoption of high-efficiency DHE in the state. This will not only reduce energy costs, but will also increase the safety and comfort to DHE users. Future research should investigate what the appropriate monetary incentives are, depending on the household location, DHE operating hours, and household income. Future research should also evaluate the energy and safety costs and benefits of high-efficiency DHE prior to establishing new building codes that will target this equipment. In addition, both types of policy measures, incentives and building codes, could be coupled with other weatherization initiatives in the state.

1. Introduction

Direct Heating Equipment (DHE) is a category of ductless, space heating appliances that provide warm air directly to the space where they are installed. DHE includes three types of heaters: wall furnaces (upright and console), floor furnaces, and room heaters. These heaters tend to have lower first costs than other heating system types due to their simplicity and lack of ductwork, but the lack of active heat distribution results in comfort issues. We estimate that DHE uses 3.7% of the total energy used for space heating in the United States (U.S.),¹ and that 36% of the DHE in use in the United States are installed in California.² We also estimate that DHE is the primary or secondary source of space heating in 12.1% of households in California,³ yet little is known about the DHE supply-chain participants in the state. This is especially relevant when it comes to the supply-chain participants' perspective about high-efficiency DHE, since those are the entities that will ultimately affect consumer purchases.

Previous research conducted by the U.S. Department of Energy (DOE) has addressed the DHE supply chain and manufacturers in the country. In their *Technical Support Document* (DOE, 2010), DOE describes the different distribution channels through which a consumer may purchase a DHE unit (DOE, 2010: Chapter 3). DOE also describes their own survey of DHE manufacturers, where they addressed product characteristics, manufacturer characteristics, and market and product trends (DOE 2010: Chapter 12). This study relies on DOE's research to inform a deep study of the DHE supply-chain participants in California.

This report describes a study of DHE market actors in California. The study relies on a survey conducted in 2021 with DHE manufacturers in the U.S. and with DHE distributors and contractors in California. The data collection activities were designed to gain a deeper understanding of the market for DHE in the state. In general, the survey addressed the market structure, supply chain paths, shipment trends, and drivers and barriers to high-efficiency DHE in California. Respondents were asked to focus their answers on natural gas DHE.

Our results are relevant to understanding the experience of the supply-chain, market actors with the DHE market in California, and to learn, from their perspectives, how to increase adoption of high-efficiency DHE in the state. In the following we describe the DHE supply chain, and present and discuss results from our survey. Section 2 describes the typical DHE distribution channels. Sections 3 and 4 focus, respectively, on the interviews conducted with DHE manufacturers and distributors (in California). Section 5 shows results from the online survey conducted with DHE contractors in the state. Section 6 concludes with our main

¹ Estimate based on the *2015 Residential Energy Consumption Survey* (EIA, 2015), considering all types of DHE fueled by natural gas or propane.

² Estimate based on the *2020 Residential Energy Consumption Survey* (EIA, 2020) considering both natural gas and propane DHE. If only natural gas DHE is considered, the fraction of the stock of DHE in the U.S. that is installed in California increases to 40.6%.

³ Estimate based on the *2019 California Residential Appliance Saturation Study* (DNV GL, 2020) considering both natural gas and propane DHE. If only natural gas DHE is considered, the fraction of the households in California with a DHE drops to 11.2%.

findings, policy implications, limitations of this study, and future research. Appendix A describes our survey approach.

2. DHE Supply Chain

In their analysis of the DHE supply chain in the U.S., the DOE (DOE, 2010) observed that consumer purchases and installations did not typically play a significant role in the way DHE is distributed. Rather, most sales started from manufacturers and went through distributors to contractors.

The manufacturer-to-distributor-to-contractor is still the backbone of the DHE supply chain in California. However, in our research we find that retailers are playing an increasing role in the DHE supply chain, as some manufacturers now sell directly to “big box” retailers and some distributors sell to smaller retailers. However, in very few cases, a consumer purchases the DHE unit directly from a retailer. In the case of replacement units, consumers tend to rely on contractors to choose and purchase the new unit on their behalf. In new home applications, contractors may choose and purchase the new unit on behalf of the builder. Figure 1 shows the alternative distribution paths of DHE, from manufacturers to consumers. The solid lines show the most typical supply chain, and the dashed lines denote a few alternative, less common ways a DHE unit is commercialized in the state.

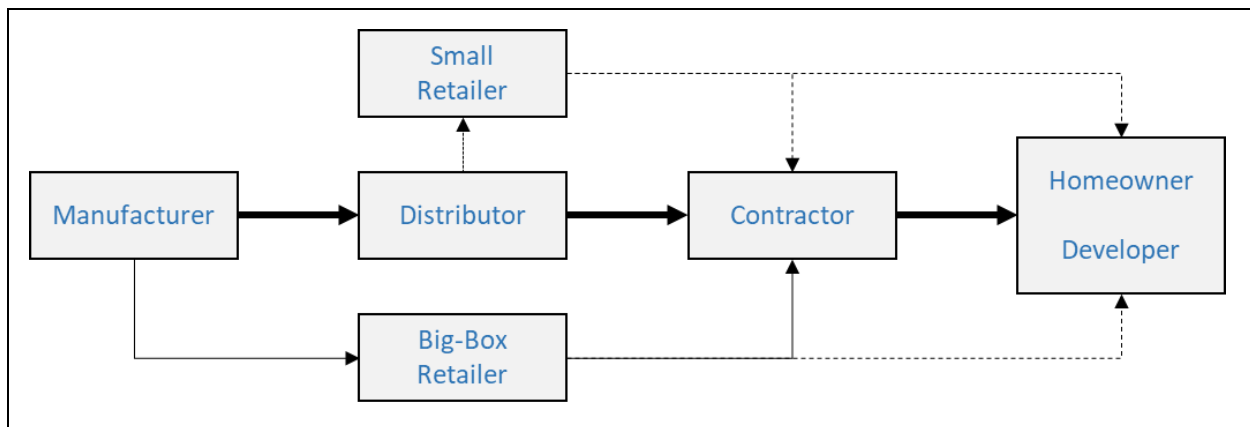


Figure 1. Alternative Distribution Paths of DHE

3. Interviews with DHE Manufacturers

DHE has been manufactured in the U.S. for at least six decades. There are currently five brands of DHE in the country, manufactured by four companies.

We conducted phone interviews with key representatives of three of the four manufacturers that make up most of national shipments of DHE.⁴ The interviews were organized into three segments: their experience with the DHE market in California; high-efficiency DHE and the associated advanced technologies; and barriers to and incentives for energy efficient DHE in the state. Results for each segment are presented below.

Experience with the DHE Market in California

We asked manufacturers about their shipments to California and the products they mostly sell in the state. Shipments to California vary from 20% to 60% of their total shipments, and the market shares of the three manufacturers range from a “minor player” in the DHE market in the state, to the “largest share of DHE sales” in California.

Shipments are mostly (approximately 90%) comprised of gravity wall furnaces. Most of the shipments are medium-size DHE (25-35 kBtu/hr⁵), followed by—when available in their line of products—models with larger capacity (50 kBtu/hr or higher). Models with smaller capacity (8-20 kBtu) are in less demand. In addition, most of shipments are of baseline models (approximately 70% of shipments), followed by models with a mid-range efficiency (approximately 20% of shipments). Shipments of high-efficiency models (approximately 10% of shipments) are usually driven by special requests from state or local government. None of the manufacturers expects any changes to their total shipments to the state, or their breakdown of shipments, in the next 5 to 10 years.

Shipments of replacement units range from 70% to 90% of units shipped. One manufacturer emphasized that the remaining shipments are installations of new units in existing houses, with no installations in new constructions. They also noted that they don’t expect this to change in the next 5 to 10 years. Concerning installations in commercial buildings, one manufacturer mentioned that 3% to 4% of shipments go to strip malls or to commercial conversions in buildings without central heating.

None of the three manufacturers sell their products directly to contractors or homeowners. Rather, they sell them mostly through distributors, and sometimes through large retailers.

⁴ We believe that those four manufacturers also make up to almost all of shipments of DHE to California.

⁵ Thousands of Btu per hour.

High-efficiency DHE and Other Advanced Technologies

We asked manufacturers about some characteristics of their high-efficiency or advanced models. The lifetime of high-efficiency models is the same as that of baseline models,⁶ although, as mentioned by one manufacturer, “when you have more complex components, they may be more apt to failure” and lead to more frequent maintenance and repairs. Another manufacturer, however, mentioned they try to keep both baseline and high-efficiency models very simple.

Two manufacturers plan to release, in the next 5 to 10 years, new, high-efficiency models with a higher AFUE than what they currently offer.⁷ One of the manufacturers offers two condensing models and is planning for improvements to some of their controls.⁸ Another manufacturer plans to offer condensing units in the future, but highlights that those units will need to be directly vented through an external wall, which doesn’t align with most of the currently installed DHE that are installed in interior walls and vent vertically. The third manufacturer mentioned that they have considered condensing units, but “it’s a very expensive endeavor to implement for a market that has not grown significantly.”

Concerning low-NOx DHE, one manufacturer mentioned they offer ultra-low-NOx models, compliant with SCAQMD rule 1111.⁹ Another manufacturer mentioned that their models that focus on low-NOx are vent-free and, therefore, cannot be sold in California. The third manufacturer does not offer any low-NOx DHE, and did not mention any plans related to low-NOx DHE.

Barriers to and Incentives for Efficient DHE

We asked manufacturers about what market barriers prevent a larger adoption of high efficiency DHE, and how those barriers could be overcome. One manufacturer does not believe that there are barriers to high efficiency DHE in the state and that any regulatory issues are not specific to California. According to that manufacturer, “everyone is looking for high-efficiency DHE” but the problem is their cost, as the high-efficiency models are 2-3 times more expensive than the less efficient ones. Another manufacturer agrees that costs are a hindrance, yet inevitable given the improvements that are required not only to achieve higher levels of AFUE, but to also reduce emissions and to design the units such that they can be installed in the same location as an existing unit with no- or minimum additional installation costs. They also noted that mandating higher efficiency DHE will likely lead consumers to find ways to extend the life of their old equipment.

⁶ One manufacturer estimated that baseline models can last for 50-60 years.

⁷ AFUE stands for Annual Fuel Utilization Efficiency, a metric that expresses furnaces energy efficiency. At the time of this publication, two of the three manufacturers offer DHE models with 80% (or slightly higher) AFUE.

⁸ Production of these models was suspended in January 2022.

⁹ The 1111 rule of the California South Coast Air Quality Management District is a 1978 rule that reduces emissions of nitrogen oxides (NOx) from certain residential and commercial gas-fired fan-type space heating furnaces. In 2009 the rule was amended to lower the NOx emission limit from 40 to 14 ng/Joule (ng/J).

The third manufacturer mentioned that the barrier for their high efficiency models is related to the location DHE is traditionally installed in the building. Since most DHE are installed on internal walls, replacing an old unit for one of their high efficiency models requires the new unit to either be power vented or relocated to an external wall where it can be side vented. They noted that, in the case of condensing units, it is challenging to deal with the condensate when there is no access to floor drains. They also added that the market has shifted in the last 30 years, and spaces that used to need only “a little bit of space heat” are now interested in both heating and cooling which is driving demand for ductless heat-pumps (“mini-splits”).

All three manufacturers agree that incentives would help with removing some of the aforementioned barriers and driving up DHE upgrades. One manufacturer mentioned that incentives that would lead distributors to lower their prices to contractors would be more effective than “having to wait for reimbursement.”¹⁰ Another manufacturer mentioned they have been partnering with a utility for decades and did see an increase in sales of higher efficiency DHE, in substitution of lower efficiency models, as a result of a rebate program. They also noted that, while manufacturers have a more vested interest in market transformation, distributors and contractors are not the drivers of innovation since they have other motivations. They are therefore working with their customers to connect them to the incentive process.

Two of the three manufacturers agree that building codes could help to remove barriers, although one expressed their concern with the resulting higher costs. The other manufacturer mentioned that, in 1989, DOE mandated vent limit safety switches to increase the safety of DHE operations. They suggest that more efficient DHE should be mandated, as more efficient DHE models are more recent and include two safety switches; or, at a minimum, old DHE without safety switches should be required to be replaced.

We also asked manufacturers how certain incentives would affect adoption of high efficiency DHE in California. In the case of a utility incentive program designed to replace baseline DHE models with high-efficiency models, one manufacturer mentioned that this sort of program should be carefully designed, ideally setting a specific efficiency target. Another manufacturer noted that that should be a “midstream incentive,” with savings directly to contractors and customers. They also added that such incentive would need to be in the order of several hundred dollars, \$200-\$500 to “really make consumer choice change.” The third manufacturer mentioned that incentives should go to manufacturers, with part going toward R&D and a large portion going toward market transformation enabling them to reduce what they “have to charge.”

Concerning special prices for bulk purchasing, one manufacturer mentioned that, in a case where a large multifamily building owner or management company is purchasing a large quantity of high-efficiency DHE units to replace existing equipment, they would be open to changing their business model and selling them directly to the customer. They also noted that, in that case, they would like to have control of those installations, to make sure these units are

¹⁰ This likely refers to rebate programs where a buyer would pay the full price upfront and submit a request for reimbursement of part of the purchase price to a utility or government agency.

properly installed by licensed contractors. Another manufacturer mentioned that, while they don't sell directly to contractors or customers, to avoid undermining their relationship with distributors, they could work with distributors to get bulk pricing. This is, in fact, what they do, on a case-by-case basis, to meet the demand of large projects.

Finally, we asked manufacturers what a discount for bulk purchasing would be like. One manufacturer mentioned that that would depend on the circumstances. However, due to the latest increased costs of controls and other components, especially the ones that are imported, they believe that any reduction in costs should be provided by incentives.

Another manufacturer mentioned that they do provide discounts for large orders, and that the discount depends on the total volume and the timeline of the order. They noted that discounts for orders over 300 units could be significant. They also added that while the state is focused on electrification, they are focused on DHE market transformation with more efficient and economical models, as they believe those 50-60-year-old models need to be replaced.

4. Interviews with DHE Distributors in California

Distributors are a key piece of the DHE supply chain, as the selection of brands and models they make available in the state constrain consumer choice. We conducted phone interviews with three distributors of HVAC appliances in California. Two of the distributors interviewed focus on local business while the third has a statewide and national sales footprint.

The interviews were organized into four segments: characteristics of the DHE they sell, energy efficient DHE, post-sale activities, and general characteristics of DHE distributors in the state. Results for each segment are presented below.

Characteristics of DHE Sold

We asked distributors about the DHE brands and models they sell. All three participants sell models from Williams, and two also sell DHE models from Cozy.¹¹ One of them mentioned they sometimes offer the Rinnai direct-vent models, although direct-vent units are not very common within the market they operate in. One distributor noted that they have been selling the same brand for 20 years, while another distributor mentioned that from time to time they change the brands they sell, depending on availability and price.

When asked if they expect any significant changes in the brands they sell in the next five years, one distributor said they do not, although they have concerns that Air Quality Management Districts in the state will eventually regulate DHE and that there will be no models that comply with the aforementioned regulations. Therefore, they are unsure of how long they will be selling DHE in California. Another distributor noted that they expect to sell “a lot more heat pump, mini-splits” due to the electrification trend in California, even though some places in the state are “locked in” with wall furnaces.

All three distributors sell mostly gravity wall furnaces, followed by counterflow (or fan) wall furnaces. One distributor mentioned that gravity wall furnaces are sold mostly in mountain areas, while counterflow wall furnaces are sold in coastal areas. The three distributors either rarely or never sell room heaters or floor furnaces. One of them noted that their sales are typically replacements of existing DHE, and that sometimes they even sell a wall furnace to replace a floor furnace.

Concerning the capacity of the DHE they sell, the three distributors agree that most sales are of models in the range of 25-50 kBtu. However, while one distributor mentioned that models with 50 kBtu are the “most popular,” another said that sales of DHE with 50 kBtu are rare and that their most popular models are those with a capacity of 35 kBtu. One of the distributors provided a breakdown of their annual sales of DHE, which shows that 16% of sales are of 50 kBtu DHE, 13% are of 35 kBtu, 23% are of 25 kBtu, and the remaining sales are of the other various

¹¹ Note that a sample of only three distributors in the state is not representative enough to one conclude that the other DHE brands are not sold in California.

capacities. The three distributors agree that almost all sales are of natural gas DHE.

Two of the three distributors sell DHE either only or mostly to contractors. One of them mentioned they also sell to developers, although rarely. The third distributor provided a different perspective mentioning that their sales are only 10%-20% to contractors, and the remaining 80%-90% of the sales are to end-users. None of the three distributors expect any significant changes in who they sell to in the next five years.

The distributors agree that most (90%) sales are of replacement DHE. According to one distributor, price is the most important aspect driving buyer choice. Another distributor noted, however, that since most sales are for replacing an existing unit, buyers look for like-for-like replacement models with no other considerations. None of the distributors are aware of sales of DHE to be installed in commercial buildings.

In the last five years, DHE sales have slightly increased for one distributor, stayed about the same for another distributor, and greatly decreased for the third distributor. The latter noted that customers are leaning more toward space conditioning solutions that can also offer air-conditioning, such as ductless mini-splits, and that only customers on a “really strict budget” are buying DHE; and they expect this to continue in the next five years. Another distributor, however, believes that the transition to electric heat-pumps will require incentives, without which DHE sales should continue to be about the same.

Energy Efficient DHE

We asked distributors about their sales of baseline¹² versus high-efficiency DHE. One distributor mentioned they are only selling one model of DHE. Another distributor noted that “there aren’t really options that are more efficient than the basic model.” The third distributor said they mostly sell baseline DHE, and very seldom get requests for higher efficiency. The third distributor also noted that, since most of sales are of replacement units, customers in general are more concerned with making sure that the new unit fits in the same place where the existing unit is installed. They are therefore more likely to install a DHE similar to what was already installed in the home.

The three distributors agree that customers do not seem to be interested in energy efficiency, and that their primary focus is on how little they can spend on a new unit. One distributor mentioned that they are aware of an incentive program for efficient DHE, but they have not seen any changes in sales due to that program. Concerning potential changes in the next five years, one distributor mentioned that high efficiency DHE are expensive and will not be adopted unless building codes are changed.

Asked about condensing units, the three distributors mentioned that they have never sold or stocked a condensing DHE. One distributor noted that while condensing units are a step up

¹² A baseline model is one that complies with the U.S. DOE’s minimum efficiency standards.

from traditional wall furnaces, they are expensive to purchase and install, and other models on the market that can modulate the output heat also “are efficient.”

One distributor mentioned that their markups are the same for baseline and high-efficiency DHE. In addition, the three distributors will typically work with the manufacturer on a discount for bulk purchases, which they would pass on in full to customers. One distributor noted that, in their case, the discount for large projects is usually 12%.¹³

Post-Sale Activities and Other Distributors in California

We asked distributors about their post-sale activities. One of the distributors provides installation services, but when asked about DHE maintenance and repair, they mentioned that there is not much DHE maintenance, and that they are called only when the heater breaks.

We also asked distributors whether they believe that other distributors in the state have similar experiences with the DHE market in California. One distributor mentioned that “anybody in the business has access to the same equipment.” Another distributor noted that the experience could change in some specific contexts where DHE is used, such as areas with older homes, beach communities, smaller multifamily buildings, etc. The third distributor also agrees that the experience may change depending on circumstances and noted that, for example, in the North Bay region of the San Francisco Bay Area, one cannot replace a wall furnace unless it’s for a more efficient one, and that in fire zones one has to install heat pumps. Concerning how other distributors in the state purchase and sell DHE, one distributor mentioned that the way it is done is relatively standard for all distributors.

¹³ Note that, even though the focus of the questions related to bulk purchase discounts was associated with high-efficiency DHE, distributors’ answers refer to bulk purchases of DHE of any efficiency rating.

5. Survey with DHE Contractors in California

Contractors are the most critical market actor in the DHE supply chain when it comes to equipment choice. We conducted an online survey with 20 contractors in the state. Figure A.4 and Table A.5 (Appendix A) show the geographical distribution of respondents.

Most of the respondents (80%) were either a company president, owner, or general manager.¹⁴ Thirteen of the 20 companies represented have an annual revenue equal to or greater than one million dollars, and for almost half of the respondents DHE services represent less than 5% of their revenue. Table 1 presents the distributions of contractors' revenue. Half of the companies have 6 to 20 employees, and 25% have 21 to 50 employees. Of the remaining companies, only one has more than 50 employees, while the others have five employees or less. The vast majority of contractors surveyed service only upright wall furnaces, and 75% of respondents have either 'often' or 'sometimes' provided DHE services in California in the last 5 years.

Table 1. Distribution of Contractors' Revenue*

Total Annual Revenue**	< 5%	5-20%	21-50%
\$100k - \$249k	5%		5%
\$250k - \$499k		5%	
\$500k - \$999k	5%	10%	
\$1M or more	30%	20%	15%

* The column headers denote the percentage of contractors' total business revenue that is associated with installing or servicing DHE.

** One respondent 'preferred not to say' their revenue.

The survey was organized into three segments: DHE installations, installation costs, and high-efficiency DHE. Results for each segment are presented below.

DHE Installations

We asked contractors about their DHE services in the state and, on average, how often they provide these services annually. All contractors install replacement units, and 90% or more provide maintenance to or repair existing units. Half of the contractors mentioned they sometimes install a new DHE unit in an existing home, and 30% responded that they install DHE in new construction. Table 2 shows the services contractors provide and their average annual frequency.

¹⁴ Of the remaining respondents, one was a service manager, one a supervisor, one an installer technician, and one preferred not to state their his position.

Table 2. DHE Services Provided and their Annual Frequency

Type of Service	Never	1-10	11-20	21+
Installation of a new unit in new construction	14	5	1	
Unit replacement		11	4	5
Installation of a new unit in existing homes	10	8		2
Repair	2	6	2	10
Maintenance	1	8	1	10

DHE services, for most contractors (65%), have either not changed or slightly decreased in the 5 years prior to COVID (2015-2019). Some contractors (20%) mentioned that services have slightly increased during that same period. During the COVID period (2020-2021), services have mostly not changed or have decreased some. Contractors have mixed expectations regarding the change in their DHE services in the next 5 years (2022-2026). Almost half of contractors (45%) expect the services to decrease some, 30% do not expect any changes to their DHE services, and 25% expect some increase.

The types of buildings where contractors mostly serviced DHE in the last 5 years were single-family homes (93% of contractors), followed by multi-family buildings (58% of contractors), commercial buildings (55% of contractors), and mobile homes (45% of contractors). In addition, in the last 5 years, 65% of contractors have rarely installed DHE in a home or commercial building that has another heating system. The remaining respondents mentioned they have sometimes (20%) or never (15%) performed such installations. In addition, DHE replacements are mostly never or rarely initiated proactively (70%). Rather, they occur when the unit breaks.

Most of contractors purchase DHE from a wholesaler (85%), followed by big box retailers (30%). Only 15% of contractors purchase DHE directly from manufacturers, 10% from online-only retailers, and 5% from a hardware retail store. None of the contractors surveyed indicated the DHE was purchased by the customer. The brand that contractors most purchase are Williams (95% of contractors) and Cozy (65% of contractors), followed by Empire (35% of contractors) and Rinnai (20% of contractors).

The type of DHE that was mostly installed in the last 5 years was gravity upright wall furnaces (95% of contractors), which sometimes (65% of contractors) were dual-sided units. The second most installed type of DHE was counterflow upright wall furnaces (70% of contractors), and they rarely included a rear- or side blower. The other types of DHE were mostly rarely installed, although direct-vent gravity wall furnaces and floor furnaces sometimes were installed. Figure 2 shows, for each type of DHE, the frequency that they have been installed in the last five years.

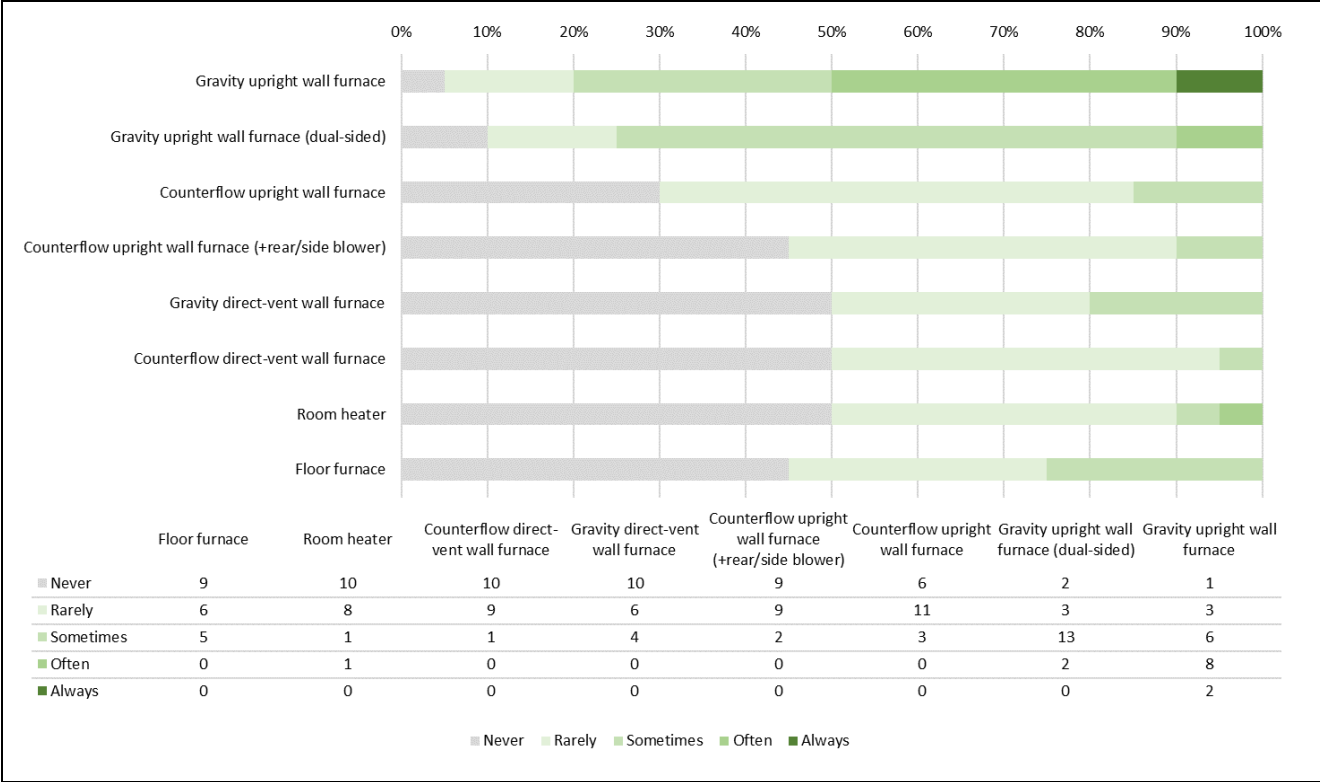


Figure 2. Frequency of DHE Installations in the Last 5 Years

All contractors recommend that their customers replace their DHE unit, rather than repair it, when the heater needs repair, but it makes more financial sense to replace it. Additional reasons for this recommendation are when the heater is not installed to code/safety concerns (85%) or the heater is old (80%). Less common reasons are when the heater does not provide sufficient heating (40%) and when heater uses too much energy (35%). Two contractors provided additional reasons: they recommend the replacement when the unit has a cracked heat exchanger or when a new unit is available faster than parts.

In addition, when replacing an existing unit, most contractors calculate the size of the new unit based on their estimates of heat load (45%) or replace it with a unit of the same size (40%). One contractor mentioned they suggest a smaller unit. Another contractor added that while they do estimate the size based on the heat load, they also adjust it up or down based on customers' experience.

Most contractors estimate that DHE has a lifetime shorter than 20 years, while only one contractor believes DHE can live for more than 30 years. Figure 3 shows the distribution of contractors' estimates of DHE lifetime.

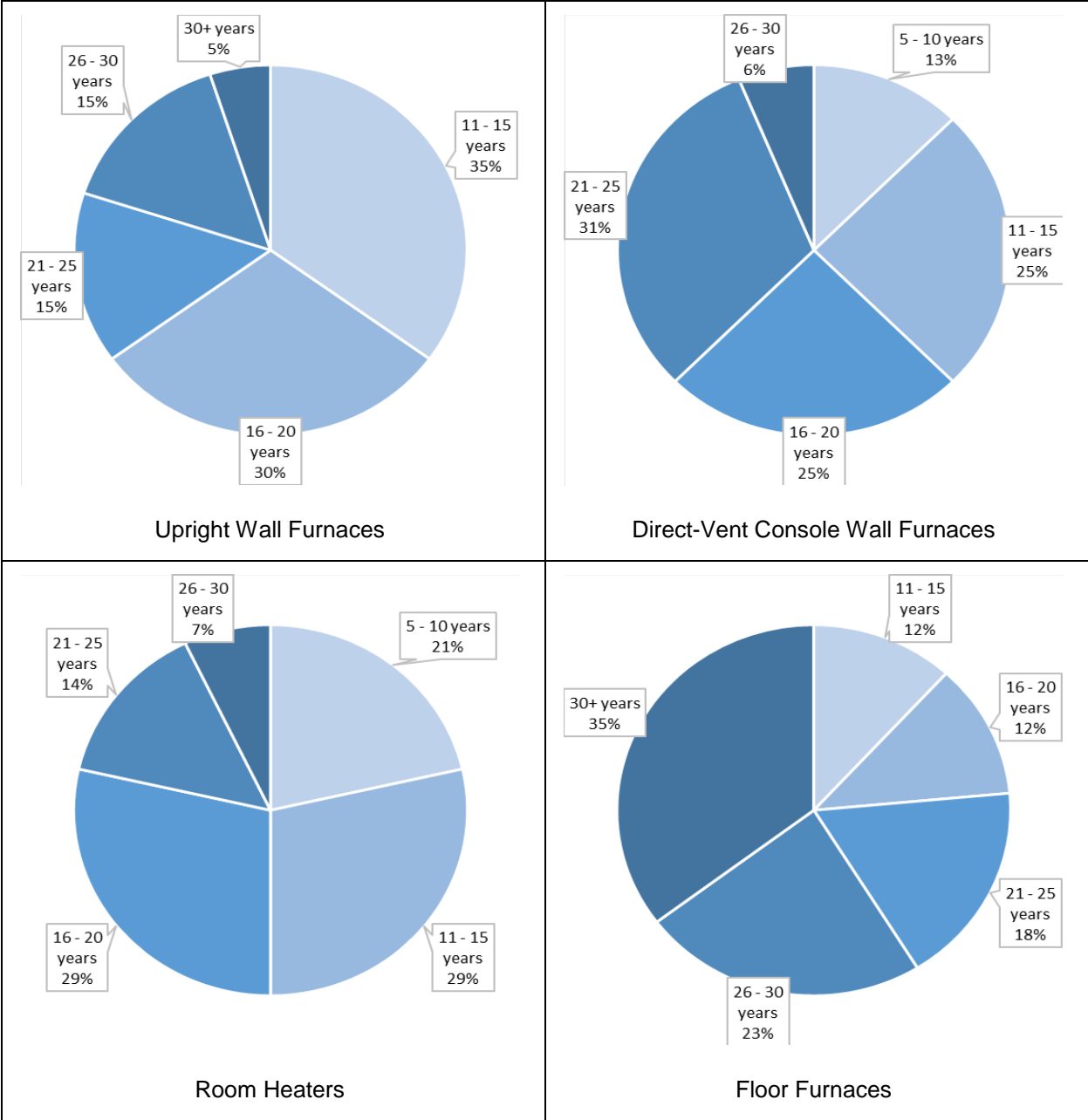


Figure 3. Estimates of DHE Lifetime

Installation Costs

We asked contractors about the typical total installed costs of DHE in the state. Considering that the vast majority of DHE is purchased by contractors, on behalf of their customers, we asked contractors about their markups on the purchased units. Most contractors (55%) mark their DHE purchases up 30% or more. The second largest group of contractors (30%) mark their DHE purchases up 11% to 20% (30%), followed by 21% to 30% (10% of contractors) and 1% to 5% (5% of contractors).

We also asked contractors what their best estimates are for installation costs and labor requirements of a typical DHE replacement. Estimates of installation costs fall mostly into one of these two ranges: \$150 to \$685 (45%) and \$1,000 to \$4,000 (50%). One contractor provided an estimate of \$2,500 to \$6,000 for a replacement. This shows contractors may have different experiences in terms of type of DHE replacements they do and the challenges associated with those replacements. Estimates of labor efforts also fall into two ranges. Of the 14 responses we received, 10 contractors provided estimates ranging from 2 to 6 hours, with most contractors' estimates in the upper bound of this range, and four contractors estimated an effort of 8 to 16 hours to replace a DHE.

High-Efficiency DHE

We asked contractors about their experience with high-efficiency DHE.¹⁵ Most of the surveyed contractors mentioned that in the last 5 years they have either never (45%) or rarely (30%) installed a high-efficiency DHE (45%). The remaining contractors have either sometimes (10%) or often (15%) installed a high-efficiency DHE. Of the 15 contractors who said they never or rarely install high-efficiency DHE nine contractors stated that their customers do not see any value in high-efficiency units, three contractors said they do not believe it is worth the additional cost to their customers, and two mentioned that their company is not prepared to install high-efficiency units. Three contractors said that customers are not willing to pay for the additional costs.¹⁶ Other contractors mentioned that they don't offer high-efficiency DHE to their customers because they (contractors) are not aware of these units, because of the unknown additional costs, and because they don't know their suppliers stock on these units.

We also asked contractors, in their experience, why some customers decide to replace their DHE for a high-efficiency unit. Five contractors answered this question. The most frequent reasons are to lower energy costs (4 contractors) and to improve safety or air quality (4 contractors). Other reasons are: our company's recommendation (3 contractors), better for the environment (2 contractors), improve in home comfort (2 contractors), and expected lower maintenance and/or repair costs (1 contractor).

Finally, we asked contractors how often they replace a non-condensing DHE for a condensing unit. Out of the five responses we received, two contractors said they have either never or rarely performed such replacement, while three said they have sometimes done it.¹⁷

¹⁵ Contractors were asked to consider a high-efficiency DHE: (a) a counterflow upright wall furnace, or (b) a direct-vent console wall furnace with an AFUE of 80% or higher.

¹⁶ One of the three contractors mentioned that they always offer their customers high-efficiency DHE, but that they are rejected due to their additional costs. According to that contractor, typical DHE users are "low-income or landlords and motivated by price point."

¹⁷ Note that this may seem inconsistent with the distributors' statement that they have never sold or stocked condensing DHE. While that could be true for the three distributors interviewed, it does not mean that condensing DHE was never sold in California.

6. Conclusions

DHE is more common in California homes, when compared to homes in the rest of the country. Concerns with how to increase adoption of high-efficiency DHE in the state have led us to investigate if and how those units are marketed in California. We surveyed DHE supply chain participants in the state to obtain a deeper understanding of the types of DHE offered, how they are sold and serviced, and what the potential supply chain barriers to high-efficiency DHE are.

We interviewed three of the four DHE manufacturers in the U.S., who own four of the five brands of DHE currently available in the country. Manufacturers are interested in selling more of their high-efficiency DHE models. However, they recognize that the additional costs associated with a higher efficient unit, along with other advanced features and controls that those units typically embed that also improve users comfort and safety, are a barrier to their adoption. They all agree that incentives would help with mitigating part of those additional costs and could contribute to increased adoption of high-efficiency DHE in the state. In addition, one manufacturer suggested that if higher safety standards were required by state or local authorities, homeowners would have to replace old units with newer models which are safer and also tend to be more energy efficient.

Distributors are the next type of market actors downstream in the DHE supply chain. We interviewed three distributors of DHE in California. While such a small set of interviewees is far from a representative sample of DHE distributors in the state, we believe their perspectives can be—with some caution—generalized to the population of DHE distributors in California. First, of the three distributors we interviewed, two distributors serve (individually) the two regions where DHE is most used (San Francisco Bay Area and Southern California), while one has a statewide and national sales footprint. Second, their perspectives are consistent with our previous experience analyzing the DHE supply chain in the country.

It seems that distributors do not usually stock high-efficiency DHE as they don't see a demand for such units. The market is driven mostly by replacements, and most of these replacements occur in an unplanned way, when the heater breaks, and the unit is too old to be repaired. Under such circumstances, homeowners are unwilling to pay for any additional costs and typically prefer to replace the failed unit with a new unit that can fit in the same location as the existing unit with no- or minimal additional replacement costs. They also agree that their customers, mostly contractors, do not seem concerned with energy efficiency. In addition, distributors have concerns that the demand will shift towards mini-split equipment, given the increased demand for air-conditioning in houses where there is currently a DHE installed and due to the electrification trends in the state.

One distributor is aware of a utility rebate program but did not see any significant impact from that program on their sales. One distributor believes that only new building codes or new indoor air quality requirements will force homeowners to upgrade their DHE when replacing them, despite the additional costs.

We surveyed DHE contractors in California, the next participants downstream in the supply chain. We conducted an online survey with 20 contractors, reasonably distributed all over the state. We believe that the contractors we surveyed represent, relatively well, the issues and challenges that DHE contractors face, according to the market they serve. Therefore, with some caution, we assume that their perspectives represent, on average, the perspectives of the population of DHE contractors in California.

Contractors agree with distributors that the DHE market in California is a replacement market, and that homeowners are mostly interested in minimizing the costs of these replacements. Some contractors seem careful when sizing the new unit, which may contribute to their customers' future energy savings. However, three quarters of the contractors we surveyed have never or rarely installed a high-efficiency DHE because (a) their customers do not see any value in high-efficiency units, (b) they (contractors) do not believe that high-efficiency DHE is worth the additional cost to their customers, or (c) their company is not prepared to install high-efficiency units. The other contractors who have had some experience with installing high-efficiency DHE in the state cited their customers decided to upgrade their heater to a higher efficiency unit mostly to lower energy costs and to improve safety or air quality.

While some homeowners in California value high-efficiency DHE, it seems that the main source of barriers to increasing adoption of high-efficiency DHE in the state is contractors: They believe their customers do not see value in these units and they do not believe high-efficiency DHE is cost effective. Therefore, they are cautious about offering this alternative to their customers during a (typically) unplanned DHE replacement due to the additional costs incurred. Future research should therefore evaluate the conditions under which high-efficiency DHE in California is cost-effective. This may better inform contractors when making DHE purchase choice on behalf of their customers. And, if contractors start demanding high-efficiency, this will propagate backwards across the supply chain and lead distributors to increase the availability of these models. An increase in demand of high-efficiency DHE may, eventually, lead to lower manufacturing costs and, therefore, lower incremental costs when compared to less efficient models.

Monetary incentives, likely targeting contractors, and more stringent building codes that apply to DHE replacement can contribute to increasing adoption of high-efficiency DHE in the state. This will provide DHE users not only with lower energy costs, but also with the additional safety and health benefits these heaters offer. Future research should investigate what the appropriate monetary incentives are, according to, for example, household location, DHE operating hours, and household income. Future research should also evaluate the energy and safety costs and benefits of high-efficiency DHE prior to establishing new building codes that will target this equipment. Both types of policy measures, incentives and building codes, could, in addition, be coupled with other weatherization initiatives in the state.

References

- DNV GL (2020): *2019 California Residential Appliance Saturation Study*. California Energy Commission. Publication Number: CEC-200-2021-005-PO.
<https://www.energy.ca.gov/publications/2021/2019-california-residential-appliance-saturation-study-rass>.
- DOE (2010): *2010-04-08 Final Rule Technical Support Document*. Energy Efficiency Standards for Pool Heaters, Direct Heating Equipment and Water Heaters (EE-2006-STD-0129), Regulations.gov. <https://www.regulations.gov/document/EERE-2006-STD-0129-0149>.
- EIA (2015): *2015 Residential Energy Consumption Survey (RECS)*. U.S. Energy Information Administration. <https://www.eia.gov/consumption/residential/data/2015/>.
- EIA (2020): *2020 Residential Energy Consumption Survey (RECS)*. U.S. Energy Information Administration. <https://www.eia.gov/consumption/residential/>.

Appendix A. Survey Approach

The survey was developed in partnership with TRC Engineers, Inc. (TRC).¹⁸ TRC supported the LBNL team in the development of the interview and survey guides, providing feedback and guidance on the tools and content. LBNL developed the final interview and survey guides based on this feedback. TRC also led recruitment for interviews and surveys, conducted interviews, and fielded surveys.

The sections below detail recruitment goals and strategies used during the data collection effort. As an overview, TRC ultimately conducted 26 interviews or surveys with DHE market actors, as shown in Table A.3. This includes interviews with the manufacturer who has the largest market share in California as well as interviews with two manufacturers who hold smaller market shares in the state. This also includes interviews with distributors and a survey of contractors representing a mix of geographic regions across the state.

Table A.3. Summary of Interview and Survey Dispositions

Interview or Survey Type	Target	Completed
Manufacturer Interviews	3	3
Distributor Interviews	6	3
Contractor Surveys	20	20
Total Market Actors Interviewed or Surveyed	29	26

6.1 Interview Recruitment

LBNL initially provided TRC with a list of five manufacturers to contact and a goal of completing three phone interviews. By the time the interviews were conducted, there were only four active manufacturers, as Williams had acquired the Cozy brand. TRC used a mix of contacts provided by LBNL, existing TRC contacts, and internet searches to identify contacts at each manufacturer. One manufacturer was not responsive to requests for an interview, but TRC was able to successfully complete interviews with the remaining three. TRC completed manufacturer interviews with all three companies, by reaching out to eight different manufacturer representative contacts. Manufacturer interviewees included a Vice President of Sales, a National Sales Director, and a Senior Director of Regulatory and Product Performance.

The project also had a goal of interviewing six distributors. TRC identified distributor companies

¹⁸ This appendix relies on TRC's *DIRECT HEATING EQUIPMENT MARKET CHARACTERIZATION* memorandum to LBNL (January, 2022).

from lists on the DHE manufacturer websites. TRC then used internet searches and ZoomInfo¹⁹ to locate representative names and emails at distributor companies, since manufacturers did not provide representative contact names or emails for the distributor companies listed on their websites. Given that the manufacturers sell other products and they did not specify which distributors listed on their websites carried DHE, TRC confirmed through web searches which distributor sold DHE. In addition, TRC requested that their contacts at DHE manufacturers and their contacts who implement utility-funded residential programs provide leads for DHE distributor companies.

TRC primarily contacted distributors for interview requests using email, and made phone calls to distributors that were warm leads from manufacturers or program implementers, or that expressed interest in interviews. TRC was able to complete three distributor interviews after 151 contact attempts to 82 different distributor contacts. Distributors interviewed included one with a statewide and national sales footprint, and two focused on local business. One of the local distributors also had an HVAC contracting business.

The low recruitment rate illustrates the challenges that TRC encountered for recruiting distributors for interviews. These include:

- Non-responsiveness: The vast majority of distributors did not respond to requests for interviews.
- No clear contact: When reaching out to distributor companies, it was difficult to speak with the appropriate person since we lacked specific representative contact names.
- “Passing the buck”: Occasionally there was debate over who would be the appropriate interviewee between the main office or franchise locations (each entity stated the other would be more appropriate to speak to regarding the study), although TRC assured contacts that either type of staff member could answer most questions in the interview. This may indicate that neither type of staff member wanted to participate in the interview.

In summary, while the study faced challenges with interview recruitment, TRC was able to complete interviews from all DHE manufacturers serving California and three distributors, thereby capturing data from most of the top of the California DHE supply chain.

6.2 Survey Recruitment

The study had a goal of completing 20 contractor surveys – meaning contractors that install, replace, and/or repair DHE equipment in California. TRC used an online survey programmed in Qualtrics,²⁰ based on the survey guide primarily developed by LBNL.

¹⁹ ZoomInfo (zoominfo.com) is a software company that provides detailed information of businesses and business professionals.

²⁰ Qualtrics (qualtrics.com) is a digital platform for online survey development and implementation.

TRC used three primary outreach methods to recruit survey respondents:

- (a) Direct email outreach to available contractor contacts,
- (b) An electronic newsletter (e-newsletter) distributed by one DHE manufacturer, and
- (c) An e-newsletter distributed by an implementer of a California utility-funded residential retrofit program serving the Bay Area. This area was targeted because many San Francisco Bay Area homes have DHE.

TRC developed a three-tiered approach to prioritize outreach efforts, whereby contractors that were likely active in the DHE retrofit market were contacted first, and general contractors (that may or may not be active in the DHE retrofit market) were contacted last. The survey also included upfront screener questions to ensure that the respondent installed or repaired DHE. TRC recruited contractors for the survey in the following order:

- (a) High priority: HVAC contractors from DHE manufacturer websites and from the North American Technical Excellence (NATE) Certified Contractor²¹ website (following a link provided on a manufacturer website) for direct email outreach by TRC; from the manufacturer e-newsletter, and from the program implementer e-newsletter.
- (b) Medium priority: HVAC contractor contacts sourced through internal TRC networks. These include contractors that had participated in previous HVAC efficiency training events and that had been identified as potential trade allies through TRC's program implementation staff.
- (c) Low priority: Companies identified as residential HVAC or water heating contractors through a data service (Data Axel), based on Standard Industrial Classification (SIC) code and location.

While the screener questions ensured that all respondents were at least somewhat active in the DHE market, this prioritization method increased the chance of contractors that are highly active in the DHE market getting “first dibs” on the survey, and it streamlined recruitment efforts. Table A.4 shows how TRC achieved the target using the recruitment methods and sources described above.

²¹ NATE (natex.org) is a third-party testing and certification program for HVAC technicians. NATE certifies HVAC technicians through a series of knowledge and experience-based testing, then initiates follow-up training and testing every two years. Rather than recommending specific contractors, one DHE manufacturer linked directly to the NATE certified contractor website. Since this DHE manufacturer recommended this resource, TRC also chose to use the NATE contractor list to identify potential survey respondents.

Table A.4. Contractor Survey Recruitment and Disposition

Recruitment Method	Contractor Source	Completed
TRC Direct Outreach	NATE website	7
	TRC internal sources	5
	Data Axel	4
	Williams website	1
Manufacturer e-newsletter	Manufacturer	2*
Program implementer e-newsletter	Program Implementer	1
Total Contractors Surveyed		20

* Number of surveys through e-newsletter inferred based on surveys completed using an anonymous link and newsletter launch dates.

TRC obtained contractor surveys within the diverse California regions, as requested by the LBNL team. Figure A.4 illustrates the California regions as defined in the survey, and Table A.5 shows the distribution of survey respondents by region. The highest number of completions were in the San Francisco Bay Area and Southern California. This aligns with the recent *2019 Residential Appliance Saturation Survey* (DNV GL, 2020) which found that these areas have the highest penetration of DHE in existing homes.



Figure A.4. Map of California Regions for Contractor Survey

Table A.5. Contractor Survey Responses by California Region

California Region	Completed
North Coast	2
North Eastern California	2
San Francisco Bay Area	7
Sacramento Valley	2
San Joaquin Valley	4
Sierra Nevada	2
Central Coast	4
Southern California	5