California Residential Efficiency Market Share Tracking

First-Year Interim Report

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Introduction

1.1 Introduction

This report presents the first-year results of the California Residential Market Share Tracking project. The project, conducted by Regional Economic Research, Inc. (RER) under Southern California Edison (SCE) management, plays a significant role in market assessment and evaluation activities supporting California's publicly funded energy efficiency programs.

Residential efficiency market share tracking in California is an ongoing, long-term effort designed to support publicly funded energy efficiency program planning, evaluation, and related policy decisions over the next several years. This report represents the first of many interim reports for the Residential Market Share Tracking (RMST) project. Subsequent reports will be prepared on a periodic basis yet to be determined. In many respects, the first year was devoted to developing the RMST project to operate on a long-term basis.

The development of the RMST benefited from the insight, support, and cooperation from many individuals, organizations, and companies in both the energy efficiency community and the private sector. The project management team, consisting of Rich Pulliam (SCE) and Rick Ridge (Ridge & Associates), provided outstanding guidance and greatly appreciated insight and support.

1.2 Background

As directed by the California Public Utilities Commission (CPUC), California's publicly funded energy efficiency programs are dedicated to transforming markets to a higher, sustainable level of energy efficiency. The evaluation of market transformation initiatives requires knowledge of baseline market conditions and changes relative to that baseline over time. In order to assess the success of these market transformation efforts, it is necessary to develop a reasonably comprehensive system to track a variety of indicators of market changes that are attributable to these efforts (market effects). While some market behaviors (and behavioral changes) cannot be observed quantitatively, the market share trend of energy efficiency measures over time is one market effects indicator that is truly measurable.

Tracking systems (including those specifically tracking market shares) are needed for program development, program redesign, and broader policy-making decisions:

- To assess the effectiveness of specific programs and intervention strategies,
- To assess the success of the overall market transformation process, and
- To determine the need for continued publicly supported programs at the end of the transition period.

RER's approach to developing and implementing the first year of residential sector efficiency tracking closely follows recommendations developed from a publicly funded scoping study, conducted by RER (referred to hereinafter as the tracking scoping study) under the direction of the now defunct California Board for Energy Efficiency.[1,2] RER based the tracking scoping study upon specific tracking system requirements: 1) that data represent unit sales, so levels and percentages of shipments of energy efficiency measures could be estimated, 2) that data be segmented by efficiency type, so the share of efficient products could be tracked continuously even in the face of shifts in the overall distribution of efficiency and changes to energy efficiency standards, and 3) that data be available at the state level and, if possible, at finer levels of geographic aggregation. RER also recommended that data be collected to support efficiency tracking by decision type (new construction, net acquisition, retrofit, and replacement). It is necessary to distinguish decision type in market share tracking in order to accommodate the assessment of programs that are designed to influence choices under specific market events.

1.3 Project Overview

Measure Coverage

The ultimate objective of the RMST project is to estimate and track the market shares of high efficiency measures purchased and installed in California's residential sector over the next several years. Table 1-1 includes the specific measures currently covered by the RMST and the decision type levels for which market share analysis is possible for each. The sections in which the efficiency tracking results are presented in this report are also provided.

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1 Regional Economic Research, Inc. *Efficiency Market Share Tracking Needs Assessment and Feasibility Scoping Study*. Prepared for the California Board for Energy Efficiency and Pacific Gas & Electric. May 10, 1999.

2 Regional Economic Research, Inc. *Emerging Technologies Efficiency Market Share Tracking Needs Assessment, Feasibility and Market Penetration Scoping Study*. Prepared for the California Board for Energy Efficiency and Pacific Gas & Electric. December 6, 1999.

Table 1-1: Measures Currently Covered by the RMST Project

Measures	*Results Section*	Decision Type		
		Overall Market	**New Construction**	**Retrofit, Replacement, & Net-Acquisition**
Space Heating & Cooling Equipment				
Central Air Conditioners	*Section 3*	X	X	X
Gas Furnaces	*Section 4*	X	X	X
Heat Pumps	*Section 5*	X		
Air Duct Construction				
Air Duct Leakage	*Section 6*		X	
Water Heating Equipment				
Gas Water Heaters	*Section 7*	X	X	
Electric Water Heaters	*Section 7*	X	X	
Appliances				
Refrigerators	*Section 8*	X		
Clothes Washers	*Section 8*	X		
Dishwashers	*Section 8*	X		
Room Air Conditioners	*Section 8*	X		
Windows				
Windows	*Section 9*		X	
Interior & Exterior Lighting				
Torchieres	*Section 10*		X	
CFL Fixtures	*Section 10*		X	
CFL Lamps	*Section 10*			
CFL Lamps	*Forthcoming*	X	X	

For the purposes of this project, the decision types are defined as the following:

- ***Overall Market*** refers to all installations/sales irrespective of market event or the purpose for which it was installed/purchased.
- ***New Construction*** refers to installations in newly constructed buildings that were not previously occupied by a building owner or tenant.
- ***Retrofit/Replacement*** refers to the complete replacement or major upgrade of existing equipment or system.

- ***Net Acquisition.*** A net acquisition is the installation/purchase of a measure that did not previously exist in a building and/or was not previously owned by the end user.

There are three driving factors with respect to analysis at the decision type level. First, analysis at the decision type level is only possible where warranted by the available data (explained below). Second, analysis at the decision type level is not logical for some measures. Appliances for example, are generally not standard in newly constructed homes and are typically purchased by the consumer at retail establishments. Third, decision level analyses should correspond to the markets served by the energy efficiency programs they are designed to support. For example, the California statewide appliance program does not target new construction and replacement/net acquisition purchases separately, so it would not be logical sense to track efficiencies by these specific decision types.

Data Collection

As revealed during the tracking scoping study tracking the share of high efficiency measures requires substantial amounts of data that are not generally collected by other entities.[3] The data collection approach developed for the RMST represents a comprehensive strategy enabling us to track efficiencies of the identified measures by decision type if appropriate. RER's approach involves four major components, described below.

- ***New Construction Sector Data Collection.*** Data collection in the new construction sector included new construction on-site surveys of single and multi-family residential buildings and the collection of building department installation forms throughout California. To supplement the on-site survey data, RER obtained installation forms containing data on key measures installed in new homes throughout the State. Required to be completed by builders and installation contractors under California's Title 24 energy efficiency standards, these forms (CF-6R forms) are sometimes publicly available from local building departments.

  Data from the on-site surveys and the CF-6R forms were combined to estimate the market shares and average efficiencies of a variety of measures in California's residential new construction sector. A second round of on-site surveys is currently underway for the second year of the RMST. Additionally, RER is working with building departments and other contractors to obtain installation data on key measures to support the RMST project.

- ***Equipment Distributor Sales Data Collection.*** RER recruited panels of equipment distributors to provide sales data used to estimate efficiency market

[3] Regional Economic Research, Inc. *Efficiency Market Share Tracking Needs Assessment and Feasibility Scoping Study*. Prepared for the California Board for Energy Efficiency and Pacific Gas & Electric. May 10, 1999.

shares of HVAC and water heating equipment in California. These data together with the estimates of new construction installations enable us to estimate retrofit/replacement shares. Efforts continue to expand the distributor panels during the second year of the RMST project.

- ***Appliance Retail Sales Data Collection.*** RER obtained retail sales data from a panel of independently owned appliance retailers, in addition to national chain sales data collected by D&R International under the auspices of the ENERGY STAR Appliance Program. These data are used to estimate the share of ENERGY STAR qualified refrigerators, clothes washers, dishwashers, and room air conditioners sold in California. Efforts continue to expand the independent retailer panel during the second year of the RMST project.
- ***Purchase Point-of Sale Data for Lighting Products.*** RER has obtained point-of-sale data for a variety of lighting products, such as incandescent bulbs, compact fluorescent lamps, and halogen lamps. These data are used to estimate the share of energy efficient bulbs sold in the California marketplace. (Note the results of this portion of the analysis will be provided under separate cover.) RER is currently negotiating the development and purchase of point-of-sale data for lighting fixtures and floor lamps.

1.4 Second-Year Tracking Objectives

Preparation of this first interim report was the opportune time to evaluate the project's successes and failures, and to make mid-course corrections if necessary. This subsection briefly summarizes work in progress and objectives for the second year for each major component of the project.

- ***Residential New Construction Efficiency Tracking.*** RER is currently planning another round of on-site surveys for the second project year. RER continues to collect CF-6R installation forms from participating building departments on a regular basis, and continues to increase participation of other building departments. In addition, RER is working with other market actors who complete different portions of the CF-6R forms, including builders and HVAC, plumbing, and window contractors.
- ***HVAC and Water Heater Equipment Distributor Data Collection.*** The primary objectives for the distributor data collection effort during the second year are to continue to develop relationships with equipment distributors and to increase the market coverage, particularly at the utility service area level. Other activities relating to this component of the RMST include review and revision of project marketing materials, preparation of project summaries for the distributors in the current panel, and development of an approach for discerning new construction from replacement sales in the data.
- ***Residential Appliance Sales Data Collection.*** The primary objectives for the appliance retail data collection effort during the second year are to continue to

develop and forge new relationships with independent retailers in California. RER will also continue to work with D&R International to obtain sales data from national retail chains collected to support the evaluation of the ENERGY STAR program.

- ***Lighting Equipment Tracking with Retail Sales Data.*** RER has successfully overcome significant obstacles in developing efforts to track lighting products. RER is currently working with point-of-sale bulb data and will release the first lighting report within the next few months. Additionally, RER is working closely with members of the lighting community to ensure that information beyond the scope of the RMST project is widely available and meaningful for a variety of purposes. RER is also working with point-of-sale data vendors to develop a sales tracking system for lighting fixtures.
- ***Database Construction and Processing Automation.*** RER has already begun to review current procedures and data processing routines to automate the data processing and reporting as much as possible.
- ***Reporting Procedures.*** Early in the second project year, RER will work with the project management team to develop a schedule for reporting results on a regular basis. More frequent reporting of results would certainly benefit program planners, evaluators, and the energy efficiency community in general. In addition, because preparing reports of this detail over the next several years would be uneconomical and considerably repetitive, RER will investigate alternatives for a streamlined reporting process. Options for making the RMST reports and data available for review and/or distribution through other means, such as the Internet or CD-ROM, will also be explored. While proprietary data will not be available to the public, tracking data could be available at some aggregated level.

1.5 Organization of Report

This first-year interim report is organized as follows:

- Section 2 details the data collection and analysis methodology for developing the market share and average efficiency estimates.
- Sections 3, 4, and 5 present the RMST results for central air conditioners, gas furnaces, and heat pumps, respectively.
- Section 6 presents the results of duct construction and air flow leakage in new construction
- Section 7 includes the RMST results for water heating equipment.
- Section 8 presents the efficiency shares of residential appliances, including refrigerators, clothes washers, dishwashers, and room air conditioners.
- Sections 9 and 10 present the results of the interior and exterior lighting and windows.

- Section 11 previews work in progress and RMST activities during the second project year.
- Appendices include the following:
  - Appendix A acknowledges those who supported and contributed to the development of the RMST,
  - Appendix B, C, and D include the materials developed for the new construction efforts, including the on-site survey form, the duct blaster survey form and testing protocols, and a copy of a CF-6R form.
  - Appendix E includes a copy of the confidentiality agreement RER signed with all private companies that agreed to provide sales data for the RMST project.
  - Appendix F and G include samples of project marketing materials developed for recruiting HVAC and water heater distributors, and appliance retailers.

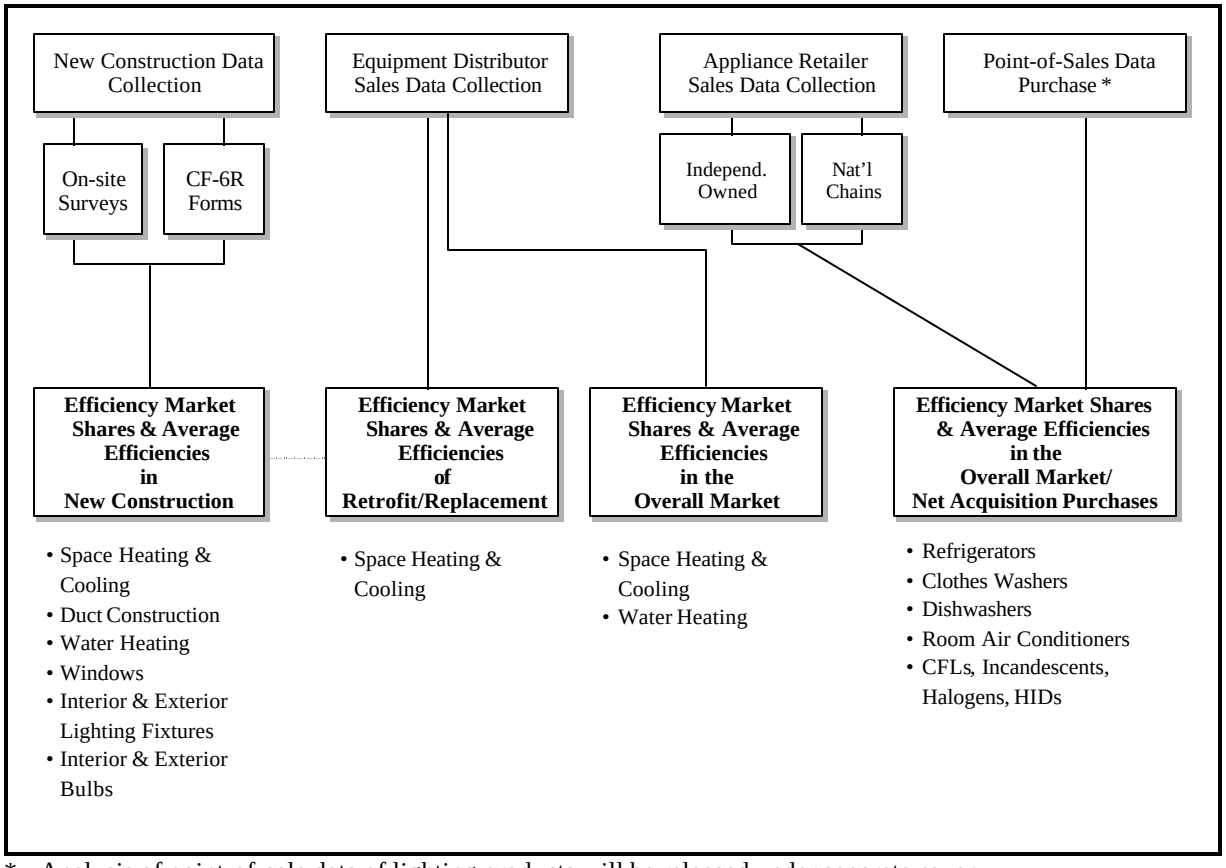
2

Data Collection and Methodology

2.1 Overview

This section details the data collection strategies and the methodologies for estimating market shares of high efficiency measures in California. As shown in Figure 2-1, RER's approach involves four major data collection components: new construction sector data collection, equipment distributor sales data collection, appliance retailer sales data collection, and the purchase of lighting product point-of-sales data. Each approach is summarized below, and subsections in which each is detailed are also noted.

Figure 2-1: Overview of RMST Data Collection



* Analysis of point-of-sale data of lighting products will be released under separate cover.

- ***New Construction Sector Data Collection.*** Data collection in the new construction sector included new construction on-site surveys of single and multi-family residential buildings and the collection of building department installation forms throughout California. To supplement the on-site survey data, RER obtained installation forms containing data on key measures installed in new homes throughout the State. Required to be completed by builders and installation contractors under California's Title 24 energy efficiency standards, these forms (CF-6R forms) are sometimes publicly available from local building departments.

  Data from the on-site surveys and the CF-6R forms were combined to estimate the market shares and average efficiencies of a variety of measures in California's residential new construction sector. A second round of on-site surveys is currently underway for the second year of the RMST. Additionally, RER is working with building departments and other contractors to obtain installation data on key measures to support the RMST project.

  As shown in Figure 2-1, the on-site survey and CF-6R data were analyzed to estimate the market share and average efficiency of the following measures:

  - Space Heating & Cooling Equipment
  - Duct Construction
  - Water Heating
  - Windows
  - Interior & Exterior Lighting Fixtures
  - Interior & Exterior Bulbs

  New construction sector data collection and analysis is detailed in Section 2.2 (beginning on page 2-4). Results are presented in subsequent sections of this report.

- ***Equipment Distributor Sales Data Collection.*** RER recruited panels of equipment distributors to provide sales data used to estimate efficiency market shares of HVAC and water heating equipment in California. As shown in Figure 2-1, the distributor sales data were analyzed to estimate the market share and average efficiency of the following measures, representing both new construction and retrofit/replacement installations (the overall market):

  - Space Heating & Cooling Equipment
  - Water Heating

  The average efficiencies of retrofits/replacements were estimated by backing out the new construction estimates from the overall market sales.

  The equipment distributor data collection and analysis is detailed in Section 2.3 (beginning on page 2-35). Results are presented in Sections 3, 4, and 7.

- ***Appliance Retail Sales Data Collection.*** RER obtained retail sales data from a panel of independently owned appliance retailers, in addition to national chain sales data collected by D&R International under the auspices of the ENERGY STAR

Appliance Program. As shown in Figure 2-1, these data are used to estimate the percentage of units sold that qualify for the ENERGY STAR label of the following measures:

- Refrigerators
- Clothes washers
- Dishwashers
- Room air conditioners

The appliance retail sales data collection and analysis is detailed in Section 2.5 (beginning on page 2-45). Results are presented in Section 8.

- ***Purchase Point-of Sale Data.*** RER has obtained point-of-sale data for a variety of lighting products, such as incandescent bulbs, compact fluorescent lamps, and halogen lamps. These data are used to estimate the share of energy efficient bulbs sold in the California marketplace. RER is also negotiating the development and purchase of point-of-sale data for lighting fixtures and floor lamps.

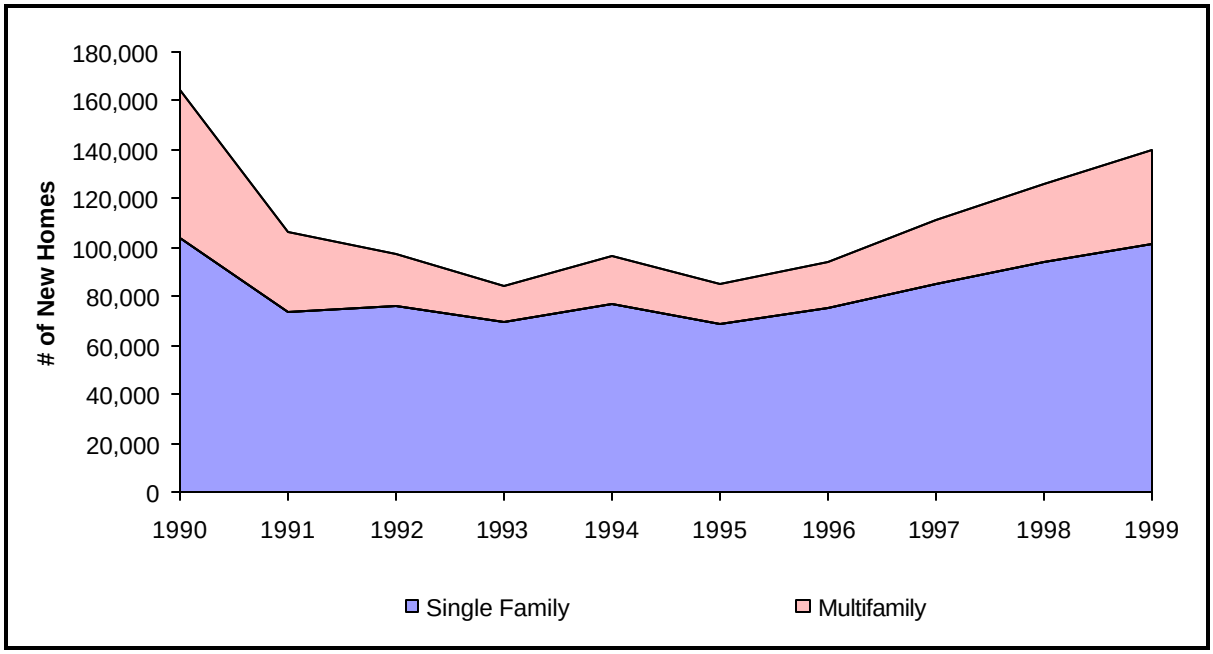
  The results of the analysis of lighting point-of-sale data will be provided under separate cover.

2.2 New Construction Sector Data Collection and Analysis

Overview of California's Residential New Construction Market

Having an understanding of the level of new construction activity in California is useful when tracking the efficiencies of measures in newly constructed homes. As shown in Figure 2-2, new construction activity decreased significantly in the early 1990s. After remaining fairly constant for several years, the number of new homes built in California has slowly increased since 1995.

Figure 2-2: New Construction in California



Single Family New Construction

As illustrated in Figure 2-3 and Table 2-1, there has been little change in the relative number of new single family homes built across utilities in the last 2½ years. New homes in PG&E's service territory account for approximately 50% of new homes built in the State, while new homes in SCE's and SDG&E's service areas account for 38% and 12%, respectively.

Figure 2-3: Single Family New Construction in California (by Utility)

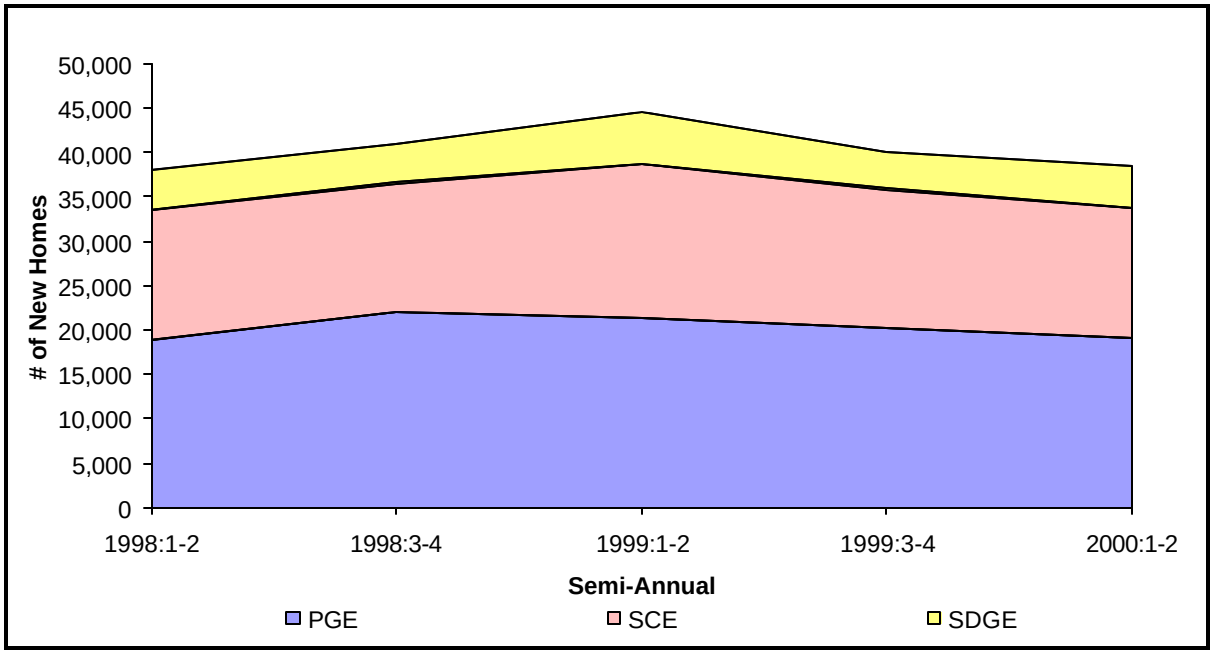


Table 2-1: Single Family New Construction in California (by Utility)

Utility	1998:1-2	1998:3-4	1999:1-2	1999:3-4	2000:1-2*
PG&E	18,893	21,917	21,282	20,234	19,034
SCE	14,582	14,570	17,457	15,710	14,764
SDG&E	4,631	4,529	5,824	4,169	4,592
Total	**38,107**	**41,016**	**44,564**	**40,113**	**38,389**

* Estimates based on January – April 2000.

Multifamily New Construction

Figure 2-4 and Table 2-2 present multifamily construction activity. As shown, the number of multifamily homes built in California has slowly increased over the last 2½ years. During the last six months of 1999, 17,942 multifamily units were built within PG&E's, SCE's, and SDG&E's service territories. This represents a 44% increase over the total number of multifamily homes built during the first six months of 1998. The percentage of homes that are multifamily that were built within PG&E's territory has decreased from 58% to 45%, while the percentages within SCE's and SDG&E's territories have increased from 30% to 39% and from 11% to 16%, respectively.

Figure 2-4: Multifamily New Construction in California (by Utility)

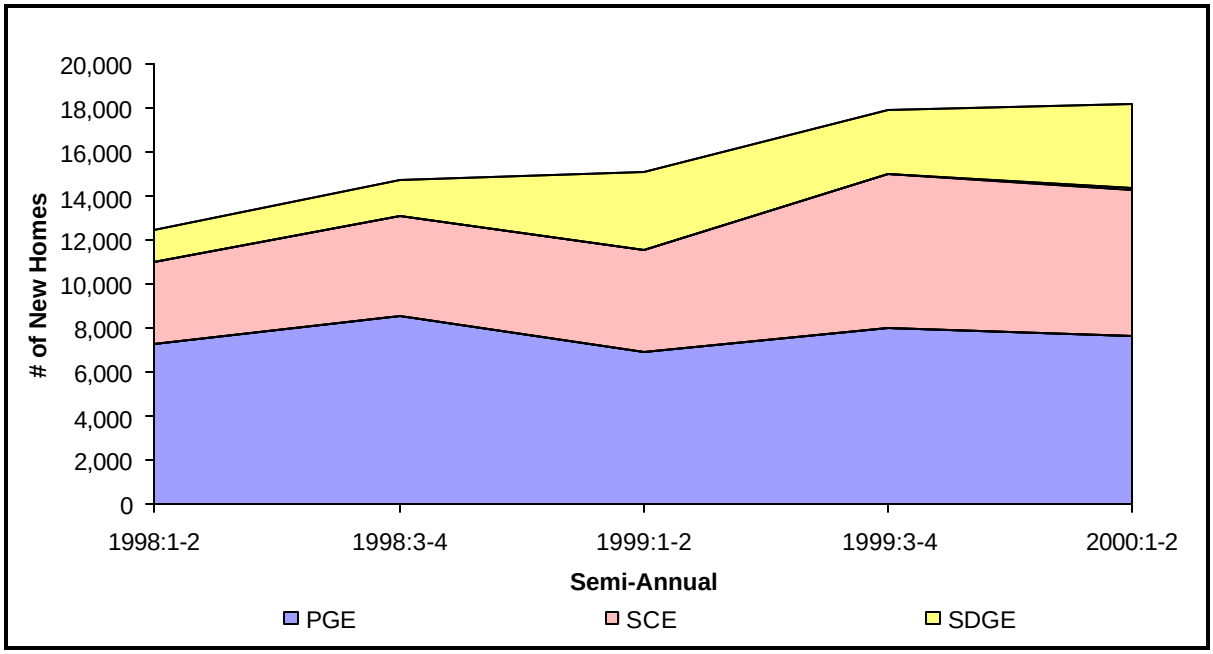


Table 2-2: Multifamily New Construction in California (by Utility)

	1998:1-2	1998:3-4	1999:1-2	1999:3-4	2000:1-2*
PG&E	7,283	8,572	6,902	8,047	7,671
SC&E	3,759	4,535	4,671	6,966	6,632
SDG&E	1,426	1,587	3,505	2,929	3,833
All	12,468	14,694	15,078	17,942	18,136

* Estimates based on January – April 2000.

Overview of New Construction Sector Data Collection and Analysis

Developing efficiency market shares and average efficiencies of measures installed in California's new construction sector involved the development and implementation of two major data collection components.

- ***On-Site Surveys.*** This element entailed a comprehensive on-site survey of a representative sample of 800 newly constructed homes in California. Detailed data on equipment efficiencies as well as building shell characteristics were gathered from 650 single family and 150 multifamily residences.
- ***CF-6R Installation Forms.*** This element entailed the development of systematic collection of CF-6R installation forms from building departments throughout California. CF-6R forms are filed by builders and include detailed data on a variety of measures installed in newly constructed homes, including HVAC and water heating equipment, duct sealing methods, and window efficiencies. RER also recognized that installation data from HVAC, window, and water heating contractors are also available. RER will collect data from these other market actors as a third element to the tracking system during the second year of the study.

Data from the on-site surveys and CF-6R forms were combined to track the market shares and average efficiencies of a variety of measures.

Table 2-3 includes a list of the measures that were proposed to be covered and those that were actually covered by this component of the project. As shown, several measures were not covered by this analysis due to relatively small samples and the fact that reliable information for some of these measures was not obtainable.

Table 2-3: Measures Covered in the New Construction Analysis

Proposed Measures to Cover	Measures Currently Covered in the New Construction Analysis
Duct Sealing	Duct Sealing
High Performance Windows	High Performance Windows
Duct Insulation	
Central Air Conditioners	Central Air Conditioners
Indirect/Direct Evaporative Coolers	-
Evaporative Condenser AC	-
Gas and Electric Furnaces	Gas Furnaces
Gas and Electric Water Heaters	Gas Water Heaters
Heat Pumps	-
Heat Pump Water Heaters	-
Dishwashers	-
Torchieres	Torchieres
Compact Fluorescent Fixtures	Compact Fluorescent Fixtures
Compact Fluorescent Lamps	Compact Fluorescent Lamps

On-site Survey Development and Implementation

The objective of the on-site survey effort was to collect efficiency data for equipment and shell measures installed in 800 single family and multifamily homes in California. As the RMST is an ongoing multi-year project, on-site surveys will continue to be conducted in the future to develop a time trend of efficiencies in this important market sector.

RER initially developed the on-site data collection effort to gather data on a subset of the measures in the first column of Table 2-3.[1] Initially, the on-site survey was relatively short. However, after discussions with project mangers of other statewide MA&E projects, it was evident that a considerably more in-depth survey would be useful to support other MA&E studies (and prevent costly duplication of efforts). Thus, the on-site data collection effort was expanded to collect data to support engineering simulations of energy usage for each of the newly constructed homes to support the needs of other MA&E projects already planned.[2]

[1] RER recommended high priority measures for tracking in the Efficiency Market Share Tracking Scoping Study conducted in 1998 through 1999. See Regional Economic Research, Inc. *Efficiency Market Share Needs Assessment and Feasibility Scoping Study*. Prepared for the California Board for Energy Efficiency and Pacific Gas and Electric. May 10, 1999.

[2] The data collected on-site will be used in the Baseline Study of Code Compliance in California. This is a statewide study managed by Pacific Gas and Electric Company.

The remainder of this subsection describes the development of the on-site data collection effort and is organized as follows:

- Sample design,
- Duct blaster test sample development,
- Development of the on-site survey form and survey protocol, and
- The completed sample.

On-site Survey Sample Design

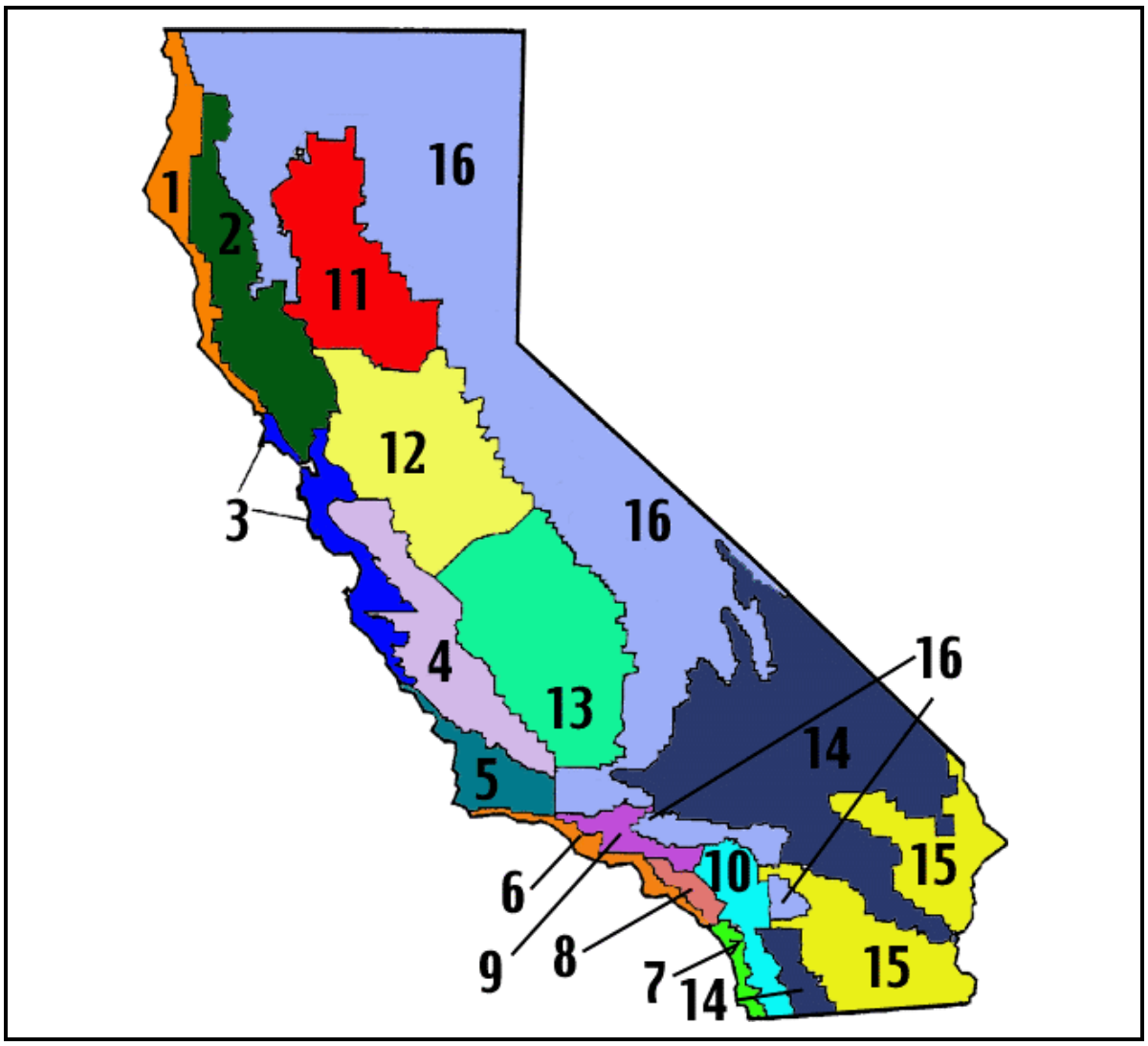
The on-site sample frame, the comparison with building department permit data, on-site sampling plan, and sample selection are discussed below.

Sample Frame Overview. The new construction survey frame was developed using customer frame data provided to RER by California's investor owned utilities (IOUs). To ensure that the case weights represent new home populations by residence type and climate zone, data on total building permits by type and climate zone were also used to provide a sanity check for the frame estimates.

For purposes of developing the new construction sample frame, RER defines newly constructed homes as those first occupied between June 30, 1998 and July 1, 1999. Further, it was essential that the frame data include information on residence type and CEC climate zone.

- ***Residence Type.*** Each utility has a residence type indicator in their billing frame. These definitions vary widely and, at best, could be aggregated only into single family and multifamily designators. Common area accounts were omitted from the sample frame.
- ***CEC Climate Zone.*** There are 16 CEC climate zones throughout California, as shown in Figure 2-5. For this study, these zones were collapsed into five regions. The criterion for the aggregation of the climate zones was that the Title 24 requirements across these climate zones are the same or vary in only one component. Using this approach, climate zones were aggregated as described below:
  - Climate Zone 1 (CZ1) includes CEC climate zones 1, 2, 3, 4, and 5
  - Climate Zone 2 (CZ2) includes CEC climate zones 6 and 7
  - Climate Zone 3 (CZ3) includes CEC climate zones 8, 9, and 10
  - Climate Zone 4 (CZ4) includes CEC climate zones 11, 12, and 13
  - Climate Zone 5 (CZ5) includes CEC climate zones 14, 15, and 16

Figure 2-5: CEC Climate Zones



Source: California Energy Commission.

In addition to the residence type and climate zone indictors, the frame data contained an identifier that allows the gathering of usage data, such as premise identifier, meter number, or account number.

Developing the frame data from utility billing frame data varied across utilities, as each has a different customer frame system. The following is a brief overview of how the on-site customer frame data were constructed for each utility.

Pacific Gas and Electric Company (PG&E). The PG&E residential billing frame was screened by meter set date being after July 1, 1998 and the date the customer was first served coming after the meter set date. These screens yielded a sample that was roughly 20% larger than would be expected by using building permit data (allowing for lag in building permits to

actual finished construction). Discussions with PG&E staff revealed the existence of a control number assigned to each premise. This number, assigned in a consecutive manner, is assigned to new premises in the PG&E service territory when they are added to the billing frame. By inspecting the customers with meter set dates on July 1 or 2, RER determined that control numbers above 6,605,000 would indicate that these were new accounts and not meter change-outs. Using this additional screen yields a count that is in line with building permits. Residence type indicators were developed from a residence type indicator on the PG&E billing frame. Weather zone indicators for the PG&E service territory were developed from CEC weather zone to city mappings and some limited weather zone to zip code mappings.

Table 2-4 presents the new construction frame for PG&E.

Table 2-4: Summary of PG&E New Construction Frame

CEC Climate Zone	Single Family	Multifamily
CZ:1	18,693	9,694
CZ:2	4	-
CZ:3	-	-
CZ:4	26,354	2,668
CZ:5	579	10
Total	**45,630**	**12,372**

San Diego Gas & Electric Company (SDG&E). SDG&E staff developed the frame of newly constructed homes according to meter set dates. RER attached weather zone indicators based on a zip code-to-weather zone mapping key developed by SDG&E staff. SDG&E staff attached residence type indicators. It is our understanding that these indicators are attached at the time new meters are hooked up and added to the billing system.

Table 2-5: Summary of the SDG&E New Construction Frame

CEC Climate Zone	Single Family	Multifamily
CZ:1	-	-
CZ:2	5,370	845
CZ:3	1,103	66
CZ:4	-	-
CZ:5	15	-
Total	**6,488**	**911**

Southern California Edison (SCE). The SCE residential billing frame was screened for customers with a *service-in-premise* date coming after July 1, 1998. Residence types were derived from a use code variable that describes the dwelling type associated with each meter. SCE's CEC weather zone indicator variable was also provided. Table 2-6 presents the SCE new construction frame by residence type and CEC weather zone.

Table 2-6: Summary of SCE New Construction Frame

CEC Climate Zone	Single Family	Multifamily
CZ:1	-	-
CZ:2	4,487	1,377
CZ:3	22,061	3,736
CZ:4	2,089	60
CZ:5	4,313	345
Total	**32,950**	**5,518**

Southern California Gas Company (SoCalGas). The initial approach for the new construction portion of the study assumed that the SCE, PG&E, and SDG&E service territories would be representative of the new construction market. However, after reviewing the extent of overlap between the SDG&E, SCE, and PG&E service areas with SoCalGas' service area, RER determined that a significant number of new homes in the SoCalGas areas

would not be accounted for in the frame. Therefore, after screening out the zip codes associated with all of the new construction in the other service territories, SoCalGas provided a listing of all homes with meter set dates after July 1, 1998. A residence-type indicator and CEC weather zone was also included. Table 2-7 presents the SoCalGas new construction frame by weather zone and residence type.

Table 2-7: Summary of SoCalGas' New Construction Frame

CEC Climate Zone	Single Family	Multifamily
CZ:1	-	-
CZ:2	148	119
CZ:3	2,094	1,452
CZ:4	-	-
CZ:5	1,415	198
Total	**3,657**	**1,769**

On-site Survey Sample Summary. Table 2-8 presents a summary of the combined frame used for developing the new construction survey sampling plan. Note that the sample has been further segmented by six-month period of construction.

Table 2-8: On-Site Survey Sample Frame

Res. Type & Climate Zone	PG&E			SCE			SCG			SDG&E		
	1998: 3-4	1999: 1-2	All	1998: 3-4	1999: 1-2	All	1998: 3-4	1999: 1-2	All	1998: 3-4	1999: 1-2	All
SF.CZ1	9,552	9,141	18,693	-	-	0	-	-	0	-	-	0
SF.CZ2	2	2	4	2,372	2,115	4,487	58	90	148	3,584	1,786	5,370
SF.CZ3	-	-	0	11,890	10,171	22,061	926	1,168	2,094	665	438	1,103
SF.CZ4	12,933	13,421	26,354	1,097	992	2,089			0	-	-	0
SF.CZ5	354	225	579	2,235	2,078	4,313	641	774	1,415	11	4	15
SF Total	22,841	22,789	45,630	17,594	15,356	32,950	1,625	2,032	3,657	4,260	2,228	6,488
MF.CZ1	5,285	4,409	9,694	-	-	0	-	-	0	-	-	0
MF.CZ2	-	-	0	787	590	1,377	43	76	119	538	307	845
MF.CZ3	-	-	0	1,513	2,223	3,736	765	687	1,452	34	32	66
MF.CZ4	1,244	1,424	2,668	33	27	60	-	-	0	-	-	0
MF.CZ5	5	5	10	215	130	345	87	111	198	-	-	0
MF Total	6,534	5,838	12,372	2,548	2,970	5,518	895	874	1,769	572	339	911
All Total	**29,375**	**28,627**	**58,002**	**20,142**	**18,326**	**38,468**	**2,520**	**2,906**	**5,426**	**4,832**	**2,567**	**7,399**

SF = Single Family
MF = Multifamily

Comparison of Sample Frame with Building Department Permit Data. As a sanity check in developing a new construction database from utility billing records, RER staff compared the sample frame with the number of new housing starts. New housing starts, developed from data on building permits, were obtained from the Construction Industry Research Board (CIRB). Table 2-9 compares the number of new homes from the utility customer frames with new housing starts for each utility area. As shown, the lagged building department permit data align well with the utility frame, with the exception of the SDG&E multifamily sector. No attempt was made to align the SoCalGas sector because it was difficult to map the areas covered by SoCalGas (without SCE or SDG&E electricity) to the building department permits.

Table 2-9: Comparison of Building Department Permits to New Construction Sample Frame by Weather Zone and Residence Type

	Single Family		Multifamily		All Housing Types	
Utility	New Housing Starts	Frame	New Housing Starts	Frame	New Housing Starts	Frame
PG&E	40,810	45,630	15,855	12,372	56,665	58,002
SCE	29,153	32,950	8,294	5,518	37,447	38,468
SDG&E	9,160	6,488	3,763	911	12,923	7,399
Total	**79,123**	**85,068**	**27,912**	**18,801**	**107,035**	**103,869**

New housing starts were developed by the Construction Industry Research Board and are based upon building permits.

Sampling Plan and Sample Selection. Next, RER developed the sampling plan for the on-site survey. The sample was to be stratified by residence type, CEC climate zone, and by six-month periods of construction to allow representation across the year.[3] Table 2-10 presents a summary of the on-site survey sample design. RER allocated the sample targets proportionally with some oversampling for the SDG&E service territory, with a total completed sample size of 800. Note that the completed targets were divided equally across six-month period of construction.

With the sampling plan complete, RER then randomly selected the primary and secondary members of the sample by sample stratum.

[3] This will not detract from the precision of the survey in developing annual estimates. Doing so merely ensures that some finer segmentations of the data are available (at an admittedly lower level of precision than the summarized annual estimates) if desired.

Table 2-10: Completed Targets for the On-Site Survey

Res. Type & Climate Zone	PG&E			SCE			SCG			SDG&E		
	1998: 3-4	1999: 1-2	All	1998: 3-4	1999: 1-2	All	1998: 3-4	1999: 1-2	All	1998: 3-4	1999: 1-2	All
SF.CZ1	59	59	118	-	-	-	-	-	-	-	-	-
SF.CZ2	-	-	-	17	17	34	1	1	2	39	39	78
SF.CZ3	-	-	-	80	80	160	7	7	14	8	8	16
SF.CZ4	82	82	164	8	8	16	-	-	-	-	-	-
SF.CZ5	2	2	4	16	16	32	5	5	10	-	-	-
SF	**143**	**143**	**286**	**121**	**121**	**242**	**13**	**13**	**26**	**47**	**47**	**94**
MF.CZ1	31	31	62	-	-	-	-	-	-	-	-	-
MF.CZ2	-	-	-	5	5	10	1	1	2	6	6	12
MF.CZ3	-	-	-	14	14	28	6	6	12	1	1	2
MF.CZ4	9	9	18	-	-	-	-	-	-	-	-	-
MF.CZ5	-	-	-	2	2	4	1	1	2	-	-	-
MF	**40**	**40**	**80**	**21**	**21**	**42**	**8**	**8**	**16**	**7**	**7**	**14**
Total	**183**	**183**	**366**	**142**	**142**	**284**	**21**	**21**	**42**	**54**	**54**	**108**

SF = Single Family
MF = Multifamily

Table 2-11: Completed Targets for the Duct Blaster Tests

Res. Type & Climate Zone	PG&E			SCE			SCG			SDG&E		
	1998: 3-4	1999: 1-2	All	1998: 3-4	1999: 1-2	All	1998: 3-4	1999: 1-2	All	1998: 3-4	1999: 1-2	All
SF.CZ1	7	7	14	-	-	-	-	-	-	-	-	-
SF.CZ2	-	-	-	2	2	4	-	-	-	5	5	10
SF.CZ3	-	-	-	10	10	20	1	1	2	1	1	2
SF.CZ4	10	10	20	1	1	2	-	-	-	-	-	-
SF.CZ5	-	-	-	2	2	4	1	1	2	-	-	-
SF	**17**	**17**	**34**	**15**	**15**	**30**	**2**	**2**	**4**	**6**	**6**	**12**
MF.CZ1	4	4	8	-	-	-	-	-	-	-	-	-
MF.CZ2	-	-	-	1	1	2	-	-	-	1	1	2
MF.CZ3	-	-	-	2	2	4	1	1	2	-	-	-
MF.CZ4	1	1	2	-	-	-	-	-	-	-	-	-
MF.CZ5	-	-	-	-	-	-	-	-	-	-	-	-
MF	**5**	**5**	**10**	**3**	**3**	**6**	**1**	**1**	**2**	**1**	**1**	**2**
Total	**22**	**22**	**44**	**18**	**18**	**36**	**3**	**3**	**6**	**7**	**7**	**14**

SF = Single Family
MF = Multifamily

Design of the On-Site Survey Instrument and Survey Protocol

RER staff developed the on-site survey instrument to obtain three primary types of information:

- Efficiency parameters for the covered measures, and
- Basic demographic and structural data.

A preliminary survey instrument was submitted to all interested parties for comments, including the RMST project managers and managers of other MA&E studies. Based on the comments received, RER developed the final survey instrument.

Volt VIEWtech (VIEWtech), a subcontractor to RER, conducted the on-site surveys. RER and VIEWtech collaborated to develop a comprehensive set of training materials for the on-site surveyors. VIEWtech conducted training sessions in Southern and Northern California that were attended by RER staff and by the RMST project managers. The training sessions covered survey objectives, survey protocols, and data entry procedures.

In addition to the extensive training provided by VIEWtech, RER coordinated a presentation by the California Window Institute (CWI) to educate the surveyors on high performance windows. SOLDATA Energy Consulting, which was sponsored by the CBEE, conducted the sessions.

Once the on-site surveyors were trained, the on-site survey instrument was pre-tested on a small sample of new homes. Senior staff from VIEWtech and RER accompanied small groups of surveyors to on-site visits. The pre-test revealed some small problems with the on-site survey instrument that resulted in minor format changes. A final on-site survey instrument is provided in Appendix B.

Duct Blaster Test Sample Development

To obtain data on duct sealing and duct construction practices, the RMST project was expanded from its original scope to include 100 duct blaster tests. The duct blaster tests were conducted by the California Home Energy Efficiency Rating System (CHEERS). CHEERS worked closely with the on-site surveyors (VIEWtech) to qualify and schedule homes for the duct blaster tests.[4]

[4] If a resident agreed to have the duct blaster test, they were screened to ensure that the home could be successfully tested. The screens included:
- Whether there was a ducted central heating or cooling system.
- If registers existed above 12 feet. If so, they did not qualify.
- About the use of wallpaper (it can be difficult to cover registers and return grates that are covered with wallpaper or located on papered walls).

The CHEERS team conducted duct blaster tests following the protocol used by the Title 24 requirements (e.g., the tests were conducted at 25 Pascals). A copy of the survey form and testing protocol used for the duct blaster tests is provided in Appendix C.

Table 2-11 presents a summary of the completed sample targets for the duct blaster tests. The sample design for this effort follows the distribution of the on-site surveys with some oversampling of multifamily homes.

Completed On-site Survey Sample

Table 2-12 presents the response rates for the on-site survey portion of the study. As shown, the sample targets set for the on-site surveys and duct blaster tests were fulfilled.

Table 2-12: Summary of On-Site Survey Response Rates

Utility Area & Residence Type	Contacted	Completed	Response Rate
PG&E	1,697	366	21.57%
Single Family	1,348	286	21.22%
Multifamily	349	80	22.92%
SCE	1,142	284	24.87%
Single Family	988	242	24.49%
Multifamily	154	42	27.27%
SDG&E	351	108	30.77%
Single Family	307	94	30.62%
Multifamily	44	14	31.82%
SoCalGas *	346	42	12.14%
Single Family	245	26	10.61%
Multifamily	101	16	15.84%

* Includes sites not served by PG&E, SCE, or SDG&E. Sites in this service area are included in the statewide analysis only.

- The number of central heating and/or cooling systems present in the home (or the number of wall-mounted thermostats).

On-site Survey Data Processing and Expansion Weights

On-site survey data processing for central air conditioners, gas furnaces, water heaters, windows, and lighting equipment is summarized below. The expansion weights for the analysis are also explained.

Central Air Conditioners. Data required from the on-site survey for tracking efficiencies of central air conditioners include manufacturer, model number, and efficiency rating (SEER). First, RER implemented several approaches to ensure that units with the same model number had identical efficiencies. RER then researched the efficiency ratings for all models with missing SEER values using ARI's equipment directories and manufacturer websites and catalogs.[5] Observations were eliminated if the unit model number was missing or incomplete.

Gas Furnaces. Data requirements for efficiency tracking from the on-site survey are fuel type, model number, and efficiency rating (AFUE). For this analysis, RER omitted all observations that were installed in manufactured or mobile homes. RER then verified efficiencies by grouping the data by model number to confirm that all units with the same model number were assigned identical efficiency ratings. Units with missing AFUE ratings were further investigated using GAMA's equipment directories and manufacturer websites and catalogs to assign efficiency ratings.[6]

Water Heaters. The on-site survey effort collected data on a number of important features of the installed water heaters. Of particular interest for tracking are the manufacturer, model number, fuel type, tank size, and efficiency. Efficiency and tank volume are used to determine the percent above the federal standard. RER verified the observed efficiency parameters and tank volumes by examining the minimum and maximum in each characteristic identify outliers. These outliers were reviewed and data entries were rectified as deemed necessary. The data were then grouped by model number to confirm that units with the same model number each had identical efficiencies and volumes. Finally, RER researched any model numbers with missing efficiency and/or volume values with GAMA's equipment directories and manufacturer websites and catalogs.[7]

Since the percent-above-standard is impossible to calculate for observations without an associated efficiency or volume, observations were eliminated if the unit's model number was missing or incomplete.

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5 Air-Conditioning and Refrigeration Institute. *ARI Electronic Unitary Directory*. ARIUD2000 V1.5. 1996-2000.

6 Gas Appliance Manufactures Association. *GAMA Consumers' Directory of Certified Efficiency Ratings for Residential Heating and Water Heating Equipment.* April and October Editions, 1997-1999.

7 Gas Appliance Manufactures Association. *GAMA Consumers' Directory of Certified Efficiency Ratings for Residential Heating and Water Heating Equipment.* April and October Editions, 1997-1999.

Windows. The on-site survey effort collected data on a number of important features of the installed windows. Data required for tracking include the frame type (metal, wood, or vinyl), the glass type (clear, tinted, or reflective), the number of layers of glazing (single, double, or triple) and the fill type (air or gas). In general, the data collected required little or no processing.

Interior Lighting. The analysis of interior lighting fixtures is based upon the type of bulb installed in each fixture, the mount type of the fixture, and the distinction between hard-wired dedicated CFL fixtures and non-dedicated CFL fixtures. The interior lighting fixture data recorded during the on-sites required little or no processing. The only data manipulation required involved the elimination of observations with incomplete information.

Interior Bulbs. Bulb data were analyzed by first grouping the data by bulb types that are interchangeable. That is, to estimate the share of CFLs, it is first necessary to determine the share of CFLs relative to the total number of CFL bulb *applications*. Based on this approach, RER developed two groupings of bulbs:

- ***Type 1:*** This includes the following interchangeable types of bulbs:
  - Incandescent (Medium Base),
  - CFLs, and
  - Halogen "A"s.
- ***Type 2:*** This includes the following interchangeable types of bulbs:
  - Incandescent PAR/Reflectors,
  - CF Reflectors, and
  - Halogen PAR/Reflectors.

Interior bulb data recorded during the on-sites required little or no processing. The only data manipulation involved the elimination of observations with incomplete information.

Torchieres and Floor/Table Lamps. Torchiere and floor/table lamp data recorded during the on-sites required little or no processing. The only data manipulation required involved the elimination of observations with incomplete information.

Exterior Fixtures. The analysis of exterior lighting fixtures is based upon the type of bulb installed in each fixture, the mount type of the fixture, and the distinction between hard-wired dedicated CFL fixtures and non-dedicated CFL fixtures. Exterior lighting fixture data recorded during the on-sites required little or no processing. The only data manipulation required involved the elimination of observations with incomplete information.

Exterior Bulbs. Analysis of exterior bulb data is based upon interchangeable bulb types. That is, to estimate the share of CFLs, it is necessary to determine the share of CFLs relative to the number of bulb *applications* that can use a CFL. Based on this approach, RER developed two groupings of bulbs:

- ***Type 1:*** This includes the following interchangeable types of bulbs:
  - Incandescent (Medium Base),
  - CFLs, and
  - Halogen "A"s.
- ***Type 2:*** This includes the following interchangeable types of bulbs:
  - Incandescent PAR/Reflectors,
  - CF Reflectors, and
  - Halogen PAR/Reflectors.

Exterior bulb data recorded during the on-sites required little or no processing. The only data manipulation required involved the elimination of observations with incomplete information.

Lighting Connected Loads. The original scope of the RMST did not include the analysis of connected lighting load. However, some experts in the lighting industry have expressed an interest in this subject. Therefore, RER conducted an analysis of connected load to serve as an indication of baseline connected load in California's residential new construction sector.

The on-site survey data contains a description of each fixture, which includes the wattage and number of bulbs per fixture. The following equation was used to find the total connected load per household (*h*) by summing across fixture items (*i*):

$$Connected\ Load_h = \sum_i \left(\#of\ \ fixtures_{h,i} * \#\ of\ bulbs\ per\ fixture_{h,i} * wattage\ per\ bulb_{h,i} \right)$$

On-site Survey Expansion Weights. RER developed expansion weights to expand the on-site data to represent to the total number of homes that were built within the three electric IOU territories between July 1, 1998 and June 30, 1999. The expansion weights are based on the number of households in each utility service area and CEC climate zone shown in Table 2-13.[8] In particular, the expansion weights for HVAC equipment are based on utility and climate zone, while the expansion weights for water heaters and windows are based solely on utility.

[8] New construction frames from the various utilities include both single family and multifamily homes.

Table 2-13: New Homes Built Between July 1, 1998 and June 30, 1999

CEC Climate Zone	PG&E	SCE	SDG&E	All
CZ:1	28,387	-	-	28,387
CZ:2	4	5,864	6,215	12,350
CZ:3	-	25,797	1,169	30,512
CZ:4	29,022	2,149	-	31,171
CZ:5	589	4,658	15	6,875
Total	**58,002**	**38,468**	**7,399**	**109,295**

Specifically, expansion weights were calculated as follows:

$$Weight_{i,U,CZ,HT,SA} = \frac{N_{U,CZ,HT,SA}}{n_{U,CZ,HT,SA}}$$

where

$N_{U,CZ,HT,SA}$ = the total number of houses built between July 1, 1998 and June 30, 1999, by utility, climate zone, housing type, and semi-annual classification,

$n_{U,CZ,HT,SA}$ = the number of completed samples points for houses built between July 1, 1998 and July 30, 1999, by utility, climate zone, housing type, and semi-annual classification.

Collection of Building Department CF-6R Forms

To augment the data obtained during the on-site surveys, RER obtained data on installed measures from building department CF-6R installation forms. The CF-6R forms, filed by builders upon completion of construction, include detailed data on a variety of measures installed in new homes, including HVAC and water heating equipment, duct sealing methods, and window efficiencies.

The objective of this effort was to obtain forms for 1,000 new homes to supplement the new construction on-site data for the tracking equipment efficiencies. Data from the on-site surveys and CF-6R forms were combined to track the market shares and average efficiencies of a variety of measures.

To help obtain and analyze data pertaining to residential market shares, RER has been and will continue to obtain CF-6R forms from building departments throughout California. The data collected helped characterize HVAC, water heating, fenestration, and other features of homes in California's residential new construction market. This information allowed RER to characterize the market, establish baseline efficiency levels for construction materials and

equipment being installed in residences today, and track the changes in the market over time to assess the impact of market transformation programs.

The CF-6R Form

CF-6R installation forms contain data on heating equipment, cooling equipment, water heating equipment, and fenestration of newly constructed residential buildings in California. Since the forms have HVAC, water heating, and fenestration information with descriptions, efficiency ratings, and model numbers, they are an excellent source of data for tracking average efficiencies and efficiency market shares in the residential new construction sector.

California's Title 24 Energy Efficiency Standards requires builders to provide the completed CF-6R to the new home owner, but does not require them to be submitted to or retained by the presiding building department. CF-6R forms are typically posted in the garage of a home that is being constructed. As each vendor installs their equipment, they document the equipment installed and sign and date the form. The CF-6R forms are to be left on-site and given to the homeowner after the home is completed.

In some building department jurisdictions, the form (or a copy of it) is filed with the presiding building department. However, because it is optional for the building departments to collect and/or retain these forms, most do not. The building departments that do retain these forms vary with respect to how long the form is kept on file. In many instances, if the CF-6R form is filed at all, the department only retains it for a limited time (for example, 90 days after the home is completed). Although there are limitations in working with building departments to collect these forms, it was the most cost-effective option compared to obtaining them from homeowners.

A sample CF-6R form is included in Appendix D.

Building Department Recruiting Protocol

The first step in establishing a CF-6R collection system consisted of obtaining building department contacts. The Construction Industry Research Board (CIRB) provided RER with a list of 513 building department contacts (department name, contact name, and telephone number). CIRB also provided statistics on permits issued. Using both sets of information, RER targeted 126 building departments based on the largest number of permits for single family homes in 1998. These building departments represent about 75% of the single family construction permits in the state.

The first objective of each contact was to determine if the building department retained copies of CF-6R forms in the office. Although this may seem a simple assessment, it is not without difficulty. Since CF-6R forms are not mandatory in most jurisdictions, many

contacts were not immediately certain that they were familiar with the form. After the initial contacts, RER faxed a project flyer that described the project to each contact. The first project fax was sent to all 126 targeted building departments.

A second round of contacts was initiated in an effort to recruit new and non-responding departments from the first round. RER developed a new, more concise project flyer, which was faxed to the new updated sample of departments.

Once it was determined that a building department collected the CF-6R form, the decision maker was asked to participate in the project. RER remained very flexible to each building department's record keeping practices. The following provides some challenges that building departments face in participating in the RMST project:

- Many departments have limited staff and budget to perform non-routine work.
- Many departments could only perform non-routine work on occasion (during low-workload periods).
- Some departments' records are publicly available, and therefore they did not feel that they should perform the work of pulling and copying the forms.
- Some could not (or did not want to) accept an extra burden on top of an already full workload.
- Some departments track the forms well, while others do not have a formalized record keeping system for the CF-6Rs.
- Some departments can easily access the forms, while others are wrapped with building plans and warehoused offsite.
- Some only kept the forms for a limited time (90 days, 180 days, one year, etc.).

Some departments face a combination of the above scenarios, while some departments do not have any of these at all.

For these and other diverse situations, it was impossible to devise a singular collection system that would work for all departments. Rather, to obtain the largest sample of CF-6R forms, RER staff worked closely with each department to develop a system that would overcome resource limitations. To overcome the cost and administrative burden, RER offered several solutions, including but not limited to the following:

- Reimbursing copy costs,
- Providing prepaid, preaddressed FedEx envelopes,
- Providing a list of addresses (since some file permit-related data as such), and
- Only requesting samples of large tract-style residential developments.

In some cases, recruiting building departments warranted in person visits to either determine the feasibility of obtaining the CF-6Rs, or to copy or pick up the forms themselves. For example, RER staff members traveled to the County of San Diego and City of Irvine in an effort to establish relationships with local building departments that retain the CF-6R forms and network through them to reach other Southern California departments. In addition, RER assessed the availability and accessibility of CF-6R forms. Each building department has a different system for collecting and storing CF-6Rs. Thus, it is necessary to understand each department's standard business practices and available resources to compile the forms in order to develop a long-term working relationship with each department.

Building Department Participation Status

To date, RER has received nearly 950 CF-6R forms from 15 building departments. As shown in Table 2-14, Temecula has been, by far, the most active participant. Temecula's CF-6R forms account for 58% of the total forms received so far. Table 2-15 summarizes the CF-6R forms by CEC climate zone and utility service area. Nearly 84% of forms are from houses built in SCE's service territory, with only 16% built within PG&E's territory. Currently, no CF-6R forms have been obtained for SDG&E's territory.

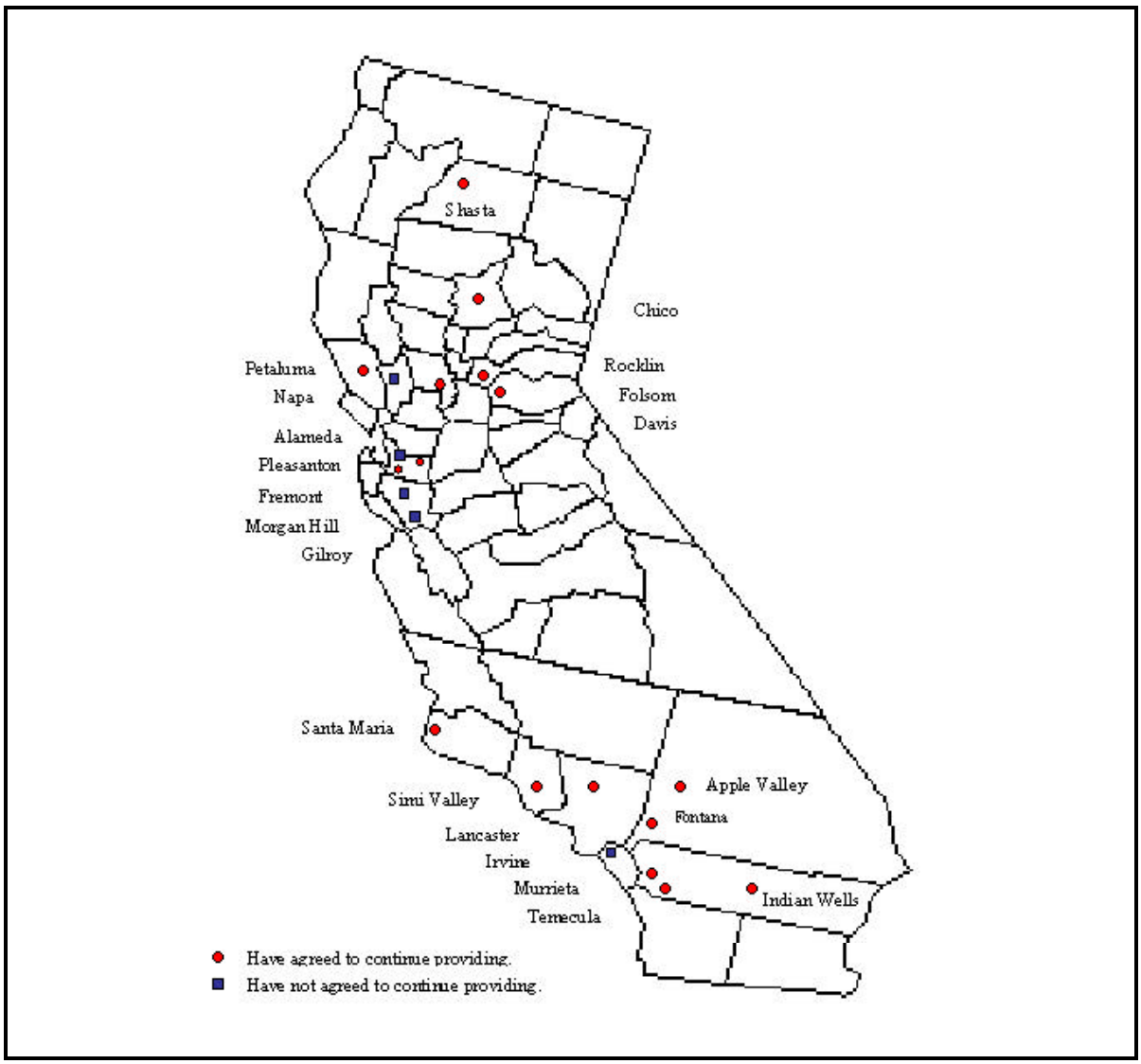
Table 2-14: Building Department Participation

Building Department	Number Of CF-6R Forms
Alameda County	1
Apple Valley town	88
Chico	15
Folsom	65
Fremont	14
Gilroy	6
Indian Wells	40
Irvine	2
Morgan Hill	5
Murrieta	17
Napa	5
Petaluma	39
Rocklin	6
Simi Valley	97
Temecula	548
Total	**948**

Table 2-15: Number of CF-6R Forms Collected To Date, by Climate Zone

CEC Climate Zone	PG&E	SCE	SDG&E	Total
CZ:1	70	-	-	70
CZ:2	-	-	-	-
CZ:3	-	664	-	664
CZ:4	86	-	-	86
CZ:5	-	128	-	128
Total	**156**	**792**	**-**	**948**

Figure 2-6: Statewide Coverage of Building Department Participation



CF-6R Data Processing and Expansion Weights

Data processing and the expansion weights for central air conditioners, furnaces, water heaters, and windows are detailed below.

The expansion weights developed to expand the on-site data to represent to the total number of homes that were built within the three electric IOU territories between July 1, 1998 and June 30, 1999. The expansion weights are based on the number of households in each utility service area and CEC climate zone.[9] In particular, the expansion weights for HVAC equipment are based on utility and climate zone, while the expansion weights for water heaters and windows are based solely on utility.[10]

Central Air Conditioners. Two fields that are especially important in the CF-6R central air conditioner data are model number and efficiency rating (SEER). First, RER verified the efficiency ratings by checking the minimum values. As a result, several data entry mistakes were corrected. Data were then grouped by model number to confirm that the units with a particular model number had identical efficiencies. Finally, RER staff identified the efficiencies for each observation that did not have an associated efficiency rating. ARI's database or the manufacturer's website or catalog was used to research these efficiencies. [11]

Observations were eliminated where the unit model number was missing or incomplete, thereby making it impossible to research the needed information.

The data from the CF-6R forms are especially important for tracking central gas furnace efficiencies are manufacturer, model number, and efficiency rating (AFUE). RER first verified the efficiencies by examining the minimum AFUE values. Data were grouped by model number to confirm that the units with a particular model number had identical efficiencies. Finally, RER staff identified the efficiencies for each observation that did not have an associated efficiency rating using GAMA's equipment director and manufacturer websites and catalogs.[12]

Observations were eliminated where the unit model number was missing or incomplete, thereby making it impossible to research and obtain the required efficiency/energy use parameters.

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9 New construction frames from the various utilities include both single family and multifamily homes.

10 While the CF-6R data spans July 1, 1999 to the June 30, 2000, at this time the expansion weights are based on the number of new homes built between July 1, 1998 and June 30, 1999. This is because these data are the most recent available. Furthermore, it is assumed that there is little change in the relative numbers across utilities.

11 Air-Conditioning and Refrigeration Institute. *ARI Electronic Unitary Directory.* ARIUD2000 V1.5. 1996-2000.

12 Gas Appliance Manufactures Association. *GAMA Consumers' Directory of Certified Efficiency Ratings for Residential Heating and Water Heating Equipment.* April and October Editions, 1997-1999.

Expansion weights were used to expand the number of observations up to the total number of homes with central air conditioners that were built within the three electric IOU territories between July 1, 1998 and June 30, 1999. These expansion weights are based on the utility that services the county in which each building department is located, the climate zone in which the building department is located, and the saturations found using the on-site database. The on-site database was used to calculate the percentage of homes that have central air conditioners and the percentage of homes that have room air conditioners. These percentages were calculated by utility service territory and climate zone.

Expansion weights were calculated as follows:

$$Weight_{i,U,CZ} = \frac{N_{U,CZ}}{n_{U,CZ}} * Saturation_{U,CZ}$$

where

$N_{U,CZ}$ = the total number of houses built between July 1, 1998 and June 30, 1999, by utility, and climate zone,

$n_{U,CZ}$ = the number of CF-6R forms for houses built between July 1, 1998 and July 30, 1999, by utility and climate zone, and

$Saturation_{U,CZ}$ = the percent of homes in the on-site database built between July, 1998 and July 30, 1999 that have a central air conditioners, by utility and climate zone.

Furnaces. The data from the CF-6R forms that are especially important for tracking central gas furnace efficiencies are manufacturer, model number, and efficiency rating (AFUE). The first step in verifying the efficiencies was to examine the minimum AFUE values. As a result, several data entry mistakes were corrected. Next, data were grouped by model number to confirm that the units with a particular model number had identical efficiencies. Finally, RER staff identified the efficiencies for each observation that did not have an associated efficiency rating using GAMA's equipment director and manufacturer websites and catalogs.[13]

Observations were eliminated where the unit model number was missing or incomplete, thereby making it impossible to research the needed information.

[13] Gas Appliance Manufactures Association. *GAMA Consumers' Directory of Certified Efficiency Ratings for Residential Heating and Water Heating Equipment.* April and October Editions, 1997-1999.

Expansion weights were developed to expand the number of observations up to the total number of homes with central gas furnace that were built within the each utility service territory between July 1, 1998 and June 30, 1999. These expansion weights are based on the utility that services the county where each building department is located, the climate zone in which the building department is located, and the saturations found using the on-site database. The on-site database was used to calculate the percentage of homes that have a central gas furnace. These percentages were calculated by utility service territory and climate zone.

Expansion weights were calculated as follows:

$$Weight_{i,U,CZ} = \frac{N_{U,CZ}}{n_{U,CZ}} * Saturation_{U,CZ}$$

where

$N_{U,CZ}$ = the total number of houses built between July 1, 1998 and June 30, 1999, by utility and climate zone,

$n_{U,CZ}$ = the number of CF-6R forms for houses built between July 1, 1998 and June 30, 1999, by utility and climate zone, and

$Saturation_{U,CZ}$ = the percent of homes in the on-site database built between July 1, 1998 and June 30, 1999 that have a central gas furnace, by utility and climate zone .

Water Heaters. The first step in verifying the efficiencies and tank volumes was to check the minimum and maximum in each field. Several data entry mistakes were then easily corrected. Next, data were grouped by model number to confirm that units with a particular model number each had identical efficiencies and volumes. The final step in verifying the efficiency and volume for each observation was to research model numbers in the data with missing efficiency and/or volume data. GAMA's database or the manufacturer's website or catalog was used to research these model numbers.[14]

Since the percent-above-standard is impossible to calculate for observations without an associated efficiency or volume, observations were eliminated where the unit model number was missing or incomplete, thereby making it impossible to research the needed information.

Expansion weights were developed to expand the number of observations up to the total number of homes with gas water heaters that were built within the three electric IOU

[14] Gas Appliance Manufactures Association. *GAMA Consumers' Directory of Certified Efficiency Ratings for Residential Heating and Water Heating Equipment.* April and October Editions, 1997-1999.

territories between July 1, 1998 and June 30, 1999. These expansion weights are based on the utility that services the county in which each building department is located and the saturations found using the on-site database. The on-site database was used to calculate the percentages of homes with electric and gas water heaters. These percentages were calculated by utility service territory.

Expansion weights were calculated as follows:

$$Weight_{i,U} = \frac{N_U}{n_U} \times Saturation_U$$

where

N_U = the total number of houses that were built between July 1, 1998 and June 30, 1999, by utility,
n_U = the number of CF-6R forms for houses built between July 1, 1998 and June 30, 1999, by utility, and
$Saturation_U$ = the percent of homes in the on-site database built between July 1, 1998 and June 30, 1999 that have gas water heaters, by utility.

Windows. Two fields that are especially important in the CF-6R data are window U-values and square feet. RER calculated the average U-value for each home.[15] As mentioned previously, less than 10% of the CF-6R forms received had information on fenestration. Therefore, there are far fewer observations for windows than other measures.

Expansion weights were developed to expand the number of observations up to the total number of homes that were built within the utility service territories between July 1, 1998 and June 30, 1999. These expansion weights are based on the utility that services the county in which each building department is located.

Expansion weights were calculated as follows:

$$Weight_{i,U} = \frac{N_U}{n_U}$$

where

N_U = the total number of houses that were built between July 1, 1998 and June 30, 1999, by utility, and

[15] The square footage of each window was used to find the weighted average U-value of the home.

n_U = the number of CF-6R forms for houses built between July 1, 1998 and June 30, 1999, by utility.

Comparison of Building Department CF-6R Forms and On-Site Data

In order to evaluate the usefulness of the CF-6R forms in market share tracking, RER attempted to gather CF-6R forms for a sample of sites that had on-site surveys. This allows for the comparison of CF-6R documentation to the equipment characteristics observed on-site. If a high correlation between the two could be ascertained, RER could be confident that the CF-6R data provided a solid foundation for tracking measure efficiencies in new construction, and the expansion of the CF-6R collection effort would be justified.

Table 2-16 presents a summary of RER's effort to compare CF-6R forms and the on-site data. As shown, RER was only able to match CF-6R data to 31 surveyed sites; of these, a considerable number had missing or incomplete data from either on the CF-6R form or the on-site survey. It was concluded that, while there is a considerable amount of agreement between the CF-6R forms and the on-site data, RER should continue this effort in the second year to evaluate these data sources more fully.

The "match" column in Table 2-16 indicates the number of exact matches between the CF-6R form and the on-site data. The "no match" column indicates cases where data were available from both sources and the information did not match. The "inconclusive/missing data" column indicates that some critical piece of information was missing that did not allow for a definitive comparison. This was due primarily to incomplete model numbers on the CF-6R form or missing survey data.

Table 2-16: Comparison of CF-6R and On-Site Survey Data

	Result			
Measure	**Match**	**No Match**	**Inconclusive/ Missing Data**	**Total**
Furnaces	14	4	13	31
Central Air Conditioners	14	4	13	31
Water Heaters	9	2	20	31
Total	**37**	**10**	**46**	**93**

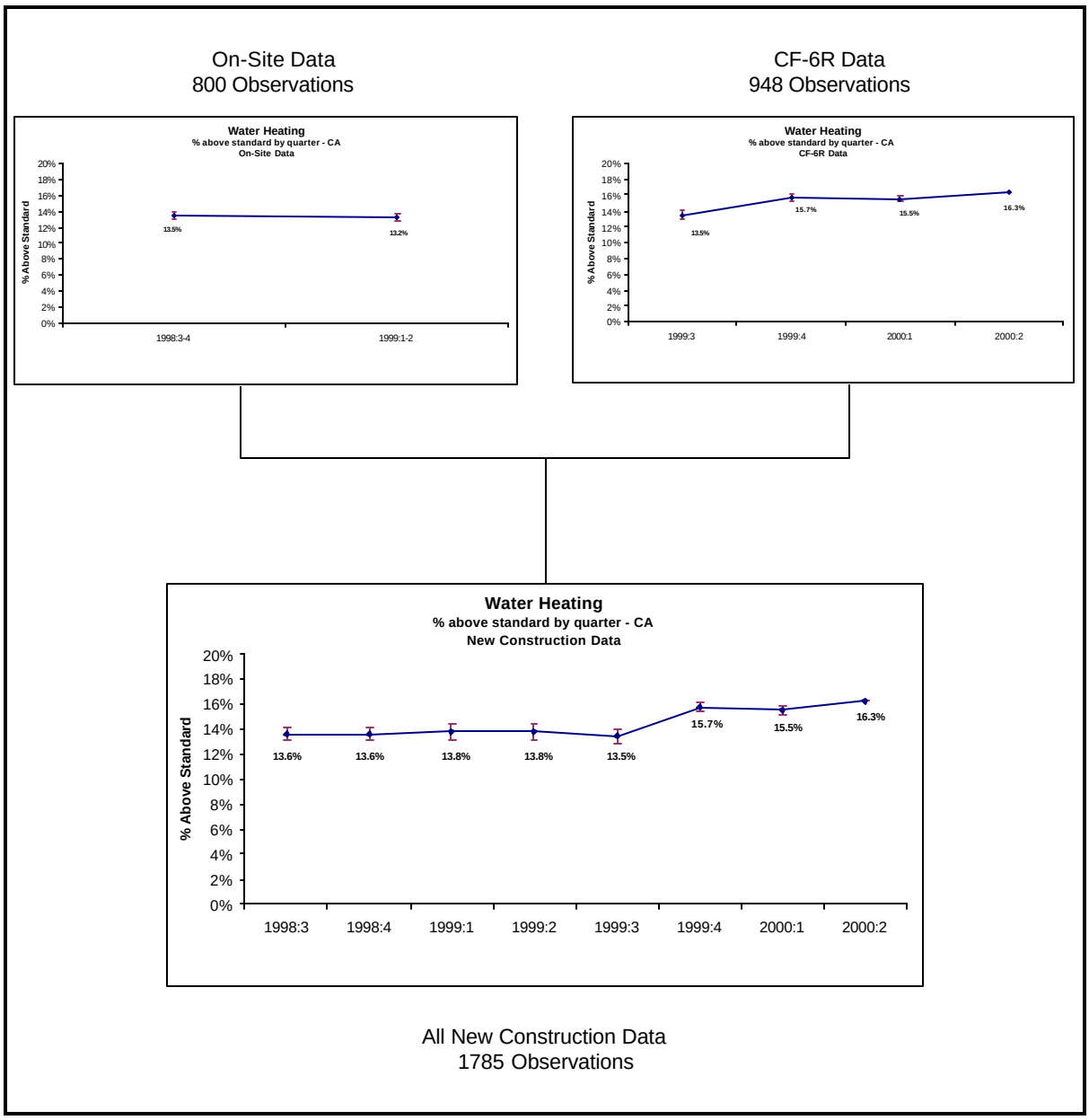
Combining the On-site Survey Analysis with the CF-6R Analysis

Figure 2-7 illustrates the framework for developing the market share estimates from the on-site surveys and CF-6R data. As shown, on-site surveys were conducted for 800 newly constructed single family and multifamily residences in California. Efficiency data obtained from the on-sites were combined with the data extracted from nearly 1,000 CF-6R forms to

estimate average efficiencies and market shares of equipment and shell measures in California's new construction sector.

Note that there is considerable lag time in the on-site survey data relative to the building department data, and that a set of weights was developed for purposes of combining the data from the two different sources. It should also be noted that the tracking system is a dynamic process. For instance, data from the second year of the project will be used to backfill the database and thus increase the sample sizes for some of the underrepresented periods. This feature will be especially true for the next round of on-site surveys, which will cover the second half of 1999 and the first half of 2000.

Figure 2-7: New Construction Sector Data Analysis Overview



2.3 Heating and Cooling Equipment Distributor Sales Data Collection

As a result of RER's market share tracking scoping study (1998-1999), RER determined HVAC equipment distributors to be the best data source for tracking HVAC efficiencies through the marketplace. While other methods for obtaining the data required for tracking were evaluated, RER deemed distributor data collection the most cost-effective and accurate means for doing so. For example, surveys of HVAC/mechanical contractors could be implemented for the analysis of equipment retrofit/replacement efficiencies, but the research

concluded that the required data could be more difficult and costly to obtain from contractors than distributors.[16]

The disadvantage of the distributor approach is that distributor-level data are limiting in the sense that the market event (e.g., new construction versus replacement installations) cannot be identified, as both builders and contractors purchase equipment from distributors for new construction and retrofit/replacement installations, respectively. Thus, the data collected from distributors are used to estimate average energy efficiency ratings in the overall market.

The long-term objectives for this component of the project, however, are to estimate efficiency share of retrofit/replacement installations by subtracting the new construction installations from the wholesale data described here.[17]

The remainder of this subsection describes the following:

1. The development of the distributor sample frame and sampling plan,
2. The protocol for recruiting the distributor panel and the current panel, and
3. Data processing and analysis.

Sample Frame and Sample Design

As shown below in Table 2-17, the RMST distributor sample frame consists of 16 companies whose primary business is the wholesale of residential space heating and cooling equipment.[18] The companies in the frame represent well over 200 branch/warehouse locations throughout California. This sample consists of independent equipment wholesalers, independently owned manufacturer dealerships, and manufacturer-owned dealers. Distributors in the frame represent all major residential equipment manufacturers and brands including York, Carrier, Bryant, Payne, Lennox, Trane, Intercity Products, Goodman, Tempstar, and Comfortmaker. Distributors in the sample were segmented according to their primary service area.

RER developed the sample of equipment distributors from a variety of resources, including contacts developed from past residential sector research, referrals from program managers of California's HVAC upstream program, referrals from other distributors, HVAC equipment

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16 Regional Economic Research, Inc. *Efficiency Market Share Needs Assessment and Feasibility Scoping Study*. Prepared for the California Board for Energy Efficiency and Pacific Gas and Electric. May 10, 1999.

17 RER will also strive to obtain information from participating distributors regarding the type of project for which equipment is purchased. Distributors do not appear to keep this information in their inventory/sales system as a normal business practice. However, they will likely be able to provide rough percentage estimates of sales by market event, and supporting information relating to sales and the HVAC marketplace.

18 The HVAC equipment wholesale market is in the midst of a great deal of consolidation, thus some companies in the sample frame are owned by the same corporation.

manufacturer web sites, and the North American Heating, Refrigeration & Air Conditioning Wholesalers Association's (NRHAW) on-line membership directory.

Table 2-17: HVAC Distributor Sample Frame

Residential and Residential/Commercial Distributors	Companies
Total in Frame	**16**
w/Statewide Service Areas	7
w/Primarily Southern California Service Area	3
w/Primarily Northern California Service Area	6
Manufacturer Dealers	4
Independent Dealers	12

This project's objective is to recruit at least 11 HVAC distributors throughout the state to provide sales data for tracking space heating and cooling equipment efficiencies in California. However, RER adopted a census sampling procedure and contacted nearly all companies in the sample frame. The ultimate objectives for recruiting a panel of HVAC distributors are 1) to recruit distributors with relatively large shares of the residential HVAC market, and 2) to have adequate representation for all utility service areas and climate regions. Preliminary discussions with California distributors, the developers of a similar HVAC equipment tracking project in Wisconsin, and knowledge about California's HVAC wholesale market helped RER develop a recruiting strategy and prioritize recruiting efforts. It is important to emphasize here that, because the RMST is an ongoing, multi-year effort, recruiting is also an ongoing effort. In the long term, RER's goal is to continue to increase participation and market coverage of the wholesale market.

Distributor Panel Recruiting Protocol and Current Panel

RER's recruiting strategy was developed according to the following principals:

- ***Develop Long-Term Relationship.*** RER is developing the distributor data collection effort *as a long-term, ongoing process*. In nearly all instances, distributors were only willing to consider participation (which required time and resources on their part) if it were a long-term commitment. Because of the sensitive nature of the data provided, trust and a positive working relationship between RER staff and the distributors have proven to be paramount. (This notion applies to not only those who have provided data thus far, but to those who have agreed to participate later, as well as those who have declined.) The long-term perspective of this project enables (and requires) RER staff to understand standard business practices unique to each company and issues in the HVAC market, in general.

- ***Guarantee Confidentiality.*** RER has guaranteed the confidentiality of all information and sales data provided by distributors. Without doing so, data collection efforts would be futile. To preserve the confidentiality of data provided by any single distributor, RER agreed to report efficiency market shares and any other information only at an aggregated level (statewide and by utility service area if possible). The confidentiality agreement is provided in Appendix E.
- ***Minimize Burden and Be Flexible.*** RER has and will continue to minimize the burden on the distributors to the extent possible. Moreover, RER offered to compensate all distributors for their time and effort in developing the required data. Due to the diverse formats of inventory and invoicing systems used by distributors, the data collection protocol is flexible and tailored specifically to each distributor. RER staff also emphasized the flexibility with respect to the format of data delivered and the timing of delivery.
- ***Provide Assistance.*** RER offered to provide on-site assistance to develop a data reporting process (computer programming, etc.). While none of the distributors contacted to date expressed a need for assistance, RER will continue to offer this in the future.
- ***Provide Value.*** In recognition of the fact that distributors have agreed to supply valuable competitive information for the RMST, RER emphasized its willingness to "return the favor" to all participating distributors. In particular, RER has proposed to prepare a sales summary report for each distributor in the panel. The content and format of this summary report has not yet been finalized. The sample report provided to distributors with other project-related materials is included in Appendix F.

The protocol for recruiting distributors as data suppliers for the HVAC and water heating equipment distributor tracking system involves four major steps.

- ***Initial Contact.*** RER staff first contacted each distributor by telephone. The purpose of this initial contact was to identify the most appropriate contact, introduce the project, discuss preliminary issues and answer initial questions, and assess the distributor's interest in participating, or at least their willingness to continue in discussions and learning more about the project. RER had developed a list of specific contacts for nearly all distributors in the sample frame.
- ***Provide Project Details.*** All distributors requested additional information in hard copy to distribute to other individuals within their company. Examples of project marketing materials sent to distributors are included in Appendix F.
- ***Engage in Detailed Discussions.*** RER held detailed discussions with each distributor, some in person and some via telephone, over a period of several months. The objectives were to provide each company with detailed information about specific data requirements for the RMST, to identify and resolve issues that would prevent a distributor from participating, to discuss options for "compensation," and to ensure confidentiality of all company-specific data.

Though the time varied for each company, in all cases these detailed discussions spanned several months and were dictated completely by the contact/company's schedule and availability.

- ***Arrange for Data Delivery and Maintain Contact.*** The final stage of the recruiting process is to make the final arrangements for data delivery and maintain contact with all distributors.

Recognizing and accepting the fact that recruiting distributors to provide data is a dynamic, ongoing, and lengthy process is important (dynamic in the sense that participation is voluntary and any distributor can elect not to participate at any time). Unlike traditional surveys and one-time data collection efforts, a refusal to participate in the RMST during one period could very well mean a distributor would be willing to participate later. (This was the case with two prominent distributors in Northern and Southern California.)

As shown in Table 2-18, RER contacted all of the independent distributors and several manufacturer dealers to provide data for the RMST project. Five distributors agreed to participate and only two distributors to date have declined to participate. Unfortunately, two of the five that had originally agreed to provide sales data declined later due to company resource constraints at the time. The three distributors in the current panel account for 19 warehouse locations in California, and less than 5% of the estimated total CAC and gas furnace sales in the State.

RER staff continues to contact and discuss the RMST project with nonparticipating California equipment distributors and maintain contact with those in the current panel.

Table 2-18: Recruiting Disposition

	Distributors
Total Companies Contacted	13
Companies Sent Materials	13
Declined to Participate	2
Agreed to Supply Data	5
Withdrew Participation*	2
Current Panel	3 (19 locations)

* Have agreed to participate at a later date.

All distributors in the panel provided data for central air conditioners, furnaces, and heat pumps. The sales data provided did not include any evaporative condenser air conditioners and contained very few sales of indirect-direct evaporative coolers.[19]

Data Processing

The sales data obtained from HVAC equipment distributors covers the first quarter of 1999 through the second quarter of 2000. As expected, distributors provided RER with data in a variety of formats at varying levels of detail. One provided quarterly summary reports of sales segmented by predetermined efficiency ranges, while others provided detailed monthly or quarterly sales reports that included the manufacturer model number, quantity sold, and date sold.

After converting all data files into a common format, RER linked efficiency parameters to each observation in the database. In particular, RER merged AFUE, SEER, and other technical data to each unit sold by the unique manufacturer model provided by the distributors. Sources for the efficiency information include the California Energy Commission's appliance efficiency database and technical directories RER obtained from ARI and GAMA. Models for which efficiency parameters were not electronically matched to any of these resources were further investigated through the manufacturers' websites and/or by contacting the manufacturer directly.

The estimation of efficiency market shares of residential HVAC equipment for this reporting period was constrained by the small number of distributors in the panel. Unfortunately, estimation was possible only at the state level for this installment because of insufficient representation at the utility service area level. It is important to note here that, because of ongoing recruiting efforts, data obtained in the future will likely augment the data used in the analysis for this first report.

2.4 Water Heating Equipment Distributor Sales Data Collection

As a result of our market share tracking scoping study, RER determined water heating equipment distributors and supply houses to be the best data source for tracking the energy efficiency of residential water heaters over the next several years.

[19] Note that these measures were not identified by RER as priorities for tracking in our original scoping study. Rather, they were identified as emerging technologies to track into the marketplace in a later study that specifically investigated tracking emerging technologies. See Regional Economic Research, Inc. *Emerging Technologies Efficiency Market Share Needs Assessment, Feasibility and Market Penetration Scoping Study*. Prepared for the California Board for Energy Efficiency and Pacific Gas and Electric. December 6, 1999.

While other methods for obtaining the data required for tracking were evaluated, RER deemed distributor data collection the most cost-effective and accurate means for doing so. Residential water heaters are sold through a variety of market channels. In the new construction sector, builders generally purchase water heaters from distributors or "plumbing supply houses." Contractors purchase replacement water heaters from plumbing supply houses or home improvement retail outlets such as Home Depot. Surveys of plumbing contractors could be implemented for the analysis of equipment retrofit/replacement efficiencies, but the research concluded that the required data could be more difficult and costly to obtain from contractors than distributors.[20]

Admittedly, this strategy does not capture retail sales through the home improvement retail market channel. However, the wholesale market channel represents a fairly large share of total water heater sales.

The wholesale plumbing supply industry is fairly decentralized in comparison to the HVAC market. There are literally hundreds of companies throughout California. Larger companies have multiple locations is particular regions, but most are smaller businesses with a single warehouse. There are, however, a few very large companies that operate on a national scale that sell both plumbing and space conditioning equipment, along with a variety of building supplies.

The remainder of this subsection describes the following:

1. The development of the distributor sample frame and sampling plan,
2. The protocol for recruiting the distributor panel and the current panel, and
3. Data processing and analysis.

Sample Frame and Sample Design

The water heater distributor sample frame consists of 210 companies whose primary business is the wholesale of water heating equipment and plumbing supplies (often referred to as "plumbing supply houses"). The companies in the frame represent hundreds of locations throughout California. RER developed the sample frame from a variety of resources including the Supply House Times Premiere 150 1999 Rankings, contacts developed from past residential sector research, manufacturer dealer lists, and companies from a U.S. business telephone directory selected by relevant SIC codes.[21] The sample frame represents all major manufacturers of residential water heaters including A.O. Smith, Rheem, American Standard, State Industries, Bradford White, and Southcorp.

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[20] Regional Economic Research, Inc. *Efficiency Market Share Needs Assessment and Feasibility Scoping Study*. Prepared for the California Board for Energy Efficiency and Pacific Gas and Electric. May 10, 1999.

[21] See http://www.supplyht.com.

The objective for this project is to recruit at least 30 water heating distributors throughout the State to provide sales data for tracking water heating efficiencies in California. Recognizing the difficulty in recruiting private sector companies for this purpose, RER adopted a census sampling procedure and contacted all companies in the sample frame. The ultimate objective is to have adequate representation for all utility service areas and climate regions. It is important to emphasize here that, because the RMST is an ongoing, multi-year effort, recruiting is also an ongoing effort. The ultimate long-term goal is to continue to increase participation and market coverage of the wholesale market.

Distributor Panel Recruitment

RER's recruiting strategy was developed according to the following principals:

- ***Develop Long-Term Relationship.*** RER is developing the water heater distributor data collection effort *as a long-term, ongoing process*. In nearly all instances, distributors were only willing to consider participation (which required time and resource on their part) if it were a long-term commitment. Because of the sensitive nature of the data provided, trust and a positive working relationship between RER staff and the distributors have proven to be paramount. (This notion applies to not only those that have provided data thus far, but to those who have agreed to participate later, as well as those who have declined.) The long-term perspective of this project enables (and requires) RER staff to understand standard business practices unique to each company and issues in the wholesale plumbing supply market, in general.
- ***Guarantee Confidentiality.*** RER has guaranteed the confidentiality of all information and sales data provided by distributors. Without doing so, data collection efforts would be futile. To preserve the confidentiality of data provided by any single distributor, RER agreed to report efficiency market shares and any other information only at an aggregated level (statewide and by utility service area if possible). The confidentiality agreement is provided in Appendix E.
- ***Minimize Burden and Be Flexible.*** RER has and will continue to minimize the burden on the distributors to the extent possible. Moreover, RER offered to compensate all distributors for their time and effort in developing the required data. Due to the diverse formats of inventory and invoicing systems used by distributors, the data collection protocol is flexible and tailored specifically to each distributor. RER staff also emphasized the flexibility with respect to the format of data delivered and the timing of delivery.
- ***Provide Assistance.*** RER offered to provide on-site assistance to develop a data reporting process (computer programming, etc.). While none of the companies contacted to date expressed a need for assistance, RER will continue to offer this in the future.

- ***Provide Value.*** In recognition of the fact that distributors have agreed to supply valuable competitive information for the RMST, RER emphasized its willingness to "return the favor" to all participating distributors. In particular, RER has proposed to prepare a sales summary report for each distributor in the panel. The content and format of this summary report has not yet been finalized. The sample report provided to distributors with other project related materials is included in Appendix F.

The protocol for recruiting distributors as data suppliers for the water heating equipment wholesale tracking system involves four major steps.

- ***Initial Contact.*** RER staff first contacted each distributor by telephone. The purpose of this initial contact was to identify the most appropriate contact, introduce the project, discuss preliminary issues and answer initial questions, and assess the distributor's interest in participating, or at least their willingness to continue in discussions and learn more about the project.
- ***Provide Project Details.*** Examples of project marketing materials sent to distributors are included in Appendix F.
- ***Engage in Detailed Discussions.*** RER held detailed discussions with each distributor over a period of several months. The objectives were to provide each company with detailed information about specific data requirements for the RMST, to identify and resolve issues that would prevent a company from participating, to discuss options for "compensation," and to ensure confidentiality of all company-specific information and data. Though the time varied for each company, in all cases these detailed discussions spanned several months and were dictated completely by the contact/company's schedule and availability.
- ***Arrange for Data Delivery and Maintain Contact.*** The final stage of the recruiting process is to make the final arrangements for data delivery and maintain contact with all distributors.

Recognizing and accepting the fact that recruiting distributors to provide data is a dynamic, ongoing, and lengthy process is important (dynamic in the sense that participation is voluntary and any distributor can elect not to participate at any time). Unlike traditional surveys and one-time data collection efforts, a refusal to participate in the RMST during one period could very well mean a distributor would be willing to participate at a later date.

Current Distributor Panel

Table 2-19 summarizes the results of the recruiting effort as of May 31, 2000. As shown, over 200 individual companies were contacted for the RMST project. Over 60% of those contacted expressed an interest in the program and requested literature. After learning specific details and data requirements, 28 agreed to provide sales data; 12 of these later withdrew. The data used for the analysis presented here accounts for 14 plumbing equipment

wholesalers with 26 branch locations. The sales data obtained for this analysis represents less than 5% of the estimated total gas furnace sales in California.

RER staff continues to contact and discuss the RMST project with California equipment distributors and maintain contact with those in the current panel.

Table 2-19: Recruiting Disposition

	Companies
Total companies contacted	210
Companies sent materials	135
Agreed to participate	28
Withdrew from the project	12
Currently participating	16 (29 locations)
Data included in periods covered by this report	14 (26 locations)

Analysis

Sales data obtained from equipment distributors cover the first and second quarters of 2000. Most companies on the panel opted to complete a monthly sales report, while some provided hard copy printouts of water heater sales. Regardless of the format, data were submitted on a monthly basis and included the manufacturer model number, quantity sold, and date sold. Note that the sales data submitted did not include any heat pump water heaters. Thus, the analysis in this installment covers gas and electric water heaters only.

After keying all submitted data into an electronic format, RER linked efficiency parameters to each observation in the database. In particular, RER merged the actual energy factor (EF_i), storage volume, fuel type, and other technical data to each unit sold by the unique manufacturer model provided by the distributors. Sources for the efficiency information include the California Energy Commission's appliance efficiency database and technical directories that RER obtained GAMA. Efficiency parameters for the models that were not electronically matched to any of these resources were further investigated through the manufacturers' websites and/or by contacting the manufacturer directly.

Before conducting any analyses, it was first necessary to calculate the required minimum efficiency rating for each unit. The percent-above-standard was then computed to each unit in the database.

As explained above, the standard efficiency rating (*StdEF*) for each unit varies by tank volume and fuel type and is computed as:

$$StdEF_{gas} = 0.62 - (0.0019 * rated\ storage\ volume)$$
$$StdEF_{electric} = 0.93 - (0.00132 * rated\ storage\ volume)$$

The percentage above the minimum standard *(%AboveStd)* for each unit *i* is:

$$\%AboveStd_i = \frac{(EF_i - StdEF)}{EF_i}$$

The estimation of efficiency market shares of residential water heaters for this reporting period was constrained by the small number of distributors in the panel. Estimation is possible only at the state level for this installment because of insufficient representation at the utility service area level. It is important to note here that, because of ongoing recruiting efforts, data obtained in the future will likely augment the data used in the analysis for this first report – particularly for the first two quarters of 2000. Thus, the samples sizes should increase and the confidence in the efficiency estimates will strengthen for these periods.

2.5 Appliance Retail Sales Data Collection

As a result of RER's market share tracking scoping study (1998-1999), RER determined appliance retailers to be the best data source for tracking appliance efficiencies through the marketplace.[22] Retail-level data collection is appropriate for several reasons. First, California's statewide appliance program targets appliance retailers. Second, sales data collection from national retailers has already been developed by D&R International to evaluate and track the success of the ENERGY STAR Appliance Program. Obtaining sales data from national chains would be very difficult and expensive without the leverage of the ENERGY STAR program. Third, because appliances are typically purchased by the end user, data would not be available through any other market channels, except at the manufacturing level. Dishwashers are the exception to this, as they are standard in many new homes.

The strategy for collecting appliance retail sales data is comprised of two major components that correspond to appliance marketing channels: national chains and independently owned/regional chain retailers. RER's objective was to ensure coverage by each segment in the RMST database.

Table 2-20 summarizes the number of appliance retailers in California. As shown, there are seven national chains serving the California marketplace, most of which are partners in the ENERGY STAR Appliance Program. There are many ENERGY STAR retail partners that are not national chains. In fact, 14 ENERGY STAR partners in California are independently owned.

[22] Regional Economic Research, Inc. *Efficiency Market Share Needs Assessment and Feasibility Scoping Study*. Prepared for the California Board for Energy Efficiency and Pacific Gas and Electric. May 10, 1999.

As shown, national chains account for roughly 53% and independently owned and regional retail chains account for 47% of the storefronts statewide.

Table 2-20: Appliance Retailers in California

	National Chains	Independents & Regional Chains	All Retailers
Companies *	7	356	363
CA Storefronts	484	422	906
ENERGY STAR Partners	6	14	20

* Includes Circuit City, who has since discontinued its appliance business in early 2000.

Data collection from national chains and independent appliance retailers is described below.

National Appliance Retailer Sales Data

National retail chains account for about 50% of appliance sales at the national level.[23] D&R International (D&R) provided RER with sales data from national retail chains for each of the appliances covered by the RMST project. D&R collects sales data from national retailers under a contract to support and evaluate the EPA/DOE ENERGY STAR Appliance Program and to track the sales of ENERGY STAR labeled products on a national level. California sales data were made available to RER to support the California RMST project. The data are summarized by the following:

- D&R provided RER with sales data for all California store locations from two national appliance retailers.
- The data included two components:
  - The total number of all units sold by zip code.
  - The total number of ENERGY STAR qualifying units sold by zip code.
  - Efficiency parameters, such as energy factors, capacity, and kWh, were not provided by all retailers, limiting the analysis to estimating the percent of ENERGY STAR units sold.
- To protect the confidentiality of the retailers, D&R did not include model numbers, retailers, or manufacturers/brands in the database provided to RER.
- The data are quarterly sales data spanning from the first quarter of 1998 through the fourth quarter of 1999.

[23] D&R International, Ltd. *ENERGY STAR Appliances: 1998 Sales Report.* November 1, 1999.

Independent Appliance and Regional Chain Retailer Sales Data

As mentioned above, national chains account for about 50% of appliance sales on a national level. Thus, small independently owned retailers and regional chains have their fair share of the market. Little is known about appliance sales through the independent retail appliance market channel, though there is some anecdotal evidence that the sales share of ENERGY STAR labeled products is slightly higher in this market than the national chain retail market. Discussions with industry professionals reveals the rationale for higher ENERGY STAR qualified sales by independents than by national chains could be attributable to the following:

- Explaining energy-related features and selling high efficiency products generally requires a more experience sales person. National chains have a very high sales person turnover rate. It is easier (e.g., more cost effective) for national chains to not train their sales staff extensively because of the anticipated turnover. In contrast, the turnover rate for independents is very low. These retailers can invest time into training staff on all aspects of their products, including energy usage/energy efficiency.
- National chains stock and sell the most popular brands and sizes, and purchase models that are manufactured in very large volumes. These models tend to be low to mid-priced and generally not the high efficiency models. If national chains cannot purchase models in volume, they need to be able to order and receive a particular product in a very short time frame, say within about two days. The models available for this type of ordering are generally not the high-end high efficiency models.
- National chains require longer lead times to respond to changes in program elements/requirements. In contrast, the independents' time horizon is shorter, enabling them to adapt more quickly to program changes and requirements.
- National chains have significant buying power with the manufacturers, while the smaller, independently owned retailers do not. This buying power results in relatively low profit margins for each unit sold. The independents cannot compete with the national chains at this level; such low margins would eventually drive the independents out of business. Because they cannot compete on a price-point basis with the nationals, independents not only tend to carry different models than the nationals, but the higher priced models, as well. Thus, independents are more likely to stock and sell high efficiency units than the national chains.

Representation of independent retailers in the RMST analysis ensures that the results represent sales of ENERGY STAR appliances in the entire market, not just large national stores.

Sample Frame and Sample Design

RER developed a sample frame of independent retailers from a sample of retailers provided by the Electric and Gas Industries Association (EGIA) and the Associated Volume Buyers

(AVB) roster.[24] As shown in Table 2-21, the sample frame consists of 442 independent appliance retail storefronts in California, 53% of which are located in PG&E's service area, 21% in SCE's service area, and 9% in SDG&E's service area. Seventeen percent of the sample is located in municipal service areas not served by investor-owned electric utilities.

Table 2-21: Independent Appliance Retailer Sample Frame

	Utility Service Area				
	PG&E	**SCE**	**SDG&E**	**Other***	**All**
All Areas					
Storefronts	233	91	41	77	442
Percent of Total	53%	21%	9%	17%	100%
PG&E, SCE, and SDG&E Only					
Storefronts	233	91	41		365
Percent of	64%	25%	11%		100%

* "Other" includes municipal utilities such as LADWP, LMUD, PP&L, SMUD, and many others.

RER's long-term sampling objectives are to recruit roughly 20% of the independent appliance retailers in California's electric utility service areas for the RMST project. Table 2-22 provides the sampling targets for each utility service area.

Table 2-22: Independent Appliance Retailer Long-Term Sample Targets

	Utility Service Area			
	PG&E	**SCE**	**SDG&E**	**All**
Storefronts	47	18	8	75
Percent of Total	64%	25%	11%	100%

Independent Retailer Panel Recruitment

The strategy for recruiting independent appliance retailers was very similar to that used for the HVAC and water heater distributors and is based upon the following principals:

- ***Develop Long-Term Relationship.*** RER is developing the appliance retail data collection effort *as a long-term, ongoing process*. Because of the sensitive nature of the data provided, trust and a positive working relationship between RER staff and the retailers have proven to be paramount. (This notion applies to not only those who have provided data thus far, but to those who have agreed to participate later, as well as those who have declined.) The long-term perspective of this project enables (and requires) RER staff to understand standard business

[24] The sample obtained from the EGIA under-represents the SDG&E service area, according to EGIA staff. Augmenting the EGIA sample with AVB members helped to alleviate this problem.

practices unique to each company, issues specific to the appliance market, as well as issues specific to independent retailers (as opposed to the larger national chains).

- ***Guarantee Confidentiality.*** RER has guaranteed the confidentiality of all information and sales data provided by retailers. Without doing so, data collection efforts would be a futile effort. To preserve the confidentiality of data provided by any single distributor, RER agreed to report efficiency market shares and any other information only at an aggregated level (statewide and by utility service area if possible). The confidentiality agreement is provided in Appendix E.
- ***Minimize Burden and Be Flexible.*** RER has and will continue to minimize the burden on the retailers to the extent possible. (For example, RER provided self-addressed envelopes to retailers who opted to send hard copy sales reports.) Moreover, RER offered to compensate all retailers for their time and effort in developing the required data. Due to the diverse formats of sales and invoicing software used by retailers, the data collection protocol is flexible and tailored specifically to each company. RER staff also emphasized the flexibility with respect to the format of data delivered and the timing of delivery.
- ***Provide Assistance.*** RER offered to provide on-site assistance to develop a data reporting process (computer programming, etc.). While none of the retailers contacted to date expressed a need for assistance, RER will continue to offer this in the future.
- ***Provide Value.*** In recognition of the fact that distributors have agreed to supply valuable competitive information for the RMST, RER emphasized its willingness to "return the favor" to all participating retailers. In particular, RER has proposed to prepare a sales summary report for each retailer in the panel. The content and format of this summary report has not yet been finalized.

The protocol for recruiting independent retailers to supply data involves four major steps.

- ***Initial Contact.*** RER staff first contacted each retailer by telephone. The purpose of this initial contact was to identify the most appropriate contact, introduce the project, discuss preliminary issues and answer initial questions, and assess the retailers interest in participating, or at least their willingness to continue in discussions and learning more about the project. RER had specific contact names for all retailers in the sample frame.
- ***Provide Project Details.*** RER developed and mailed project marketing materials to all retailers that had not refused to participate during the initial contact. Examples of project marketing materials sent to distributors are included in Appendix G. Note that the EGIA provided a letter of endorsement that was included with the literature sent to appliance retailers. (In some cases, project information was sent to retailers first, then followed up with the initial contact.)
- ***Follow-Up Contact.*** RER contacted each retailer one to two weeks after mailing the project marketing materials. The objectives at this point were to

provide each company with detailed information about specific data requirements for the RMST, to identify and resolve issues that would prevent a retailer from participating, to discuss their needs for "compensation," and to ensure confidentiality of all company-specific data. Though the time varied for each company, in most cases these detailed discussions spanned several months and were dictated completely by the primary contact's schedule and availability.

- ***Arrange for Data Delivery and Maintain Contact.*** The final stage of the recruiting process is to make the final arrangements for data delivery and maintain contact with all retailers.

Recognizing and accepting the fact that recruiting retailers to provide data is a dynamic, ongoing, and lengthy process is important. Further, the panel will continue to grow as recruiting efforts continue. Additionally, unlike traditional surveys and one-time data collection efforts, a refusal to participate in the RMST during one period could very well mean a retailer would be willing to participate later.

Current Independent Retailer Panel

As shown in Table 2-23, RER obtained appliance sales data from a panel of six independent retailers representing 13 individual storefronts. The retailers in the panel provided data in a variety of formats – electronic spreadsheets, hard-copy sales reports, and even handwritten tallies of units sold. Most retailers provided data to RER on a monthly basis. In general, the data included the manufacturer, manufacturer model number, and quantity sold. A subset of the panel provided data from the first quarter of 1999 through the fourth quarter of 1999. Others began providing data at different points in time (June 1999, November 1999, or January 2000, for example) through March 2000.

Table 2-23: Current Independent Appliance Retailer Panel

	Utility Service Area				
	PG&E	**SCE**	**SDG&E**	**Other***	**All**
Storefronts	3	5	1	4	13
Percent of Total	23%	38%	8%	31%	100%

* "Other" includes municipal utilities such as LADWP, LMUD, PP&L, SMUD, and many others.

It is important to comment here about the sample coverage during each year covered by the analysis. As illustrated below in Table 2-24, the current analysis database includes sales data from national retail chains for 1998 and 1999, and data from independent retailers for 1999 only.

Table 2-24: Appliance Sales Data Coverage, by Market Channel

Market Channel	1998	1999
National Chain Retailers *	X	X
Independent Retailers		X

* Two national chains provided 1998 data, and four provided 1999 data.

Appliance Data Analysis

RER based the analysis of residential appliance efficiencies upon the ENERGY STAR qualification threshold. In generic terms, RER estimated the percentage of units sold that qualified for the ENERGY STAR label during each quarter from the first quarter of 1998 through the second quarter of 2000. Estimating average efficiency ratings, or the average percentage above the federal standard is not feasible because of the nature of the national chain sales data provided by D&R.

The remainder of this subsection summarizes the appliance sales data processing and analysis.

Data Processing

The national chain sales data provided by D&R needed relatively little inspection and processing. The data collected from independently owned retailers, however, included the sale date and the model number of each unit sold. Thus, the first critical step was to transform the sales data into data useful for efficiency tracking. Figure 2-8 provides an overview of this procedure.

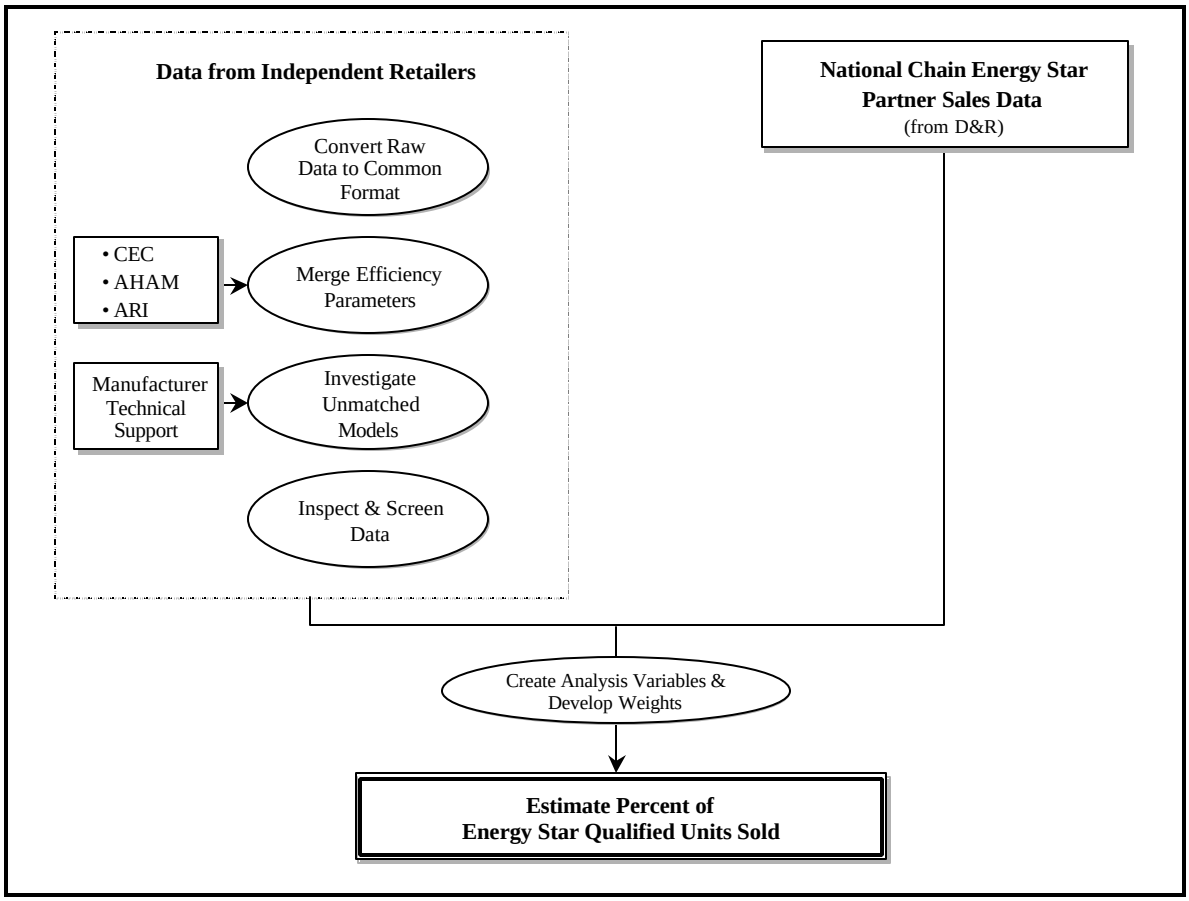
First, all data provided by the independent retailers were converted to a common format. For example, hard copy data were first coded into an electronic database. Second, the required efficiency parameters were electronically merged to the sales data by the manufacturer model numbers provided in the sales data. The primary sources for efficiency parameters were the CEC's Appliance Efficiency Database and AHAM's Directory of Certified Refrigerators and Freezers.[25] RER staff utilized manufacturer websites and contacted manufacturers directly to obtain the required energy use information for all model numbers that were not electronically matched.[26] Third, RER staff inspected the data for accuracy and screened out all appliances

[25] California Energy Commission. Appliance Efficiency Database. www.energy.ca.gov/efficiency/appliances. Association of Home Appliance Manufacturers. *AHAM Directory of Certified Refrigerators and Freezers. January and June Editions.* 1997 through 2000.

[26] Efficiency information for almost all of the refrigerators and room air conditioners in the sales data was, in fact, merged to the database. However, efficiency information for roughly 20% of the clothes washer and dishwasher models was not identified. This is primarily because the only efficiency source for these measures is the CEC's Appliance Efficiency Database. The CEC is no longer mandated to maintain data on these appliances.

not covered by the RMST project (compact refrigerators, for example). The independent retail sales data were then combined with the national chain sales data provided by D&R. Finally, any variables needed to conduct the market share analysis were created, such as an identifier for all ENERGY STAR qualified appliances and the percentage by which the units sold exceeded the ENERGY STAR qualification.

Figure 2-8: Overview of Retail Appliance Data Processing



Appliance Sales Analysis

This analysis entailed the estimation of the share of appliances sold that met or exceeded the ENERGY STAR qualification threshold. In particular, RER estimated the percentage of ENERGY STAR compliant units of each appliance sold in California and for each utility service area, on an annual and quarterly basis from the first quarter of 1998 through the fourth quarter of 1999.

Two key points are worth noting regarding the appliance sales analysis. First, as noted in Table 2-24, the sample of retailers that provided 1998 is very different from the sample that provided 1999 data. In particular, 1998 sales data was provided by only two national chain retailers. The 1999 data, however, was provided by four national chains, in addition to the

panel of independently owned retailers. Analysis of the 1998 data reveals that the 1998 sample is not representative of the appliance market as a whole, particularly with respect to sales of high efficiency appliances. To account for the differences between the 1998 and 1999 data, RER used the estimated percent of ENERGY STAR units sold during 1999 together with the 1998 sales to estimate 1998 ENERGY STAR qualified sales (explained below). Second, expansion weights were developed according to the sample design for this component of the project. In particular, separate expansion weights were developed for national chain sales and sales by independently owned retailers. This was particularly important because of speculation by industry professionals that retailers in the two market channels behave differently with respect to the product mixes they typically stock and sell.

Expansion Weights. RER developed expansion weights to expand the sample to the total sales of each appliance in the State and each utility service area. Doing so required the estimation of 1) total appliance sales in California and each utility service area, and 2) total appliance sales through each market channel.

In order to estimate the total appliance sales in each utility area, RER developed the ratio of the total number of households in each utility service area to the total number of households in California. This ratio was used to estimate the proportion of total sales of each appliance in each utility service area for each year, based on total appliance shipments to California as published by AHAM.

$$N_{ua} = \frac{P_u}{P_{CA}} \times S_{CAau}$$

where:

N_{ua} is an estimate of total sales of appliance *a* for utility *u* in 1999.

P_u is the total number of households in each utility's *u* service area in 1999.

P_{CA} is the total number of households in California in 1999.

S_{CAa} is the total shipments of appliance type *a* to California in 1999.

To estimate total sales for each market channel, RER estimated the total sales of each appliance by national chains by expanding the sales provided in the D&R database (representing four chains) to represent sales by all ENERGY STAR partner national chains. Because total unit sales by individual chains are not known, RER expanded sales by a revenue-multiplier as a proxy for total unit sales:

$$N_{ua}^{nc} = n_{ua}^{nc}\left(\frac{R_{=}^{nc}}{r^{nc}}\right)$$

where

N_{ua}^{nc} is the total sales of appliance *a* by all national chain ENERGY STAR partners (*nc*) in 1999.

n_{ua}^{nc} is the sales of appliance *a* for utility *u* in 1999.

R^{nc} is the total revenues from appliance sales by all national chain ENERGY STAR partners in 1999.

r^{nc} is the total revenues from appliance sales by the national chain retailers in the analysis sample in 1999.

Total sales by the independent retail channel is assumed to be the remainder of market, or

$$N_{ua}^{in} = N_{ua} - N_{ua}^{nc}$$

where

N_{ua}^{in} is the total sales of appliance *a* by all independent retailers (*in*) in 1999.

The expansion weights for each appliance *a* sold in each utility area *u* for sales by the national chain ENERGY STAR partners and independent retailers are computed as the ratio of total units sold to the units sold represented in the analysis sample:

$$w_{ua}^{nc} = \frac{N_{ua}^{nc}}{n_{ua}^{nc}}$$

$$w_{ua}^{in} = \frac{N_{ua}^{in}}{n_{ua}^{in}}$$

where:

w_{ua}^{nc} is the expansion weight applied to all sales by the national chain ENERGY STAR partners in the sample, and

w_{ua}^{in} is the expansion weight applied to all sales by independently owned retailers in the sample.

Shares of ENERGY STAR qualifying appliances during each quarter were estimated by expanding the sales in the database by the appropriate expansion factor, and computing the percent of the expanded sales that qualify for the ENERGY STAR label.[27]

[27] Because the 1998 sales data does not accurately represent California's appliance market, RER developed a rather simplistic approach to estimating the shares of ENERGY STAR appliances representing the entire market. In particular, the share of ENERGY STAR qualified sales of each appliance developed from the 1998 data was multiplied by the ratio of the share of ENERGY STAR sales in 1999 by the national chains in the 1998 sample to the share of ENERGY STAR sales in 1999 by the four national chains in the 1999 sample.

3

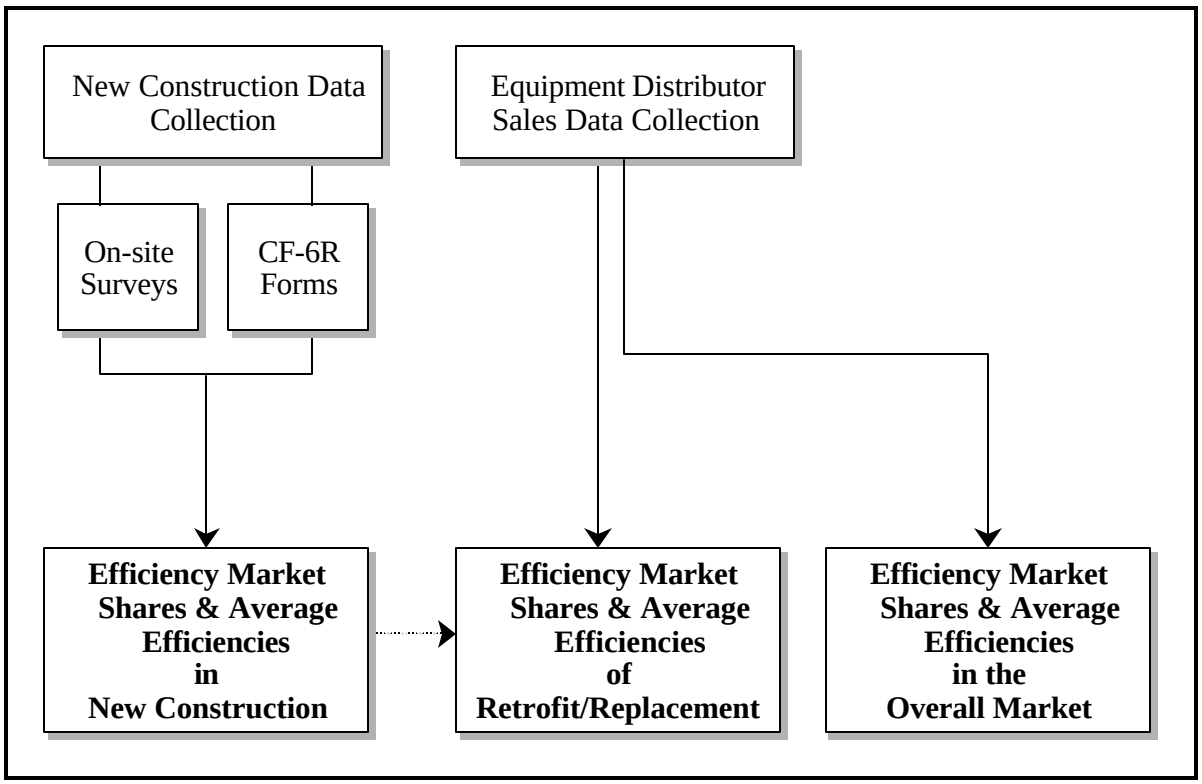
Central Air Conditioners

3.1 Overview

This section presents the efficiency market shares and average efficiencies of central air conditioners (CACs) installed/purchased in California's residential sector. This subsection includes a review of the data sources for analysis of CAC efficiencies. Subsection 3.2 summarizes energy efficiency standards for CACs and Subsection 3.3 summarizes the availability of models by efficiency level. Subsection 3.4 includes estimates of total CAC sales in California by decision type. Estimates of average efficiencies in the overall California market, in new construction, and of retrofits/replacements are presented in Subsections 3.5, 3.6, and 3.7, respectively.

Figure 3-1 provides an overview of the data sources for the CAC efficiency analysis. As shown, data from new construction on-site surveys and building department installation forms (CF-6Rs) was used to estimate the shares and average efficiencies of CACs installed in residential new construction. Data collected from a panel of HVAC equipment distributors was used to indicate CAC efficiencies in the overall market. Estimates of CAC retrofits/replacements were developed by backing out the new construction sector estimates from the overall market data. Expansion weights were developed to expand the sample data to represent the California market. The analysis of CACs in new construction was also conducted at the utility level. A detailed discussion of the data collection and analysis of CAC efficiencies is provided in Section 2.2 and 2.3.

Figure 3-1: Overview of Data Sources for Central Air Conditioner Analysis



3.2 Central Air Conditioner Efficiency Ratings

The cooling efficiency rating used to rate central air conditioners is the Seasonal Energy Efficiency Ratio (SEER). The higher the SEER rating, the more efficient the cooling equipment. SEER ratings range from 9.9 to over 15. Standard efficiency for CACs is 10 SEER.[1,2] To qualify for the ENERGY STAR label, central air conditioners must have at least a 12 SEER.

3.3 Central Air Conditioner Model Availability

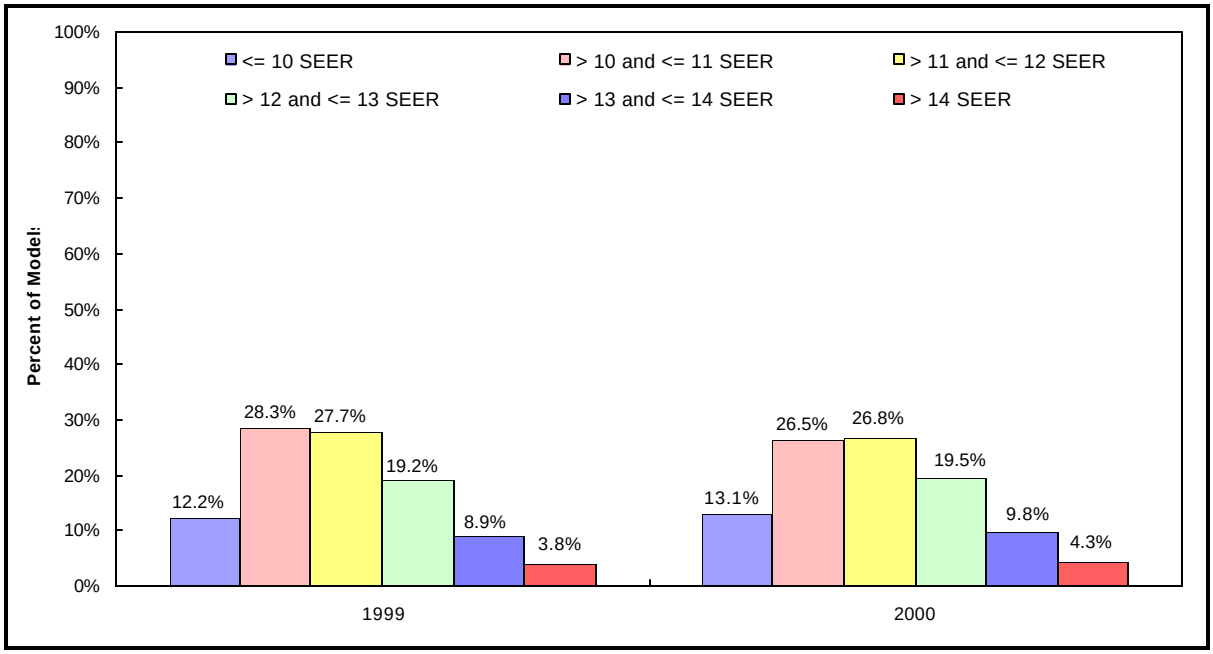
To develop distributions of available CAC models, RER relied on information maintained by prominent trade organizations such as ARI. RER examined model availability for each year covered by the RMST (1998–present), where possible.

1 Required efficiency for residential central air conditioners that are less than 65 kBtu/hr.

2 Code of Federal Regulations. Title 10, Chapter II, Subpart C, Part 430, Section 430.32.

Figure 3-2 shows the distribution of available CAC models by SEER.[3,4] As shown, just over 10% of the models have SEERs of 10.0 or less. Over half of the units have SEERs between 10.0 and 12.0, and roughly 15% have SEERs that exceed 13.0. The distribution of available central air conditioners has changed very little from 1999 to 2000.

Figure 3-2: Central Air Conditioner Availability by SEER



Source: ARI

3.4 Total Unit Sales, New Construction Installations, and Retrofit, Replacement, and Net Acquisition Estimates

Table 3-1 presents estimates of total unit sales for selected measures. There is no definitive source of annual unit sales by measure and by decision type. However, RER developed estimates at the decision type level using information on total unit sales and subtracting out the estimates of sales in the new construction sector. As shown in the notes of the table, estimates of total unit sales were developed from a variety of sources. For central air conditioning, the primary data sources were large manufactures and the Air-conditioning and Refrigeration Institute (ARI).

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3 Air-Conditioning and Refrigeration Institute. *ARI Directory of Certified Unitary Equipment Standards 210/240/270.* 1998 through 1999.

4 Air-Conditioning and Refrigeration Institute. *ARI Electronic Unitary Directory, ARIUD2000 V1.5.* 1996 through 2000.

Table 3-1: Estimates of Annual Unit Sales by Decision Type

Measure	Total Units Sales [1]	New Construction Installations [2]	Retrofit/ Replacement & Net Acquisition Estimate
Central Air Conditioners	441,000	71,574	369,426

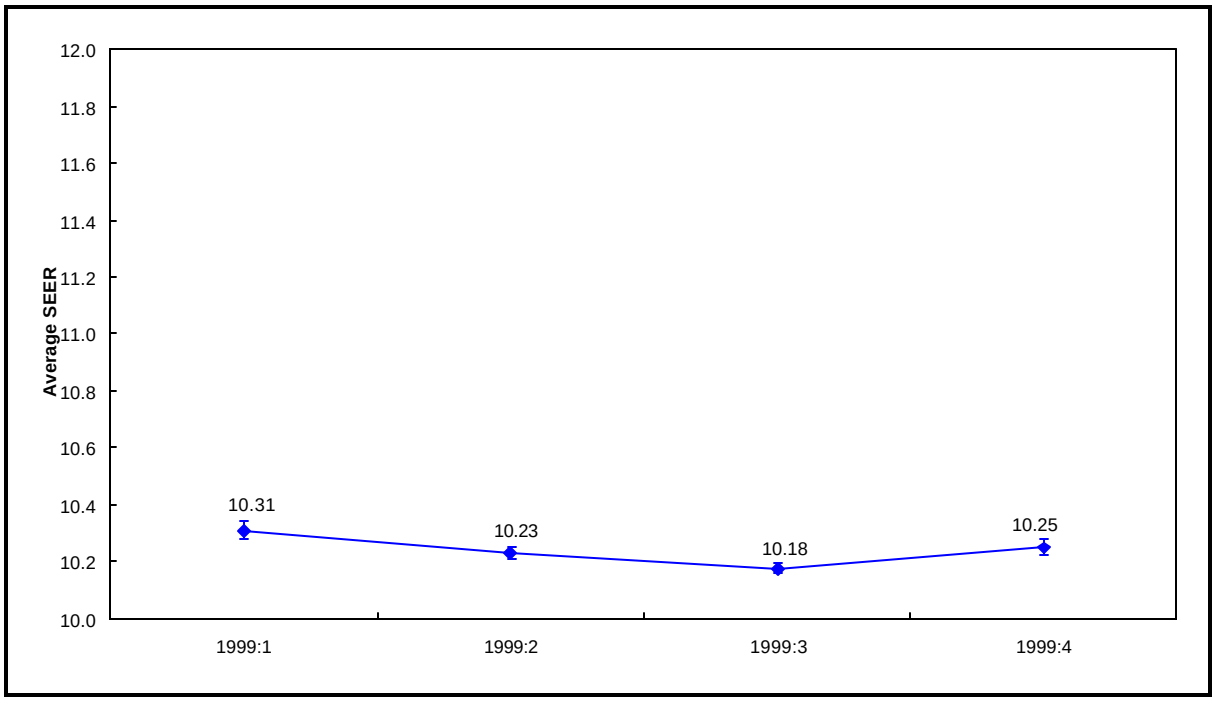
1 Total unit sales data developed from information provided by two large California distributors and ARI statistics for 1998.

2 Estimates of new construction from New Construction On-site survey, 1998:3-4 through 1999:1-2.

3.5 Efficiencies of Central Air Conditioners in the Overall Market

Figure 3-3 and Table 3-2 present the average SEER of central air conditioners sold in California in 1999 by quarter. As shown, the average SEER ranged from 10.31 in the first quarter of 1999 to 10.25 by the end of the year.

Figure 3-3: Central Air Conditioners, Average SEER by Quarter



Error bands for the 90% confidence interval.

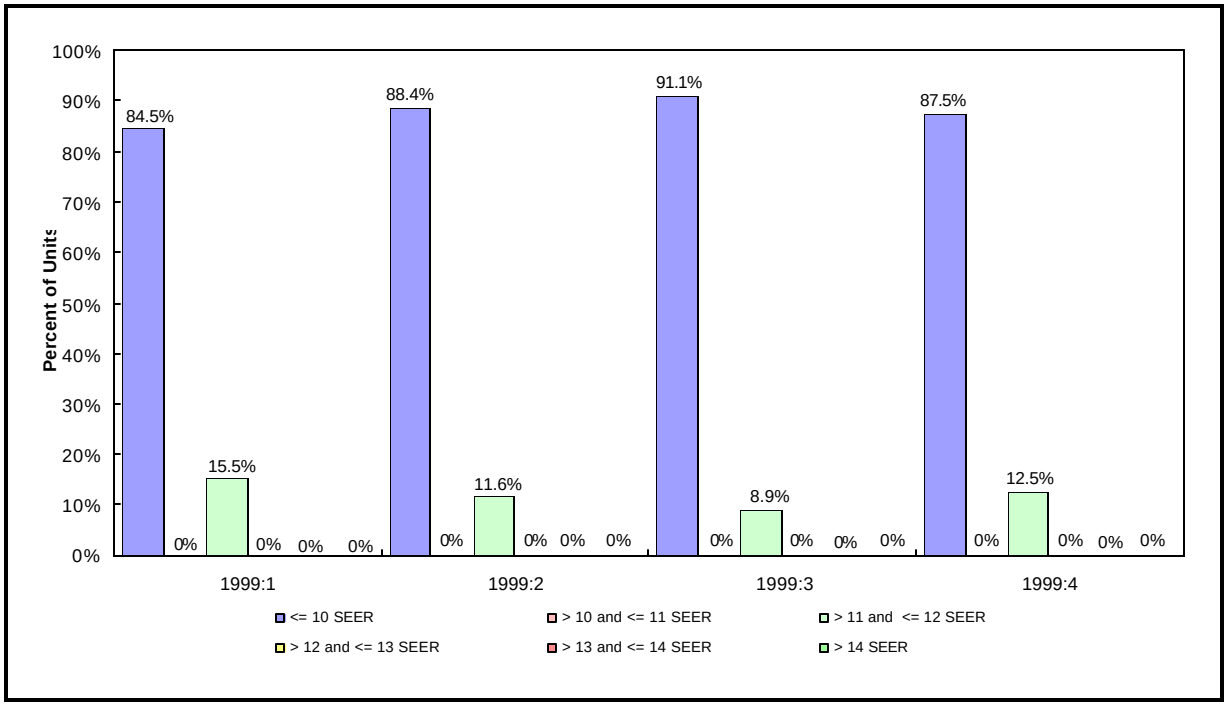
Table 3-2: Central Air Conditioners, Average SEER by Quarter

Period	Average Efficiency Rating (SEER)
1999:1	**10.31** (0.0196) n = 1,358
1999:2	**10.23** (0.0126) n = 2,589
1999:3	**10.18** (0.0105) n = 2,956
1999:4	**10.25** (0.0179) n = 1,360

Standard errors in parentheses.

Figure 3-4 illustrates the distribution of central air conditioners sold by SEER level. As shown, the majority of units sold throughout 1999 were 10.0 SEER or less (these units "just" meet standard). The percent of units with SEERs between 10 and 11 ranged from 15.5% early in the year to just over 12% by the fourth quarter.

Figure 3-4: Central Air Conditioners, Percent of Sales by SEER Level



3.6 Central Air Conditioners in New Construction

This subsection includes the average efficiency ratings of CACs installed in California's new construction sector. Results from the on-site survey analysis, the CF-6R data analysis, and the combined analysis are presented below.

New Construction On-Site Survey Results

Table 3-3 presents the average efficiency of central air conditioners by utility and six-month period. Figure 3-5 and Table 3-4 present the distribution of central air conditioners by efficiency and the saturation of central air conditioners by utility and climate zone, respectively.

Table 3-3: Central Air Conditioners, Average SEER Rating – On-Site Data

	PG&E	SCE	SDG&E	All
1998:3-4	**10.75**	**10.31**	**10.24**	**10.49**
	(0.0824)	(0.0548)	(0.1053)	(0.0449)
	n = 103	n = 134	n = 28	n = 283
1999:1-2	**10.75**	**10.28**	**10.16**	**10.50**
	(0.0879)	(0.0536)	(0.1038)	(0.0477)
	n = 101	n = 138	n = 26	n = 284

Standard Errors in parentheses.

Figure 3-5: Central Air Conditioner Shares by SEER – On-Site Data

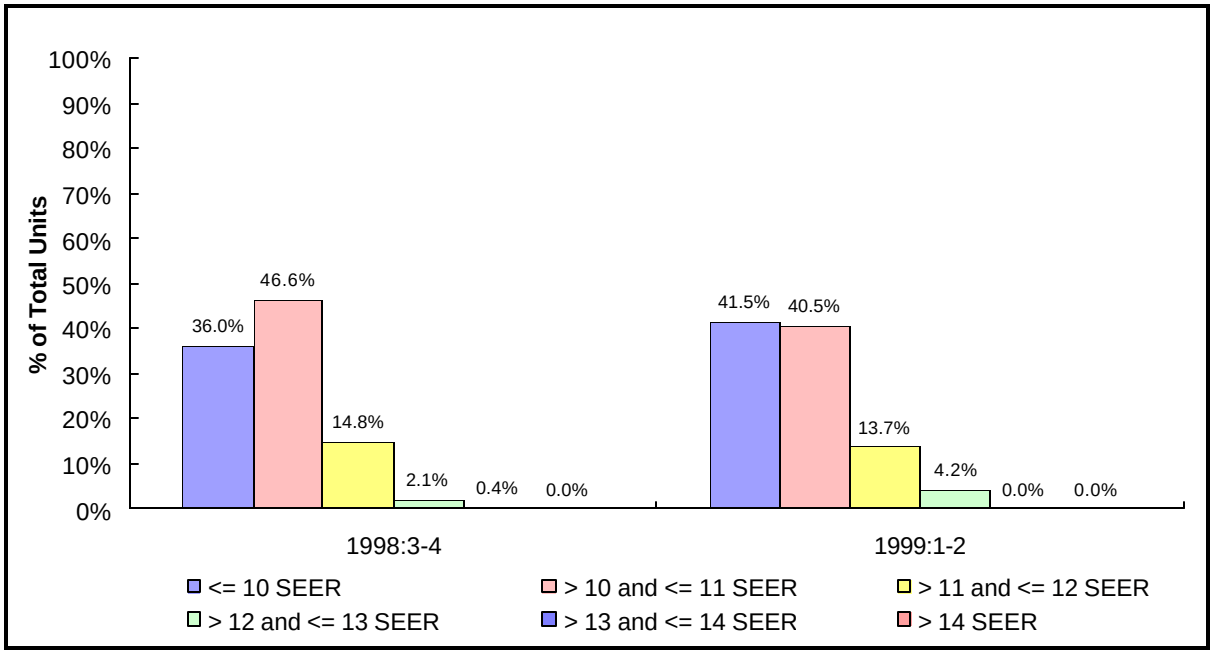


Table 3-4: Saturations of Central Air Conditioners – On-Site Data

CEC Climate Zone	PG&E	SCE	SDG&E
CZ:1	**31.5%** n = 179	**-** n = 0	**-** n = 0
CZ:2	**-** n = 0	**38.6%** n = 44	**35.2%** n = 90
CZ:3	**-** n = 0	**90.7%** n = 189	**69.0%** n = 18
CZ:4	**82.0%** n = 182	**80.9%** n = 16	**-** n = 0
CZ:5	**50.0%** n = 4	**83.1%** n = 36	**-** n = 0

CR-6R Analysis Results

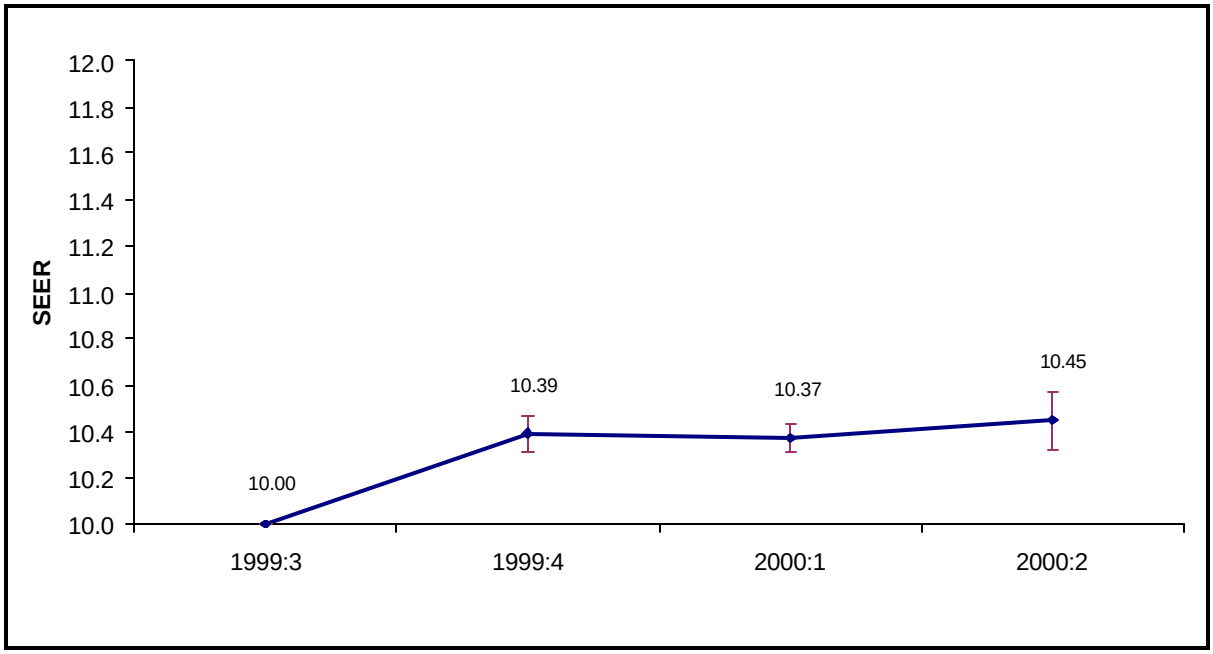
Figure 3-6 presents the average SEER over the past year. As shown, the average SEER for new construction in California ranged from 10.00 in the third quarter of 1999 to 10.45 during the first quarter of 2000.[5] Table 3-5 includes the average SEER by utility and by quarter. The average SEER for SCE's territory has slowly increased from 10.00 during the third quarter of 1999 to 10.45 during the second quarter of 2000. The average SEER for PG&E's territory ranges from 10.00 to 11.18.[6]

Figure 3-7 illustrates how the percentage of central air conditioners that fall into various efficiency levels has changed over the last year.

[5] A formal test of significance was not conducted for the California average SEER values due to sample sizes in the third quarter of 1999 and the distribution of the sample in the second quarter of 2000. However, when the on-site data and the CF-6R data are combined, covering a two-year period, a formal test will be performed. (See Section 3.7)

[6] A significance test at the 90% confidence level reveals that the estimates for PG&E's average SEER and for SCE's average SEER during the fourth quarter of 1999 are significantly different. The same test revealed that there is also significant difference between PG&E's and SCE's averages during the first quarter of 2000.

Figure 3-6: Central Air Conditioner Average SEER – CF-6R Data



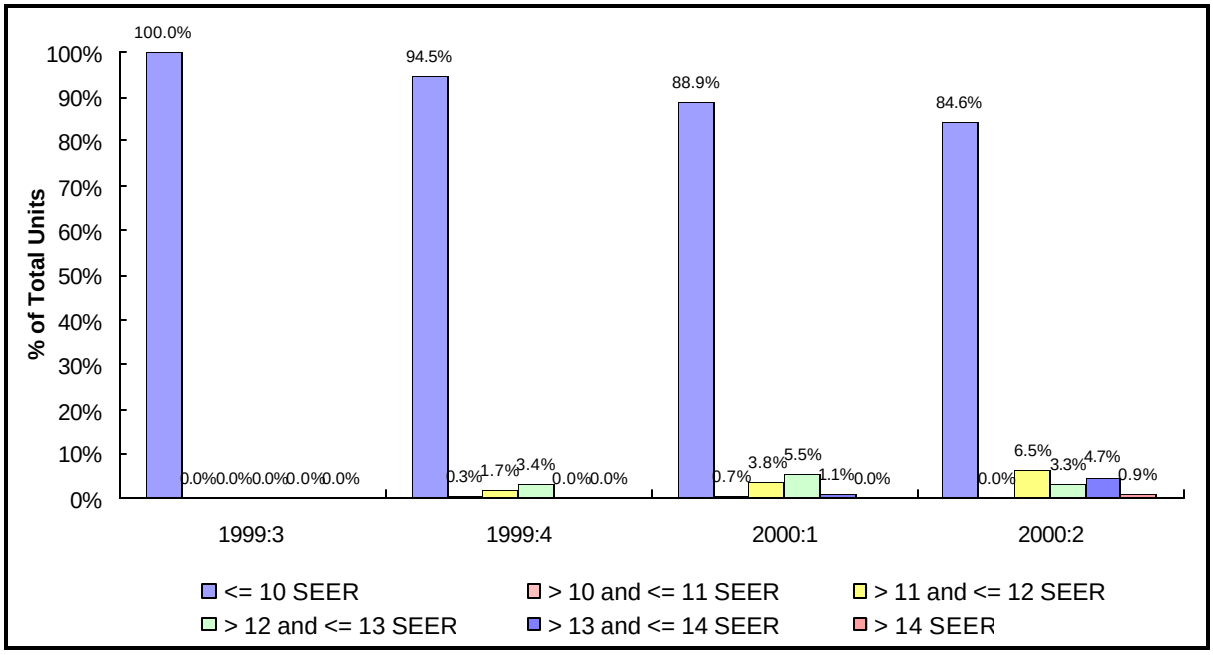
Error bands for the 90% confidence interval.

Table 3-5: Central Air Conditioner Average SEER – CF-6R Data

	PG&E	SCE	All
1999:3	**10.00** (0.0000) n = 4	**10.00** (0.0000) n = 32	**10.00** (0.0000) n = 36
1999:4	**11.18** (0.2919) n = 16	**10.07** (0.0219) n = 332	**10.39** (0.0461) n = 348
2000:1	**10.47** (0.1082) n = 75	**10.23** (0.0354) n = 475	**10.37** (0.0374) n = 550
2000:2	**-** - n = 0	**10.45** (0.0790) n = 214	**10.45** (0.0790) n = 214

Standard errors in parentheses.
CF-6R forms from SDG&E's service area were not obtained for this analysis.

Figure 3-7: Central Air Conditioners by Efficiency Level – CF-6R Data



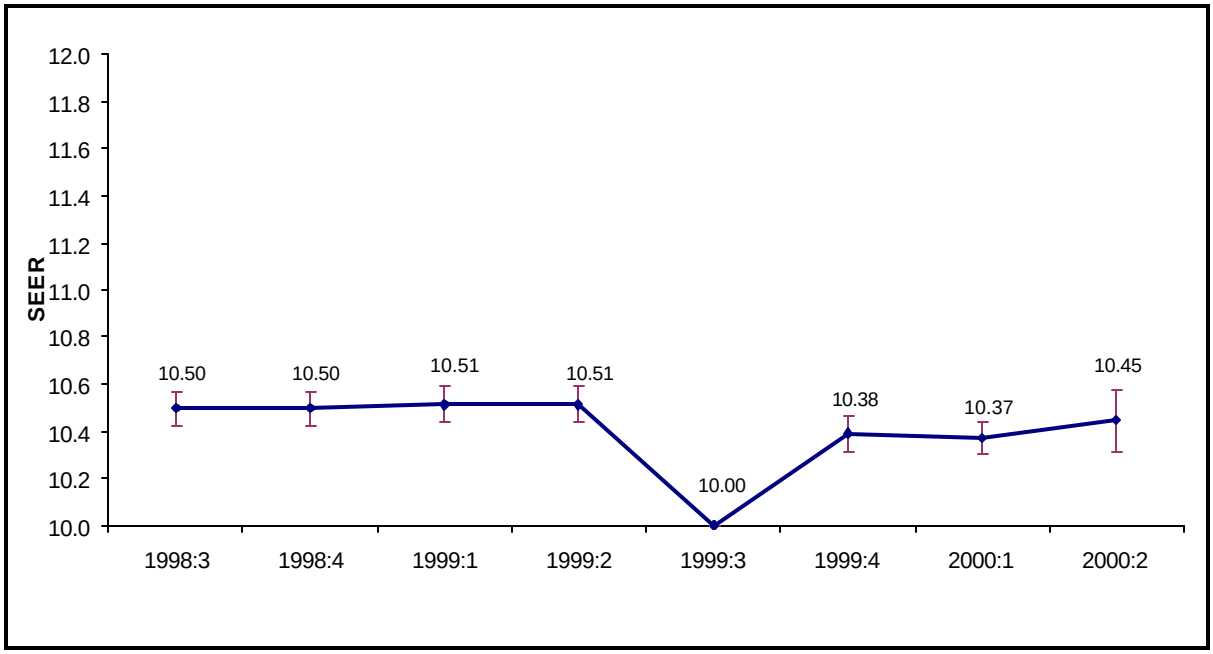
Combined New Construction Results

Figure 3-8 presents the average efficiency of central air conditioners. As shown, there has been no significant change in average efficiencies over the last eight quarters. The one outlier to this result (1999:3) is because of the relatively small sample size. The sample size for this period will increase when the results of the second-year on-site survey are added.

Table 3-6 presents the average CAC efficiency by climate zone. As depicted in this table, average SEER values are higher in the relatively hotter climate zones 4 and 5.[7] With the caveat that some of the sample sizes are small, there is a significant increase in the average SEER value in climate zone 5 over the last eight quarters.

[7] A significance test at the 90% confidence level reveals that the estimates of the average SEER values for climate zones 4 and 5 are significantly different from the average SEER values for the remaining three climate zones during each time period. (The only exception to this is that the average SEER for climate zone 1 during the second six-month period of 1998 is not significantly different from the average SEER values for climate zones 4 and 5 during the same time period.)

Figure 3-8: Central Air Conditioner Average SEER in New Construction



Error bands for the 90% confidence interval.
Results for 1999:3 are primarily attributable to small sample size.

Table 3-6: Central Air Conditioner Average SEER in New Construction by Climate Zone

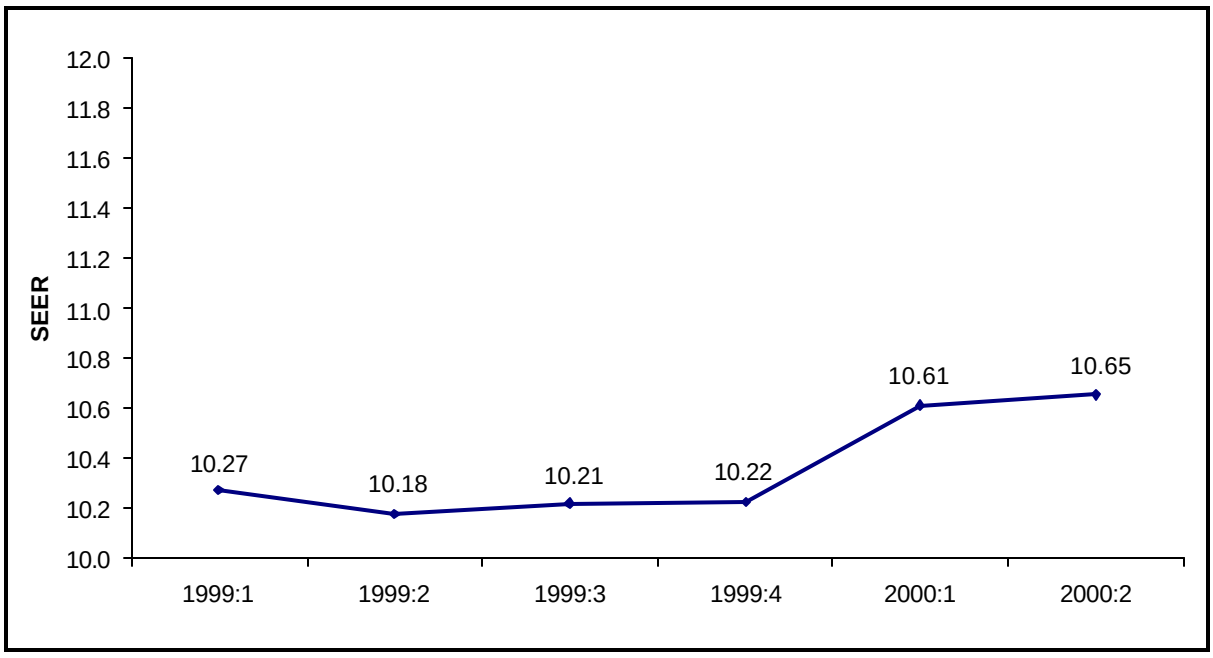
	CEC Climate Zone					
	CZ:1	**CZ:2**	**CZ:3**	**CZ:4**	**CZ:5**	**All**
1998:3	**10.46** (0.1060) n = 30	**10.19** (0.0651) n = 33	**10.19** (0.0389) n = 123	**10.82** (0.1015) n = 78	**10.99** (0.2173) n = 25	**10.50** (0.0448) n = 289
1998:4	**10.46** (0.1060) n = 30	**10.19** (0.0651) n = 33	**10.19** (0.0389) n = 123	**10.82** (0.1015) n = 78	**10.99** (0.2173) n = 25	**10.50** (0.0448) n = 289
1999:1	**10.14** (0.0309) n = 38	**10.15** (0.0793) n = 31	**10.11** (0.0221) n = 132	**10.99** (0.1033) n = 85	**11.24** (0.2011) n = 33	**10.51** (0.0460) n = 319
1999:2	**10.14** (0.0309) n = 38	**10.15** (0.0793) n = 31	**10.11** (0.0221) n = 132	**10.99** (0.1033) n = 85	**11.24** (0.2011) n = 33	**10.51** (0.046) n = 319
1999:3	**10.00** (0.0000) n = 1	**-** - n = 0	**10.00** (0.0000) n = 29	**10.00** (0.0000) n = 3	**10.00** (0.0000) n = 3	**10.00** (0.0000) n = 36
1999:4	**10.00** (0.0000) n = 1	**-** - n = 0	**10.00** (0.0000) n = 317	**11.27** (0.3003) n = 15	**11.60** (0.3024) n = 15	**10.39** (0.0461) n = 348
2000:1	**10.00** (0.0000) n = 23	**-** - n = 0	**10.01** (0.0072) n = 392	**10.71** (0.1487) n = 52	**11.32** (0.1574) n = 83	**10.37** (0.0374) n = 550
2000:2	**-** - n = 0	**-** - n = 0	**10.00** (0.0000) n = 146	**-** - n = 0	**11.47** (0.2068) n = 68	**10.45** (0.0790) n = 214

Standard errors in parentheses.

3.7 Efficiencies of Central Air Conditioner Replacements

The estimate of sales for retrofits/ replacements is depicted in Figure 3-9. As shown, the average SEER varies from 10.27 in the first quarter of 1999 to 10.65 in the second quarter of 2000.

Figure 3-9: Central Air Conditioner Average Efficiencies (SEER) – Retrofit, Replacement, and Acquisition



4

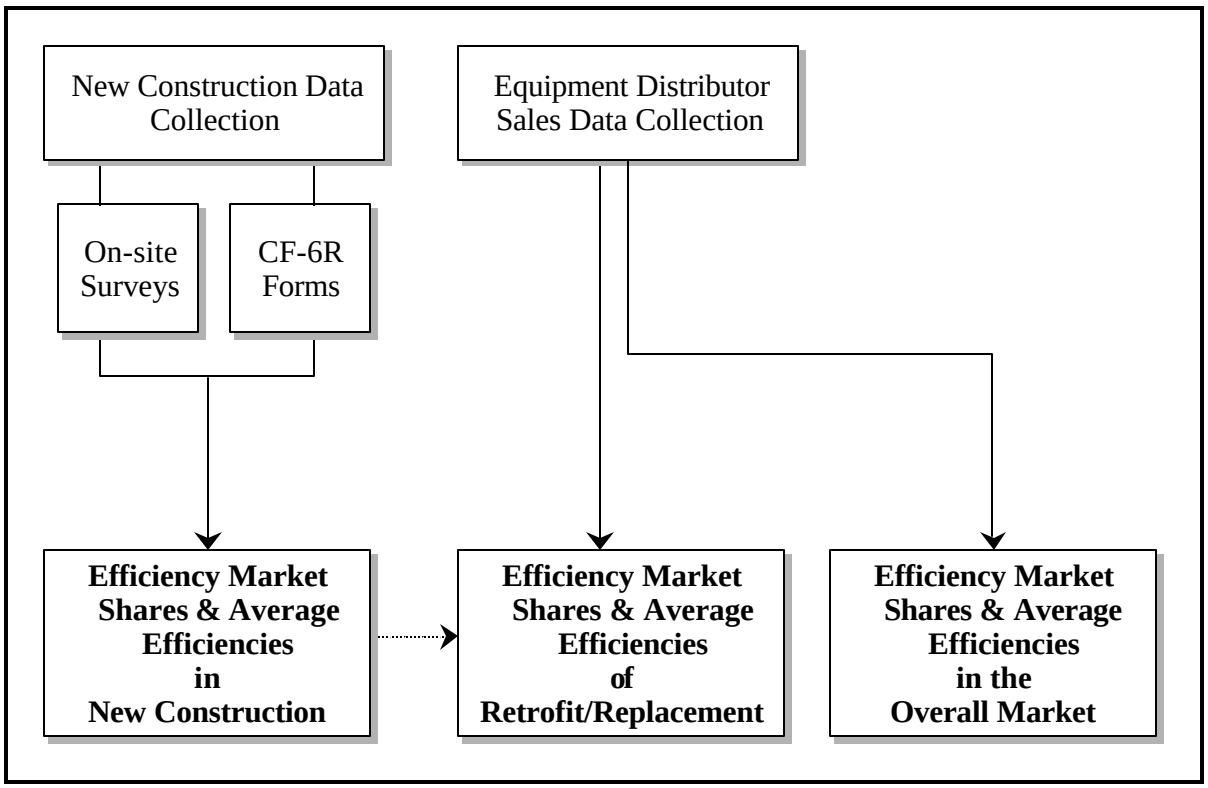
Central Gas Furnaces

4.1 Overview

This section presents the efficiency market shares and average efficiencies of central gas furnaces installed/purchased in California's residential sector. This subsection includes a review of the data sources for analysis of gas furnace efficiencies. Subsection 4.2 summarizes energy efficiency standards for gas furnaces and Subsection 4.3 summarizes the availability of models by efficiency level. Subsection 4.4 includes estimates of total gas furnace sales in California by decision type. Estimates of average efficiencies in the overall California market, in new construction, and of retrofits/replacements are presented in Subsections 4.5, 4.6, and 4.7, respectively.

Figure 4-1 provides an overview of the data sources for the gas furnace efficiency analysis. As shown, data from new construction on-site surveys and building department installation forms (CF-6Rs) was used to estimate the shares and average efficiencies of gas furnaces installed in residential new construction. Data collected from a panel of HVAC equipment distributors was used to indicate gas furnace efficiencies in the overall market. Estimates of furnace retrofits/replacements were developed by backing out the new construction sector estimates from the overall market data. Expansion weights were developed to expand the sample data to represent the California market. The analysis of gas furnaces in new construction was also conducted at the utility level. A detailed discussion of the data collection and analysis of central air conditioner efficiencies is provided in Section 2.2 and 2.3.

Figure 4-1: Overview of Data Sources for Gas Furnace Analysis



4.2 Gas Furnace Efficiency Ratings

The energy efficiency of furnaces is expressed as a percentage of Annual Fuel Utilization Efficiency (AFUE). Equipment AFUEs increase as energy efficiency increases. The federal minimum AFUE standard for furnaces is 78%.[1,2] Units must have at least a 90% AFUE to qualify for the ENERGY STAR label.

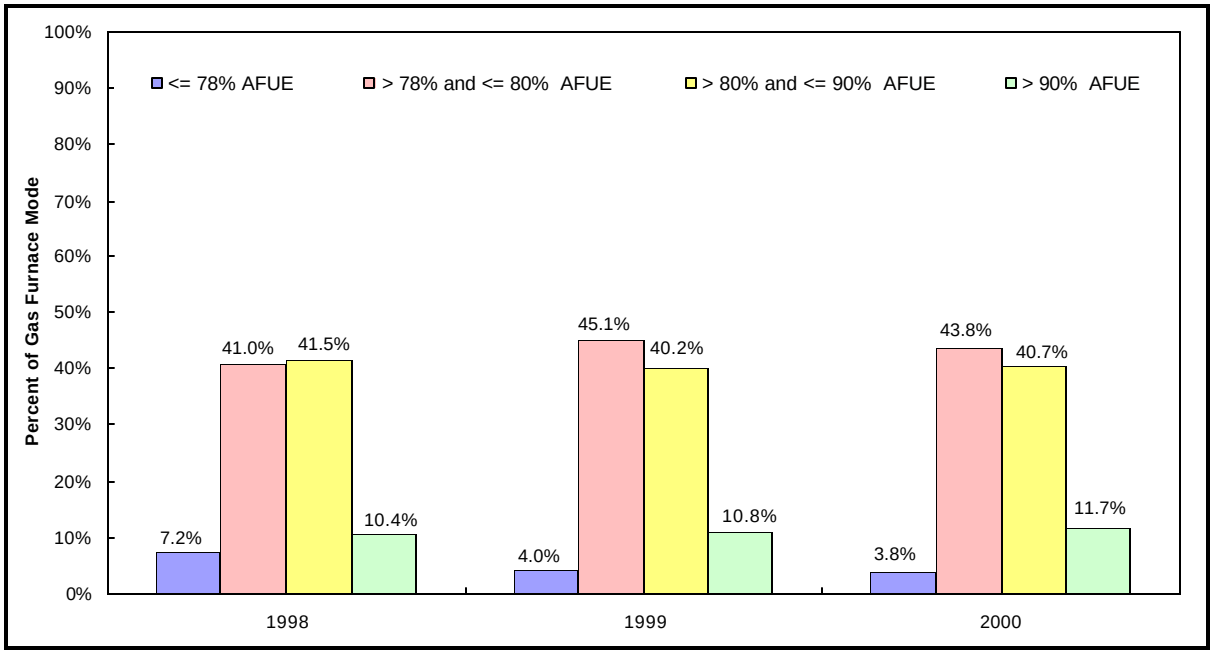
4.3 Characteristics of Available Models

To develop distributions of available forced-air furnace equipment models, RER relied on information maintained by prominent trade organizations such as GAMA. RER examined model availability for each year covered by the RMST (1998–present), where possible.

1 Code of Federal Regulations. Title 10, Chapter II, Subpart C, Part 430, Section 430.32.
2 Required efficiency for residential central gas furnaces that are less than 225 kBtu/hr.

Figure 4-2 shows that most of the available gas furnace models have AFUEs between 78% and 90%. Very few models are 78% AFUE or less and about 10% of models have AFUEs that exceed 90%.[3]

Figure 4-2: Gas Furnace Availability by AFUE



Source: GAMA

4.4 Total Unit Sales, New Construction Installations, and Retrofit, Replacement, and Net Acquisition Estimates

Table 4-1 presents estimates of total unit sales for gas furnaces. There is no definitive source of annual unit sales by measure and by decision type. However, RER developed estimates at the decision type level using information on total unit sales and subtracting out the estimates of sales in the new construction sector. As shown in the notes of the table, estimates of total unit sales were developed from a variety of sources. Sales for central gas furnaces were obtained from *Appliance Manufacturer*.[4] These data were then scaled to California annual sales based on number of households and measure saturations. In particular, the national sales figure was multiplied by the ratio of the number of California households with the measure divided by the number of national households with the measure. Data for these parameters were collected from utility end-use energy surveys and from RECS.[5]

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3 Gas Appliance Manufacturers' Association. *GAMA Consumers' Directory of Certified Efficiency Ratings for Residential Heating and Water Heating Equipment.* April and October Editions, 1997 through 1999.

4 "Special Report 2000 – Market Profile," *Appliance Manufacturer*, a publication of Business News Publishing Co.

5 Residential Energy Consumption Survey.

Table 4-1: Estimates of Annual Unit Sales by Decision Type

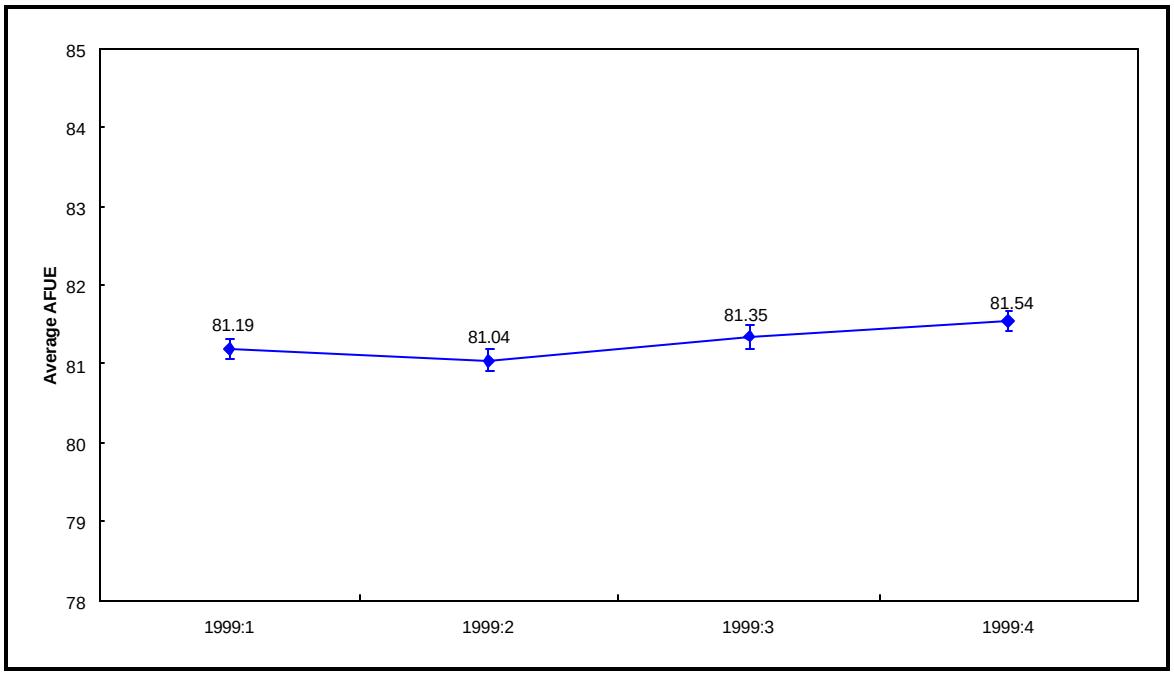
Measure	Total Units Sales [1]	New Construction [2]	Retrofit/ Replacement & Net Acquisition Estimate
Central Gas Furnaces	413,387	92,096	321,291

1 Total unit sales data provided by two large California distributors and ARI statistics for 1998.
2 Estimates of new construction from New Construction On-site survey, 1998:3-4 through 1999:1-2.

4.5 Overall Gas Furnace Efficiency

Figure 4-3 and Table 4-2 present the average AFUE of central gas furnaces sold in California by quarter from January 1, 1999 through March 31, 2000. As shown, the average AFUE ranged from 81.19% in the first quarter of 1999 to 80.82% during the second quarter of 2000.[6]

Figure 4-3: Central Gas Furnaces, Average AFUE



Error bands for the 90% confidence interval.

6 A significance test at the 90% confidence level reveals that the estimates for the first and second quarter 2000 estimates are not significantly different.

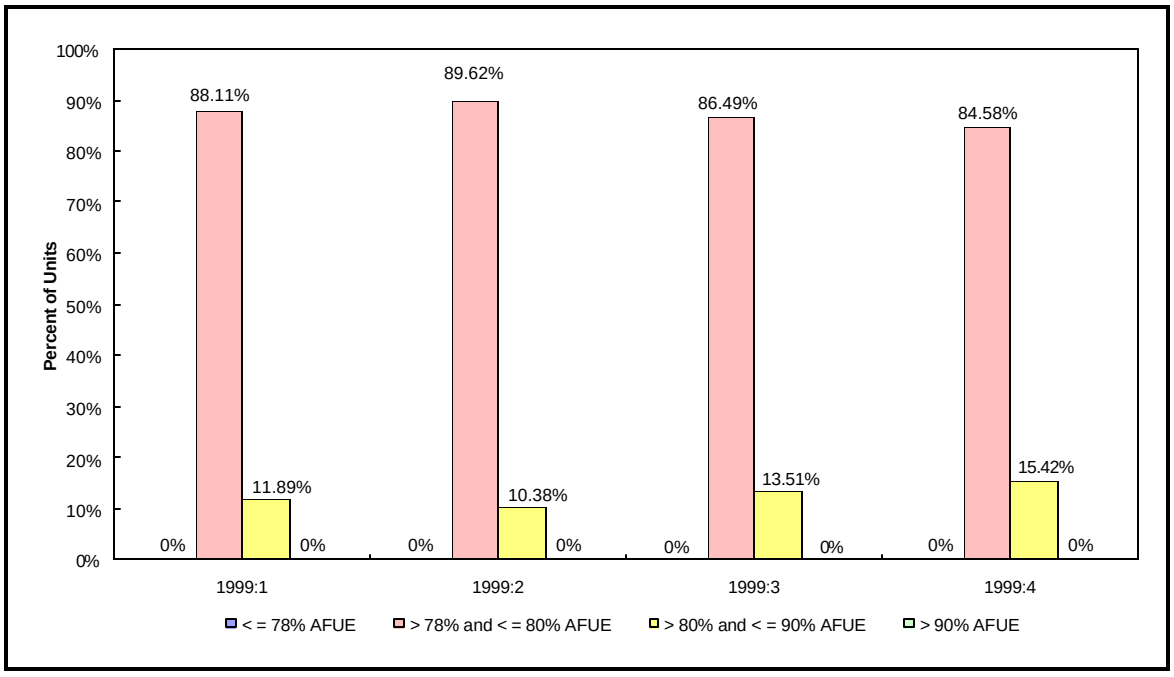
Table 4-2: Central Gas Furnaces, Average AFUE

Period	Average AFUE
1999:1	**81.19** (0.0821) n = 1,556
1999:2	**81.04** (0.0846) n = 1,300
1999:3	**81.35** (0.0909) n = 1,414
1999:4	**81.54** (0.0780) n = 2,147

Standard errors in parentheses.

Figure 4-4 illustrates the distribution of gas furnaces sold by AFUE level. As shown, just under 90% of units sold throughout 1999 had AFUEs between 78% and 80%. In 2000, the share of these units increased slightly to almost 94% in the second quarter. Interestingly, the share of units with AFUEs between 80% and 90% decreased from 15% in the fourth quarter of 1999 to less than 2% in the first quarter of 2000. This shift seemed to be partially offset with an increase in units with AFUEs greater than 90%.

Figure 4-4: Gas Furnaces, Percent of Sales by AFUE Level



4.6 Gas Furnace Efficiency in New Construction

This subsection includes the efficiency shares and average efficiency ratings of gas furnaces installed in California's new construction sector. Results from the on-site survey analysis, the CF-6R data analysis, and the combined analysis are presented below.

New Construction On-Site Survey Results

The results of the analysis of the gas furnace data obtained from the on-site surveys are presented below. Table 4-3 presents the average AFUE for central gas furnaces by utility service area and Figure 4-5 illustrates the distribution of gas furnaces by efficiency level. Saturations of gas and electric central furnaces by utility and climate zone are presented in Table 4-4 and Table 4-5, respectively.

Table 4-3: Central Gas Furnace Average AFUE – On-Site Survey Data

	PG&E	SCE	SDG&E	All
1998:3-4	**80.60** (0.2477) n = 115	**80.42** (0.1647) n = 117	**80.03** (0.0325) n = 37	**80.46** (0.1276) n = 283
1999:1-2	**80.59** (0.2431) n = 112	**80.01** (0.0087) n = 123	**80.00** (0.0000) n = 33	**80.29** (0.1052) n = 287

Standard errors in parentheses.

Figure 4-5: Central Gas Furnace Shares by AFUE – On-Site Data

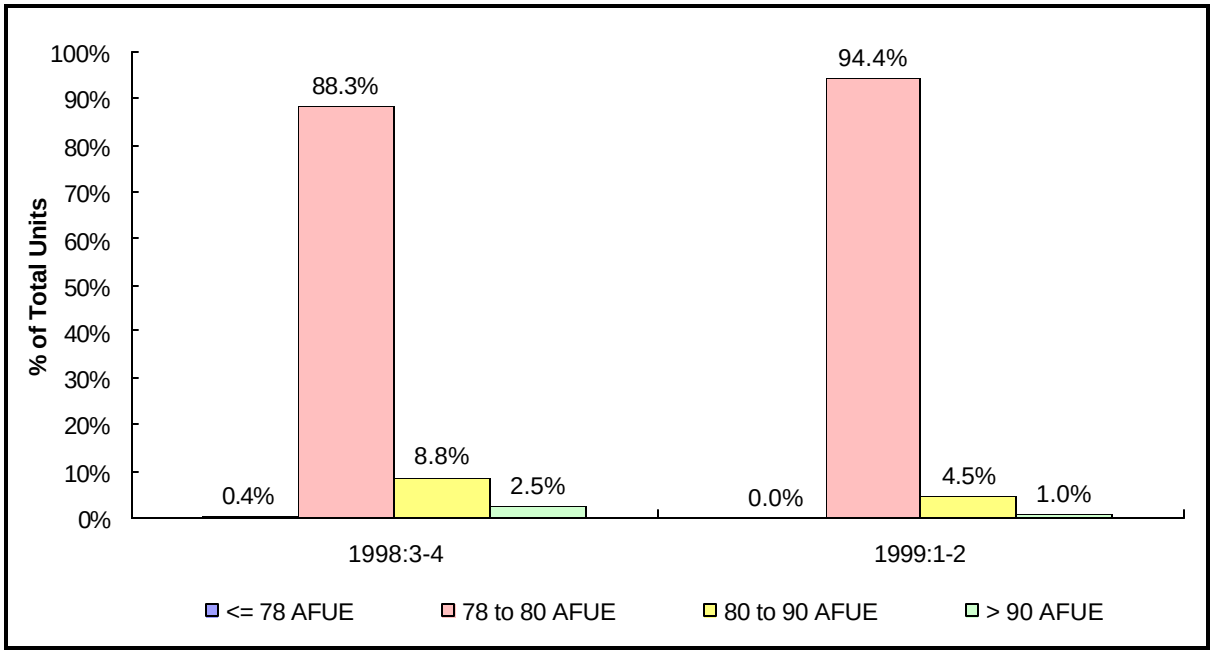


Table 4-4: Saturations of Central Gas Furnaces – On-Site Data

CEC Climate Zone	PG&E	SCE	SDG&E
CZ:1	**82.0%**	**-**	**-**
	n = 179	n = 0	n = 0
CZ:2	**-**	**80.9%**	**83.5%**
	n = 0	n = 44	n = 90
CZ:3	**-**	**89.9%**	**71.5%**
	n = 0	n = 189	n = 18
CZ:4	**81.6%**	**100.0%**	**-**
	n = 182	n = 16	n = 0
CZ:5	**69.4%**	**89.6%**	**-**
	n = 4	n = 36	n = 0

Table 4-5: Saturations of Central Electric Furnaces

CEC Climate Zone	PG&E	SCE	SDG&E
CZ:1	**9.9%**	**-**	**-**
	n = 179	n = 0	n = 0
CZ:2	**-**	**0.0%**	**1.4%**
	n = 0	n = 44	n = 90
CZ:3	**-**	**1.0%**	**0.0%**
	n = 0	n = 189	n = 18
CZ:4	**0.0%**	**0.0%**	**-**
	n = 182	n = 16	n = 0
CZ:5	**0.0%**	**0.0%**	**-**
	n = 4	n = 36	n = 0

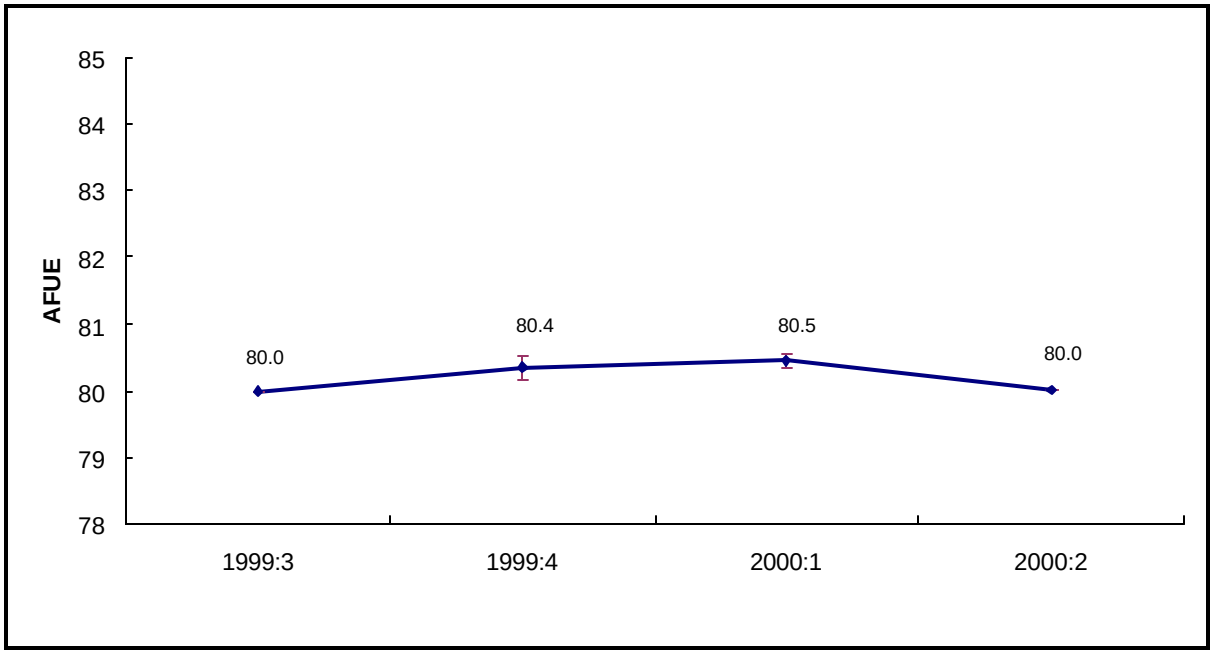
CR-6R Analysis Results

Figure 4-6 presents the average AFUE over the past year, by quarter. As shown, the average AFUE for new construction in California ranged from 80.0% in the third quarter of 1999 to 80.5% during the first quarter of 2000. Table 4-6 shows the average AFUE by utility and by quarter. While the average AFUE for SCE's territory remains near 80%, the average AFUEs in PG&E's service area range from 80% in the third quarter of 1999 to just under 81% during the fourth quarter of 1999. Furthermore, it is clear that the increase in the statewide average AFUE during the fourth quarter of 1999 and the first quarter of 2000 is attributable to the households in PG&E's territory.[7]

[7] A formal test of significance was not conducted for the CF-6R data due to sample sizes in the third quarter of 1999 and the distribution of the sample in the second quarter of 2000. However, when the on-site data

Figure 4-7 illustrates how the percentage of central gas furnace that fall into various efficiency levels has changed over the last year.

Figure 4-6: CF-6R Central Gas Furnace Data (Average AFUE by Quarter)



Error bands for the 90% confidence interval.

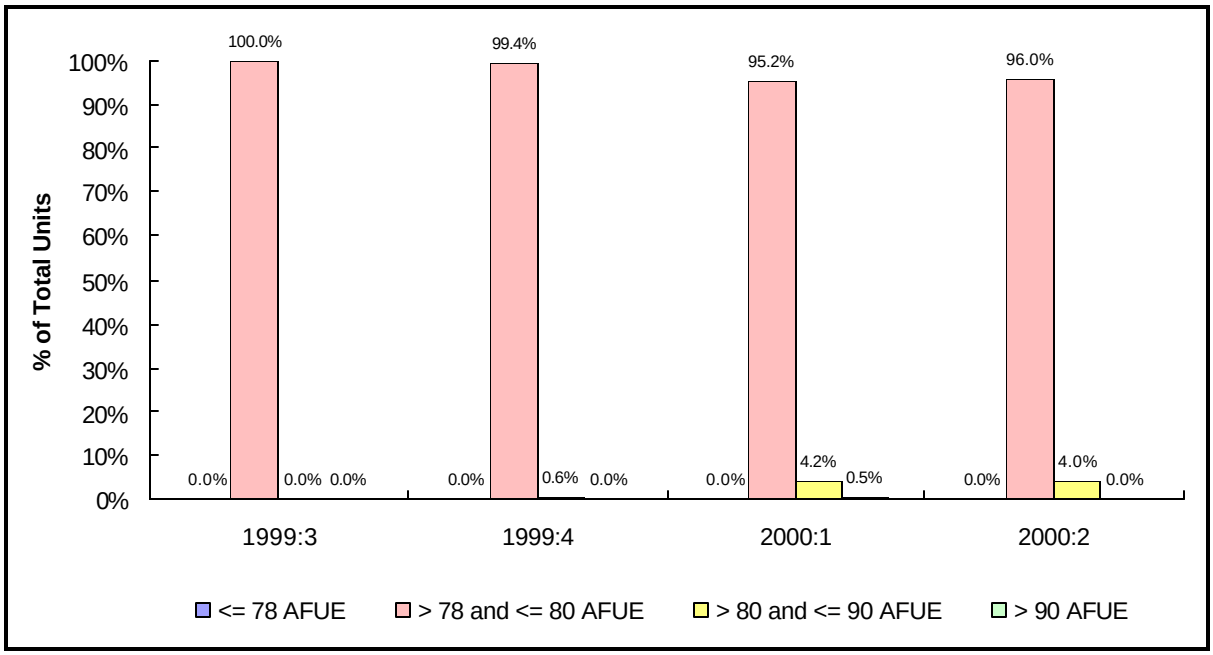
and the CF-6R data are combined, covering a two-year period, a formal test will be performed. (See Section 3.7)

Table 4-6: CF-6R Central Gas Furnace Data (Average AFUE)

	PG&E	SCE	All
1999:3	**80.00** (0.0000) n = 6	**80.00** (0.0000) n = 31	**80.00** (0.0000) n = 37
1999:4	**80.97** (0.7179) n = 18	**80.00** (0.0000) n = 312	**80.35** (0.1007) n = 330
2000:1	**80.71** (0.2397) n = 76	**80.01** (0.0042) n = 491	**80.45** (0.0705) n = 567
2000:2	- - n = 0	**80.02** (0.0082) n = 201	**80.02** (0.0082) n = 201

Standard errors in parentheses.
CF-6R forms from SDG&E's service area were not obtained for this analysis.

Figure 4-7: CF-6R Central Gas Furnace Data (AFUE Groups by Quarter)

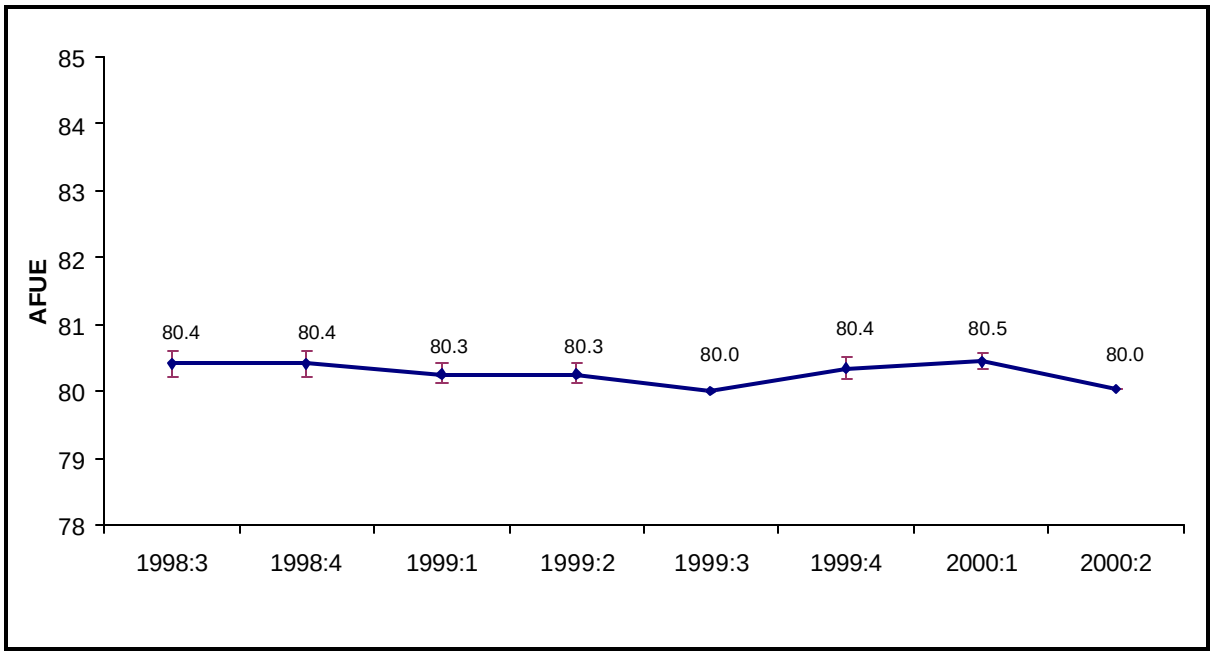


Combined New Construction Results

Figure 4-8 presents the average gas furnace efficiency by quarter. Included in this figure is a 90% confidence interval around the estimated average efficiency. These results indicate that there has been a significant change in the overall average efficiency of gas furnaces statewide from the third quarter of 1998 to the first quarter of 2000.[8] Notice that the two observations, which are significantly lower than the other averages (1999:03 and 2000:02), have relatively small sample sizes. RER expects these sample sizes to increase in the next round of estimates due to the second-year on-site survey and increased participation by contractors and building departments.

Table 4-7 presents the average efficiency by climate zone. With the caveat that some of the sample sizes are small, there is a significant increase in the average AFUE value in climate zones 1 and 4 between the third quarter of 1998 and the first quarter of 2000.[9]

Figure 4-8: Central Gas Furnace Average AFUE in New Construction



Note: 90% confidence interval shown for each quarterly estimate.

[8] A significance test was conducted at the 90% confidence level.

[9] A significance test was conducted at the 90% confidence level.

Table 4-7: Central Gas Furnace Average AFUE in New Construction by Climate Zone

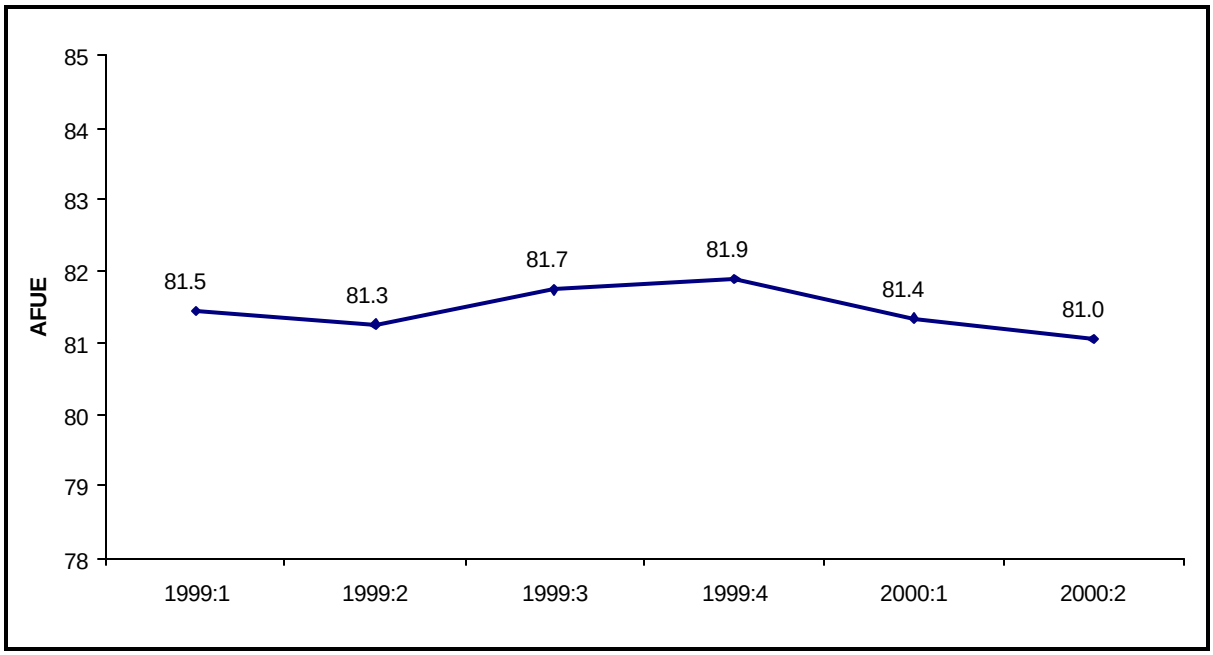
Quarter	CEC Climate Zone					
	CZ:1	**CZ:2**	**CZ:3**	**CZ:4**	**CZ:5**	**All**
1998:03	**80.36** (0.2540) n = 61	**80.08** (0.0444) n = 45	**80.40** (0.1883) n = 101	**80.52** (0.3162) n = 65	**80.73** (0.4768) n = 23	**80.41** (0.1187) n = 295
1998:04	**80.36** (0.2540) n = 61	**80.08** (0.0444) n = 45	**80.40** (0.1883) n = 101	**80.52** (0.3162) n = 65	**80.73** (0.4768) n = 23	**80.41** (0.1187) n = 295
1999:01	**80.17** (0.1613) n = 62	**80.04** (0.0219) n = 46	**80.10** (0.0888) n = 113	**80.65** (0.3184) n = 72	**80.29** (0.3388) n = 32	**80.27** (0.0944) n = 325
1999:02	**80.17** (0.1613) n = 62	**80.04** (0.0219) n = 46	**80.10** (0.0888) n = 113	**80.65** (0.3184) n = 72	**80.29** (0.3388) n = 32	**80.27** (0.0944) n = 325
1999:03	**80.00** (0.0000) n = 3	**-** - n = 0	**80.00** (0.0000) n = 29	**80.00** (0.0000) n = 3	**80.00** (0.0000) n = 2	**80.00** (0.0000) n = 37
1999:04	**80.00** (0.0000) n = 3	**-** - n = 0	**80.00** (0.0000) n = 297	**81.33** (0.9085) n = 15	**80.00** (0.0000) n = 15	**80.35** (0.1007) n = 330
2000:01	**80.72** (0.1149) n = 25	**-** - n = 0	**80.00** (0.0000) n = 411	**80.71** (0.3993) n = 51	**80.06** (0.0249) n = 80	**80.45** (0.0705) n = 567
2000:02	**-** - n = 0	**-** - n = 0	**80.00** (0.0000) n = 136	**-** - n = 0	**80.07** (0.0242) n = 65	**80.02** (0.0082) n = 201

Standard errors in parentheses.

4.7 Gas Furnace Retrofit/Replacement Efficiency

The estimate of sales in the retrofit/replacement/acquisition sector is depicted in Figure 4-9. As shown, the average AFUE varies from 81.45 in the first quarter of 1999 to 81.05 in the second quarter of 2000.

Figure 4-9: Central Gas Furnace Average Efficiencies (AFUE) – Retrofit, Replacement, and Acquisition



5

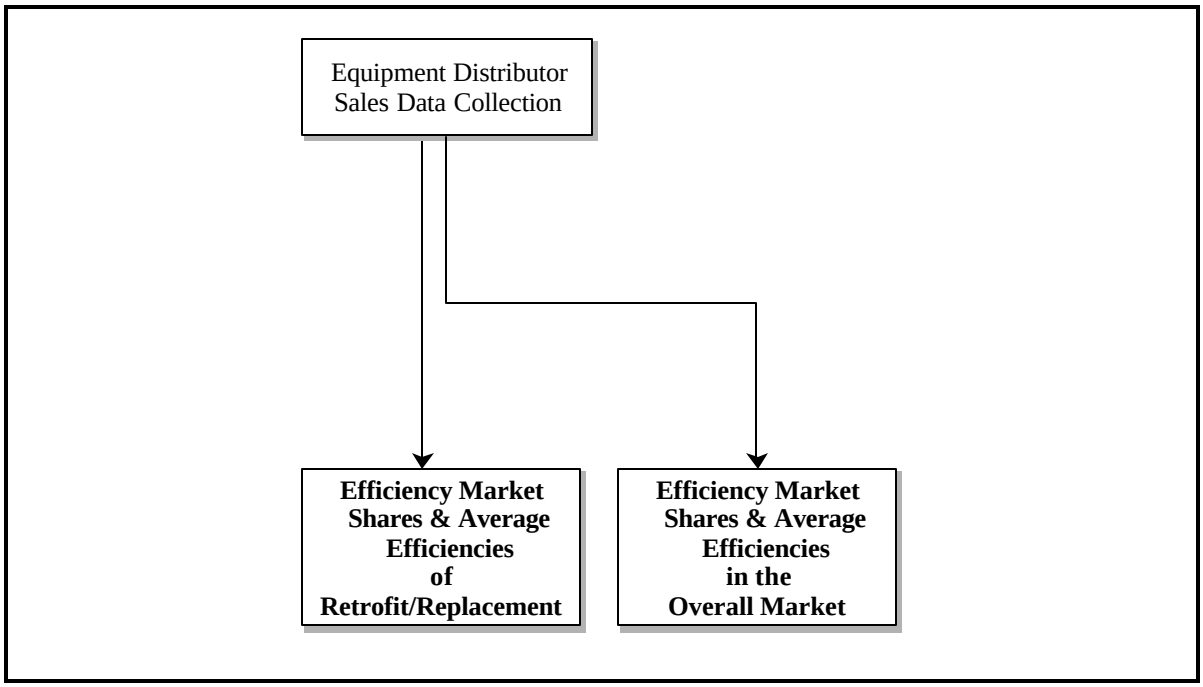
Heat Pumps

5.1 Overview

This section presents the efficiency market shares and average efficiencies of heat pumps installed/purchased in California's residential sector. This subsection includes a review of the data sources for analysis of heat pump efficiencies. Subsection 5.2 summarizes energy efficiency standards for heat pumps and Subsection 5.3 summarizes the availability of models by efficiency level. Subsection 5.4 presents estimates of average efficiencies in the overall California market; estimates of heat pumps installed in new construction were not feasible because of extremely low saturations observed on-site.

Figure 5-1 provides an overview of the data sources for the heat pump efficiency analysis. As shown, data from data collected from a panel of HVAC equipment distributors was used to estimate shares of high efficiency heat pumps, and average heat pump efficiencies in the overall market.

Figure 5-1: Overview of Data Sources for Heat Pump Analysis



5.2 Heat Pump Efficiency Ratings

Air source heat pumps have both cooling and heating efficiency ratings. Cooling efficiency is expressed as the SEER value. Like central air conditioners, the minimum federal standard is 10 SEER. Heat pump heating efficiency rating is expressed in Heating Seasonal Performance Factor (HSPF). The higher the HSPF, the more efficient the heat pump. The minimum heating efficiency for heat pumps is 6.6 HSPF for single package systems and 6.8 HSPF for split systems. Units must have an HSPF of at least 7.0 to qualify for the ENERGY STAR program.

5.3 Heat Pump Model Availability

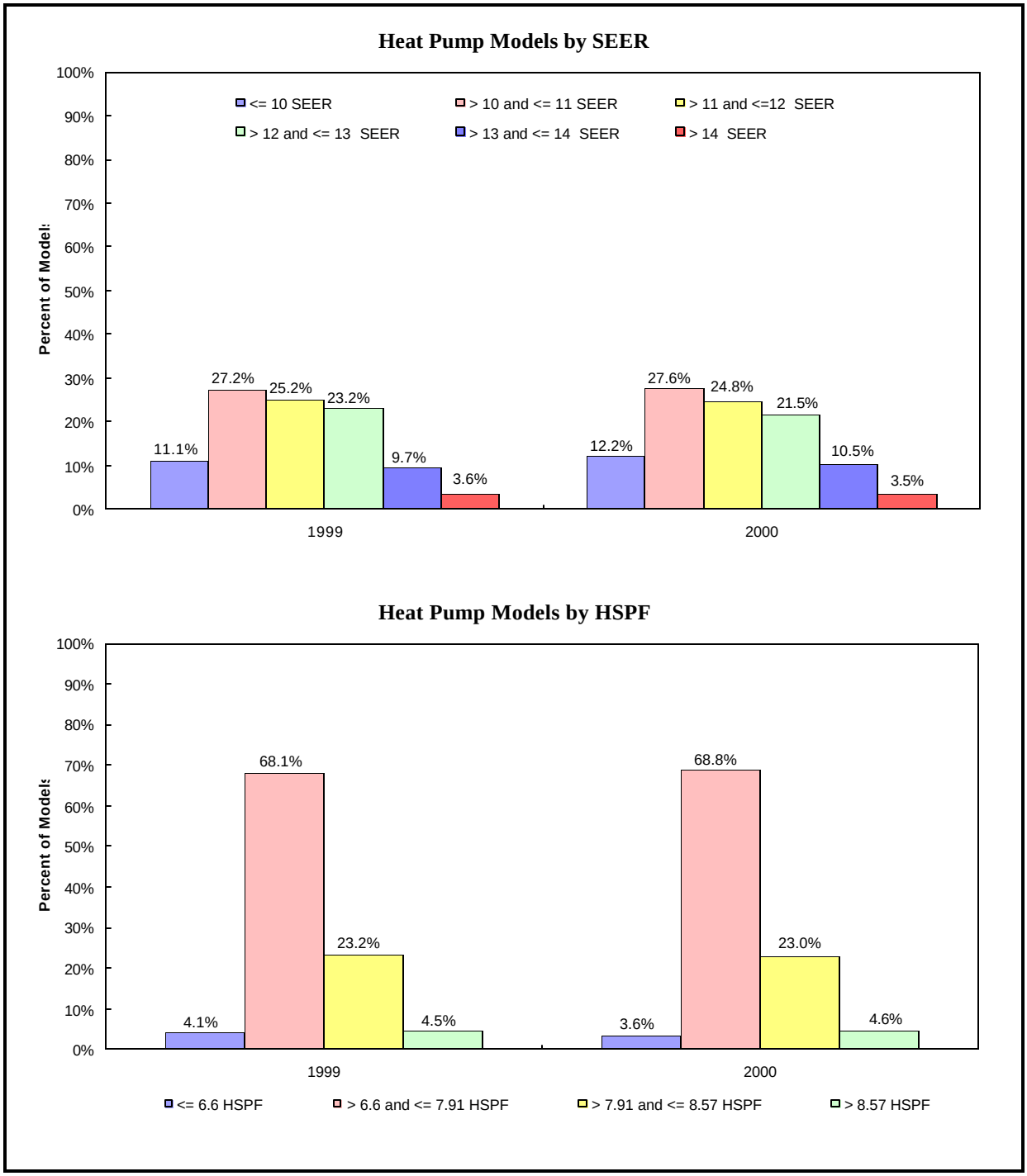
To develop distributions of available HVAC equipment models, RER relied on information maintained by prominent trade organizations such as GAMA and ARI. RER examined model availability for each year covered by the RMST (1998–present), where possible.

Figure 5-2 illustrates the distribution of available models by efficiency level for heat pumps over the past few years. As shown, the distribution of cooling and heating efficiency ratings of available heat pumps.[1,2] The distribution by SEER is very similar to that of central air conditioners – the majority of units have an average cooling efficiency between 10.0 and 12.0 SEER. Nearly 70% of heat pumps have an average heating efficiency rating between 6.60 and 7.91 HSPF.

[1] Air-Conditioning and Refrigeration Institute. ARI Directory of Certified Unitary Equipment Standards 210/240/270. 1998 through 1999.

[2] Air-Conditioning and Refrigeration Institute. *ARI Electronic Unitary Directory, ARIUD2000 V1.5*. 1996 through 2000.

Figure 5-2: Heat Pump Availability, by SEER and HSPF



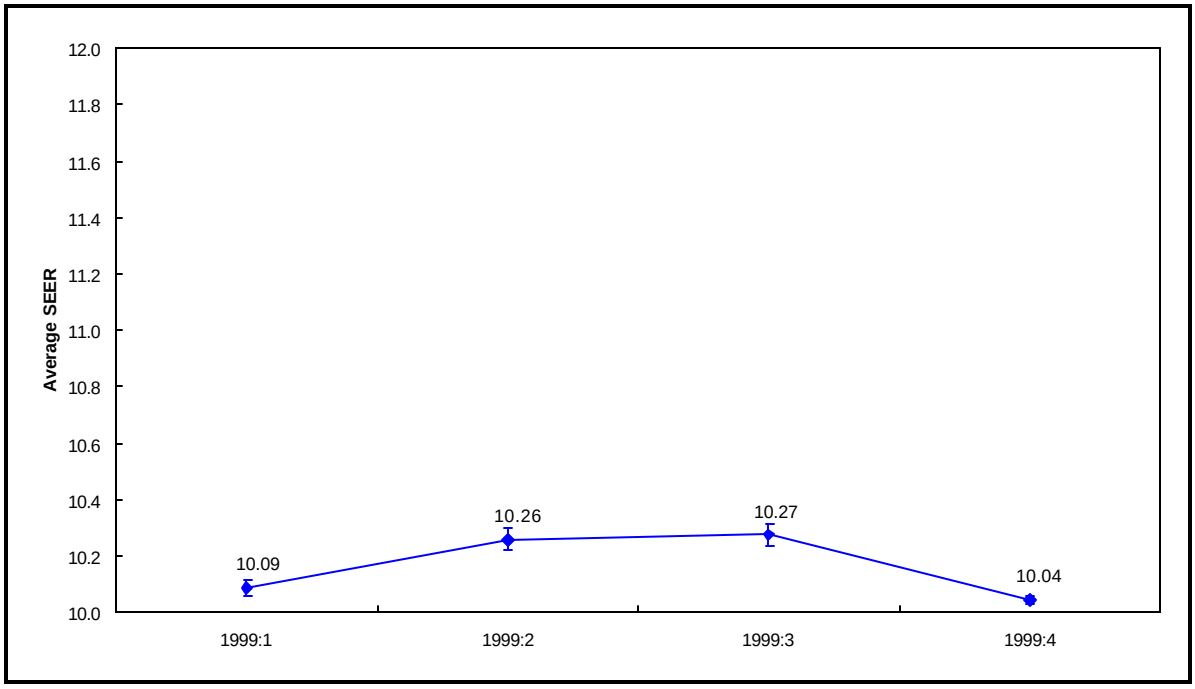
Source: ARI

5.4 Overall Efficiency of Heat Pumps

Figure 5-3 and Table 5-1 present the average cooling efficiency ratings (SEER) of heat pumps sold in California during 1999 by quarter. As shown, the average SEER ranged from 10.09 in the first quarter of 1999 to 10.04 by the end of the year. Despite the relatively small sample sizes for heat pumps, the confidence band and standard errors suggest little variation in heat pump cooling efficiency ratings.

Figure 5-4 illustrates the distribution of heat pumps sold by SEER level. As shown, the majority of units sold throughout 1999 had cooling efficiency ratings of 10.0 SEER or less.

Figure 5-3: Heat Pumps, Average Cooling Efficiency (SEER)



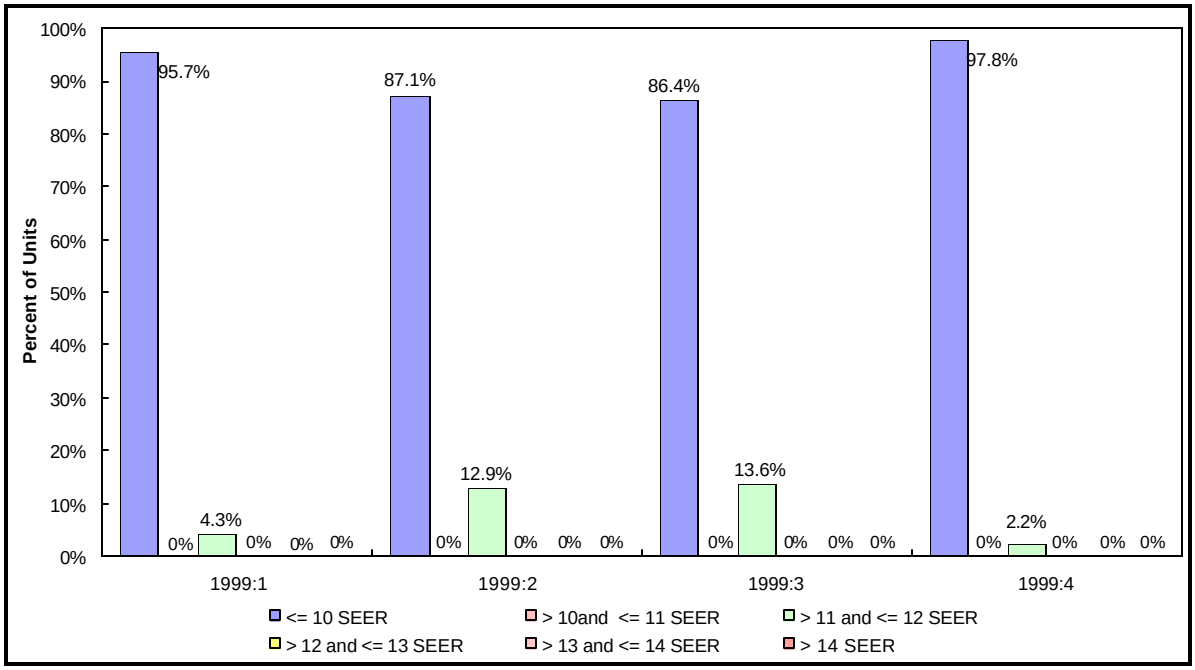
Error bands for the 90% confidence interval.

Table 5-1: Heat Pumps, Average Cooling Efficiency (SEER)

Period	Average SEER
1999:1	**10.0860** (0.0176) n = 535
1999:2	**10.2573** (0.0249) n = 723
1999:3	**10.2723** (0.0229) n = 896
1999:4	**10.0447** (0.0099) n = 894

Standard errors in parentheses.

Figure 5-4: Heat Pumps, Percent of Sales by SEER Level



6

Air Ducts

6.1 Overview

To obtain data on duct sealing and duct construction practices, the RMST project was expanded from its original scope to include 100 duct blaster tests. This section presents the analysis of duct blaster test results to evaluate overall duct construction and average air duct loss in California's residential new construction sector. Poorly installed ducts diminish heating and cooling efficiency. A duct blaster test is a method used to test duct integrity, or how well ducts are sealed. This test measures air duct loss in cubic feet per minute (CFM).

The duct blaster tests were conducted by the California Home Energy Efficiency Rating System (CHEERS). The CHEERS team conducted duct blaster tests following the protocol used by the Title 24 requirements (e.g., the tests were conducted at 25 Pascals). A copy of the survey form and testing protocol used for the duct blaster tests is provided in Appendix C.

Subsection 6.2 explains the standards for air duct leakage and Subsection 6.3 presents the average new construction air flow loss rates estimated for California and each utility area.

6.2 Standards for Duct Construction and Air Leakage

A duct system with a rating of 110 CFM is more efficient than one with a 500 CFM rating. A typical new home averages 400 CFM, while a home with more tightly sealed ducts should be near 110 CFM.[1]

[1] See http://www.pge.com/customer_services/residential/comfort/program/ducts.html.

6.3 Air Flow Loss in New Construction

Table 6-1 summarizes the average air flow loss in California and for each utility area, by six-month period. Based on our sample, there has been no significant decrease in average air flow loss across the two periods.[2] It should be noted, however, that the sample sizes in the SDG&E service territory are relatively small.

Figure 6-1 presents the distribution of air flow loss across the two six-month periods. As shown, there appears to be a perceptible shift in the distribution towards the lower air flow loss during the first two quarters of 1999. Figure 6-2, Figure 6-3, and Figure 6-4 present similar information by utility service territory.

Table 6-2 presents the average air flow losses by climate zone and Table 6-3 presents average air flow losses by residence type. These results suggest no evidence of differences across climate zones or time period.[3,4] Similarly, there is no evidence of decreases in average air flow losses across residence types or periods.[5]

Table 6-1: Average Air Flow Loss (CFM) by Utility

	PG&E	SCE	SDG&E	All
1998:3-4	**190**	**289**	**267**	**251**
	(32.03)	(50.58)	(53.47)	(29.04)
	n = 22	n = 18	n = 7	n = 50
1999:1-2	**169**	**206**	**289**	**204**
	(25.19)	(19.45)	(61.22)	(17.04)
	n = 22	n = 18	n = 6	n = 49

[2] This result is based on a test for differences in means with a 90% significance level. Note that there is a significant drop in the average air flow loss in the SCE service territory if the significance level is relaxed to 80%.

[3] This is using a test for differences in means and a significance requirement of 90%.

[4] The one exception is climate zone 5. If we relax the significance to 80% there is a significant decrease in average air flow loss in climate zone 5. This result is further weakened by the relatively small sample size.

[5] The one exception is multifamily. If we relax the significance to 80% there is a significant decrease in average air flow loss across time periods for multifamily homes.

Figure 6-1: Distribution of Average Air Flow Loss (CFM)

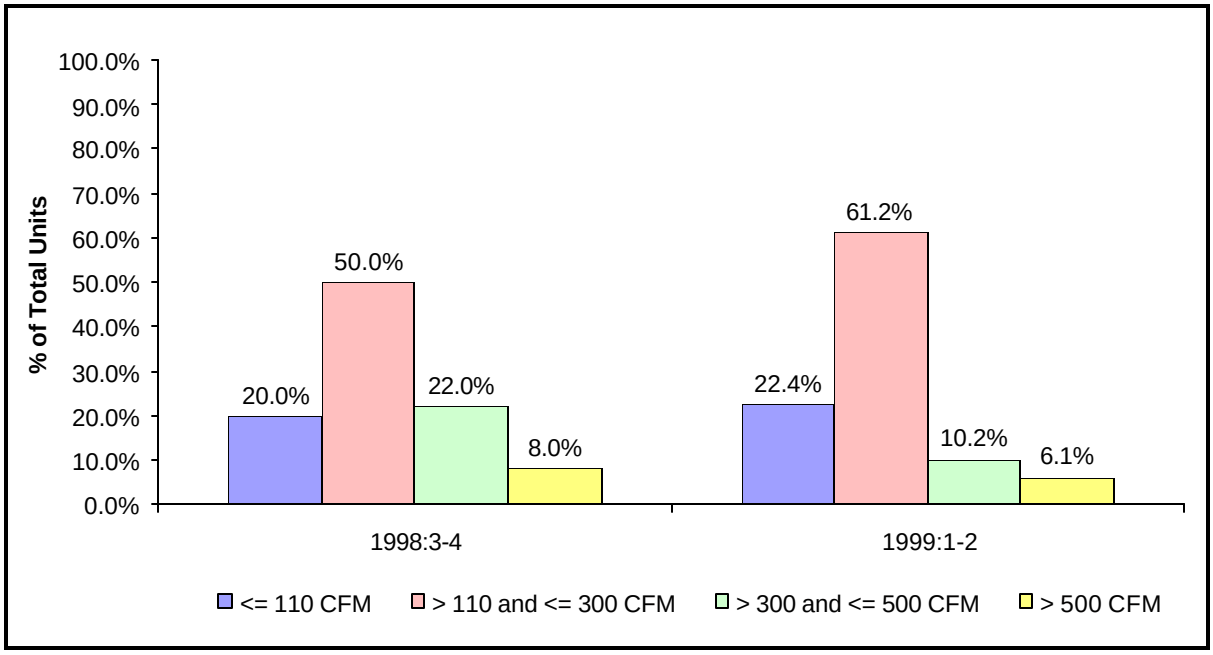


Figure 6-2: Distribution of Air Flow Loss (CFM) – PG&E

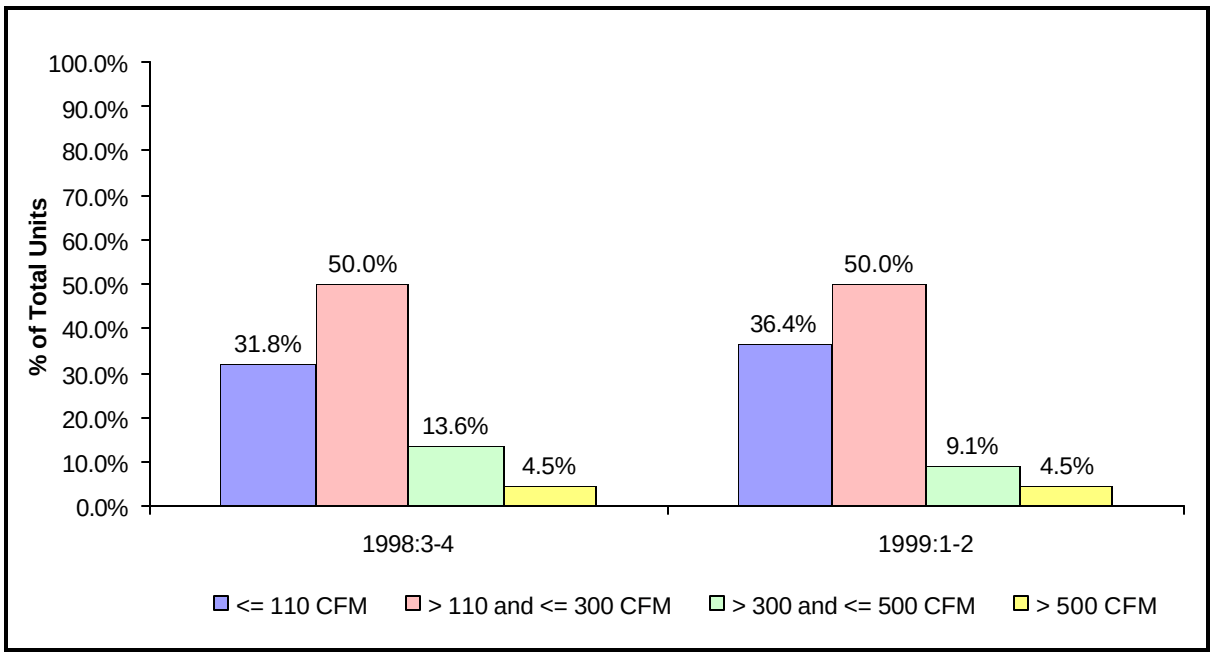


Figure 6-3: Distribution of Air Flow Loss (CFM) – SCE

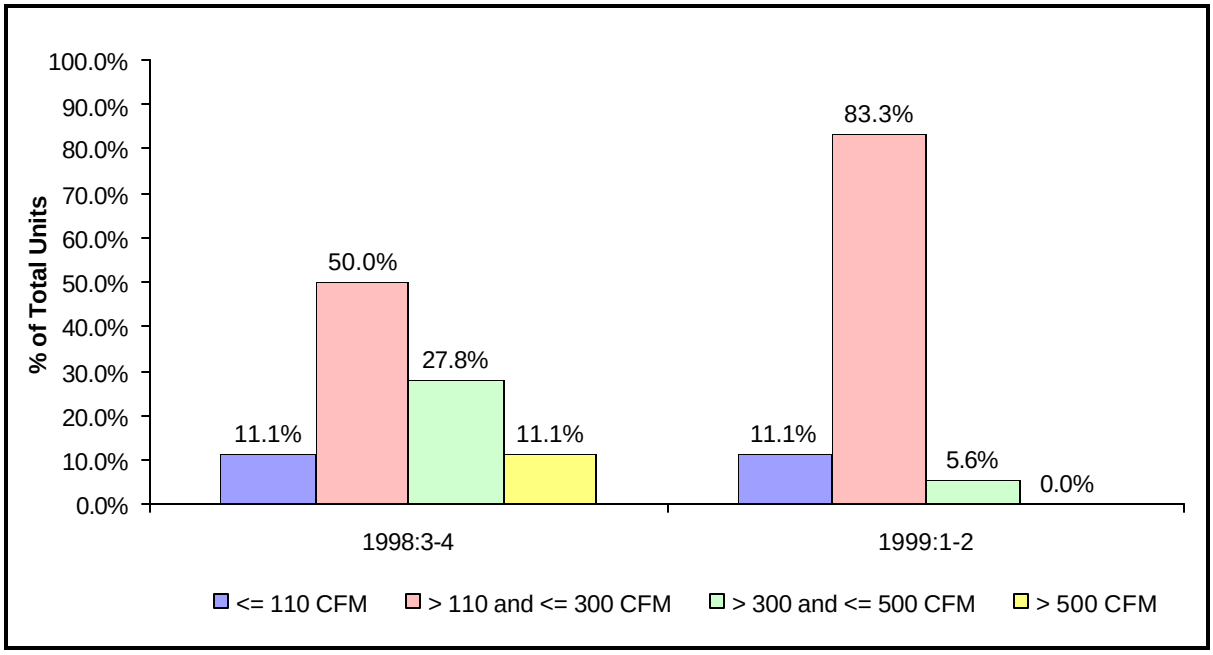


Figure 6-4: Distribution of Air Flow Loss (CFM) – SDG&E

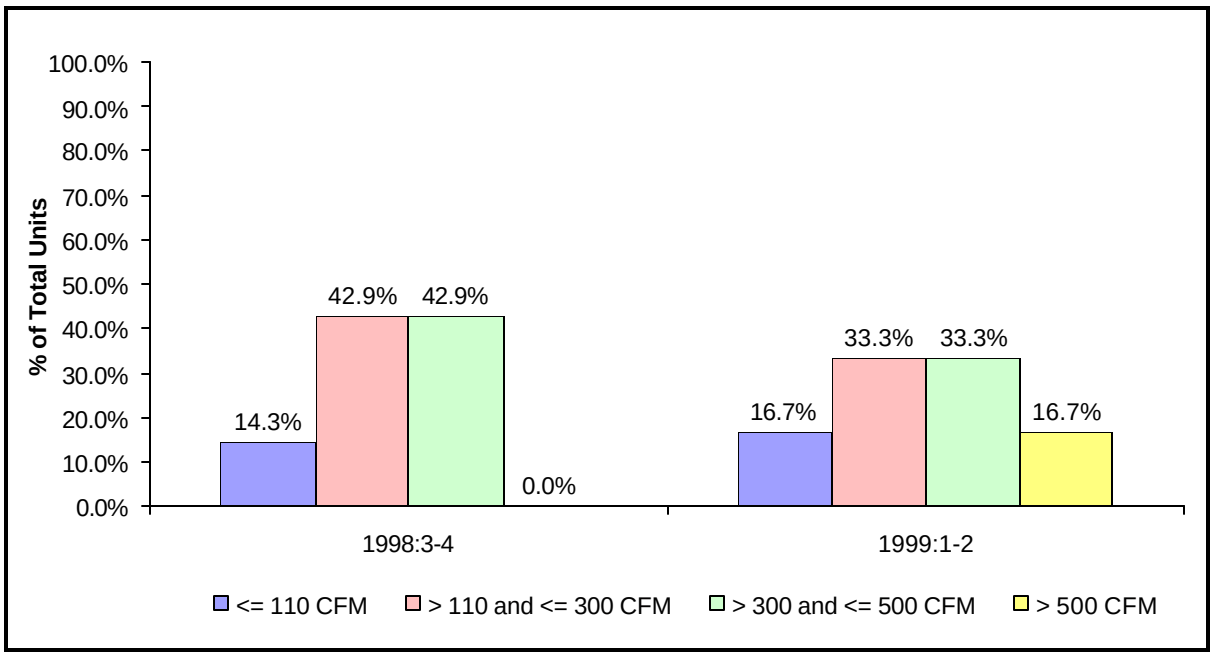


Table 6-2: Average Air Flow Loss (CFM) by Climate Zone

	CEC Climate Zone				
	CZ:1	**CZ:2**	**CZ:3**	**CZ:4**	**CZ:5**
1998:3-4	**179** (38.99) n = 11	**307** (56.85) n = 9	**203** (29.37) n = 15	**205** (48.27) n = 12	**761**[6] (204.78) n = 3
1999:1-2	**200** (47.85) n = 11	**241** (53.23) n = 8	**236** (28.15) n = 15	**147** (15.27) n = 12	**187** (38.19) n = 3

Standard errors in parentheses.

Table 6-3: Average Air Flow Loss (CFM), by Residence Type

	Multifamily	Single Family
1998:3-4	**274** (56.72) n = 10	**245** (33.68) n = 40
1999:1-2	**172** (36.04) n = 10	**212** (19.33) n = 39

Standard errors in parentheses.

6 During duct testing, two of these three sites were found to have "leaky" ducts. Because of this, the air flow loss at these two sites was greater than 900 CFM.

7

Water Heating Equipment

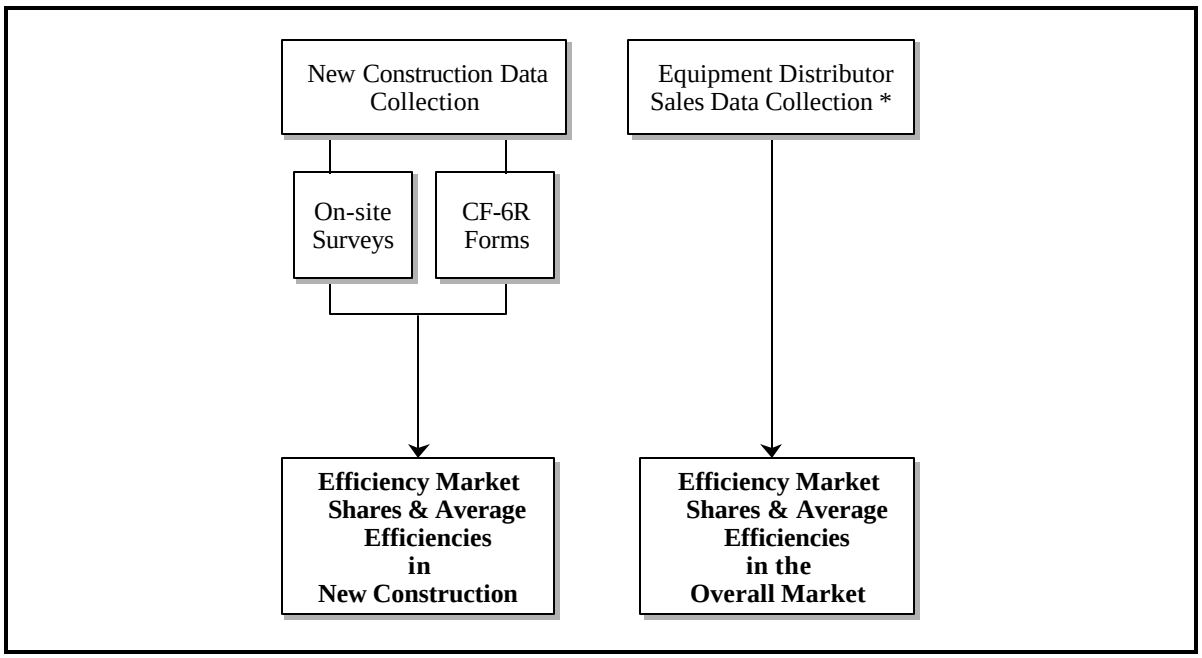
7.1 Overview

This section presents the efficiency market shares and average efficiencies of gas water heaters. This subsection includes a review of the data sources for analysis of water heater efficiencies. Subsection 7.2 summarizes energy efficiency standards for water heaters and Subsection 7.3 summarizes the availability of models by storage tank volume and efficiency level. Subsection 7.4 includes estimates of total gas water heater sales in California by decision type. Estimates average efficiencies and sales by storage volume in the overall California market, and shares and average efficiencies in new construction are presented in Subsections 7.5 and 7.6, respectively.

Figure 7-1 provides an overview of the data sources for the water heater efficiency analysis. As shown, data from new construction on-site surveys and building department installation forms (CF-6Rs) was used to estimate the shares and average efficiencies of gas water heaters installed in residential new construction. Data collected from a panel of water heating equipment distributors was used to indicate gas water heater efficiencies in the overall market. Estimates of average efficiencies of water heater retrofits/replacements were not developed; however, the methodology to do so for CAC and furnaces could be used to estimate retrofit/replacement efficiencies in the future.

Expansion weights were developed to expand the sample data to represent the California market. Because of relatively small samples, estimates by utility level were not conducted. Further, data provided by distributors began in January 2000. Unlike the other measures, analysis of the distributor data does not reveal efficiency shares or average efficiencies prior to this time.

Figure 7-1: Overview of Data Sources for Gas Water Heater Analysis



* Data covers the first two quarters of 2000 only.

7.2 Gas Water Heater Efficiency Ratings

The energy efficiency of water heaters is expressed as an energy factor rating (EF). Water heater EFs vary by storage tank size and fuel type.[1] Therefore, to standardize for tank size, the standard efficiency was calculated for each gas water heater in the sample. To conduct analysis of water heater efficiencies, RER computed the percent-above-standard for each water heater observed from the on-sites. The formulas used for these calculations are below:

$$\%AboveStd_i = \frac{(Eff_i - StdEff_i)}{StdEff_i}$$

where

Eff_i = Actual efficiency rating of unit i and
$StdEff_i$ = $0.62 - (0.0019 \times (TankVolume_i))$[2]

Using this approach standardizes for tank size and eliminates the need to conduct the analysis by tank size.

[1] Code of Federal Regulations. Title 10, Chapter II, Subpart C, Part 430, Section 430.32.

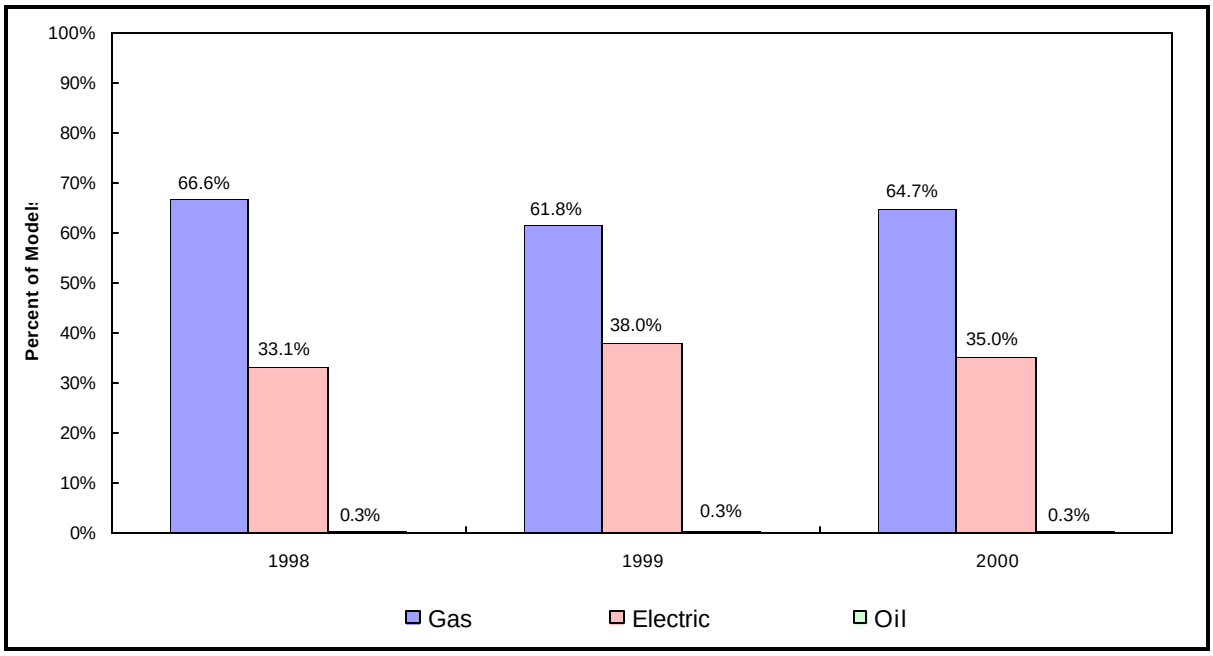
[2] This standard efficiency equation is applicable for residential gas water heaters that have a tank size of more than or equal to 20 gallons and that have an input rating of less than or equal to 75,000 Btu/hr.

7.3 Water Heater Model Availability

When developing a time series of efficiency levels of equipment sold or installed in the marketplace, it is useful to have knowledge of the efficiencies of equipment models that are *available* during the relevant period. RER characterized available water heater models during 1998, 1999, and 2000 from data obtained and maintained by GAMA.[3]

Figure 7-2 and Figure 7-3 characterize available residential water heaters by fuel type and storage volume, respectively. As shown, nearly 65% of residential water heaters are gas models in 2000, down slightly from 66% in 1998. About one-third of the available models are electric and very few are oil-fired models. Most (roughly 75%) gas-fired water heaters have tank storage volumes between 30 and 50 gallons. Very few gas water heaters are available with tanks larger than 100 gallons. In contrast, just over 50% of electric models fall within this range. A greater percentage of electric models have tanks smaller than 30 gallons and larger than 100 gallons.

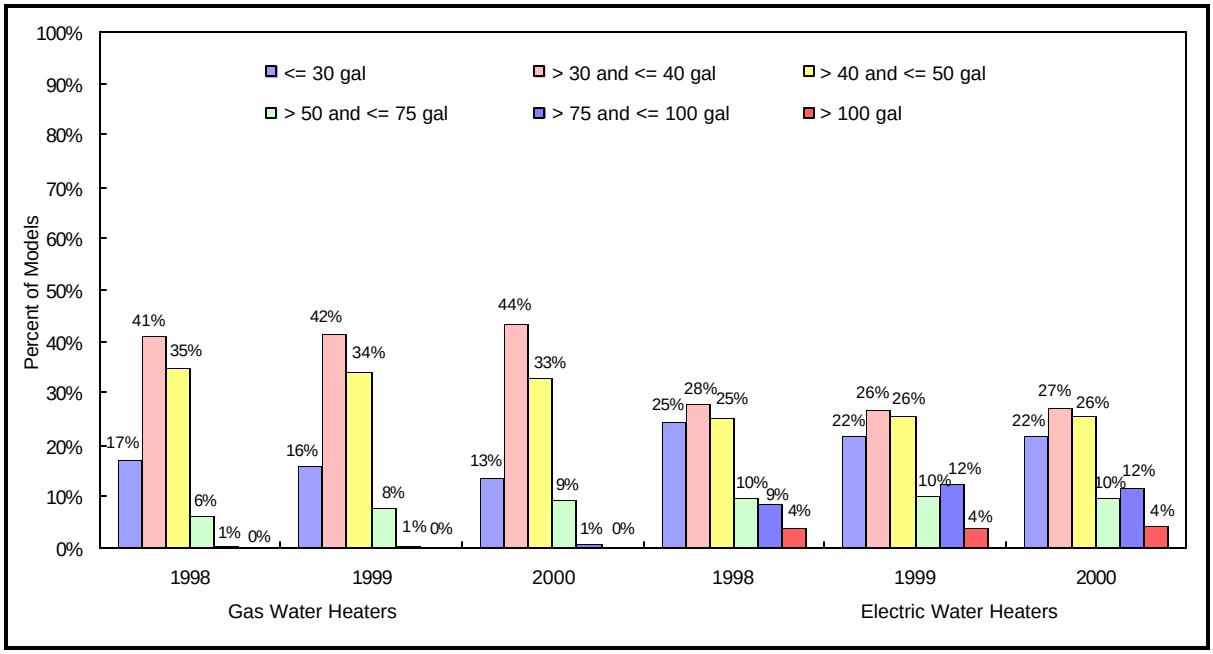
Figure 7-2: Water Heater Model Availability by Fuel Type



Source: GAMA

[3] Gas Appliance Manufacturers' Association. *GAMA Consumers' Directory of Certified Efficiency Ratings for Residential Heating and Water Heating Equipment.* April and October Editions, 1997 through 1999.

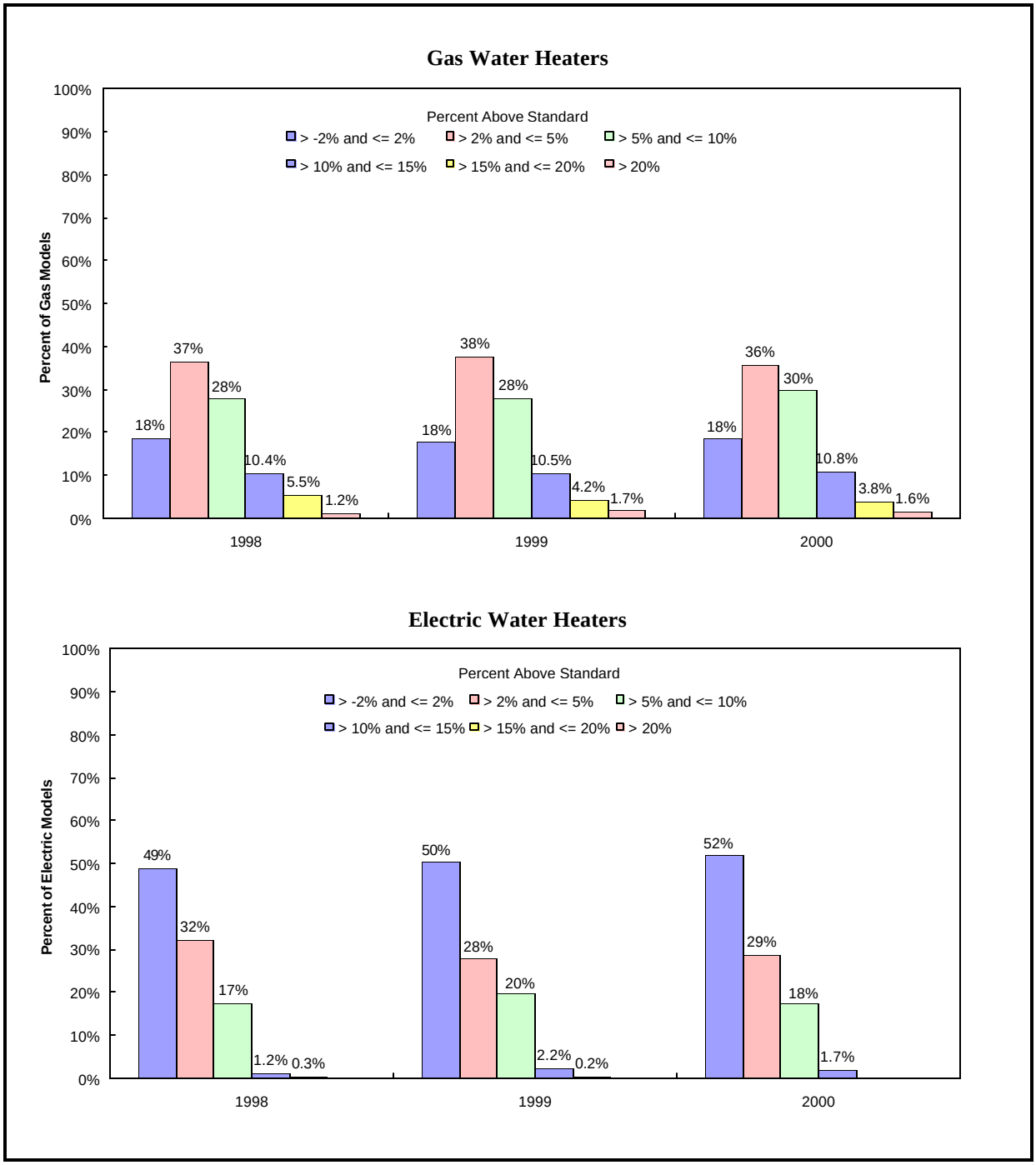
Figure 7-3: Water Heater Availability by Fuel Type and Storage Volume



Source: GAMA

Figure 7-4 illustrates the distribution of available residential water heaters relative to the federal efficiency standard. About one-fifth of residential gas water heaters have efficiency ratings between –2% and +2% the federal standard. Most gas models (around 37%) have efficiency ratings that exceed the federal standard by 2% to 5%. About 35% of available models exceed the federal standards by at least 5%. A very small percentage of available gas models exceed federal standards by more than 20%. In contrast, about 50% of electric water heaters exceed the federal standard by 2% or less. About one-third of electric models exceed the standard by 2% to 5%. These distributions have changed very little between 1998 and 2000.

Figure 7-4: Percent of Available Water Heater Models by Percent Above Federal Standard



Source: GAMA

7.4 Total Unit Sales, New Construction Installations, and Retrofit/ Replacement Estimates

Table 7-1 presents estimates of total unit sales for gas and electric water heaters. There is no definitive source of annual unit sales by measure and by decision type. However, RER developed estimates at the decision type level using information on total unit sales and subtracting out the estimates of sales in the new construction sector. As shown in the notes of the table, estimates of total unit sales were developed from a variety of sources. Sales for electric and gas water heaters were obtained from *Appliance Manufacturer*.[4] These data were then scaled to California annual sales based on number of households and measure saturations. In particular, the national sales figure was multiplied by the ratio of the number of California households with the measure divided by the number of national households with the measure. Data for these parameters were collected from utility end-use energy surveys and from RECS.[5]

Table 7-1: Estimates of Annual Unit Sales by Decision Type

Measure	Total Units Sales [1]	New Construction [3]	Retrofit/ Replacement
Gas Water Heaters [2]	885,655	96,899	788,756

1 National annual appliance sales *from Appliance Manufacturer*, scaled to the California market.[6]
2 Gas water heaters include propane fueled units.
3 Estimates of new construction from New Construction On-site survey 1998:3-4 through 1999:1-2.

7.5 Overall Gas Water Heater Efficiencies

As shown in Figure 7-5, one-fifth of gas water heaters sold in the first quarter of 2000 had storage volumes of 30 gallons or less. This share doubled to over 50% in the second quarter. Water heaters with tanks between 30 and 40 gallons accounted for nearly 50% of the sales in the first quarter and 27% of second quarter sales. A very small percentage of the units sold had storage volumes greater than 50 gallons.

4 "Special Report 2000 – Market Profile," *Appliance Manufacturer*, a publication of Business News Publishing Co.
5 Residential Energy Consumption Survey.
6 Scaled using a ratio based on the number of households in California with the end-use divided by the number of national households with the end use. The data for these parameters were gathered from saturation estimates from utility residential energy use surveys and the most recent Residential Energy Consumption Survey (RECS).

Figure 7-5: Gas Water Heater Sales by Storage Volume

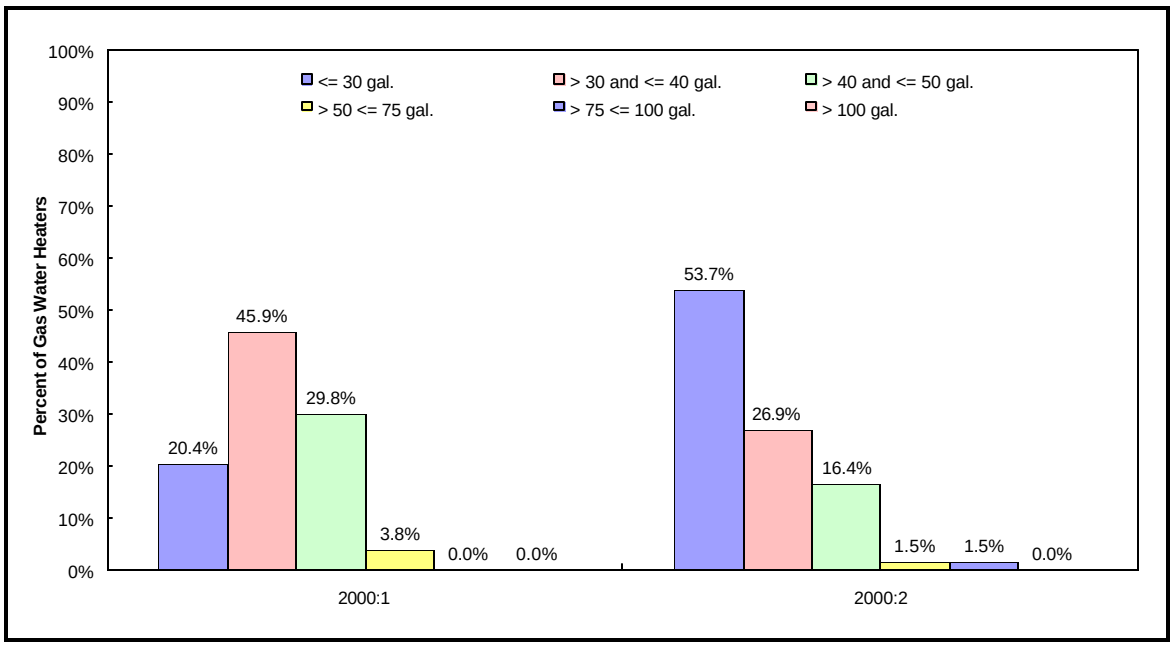


Table 7-2 and Figure 7-6 present water heater efficiencies relative to the federal minimum standards. As shown in Table 7-2, the average percent-above-standard for gas water heaters sold in the first and second quarters of 2000 was 9.45% and 8.16%, respectively.[7] In contrast, electric water heaters sold in the same period exceeded the minimum standard by about 1%.

Figure 7-6 illustrates the percentage of units sold according to percent-above-standard. Most units sold in early 2000 exceeded the standard by 10% to 15%. This proportion decreased in the second quarter to just over 20%. This decrease seems to be offset by an increase in the percentage of units with energy ratings between 5% and 10% above standard.

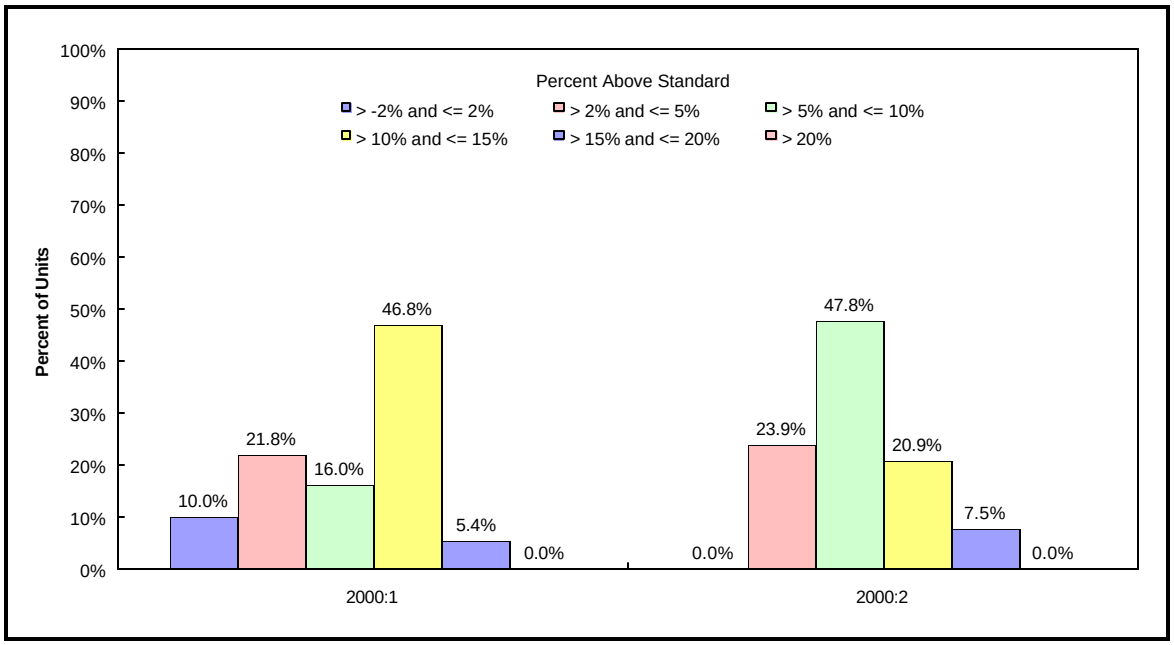
[7] A significance test at the 90% confidence level reveals that the estimates for the first and second quarter of 2000 are significantly different.

Table 7-2: Water Heaters, Average Percent-Above-Standard

Fuel Type	Average Percent Above NAECA Standard		
	2000:1	2000:2	2000:All
Gas	**9.45%** (0.0012) n = 1,927	**8.16%** (0.0053) n = 67	**9.41%** (0.0011) n=1,994
Electric	**1.18%** (0.0035) n = 26	**-0.04%** (0.0000) n = 5	**0.98%** (0.0031) n = 31

Standard errors in parentheses.

Figure 7-6: Percent of Gas Water Heater Sales by Percent-Above-Standard



7.6 Water Heaters in New Construction

Table 7-3 presents the average percent-above-standard efficiency for gas water heaters by utility zone and six-month period. The distribution of the percent-above-standard is shown in Figure 7-7. Saturations for gas and electric water heaters by climate zone and residence type are presented in Table 7-4 and Table 7-5, respectively.

Table 7-3: Gas Water Heating Average Percent-Above-Standard – On-Site Data

	PG&E	SCE	SDG&E	All
1998:3-4	**12.6%**	**14.0%**	**16.4%**	**13.5%**
	(0.0046)	(0.0043)	(0.0034)	(0.0028)
	n = 104	n = 104	n = 36	n = 253
1999:1-2	**12.9%**	**13.8%**	**15.4%**	**13.2%**
	(0.0031)	(0.0046)	(0.0058)	(0.0024)
	n = 119	n = 82	n = 25	n = 236

Figure 7-7: Gas Water Heater Distribution by Percent-Above-Standard – On-Site Data

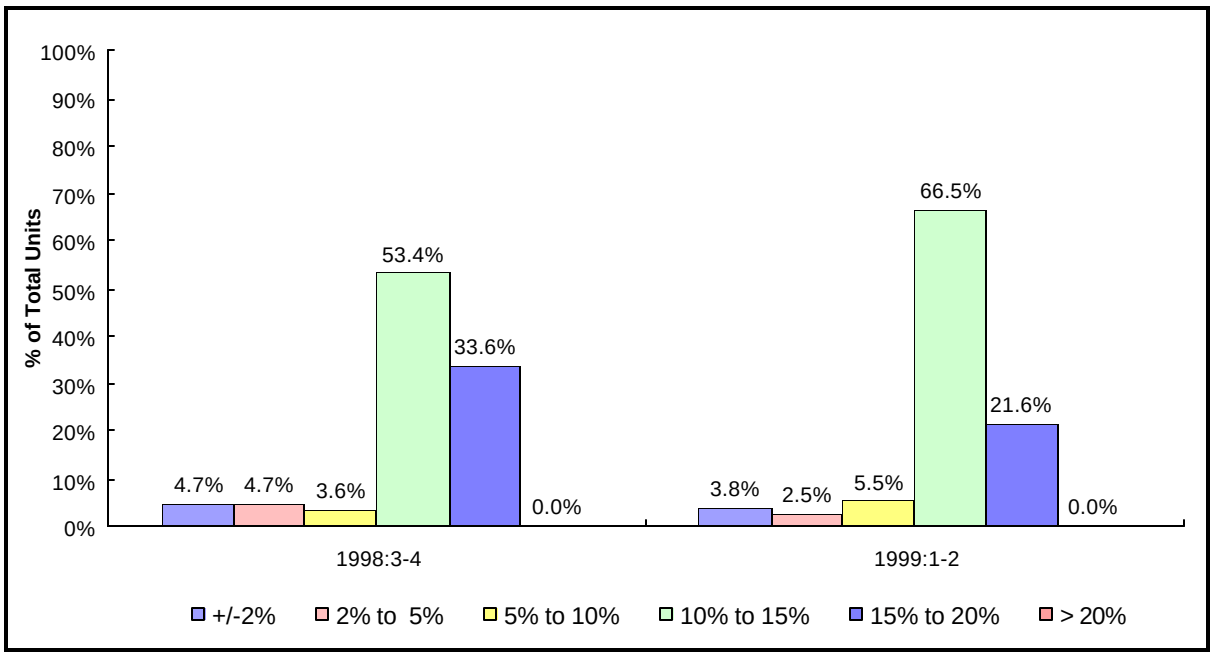


Table 7-4: Saturations of Gas (and Propane) Water Heaters – On-Site Data

Residence Type	PG&E	SCE	SDG&E
Multifamily	**100.0%**	**91.8%**	**91.2%**
	(0.0000)	(0.0538)	(0.1068)
	n = 49	n = 27	n = 8
Single Family	**98.6%**	**99.2%**	**100.0%**
	(0.0071)	(0.0058)	(0.0000)
	n = 279	n = 237	n = 85

Standard errors in parentheses.

Table 7-5: Saturations of Electric Water Heaters – On-Site Data

	PG&E	SCE	SDG&E
Multifamily	**0.0%** (0.0000) n = 49	**8.2%** (0.0538) n = 27	**8.8%** (0.1068) n = 8
Single Family	**1.4%** (0.0071) n = 279	**0.8%** (0.0058) n = 237	**0.0%** (0.0000) n = 85

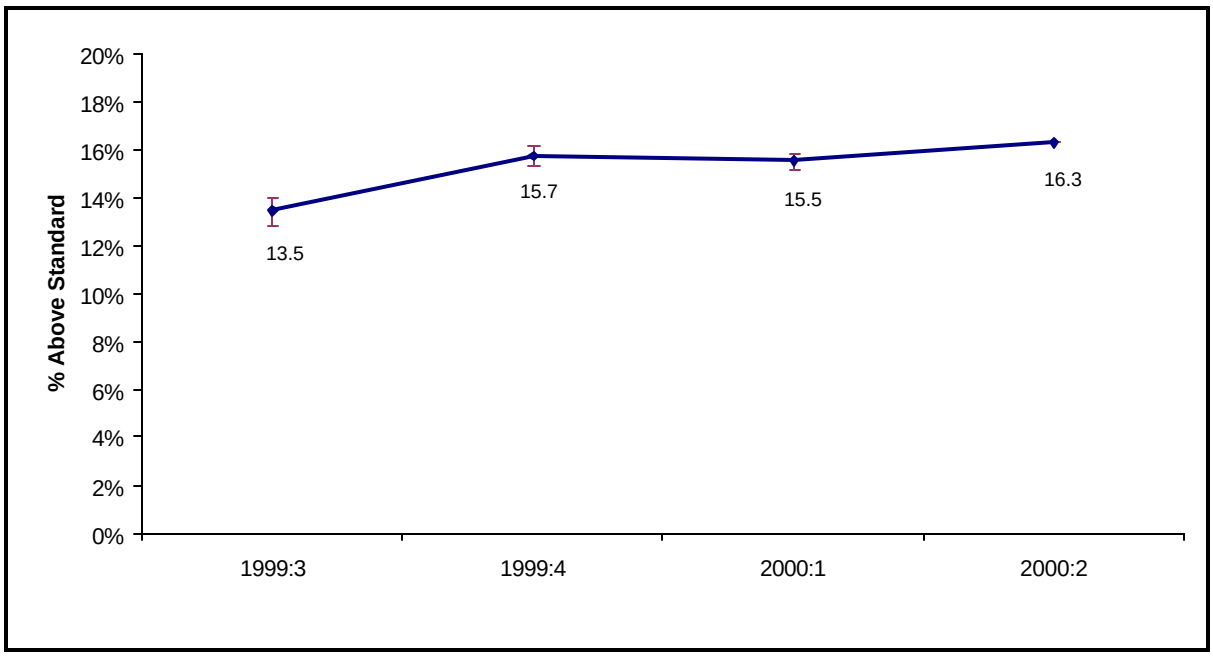
Standard errors in parentheses.

CF-6R Analysis Results

Figure 7-8 presents the average percent-above-standard efficiency for gas water heaters in California over the past year by quarter. As shown, the average percent-above-standard efficiency for new construction in California ranged from 13.5% in the third quarter of 1999 to 16.3% during the first quarter of 2000. Table 7-6 shows the average percent-above-standard efficiency by utility. The average percent-above-standard efficiency for SCE's territory has slowly increased from 10.7% during the third quarter of 1999 to 16.3% during the second quarter of 2000. The average percent-above-standard efficiency for PG&E's territory ranges from 14.2% to 15.2%.[8]

[8] A formal test of significance was not conducted for the CF-6R data due to sample sizes in the third quarter of 1999 and the distribution of the sample in the second quarter of 2000. However, when the on-site data and the CF-6R data are combined, covering a two-year period, a formal test will be performed. (See Section 3.7)

Figure 7-8: Gas Water Heaters, Average Percent-Above-Standard – CF-6R Data



Error bands for the 90% confidence interval.

Table 7-6: Gas Water Heaters, Average Percent-Above-Standard – CF-6R Data

	PG&E	SCE	All
1999:3	**14.2%**	**10.7%**	**13.5%**
	(0.0006)	(0.0058)	(0.0036)
	n = 7	n = 17	n = 24
1999:4	**15.1%**	**16.2%**	**15.7%**
	(0.0054)	(0.0029)	(0.0024)
	n = 15	n = 233	n = 248
2000:1	**15.2%**	**16.2%**	**15.5%**
	(0.0025)	(0.0034)	(0.002)
	n = 75	n = 379	n = 454
2000:2	-	**16.3%**	**16.3%**
	-	(0.0019)	(0.0019)
	n = 0	n = 199	n = 199

Standard errors in parentheses.
CF-6R forms were not obtained for sites in SDG&E's service territory for this analysis.

In addition to calculating the average percent-above-standard efficiency, it is important to notice the percentage of water heaters that falls into various efficiency levels. Several efficiency groups were selected to show this distribution. As shown in Figure 7-9, the first efficiency group is assumed to consist of water heaters with an efficiency close to standard. These units have an efficiency of ±2% of the federal requirement.

Size groups were also developed to show the distribution of gas water heaters. See Figure 7-10 for the breakdown of water heaters by storage tank volume.

Figure 7-9: Gas Water Heaters, Percent-Above-Standard – CF-6R Data

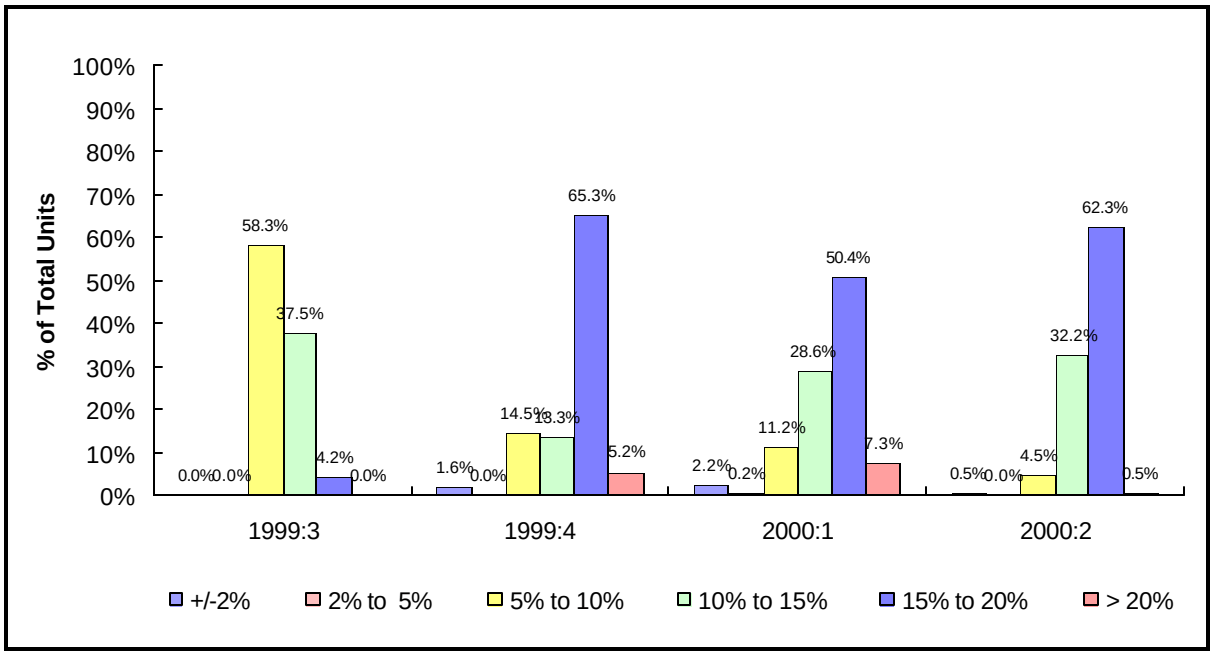
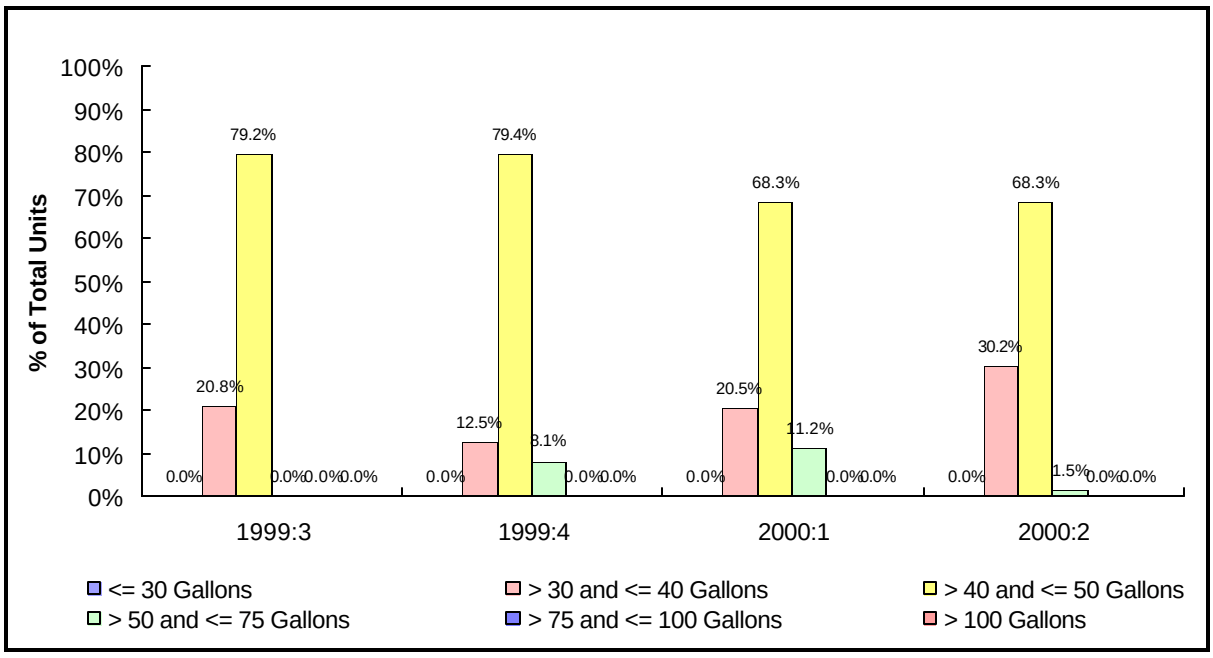


Figure 7-10: Gas Water Heaters by Storage Tank Volume (Gallons) – CF-6R Data



Combined New Construction Results

The average percent-above-standard for gas water heaters is shown in Figure 7-11. As shown, there has been a significant increase in the average percent-above-standard when comparing early 2000 to quarters before 2000. [9,10]

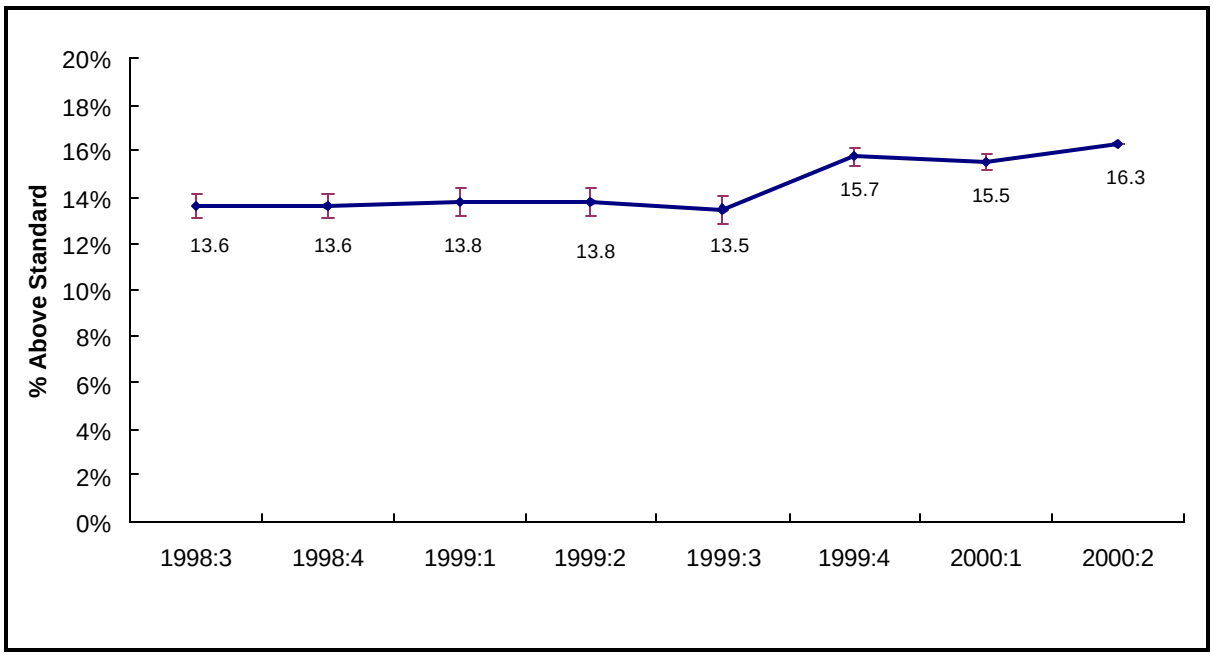
Table 7-7 presents the breakout of average percent-above-standard for gas water heaters by utility. The average percent-above-standard for gas water heaters within PG&E's territory have been significantly lower than the averages found for gas water heaters within SCE's territory over the last two years.[11]

9 See the previous section for a discussion on the definition of percent-above-standard as a measure of gas water heater efficiency.

10 A significance test was conducted at the 90% confidence level.

11 A significance test at the 90% confidence level reveals that the estimates of the average percent-above-standard for PG&E are significantly lower than the average percent-above-standard for SCE during each period.

Figure 7-11: Gas Water Heaters in New Construction, Average Percent-Above-Standard



Error bands for the 90% confidence interval.

Table 7-7: Gas Water Heaters in New Construction, Average Percent-Above-Standard

	PG&E	SCE	SDG&E	All
1998:3-4	**12.7%** (0.0042) n = 112	**14.4%** (0.0058) n = 110	**16.4%** (0.0034) n = 36	**13.6%** (0.0032) n = 267
1999:1-2	**13.2%** (0.0029) n = 136	**14.9%** (0.0091) n = 97	**15.4%** (0.0057) n = 25	**13.8%** (0.0036) n = 268
1999:3	**14.2%** (0.0006) n = 7	**10.7%** (0.0058) n = 17	- - n = 0	**13.5%** (0.0036) n = 24
1999:4	**15.1%** (0.0054) n = 15	**16.2%** (0.0029) n = 233	- - n = 0	**15.7%** (0.0024) n = 248
2000:1	**15.2%** (0.0025) n = 75	**16.2%** (0.0034) n = 379	- - n = 0	**15.5%** (0.0020) n = 454
2000:2	- - n = 0	**16.3%** (0.0019) n = 199	- - n = 0	**16.3%** (0.0019) n = 199

Standard errors in parentheses.

8

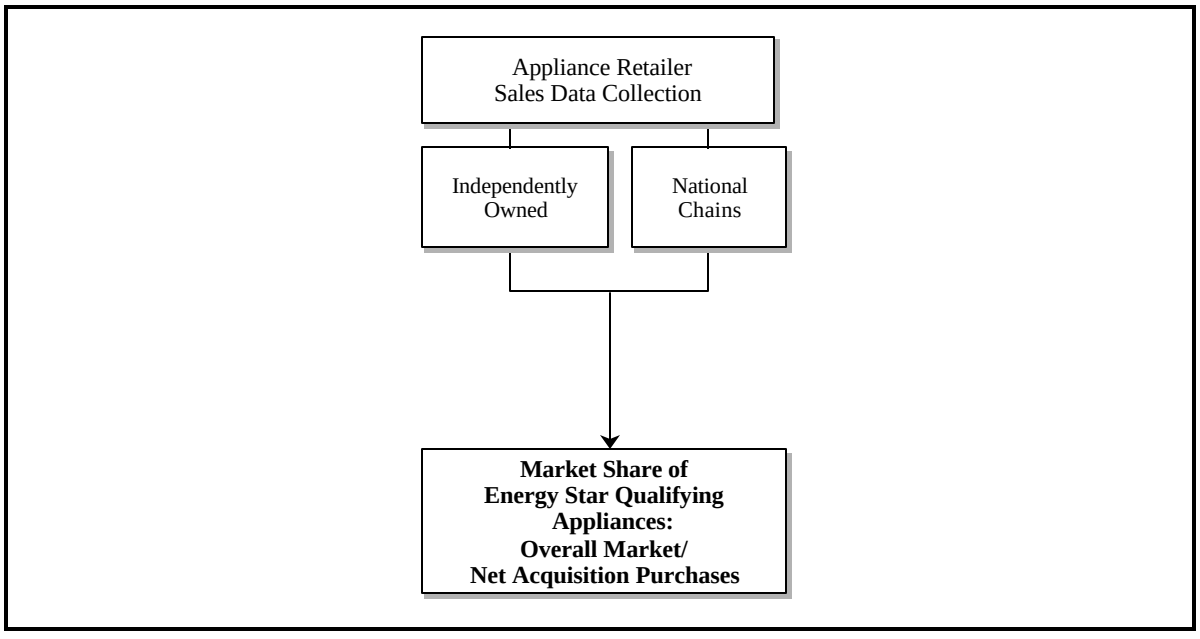
Appliances

8.1 Overview

This section presents the efficiency market shares and average efficiencies of major appliances installed/purchased in California's residential sector. This subsection includes a review of the data sources for analysis of appliance efficiencies, and Subsection 8.2 includes estimates of total appliance sales in California by decision type. Subsections 8.3 through 8.6 include the RMST results for refrigerators, clothes washers, dishwashers, and room air conditioners, respectively. Each of these sections describes model availability with respect to energy efficiency ratings, energy efficiency standards, the estimated percentage of units sold that qualify for the ENERGY STAR label, and analysis by market channel (national chains and independently owned retailers).

Figure 8-1 provides an overview of the data sources for the appliance analysis. As shown, Data collected from a panel of independently owned retailers, together with the national chain sales data provided by D&R International, was used to estimate the market share of ENERGY STAR qualifying appliances sold in California.

Figure 8-1: Overview of Data Sources for Appliance Sales Analysis



Data sources and the applicability of the results to support California's statewide appliance program are the reasons for basing this analysis on the share of ENERGY STAR qualifying units sold. The national chain ENERGY STAR partner sales data collected by D&R that was provided for the RMST only includes the total number of units sold, and the number of ENERGY STAR qualifying units sold by quarter. While this is somewhat limiting, the usefulness does not completely diminish, as California's statewide appliance program has adopted the ENERGY STAR platform and is based upon increasing the sales of ENERGY STAR qualifying appliances.

Characteristics of the analysis sample are worth reviewing. As shown above in Figure 8-1, the sample represents two distinctly different market channels: national chain ENERGY STAR partners and smaller independently owned and regional chain appliance retailers. The national chain ENERGY STAR partners in the 1998 data provided by D&R includes only two retail chains, while the 1999 data provided by D&R includes four retail chains. Analysis of these data sets reveals that the national chains not included in the 1998 data behave very differently than those that were included in the 1998 sample. To estimate a more realistic market share trend, RER scaled up the 1998 estimates by the ratio of the 1999 results to the 1999 results with only the two retailers.

The results presented in this section include analysis of market share by market channel. As these results reveal, national chains and independently owned retailers behave very differently with respect to stocking/ordering practices and the mix of models that dominate their main product lines. In particular, national chains generally sell a smaller percentage of high efficiency appliances than the independent stores and regional chains. Industry professionals explain this could be due to the following:

- Explaining energy-related features and selling high efficiency products generally requires a more experience sales person. National chains have a very high salesperson turnover rate. It is easier (e.g., more cost effective) for national chains to not train their sales staff extensively because of the anticipated turnover. In contrast, the turnover rate for independents is very low. These retailers can invest time into training staff on all aspects of their products, including energy usage/energy efficiency.
- National chains stock and sell the most popular brands and sizes, and purchase models that are manufactured in very large volumes. These models tend to be low to mid-priced and generally not the high efficiency models. If national chains cannot purchase models in volume, they need to be able to order and receive a particular product in a very short time frame, say within about two days. The models available for this type of ordering are generally not the high-end high efficiency models.

- National chains require longer lead times to respond to changes in program elements/requirements. In contrast, the independents' time horizon is shorter, enabling them to adapt more quickly to program changes and requirements.
- National chains have significant buying power with the manufacturers, while the smaller, independently owned retailers do not. This buying power results in relatively low profit margins for each unit sold. The independents cannot compete with the national chains at this level; such low margins would eventually drive the independents out of business. Because they cannot compete on a price-point basis with the nationals, independents not only tend to carry different models than the nationals, but the higher priced models, as well. Thus, independents are more likely to stock and sell high efficiency units than the national chains.

Representation of independent retailers in the RMST analysis ensures that the results represent sales of ENERGY STAR appliances in the entire market, not just by large national stores. A detailed discussion of the data collection and analysis of appliance efficiencies is provided in Section 2.5.

8.2 Total Unit Sales, New Construction Installations, and Replacement/Net Acquisition Estimates

Table 8-1 presents estimates of total unit sales for refrigerators, dishwashers, clothes washers, and room air conditioners. There is no definitive source of annual unit sales by measure and by decision type. However, RER developed estimates at the decision type level using information on total unit sales and subtracting out the estimates of sales in the new construction sector. Data for these measures were obtained from the Association of Home Appliance Manufacturers (AHAM).

Table 8-1: Estimates of Annual Unit Sales by Decision Type

Measure	Total Units Sales [1]	New Construction [2]	Replacement & Net Acquisition Estimate
Refrigerators	949,400	78,726	870,674
Clothes Washers	702,000	n/a	n/a
Dishwashers	509,000	100,952	408,048
Room Air Conditioners	231,100	3,080	228,020

1 Total unit sales data from Association of Home Appliance Manufacturers (AHAM).
2 Estimates of new construction from New Construction On-site survey, 1998:3-4 through 1999:1-2.

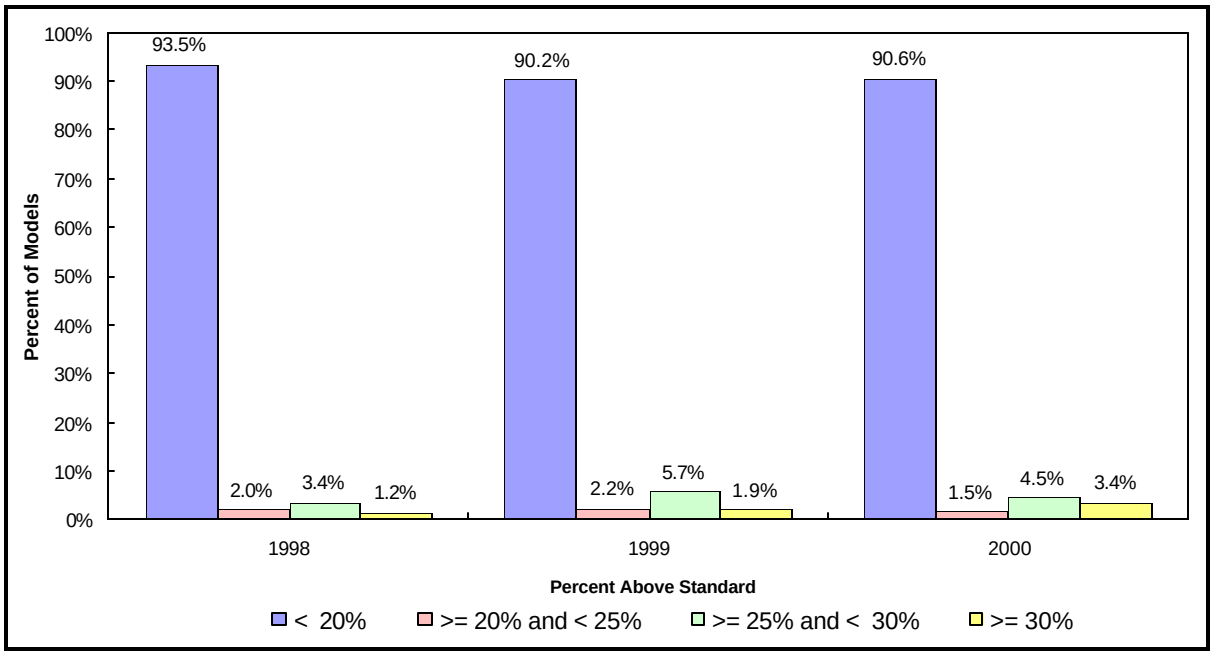
8.3 Refrigerators

Characteristics of Available Models

RER utilized the AHAM Directory of Certified Refrigerators and Freezers to examine energy use attributes of available refrigerator models.[1] Figure 8-2 and Figure 8-3 characterize refrigerators available in the marketplace in terms of their energy use characteristics. As shown in Figure 8-2, almost 94% of models available in 1998 used 20% less energy than the maximum requirement. This percentage decreased slightly to 90% in 1999 and 2000.

Figure 8-3 provides a time trend of the average percent-above-standard across all available refrigerator models. The average number of units that are greater than 20% above average has increased from 6.5% in 1999 to 9.4% in 2000.

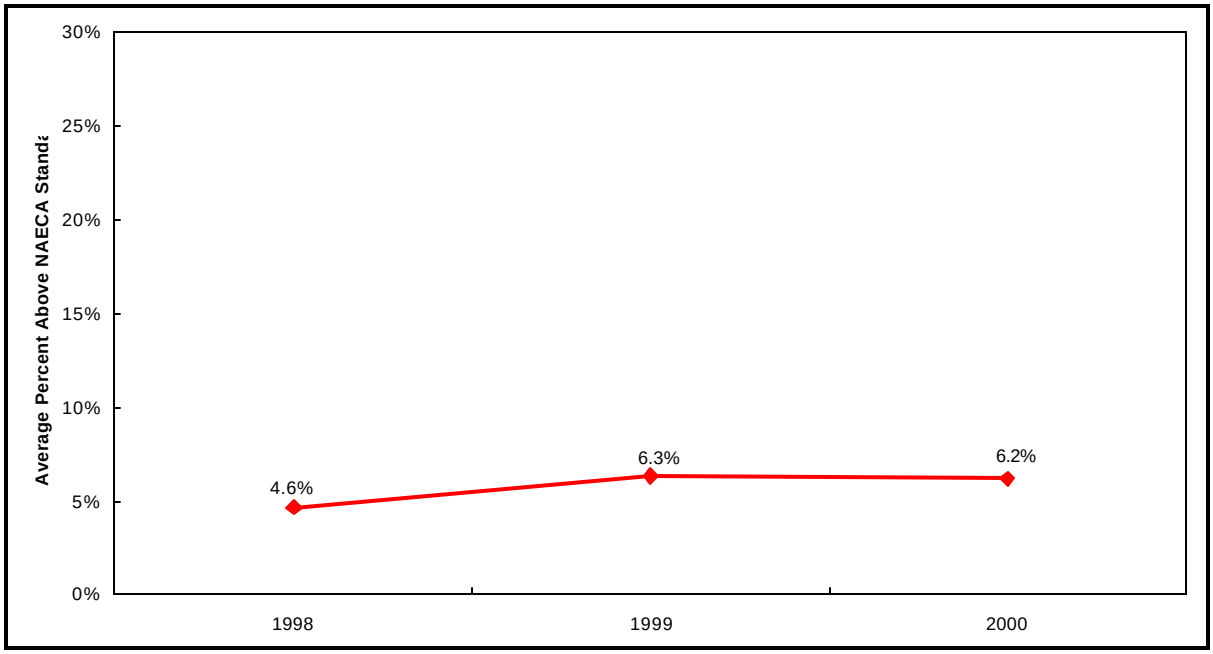
Figure 8-2: Refrigerator Model Availability by Percent-Above-Standard



Source: AHAM

[1] Association of Home Appliance Manufacturers. AHAM Directory of Certified Refrigerators and Freezers. January and June Editions. 1997 through 2000.

Figure 8-3: Available Refrigerator Models, Average Percent-Above-Standard



Source: AHAM

Refrigerator Efficiency Standards

Refrigerator energy use ratings are expressed in terms of expected annual energy use (kWh) under "typical conditions." Federal energy use standards vary by refrigerator configuration and are a function of the unit's adjusted volume (AV). Table 8-2 includes the current formulas for computing the federally mandated maximum energy use requirements for refrigerators for each configuration type. Table 8-2 also shows the energy reductions required for a refrigerator to qualify for the ENERGY STAR label (at least 20% less kWh) and the Super Efficient Home Appliance initiative (SEHA).

New refrigerator energy use standards become effective on July 1, 2001.[2] The new formulas for computing maximum energy usage are included in the final column of Table 8-2. The required energy use reductions from the current standard to the new 2001 standard vary by configuration, ranging between 27% and 32%. There are 31 currently available refrigerator models identified that already meet the new 2001 standard.[3] When the 2001 standard becomes effective, refrigerators must use 10% less energy than the standard to qualify for the ENERGY STAR program.

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[2] The new 2001 federal standard for refrigerators can be found in the following: Energy Conservation Program for Consumer Products: Energy Conservation Standards for Refrigerators, Refrigerator-Freezers and Freezers. *Federal Register*. Vol. 62, No. 81 April 28 1997.

[3] D&R International. "Notes on 2001 Compliant Refrigerators." May 1, 2000.

Table 8-2: Refrigerator Energy Use Standards and Program Requirements

	Current Standard (Max. kWh)	2001 Standard (July 1, 2001)
Federal Standard		
Manual defrost	13.5*AV+299	8.82*AV+248.4
Partial defrost	10.4*AV+398	8.82*AV+248.4
Automatic defrost, top mount without TTD	16.0*AV+355	9.80*AV+276.0
Automatic defrost, side mount without TTD	11.8*AV+501	4.91*AV+507.5
Automatic defrost, bottom mount without TTD	16.5*AV+367	4.40*AV+459.0
Automatic defrost, top mount with TTD	17.6*AV+391	10.2*AV+356.0
Automatic defrost, side mount with TTD	16.3*AV+527	10.1*AV+406.0
ENERGY STAR Qualification	20% less kWh	10% less kWh
SEHA Tier 1 Qualification	30% less kWh	n/a
SEHA Tier 2 Qualification	37% less kWh	n/a

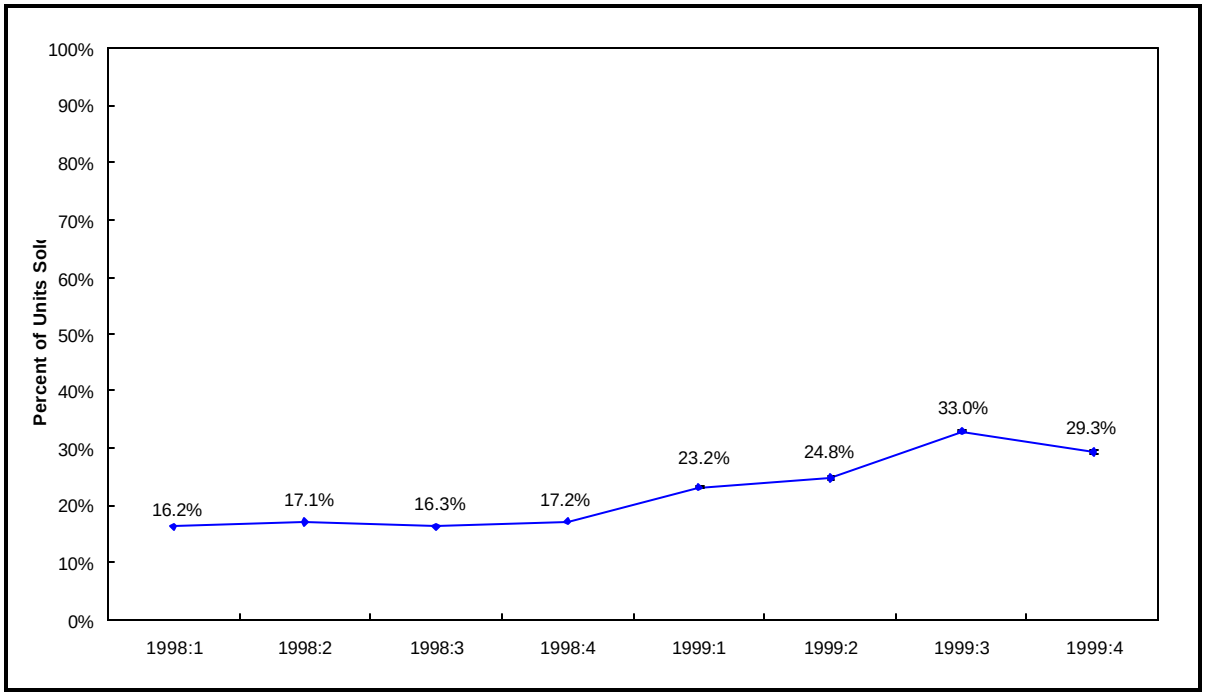
TTD = through-the-door ice dispenser.
AV = Adjusted Volume = Fresh Volume + (1.63*Freezer Volume).

Market Share of ENERGY STAR Qualified Refrigerators

Figure 8-4 and Table 8-3 present the percentage of ENERGY STAR qualified refrigerators sold in California during the first quarter of 1998 through the fourth quarter of 1999. As shown, the percent of ENERGY STAR refrigerators remained relatively steady between 16% and 17% in 1998, then increased sharply to 33% by the third quarter of 1999. By then end of 1999, nearly 30% of refrigerators sold in California qualified for the ENERGY STAR label.

Table 8-4 reports the percentage of ENERGY STAR compliant refrigerators sold in each utility service area annually and by quarter.

Figure 8-4: Refrigerator Sales, Percent of ENERGY STAR Qualified Units



Error bands for the 90% confidence interval.

Table 8-3: Refrigerator Sales, Percent of ENERGY STAR Qualified Units, Statewide

Year	Percent of ENERGY STAR Qualified Refrigerators				
	Annual	**Q1**	**Q2**	**Q3**	**Q4**
1998	**16.67%** (-) n = 230,171	**16.21%** (-) n = 46,004	**17.12%** (-) n = 55,309	**16.28%** (-) n = 76,525	**17.17%** (-) n = 52,333
1999	**28.41%** (0.0007) n = 474,063	**23.23%** (0.0013) n = 184,070	**24.78%** (0.0012) n = 198,741	**33.01%** (0.0013) n = 318,288	**29.33%** (0.0014) n = 274,601

Standard errors in parentheses.

Table 8-4: Refrigerator Sales, Percent of ENERGY STAR Qualified Units by Utility Service Area

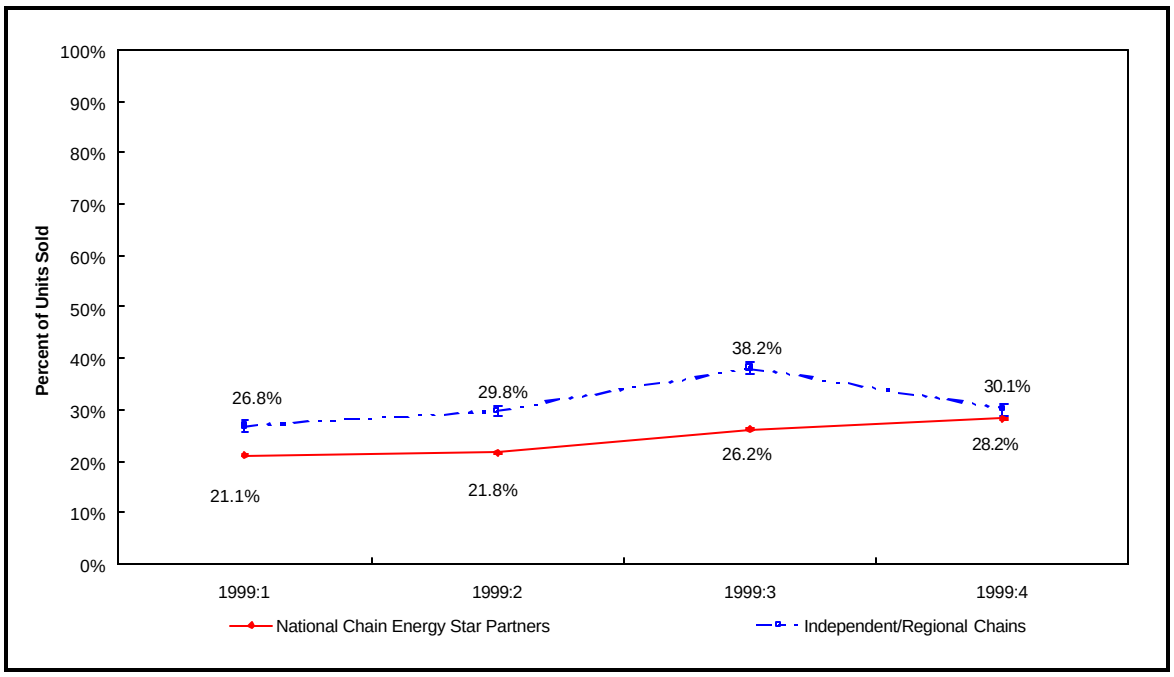
Utility	Year	Percent of ENERGY STAR Qualified Refrigerators [1, 2]				
		Annual	Q1	Q2	Q3	Q4
PG&E	1998	**17.37%** (-) n =90,493	**17.88%** (-) n = 19,547	**19.13%** (-) n =21,576	**16.29%** (-) n =28,722	**16.53%** (-) n =20,648
	1999	**33.36%** (0.0012) n =157,820	**26.31%** (0.0022) n =38,324	**27.35%** (0.0022) n =40,314	**37.74%** (0.0024) n =41,510	**33.96%** (0.0024) n =37,672
SCE	1998	**16.17%** (-) n =69,987	**14.16%** (-) n =13,179	**15.81%** (-) n =17,023	**16.25%** (-) n =24,049	**18.13%** (-) n =15,736
	1999	**25.72%** (0.0011) n =168,527	**21.70%** (0.0021) n =37,392	**24.02%** (0.0021) n =43,460	**30.99%** (0.0021) n =48,231	**24.76%** (0.0022) n =39,444
SDG&E	1998	**23.10%** (-) n =17,969	**25.41%** (-) n =2,980	**21.12%** (-) n =4,484	**22.83%** (-) n =6,434	**24.00%** (-) n =4,071
	1999	**29.81%** (0.0023) n =39,695	**28.64%** (0.0046) n =9,483	**29.18%** (0.0045) n =10,237	**32.20%** (0.0046) n =10,417	**28.69%** (0.0046) n =9,558
Other	1998	**13.90%** (-) n =51,722	**13.00%** (-) n = 10,298	**13.94%** (-) n =12,226	**13.87%** (-) n =17,320	**14.69%** (-) n =11,878
	1999	**21.69%** (0.0013) n =108,021	**18.56%** (0.0025) n =24,993	**20.20%** (0.0024) n =27,246	**22.98%** (0.0024) n =30,442	**24.67%** (0.0027) n =25,340

1 Standard errors in parentheses.
2 "Other" includes municipal utilities, such as LADWP, LMUD, PP&L, SMUD, and others.

Analysis by Market Channel

Figure 8-5 and Table 8-5 compare the shares of ENERGY STAR qualified refrigerators sold by national chain ENERGY STAR partners to sales by independently owned stores and regional chains. As shown, the share sold by the national chains is lower than the share sold by the independent store throughout the year. However, the shares by both market channels approached 30% by the fourth quarter.

Figure 8-5: Refrigerator Sales, Percent of ENERGY STAR Qualified Units by Market Channel



Error bands for the 90% confidence interval.

Table 8-5: Refrigerator Sales, Percent of ENERGY STAR Qualified Units by Market Channel

Market Channel	1999:1	1999:2	1999:3	1999:4
National Chain ENERGY STAR Partners	**21.08%** (0.0012) n =106,212	**21.79%** (0.0012) n =116,872	**26.16%** (0.0012) n =124,803	**28.24%** (0.0014) n =107,273
Independents and Regional Chains	**26.79%** (0.0070) n =3,980	**29.81%** (0.0069) n =4,385	**38.15%** (0.0064) n =5,797	**30.14%** (0.0067) n =4,741

8.4 Clothes Washers

Characteristics of Available Models

Comprehensive data sources to characterize available clothes washer models were not available.

Clothes Washer Efficiency Standards

Clothes washer energy use is expressed in estimated annual energy use (kWh) under "typical conditions" and is based on an average 392 loads of laundry per year. Clothes washer efficiency ratings are expressed as an energy factor rating (EF). Clothes washer EF is computed as:

$$EF = \frac{392 \times Washer\ Tub\ Volume\left(ft^3\right)}{Actual\ Annual\ EnergyUsage\left(kWh\right)}$$

Federal energy use standards for clothes washers vary by tub volume. Compact washers with a tub capacity less than 1.6 cubic feet have a minimum EF requirement of 0.90. Table 8-6 summarizes the federal energy use standards for standard capacity (≥ 1.6 and < 2.74 ft^3) clothes washers.

Table 8-6: Summary of Energy Use Standards for Standard Capacity Clothes Washers

	Minimum Energy Factor (EF)	Percent-Above-Standard
Federal Standard	1.18	-
ENERGY STAR Qualification	2.5	111%
SEHA Tier 1	2.5	111%
SEHA Tier 2	3.25	175%

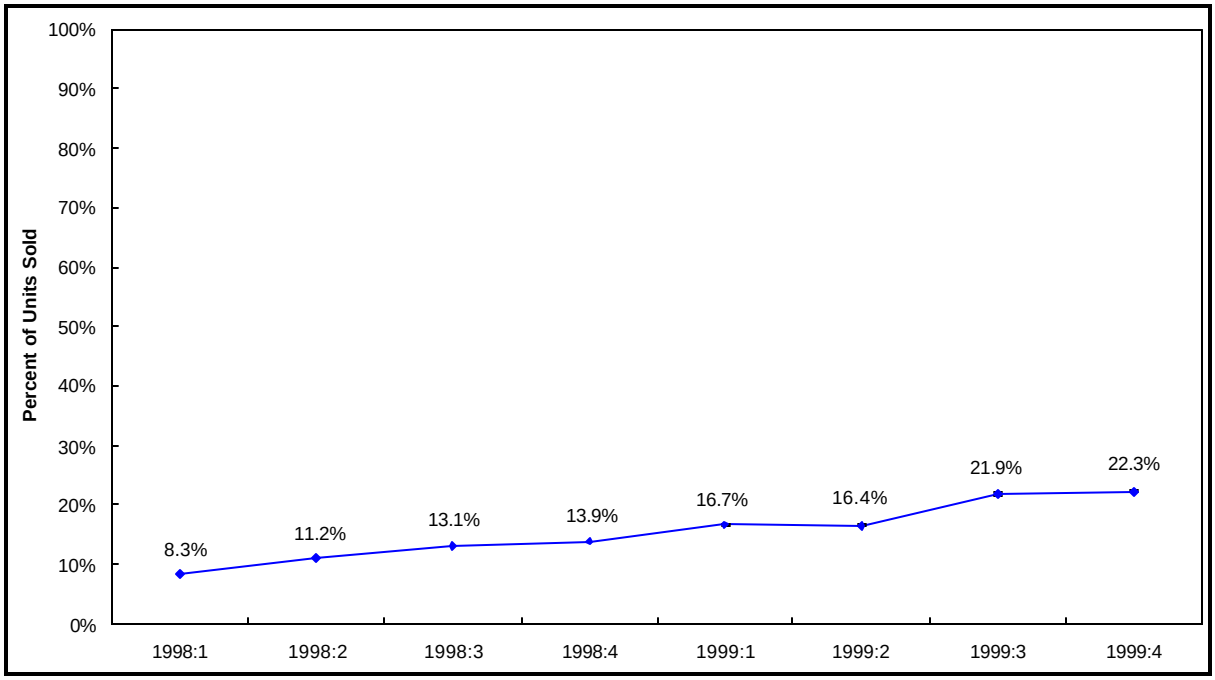
The current standard became effective on May 14, 1994.

Market Share of ENERGY STAR Qualified Clothes Washers

Figure 8-6 and Table 8-7 present the percentage of ENERGY STAR qualified clothes washers sold in California during the first quarter of 1998 through the fourth quarter of 1999. As shown, the market share of ENERGY STAR qualified clothes washers has steadily increased during the past two years – climbing from over 8% in early 1998 to over 20% by the final quarter of 1999.

Table 8-8 reports the percentage of ENERGY STAR compliant clothes washers sold in each utility service area annually and by quarter.[4]

Figure 8-6: Clothes Washer Sales, Percent of ENERGY STAR Qualified Units



Error bands for the 90% confidence interval.

Table 8-7: Clothes Washer Sales, Percent of ENERGY STAR Qualified Units (Statewide)

Year	Percent of ENERGY STAR Qualified Clothes Washers				
	Annual	**Q1**	**Q2**	**Q3**	**Q4**
1998	**11.68%** (-) n = 180,983	**8.33%** (-) n = 44,233	**11.20%** (-) n = 43,366	**13.09%** (-) n = 44,746	**13.87%** (-) n = 48,638
1999	**19.50%** (0.0006) n = 425,672	**16.75%** (0.0011) n = 115,629	**16.40%** (0.0011) n = 107,990	**21.89%** (0.0013) n =101,757	**23.80%** (0.0013) n = 100,296

Standard errors in parentheses.

[4] Axis orientation (vertical versus horizontal) was not available in the national chain sales data provided by D&R. However, RER would like to explore the possibility of expanding the analysis by orientation if possible during the second project year.

Table 8-8: Clothes Washer Sales, Percent of ENERGY STAR Qualified Units by Utility Service Area

Utility	Year	Percent of ENERGY STAR Qualified Clothes Washers [1, 2]				
		Annual	Q1	Q2	Q3	Q4
PG&E	1998	**12.65%** (-) n =83,563	**80.63%** (-) n = 19,916	**13.65%** (-) n = 20,751	**15.29%** (-) n = 20,520	**12.87%** (-) n = 22,376
	1999	**22.13%** (0.0010) n =165,288	**17.17%** (0.0017) n = 47,444	**17.56%** (0.0019) n = 42,096	**24.30%** (0.0022) n = 37,992	**26.28%** (0.0023) n = 37,766
SCE	1998	**8.74%** (-) n =47,708	**7.55%** (-) n = 12,287	**7.16%** (-) n = 11,357	**7.88%** (-) n = 11,693	**12.19%** (-) n = 12,371
	1999	**18.33%** (0.0010) n =140,863	**16.35%** (0.0019) n = 36,820	**16.22%** (0.0020) n = 35,609	**20.90%** (0.0022) n = 34,829	**20.12%** (0.0022) n = 33,605
SDG&E	1998	**11.70%** (-) n =14,582	**10.59%** (-) n = 3,491	**11.65%** (-) n = 3,359	**14.19%** (-) n = 3,413	**10.66%** (-) n = 4,319
	1999	**18.80%** (0.0020) n =38,302	**19.59%** (0.0040) n = 9,915	**15.23%** (0.0036) n = 9,943	**19.38%** (0.0041) n = 9,229	**21.09%** (0.0042) n = 9,215
Other	1998	**13.37%** (-) n = 35,130	**7.82** (-) n = 8,539	**10.36%** (-) n = 7,899	**14.39%** (-) n = 9,120	**19.82%** (-) n = 9,572
	1999	**16.30%** (0.0013) n =81,219	**15.15%** (0.0024) n = 21,450	**15.46%** (0.0025) n = 20,342	**18.40%** (0.0028) n = 19,717	**16.29%** (0.0026) n = 19,710

1 Standard errors in parentheses.
2 "Other" includes municipal utilities such as LADWP, LMUD, PP&L, SMUD, and others.

Analysis by Market Channel

Figure 8-7 and Table 8-9 compare the shares of ENERGY STAR qualified clothes washers sold by national chain ENERGY STAR partners to sales by independently owned stores and regional chains. As shown, the share sold by the national chains is considerably lower than the share sold by the independent store throughout the year. The share sold by national chain ENERGY STAR partners ranged from 10.4% to nearly 12% by the end of the year, while the share sold by the independent retailers ranged from 32.5% to nearly 36% during the same period.

Figure 8-7: Clothes Washer Sales, Percent of ENERGY STAR Qualified Units by Market Channel

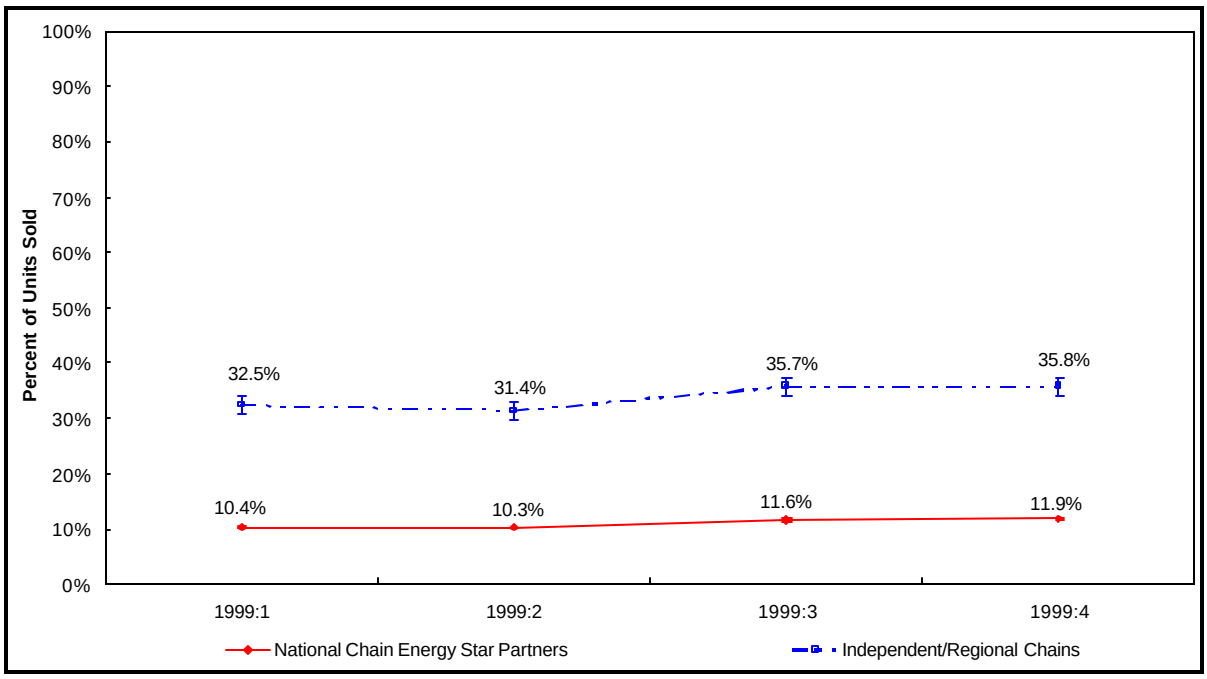


Table 8-9: Clothes Washer Sales, Percent of ENERGY STAR Qualified Units by Market Channel

Market Channel	1999:1	1999:2	1999:3	1999:4
National Chain ENERGY STAR Partners	**10.36%** (0.0010) n =113,050	**10.30%** (0.0009) n =105,551	**11.63%** (0.0010) n =99,385	**11.88%** (0.0010) n =97,766
Independents and Regional Chains	**32.50%** (0.0092) n =2,579	**31.45%** (0.0094) n =2,439	**35.73%** (0.0098) n =2,372	**35.75** (0.0095) n =2,530

8.5 Dishwashers

Characteristics of Available Models

Comprehensive data sources to characterize available dishwasher models were not available.

Dishwasher Efficiency Standards

Dishwasher energy use is based on estimated annual energy use (kWh) under "typical conditions" and an average of 322 loads per year. Dishwasher efficiency ratings are expressed as an energy factor rating (EF). The EF for dishwashers is computed as:

$$EF = \frac{322}{Actual\ Annual\ EnergyUsage\,(kWh)}$$

As summarized in Table 8-10, all standard-sized dishwashers must have an energy factor equal to at least 0.46. ENERGY STAR qualified dishwashers must exceed the minimum federal standard by at least 13%.

Table 8-10: Dishwasher Energy Efficiency Standards and Program Requirements

	Efficiency Rating (EF)	Percent-Above-Standard
Standard	0.46	-
ENERGY STAR	0.52	13.0%
SEHA Tier 1	0.58	26.1%
SEHA Tier 2	n/a	-

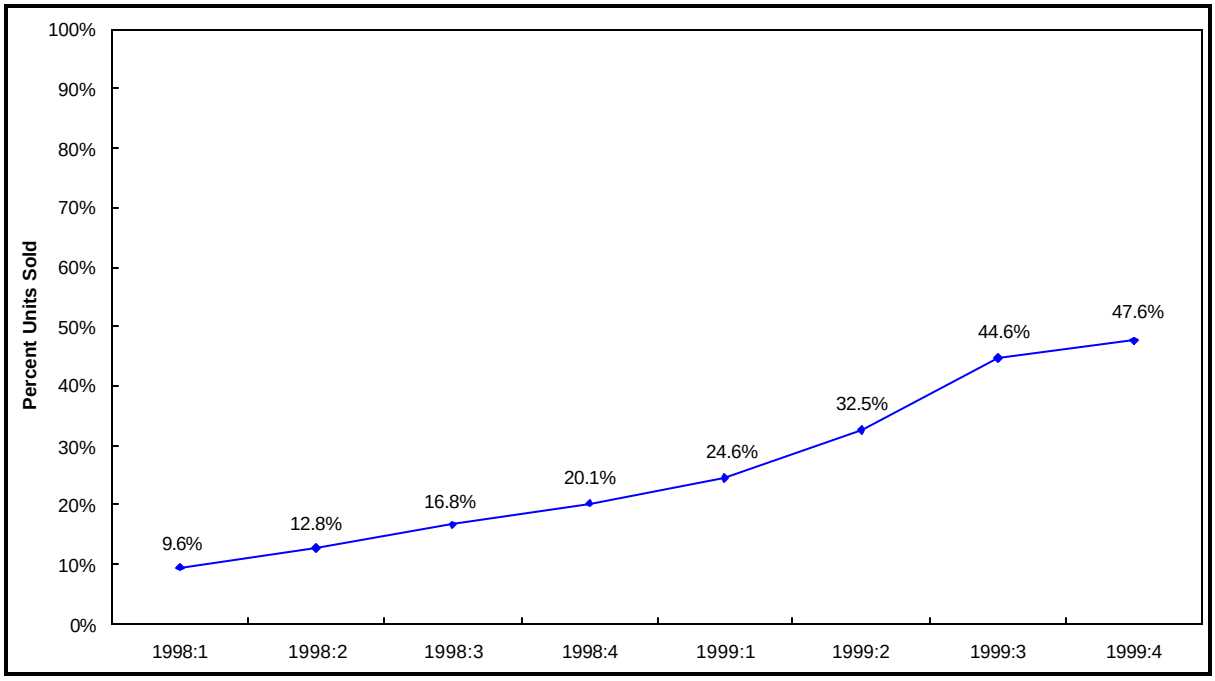
Does not apply to compact dishwashers.

Market Share of ENERGY STAR Qualified Dishwashers

Figure 8-8 and Table 8-11 present the percentage of ENERGY STAR qualified dishwashers sold in California during the first quarter of 1998 through the second quarter of 2000. The market share of ENERGY STAR qualified clothes washers increased steadily from nearly 10% in early 1998 to 47% by the end of 1999.

Table 8-12 reports the percent of ENERGY STAR compliant dishwashers sold in each utility service area annually and by quarter.

Figure 8-8: Dishwasher Sales, Percent of ENERGY STAR Qualified Units



Error bands for the 90% confidence interval.

Table 8-11: Dishwasher Sales, Percent of ENERGY STAR Qualified Units (Statewide)

Year	Percent of ENERGY STAR Qualified Dishwashers				
	Annual	Q1	Q2	Q3	Q4
1998	**15.13%** (-) n = 66,161	**9.55%** (-) n = 15,478	**12.75%** (-) n = 15,012	**16.75%** (-) n = 16,775	**20.14%** (-) n = 18,896
1999	**38.47%** (0.0011) n = 195,171	**24.57%** (0.0020) n = 47,649	**32.45%** (0.0021) n = 47,115	**44.59%** (0.0023) n = 46,759	**47.63%** (0.0022) n = 53,648

Standard errors in parentheses.

Table 8-12: Dishwasher Sales, Percent of ENERGY STAR Qualified Units by Utility Service Area

Utility	Year	Percent of ENERGY STAR Qualified Dishwashers [1, 2]				
		Annual	Q1	Q2	Q3	Q4
PG&E	1998	**12.00%** (-) n =24,900	**7.62%** (-) n =5,671	**10.76%** (-) n =5,626	**13.54%** (-) n =6,522	**15100%** (-) n =7,081
	1999	**52.88%** (0.0019) n =69,320	**16.88%** (0.0029) n =17,021	**32.33%** (0.0037) n =16,442	**61.34%** (0.0038) n =16,242	**65.75%** (0.0034) n =19,615
SCE	1998	**20.44%** (-) n =20,197	**12.01%** (-) n =4,893	**15.40%** (-) n =4,596	**22.14%** (-) n =4,940	**30.15%** (-) n =5,768
	1999	**30.03%** (0.0018) n =68,633	**26.71%** (0.0034) n =16,560	**33.01%** (0.0036) n =17,027	**31.11%** (0.0036) n =16,882	**29.78%** (0.0034) n =18,164
SDG&E	1998	**15.41%** (-) n =6,510	**12.02%** (-) n =1,466	**14.29%** (-) n =1,487	**17.64%** (-) n =1,724	**17.30%** (-) n =1,833
	1999	**30.97%** (0.0032) n =20,564	**30.41%** (0.0065) n =4,995	**32.32%** (0.0067) n =4,868	**29.89%** (0.0066) n =4,872	**31.30%** (0.0061) n =5,829
Other	1998	**12.92%** (-) n =14,554	**8.18%** (-) n = 3,448	**11.77%** (-) n =3,303	**14.76%** (-) n =3,589	**16.15%** (-) n =4,214
	1999	**28.37%** (0.0024) n =36,654	**24.72%** (0.0045) n =9,073	**28.64%** (0.0048) n =8,778	**29.95%** (0.0049) n =8,763	**31.16%** (0.0046) n =10,040

1 Standard errors in parentheses.
2 "Other" includes municipal utilities such as LADWP, LMUD, PP&L, SMUD, and others.

Analysis by Market Channel

Figure 8-9 and Table 8-13 compare the shares of ENERGY STAR qualified dishwashers sold by national chain ENERGY STAR partners to sales by independently owned stores and regional chains. As shown, the share sold by the national chains is considerably lower than the share sold by the independent store throughout the year. The share sold by national chain ENERGY STAR partners ranged from 10.4% to nearly 12% by the end of the year, while the share sold by the independent retailers ranged from 32.5% to nearly 36% during the same period.

Figure 8-9: Dishwasher Sales, Percent of ENERGY STAR Qualified Units by Retailer Type

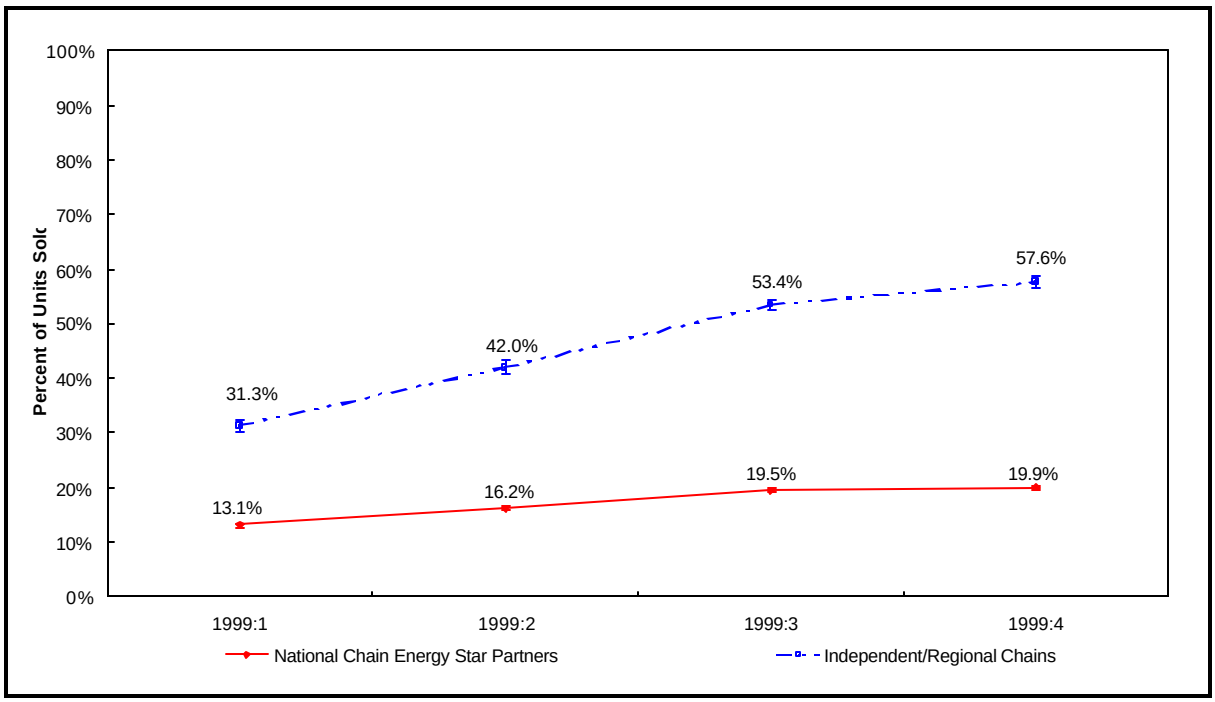


Table 8-13: Dishwasher Sales, Percent of ENERGY STAR Qualified Units by Market Channel

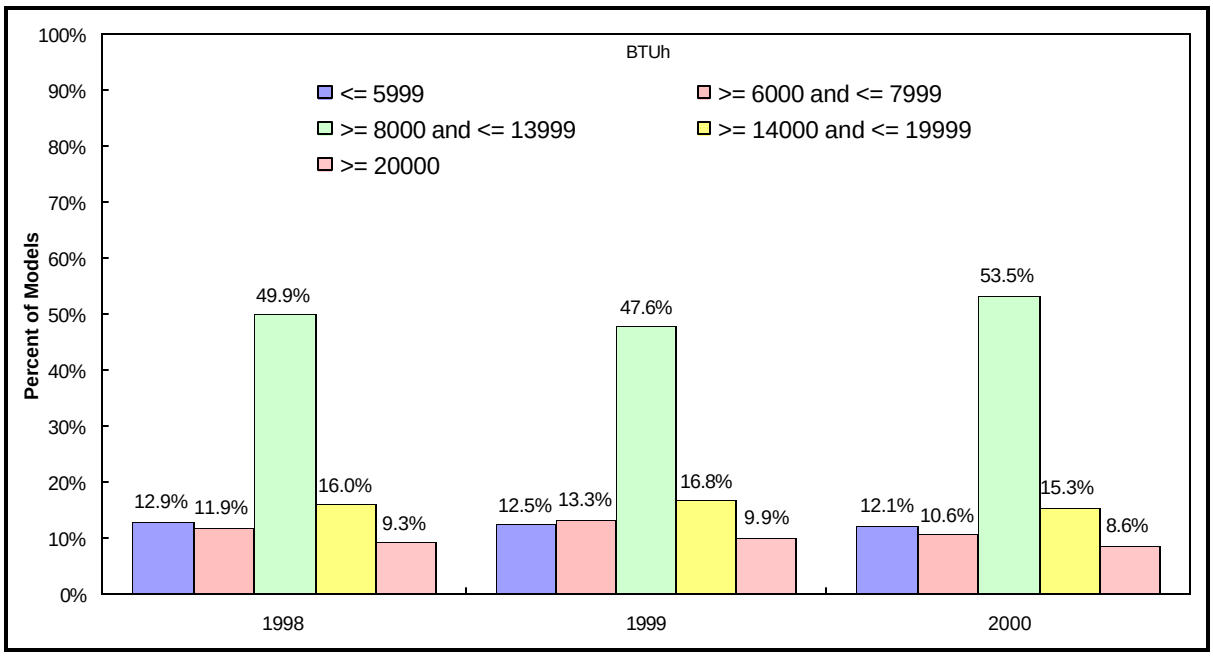
Market Channel	1999:1	1999:2	1999:3	1999:4
National Retail Chain ENERGY STAR Partners	13.06% (0.0016) n =42,566	16.17% (0.0018) n =42,227	19.48% (0.0019) n =41,425	19.94% (0.0018) n =48,184
Independents & Regional Chains	31.27% (0.0065) n =5,083	42.04% (0.0071) n =4,888	53.44% (0.0068) n =5,334	57.62% (0.0067) n =5,464

8.6 Room Air Conditioners

Characteristics of Available Models

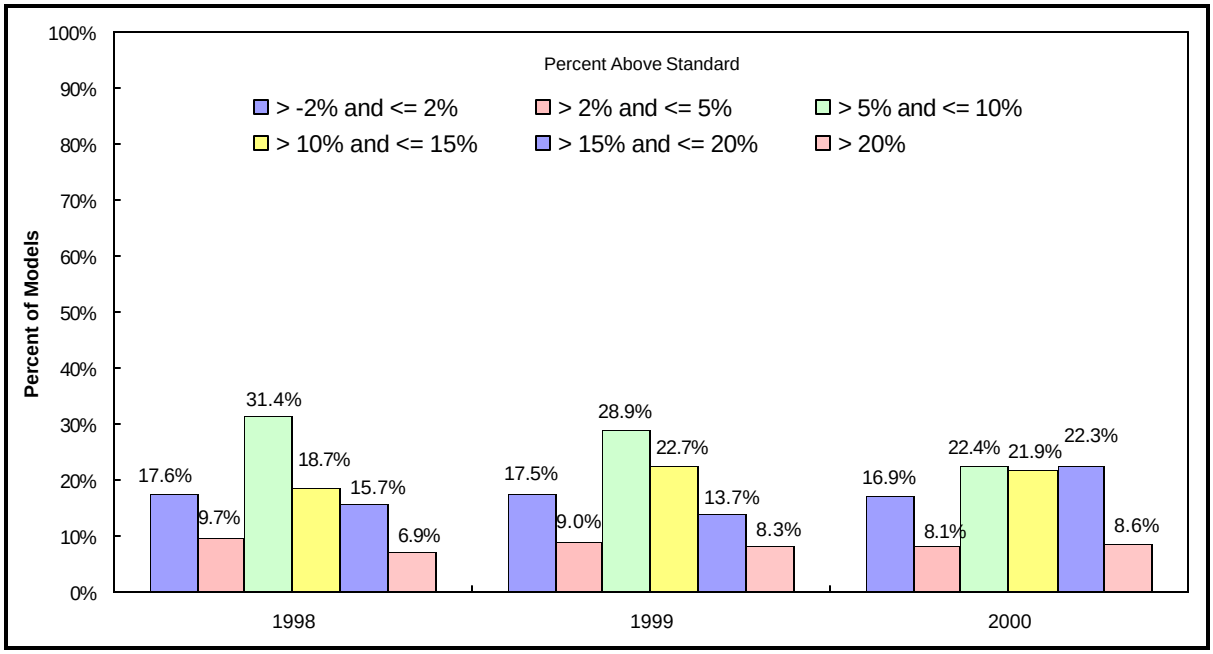
Figure 8-10 and Figure 8-11 characterize currently available room air conditioner models by output capacity and energy efficiency ratings relative to the federal standard. Figure 8-10 illustrates that about half of the room air conditioners available in 1998, 1999, and 2000 have rated output capacities between 8,000 and 14,000 BTUh. Figure 8-11 shows that the percentage of available room air conditioners that exceed the current standard by at least 10% has increased from about 41% in 1998 to over 50% in 2000.

Figure 8-10: Available Room Air Conditioner Models by Output Capacity (BTUh)



Source: ARI

Figure 8-11: Room Air Conditioner Model Availability by Percent-Above-Standard



Source: ARI

Room Air Conditioner Efficiency Standards

The energy efficiency of room air conditioners is expressed as an Energy Efficiency Rating (EER), which varies by cooling capacity (BTUh) and configuration. Table 8-14 includes the minimum energy efficiency requirement for each configuration and size. Room air conditioners must exceed the current standard by at least 15% to qualify for the ENERGY STAR label. New energy efficiency standards for room air conditioners become effective on October 1, 2000. These revised EERs are included in the final column in Table 8-14.

Table 8-14: Energy Efficiency Standards for Room Air Conditioners

BTUh	Configuration	Current Standard (EER)	New Standard (EER)
< 6,000	Without reverse cycle and with louvered sides	8.0	9.7
	Without reverse cycle and w/out louvered sides	8.0	9.0
6,000 - 7,999	Without reverse cycle and with louvered sides	8.5	9.7
	Without reverse cycle and w/out louvered sides	8.5	9.0
8,000 - 13,999	Without reverse cycle and with louvered sides	9.0	9.8
	Without reverse cycle and w/out louvered sides	8.5	8.5
14,000 - 19,000	Without reverse cycle and with louvered sides	8.8	9.7
	Without reverse cycle and w/out louvered sides	8.5	8.5
> 20,000	Without reverse cycle and with louvered sides	8.2	8.5
	Without reverse cycle and w/out louvered sides	8.2	9.0
< 14,000	With reverse cycle and w/out louvered sides	8.0	8.5
≥ 14,000	With reverse cycle and w/out louvered sides	8.0	8.0
< 20,000	With reverse cycle and with louvered sides	8.5	9.0
≥ 20,000	With reverse cycle and with louvered sides	8.5	8.5
	Casement only	*	8.7
	Casement-slider	*	9.5

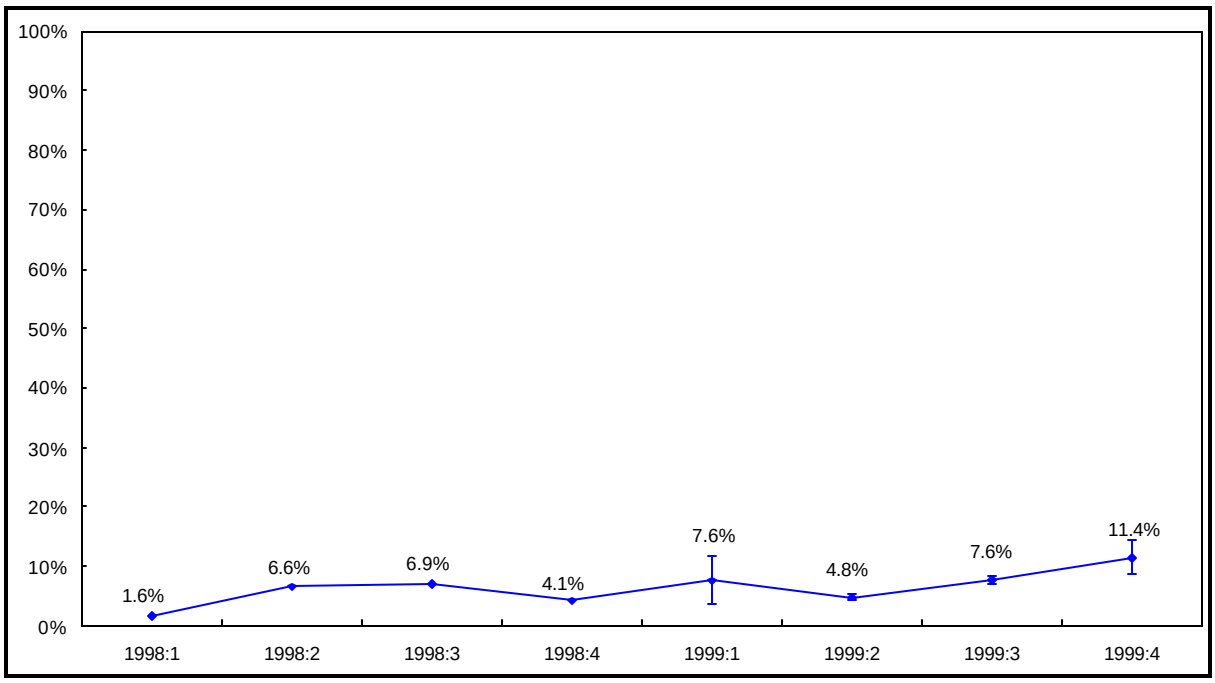
Current standards became effective January 1, 1990.
New standards become effective on October 1, 2000.

Market Share of ENERGY STAR Qualified Room Air Conditioners

Figure 8-12 and Table 8-15 present the percent of ENERGY STAR qualified room air conditioners sold by national chain ENERGY STAR partners in California during 1998 and 1999.

Table 8-16 reports the percent of ENERGY STAR compliant room air conditioners sold in each utility service area annually and by quarter.

Figure 8-12: Room Air Conditioner Sales, Percent of ENERGY STAR Qualified Units (Statewide, National Chain ENERGY STAR Partners Only)



Error bands for the 90% confidence interval.

Table 8-15: Room Air Conditioner Sales, Percent of ENERGY STAR Qualified Units, Statewide

Year	Percent of ENERGY STAR Qualified Room Air Conditioners				
	Annual	**Q1**	**Q2**	**Q3**	**Q4**
1998	**6.73%** (-) n = 19,087	**1.61%** (-) n = 186	**6.56%** (-) n = 3,627	**6.86%** (-) n = 15,176	**4.08%** (-) n = 98
1999	**20.66%** (0.0038) n = 11,176	**7.63%** (0.0244) n = 118	**4.81%** (0.0029) n = 5,319	**7.64%** (0.0036) n = 5,396	**11.40%** (0.0172) n = 342

Standard errors in parentheses.

Table 8-16: Room Air Conditioner Sales, Percent of ENERGY STAR Qualified Units by Utility Service Area

Utility	Year	Percent of ENERGY STAR Qualified Room Air Conditioners [1, 2]				
		Annual	Q1	Q2	Q3	Q4
PG&E	1998	**6.41%** (-) n =5,636	**3.70%** (-) n =54	**4.66%** (-) n =1,074	**6.86%** (-) n =4,472	**5.56%** (-) n =36
	1999	**5.99%** (0.0073) n =3,217	**33.33%** (0.1571) n = 9	**4.40%** (0.0051) n =1,638	**7.37%** (0.0067) n =1,513	**11.11%** (0.0428) n = 57
SCE	1998	**5.88%** (-) n =6,118	**3.33%** (-) n =30	**7.46%** (-) n =1,005	**5.64%** (-) n =5,038	**0.00%** (-) n = 45
	1999	**6.46%** (0.0041) n =3,576	**5.00%** (0.0218) n = 100	**5.34%** (0.0056) n =1,592	**7.59%** (0.0063) n =1,753	**6.11%** (0.0209) n = 131
SDG&E	1998	**4.53%** (-) n =728	**0.00%** (-) n = 8	**7.46%** (-) n =134	**3.79%** (-) n =580	**16.67%** (-) n =6
	1999	**6.35%** (0.0154) n =252	**0.00%** (0.0000) n = 0	**8.05%** (0.0223) n =149	**3.26%** (0.0185) n =92	**0.00%** - n = 10
Other	1998	**8.05%** (-) n =6,605	**0.00%** (-) n = 94	**7.28%** (-) n = 1,414	**8.42%** (-) n =5,086	**9.09%** (-) n =11
	1999	**6.71%** (0.0039) n =4,131	**0.00%** - n = 8	**4.49%** (0.0047) n =1,938	**8.10%** (0.0060) n =2,038	**17.01%** (0.0310) n = 147

1 Standard errors in parentheses.
2 "Other" includes municipal utilities such as LADWP, LMUD, PP&L, SMUD, and others.

Analysis by Market Channel

Analysis of the market share of room air conditioners sold by market channel was not feasible for this analysis because of extremely low sample sizes in the independent market channel. This is not surprising, given that the majority of room air conditioners are sold by large retail chains in the home improvement market channel (e.g., Home Depot), which is not represented in the data collected for this analysis.

9

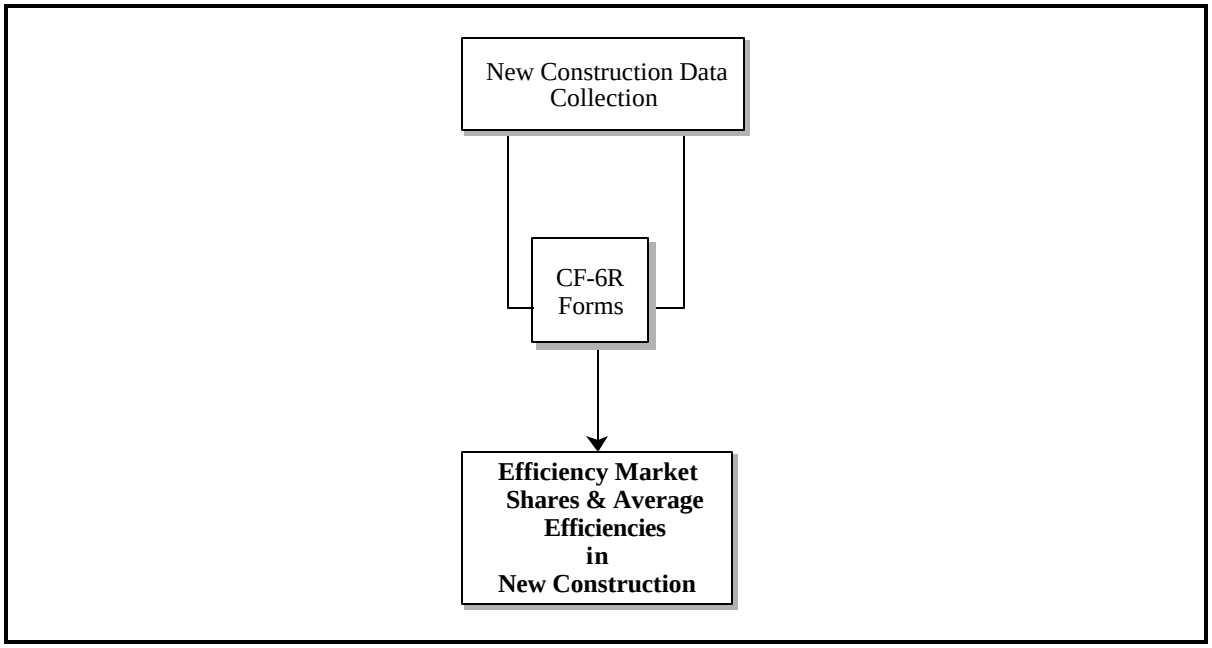
Windows

9.1 Overview

This section presents the efficiency market shares and average efficiencies of windows installed in California's residential sector. This subsection includes a review of the data sources for the window analysis. Subsection 9.2 summarizes energy efficiency ratings for windows and Subsection 9.3 provides the estimates of average window efficiencies in overall California's new construction sector. The RMST analysis does not cover window retrofits/replacements.

Figure 9-1 provides an overview of the data sources for the window analysis. As shown, data from the building department installation forms (CF-6Rs) was used to estimate the shares and average efficiencies of windows installed in residential new construction. Expansion weights were developed to expand the sample data to represent the California market. The analysis of windows in new construction was also conducted at the utility level. A detailed discussion of the data collection and analysis of is provided in Section 2.2.

Figure 9-1: Overview of Data Sources for Window Analysis



9.2 Window Efficiency Ratings

The efficiency rating used to rate windows is called a U-value. The U-value of a window is a measure of the heat flow through a construction assembly, which includes insulation, framing, and glass. The lower the U-value, the more efficient the windows.

Since U-values could not be observed during the on-site visits, the analysis of window efficiencies focuses on the types of windows installed. After reviewing every possible combination of window type, RER found that only five types of windows had a saturation of greater than 1%. These five window types, listed below, are the focus of the analysis presented here.

- Clear glass, double pane, wood/vinyl frame, and air filled.
- Clear glass, double pane, metal frame, and air filled.
- Clear glass, double pane, wood/vinyl frame, and gas filled.
- Low-e glass, double pane, wood/vinyl frame, and air filled.
- Reflective/tinted glass, double pane, wood/vinyl frame, and air filled.

9.3 Window Efficiency in New Construction

On-Site Survey Results

Table 9-1 and Figure 9-2 present the distribution of the five window types by six-month period for all newly constructed homes. Clear glass, double pane wood or vinyl framed air-filled units are by far the most predominant. The same distribution by single family and multifamily residence types is presented in Table 9-2 and Figure 9-3.

The distribution of window types by utility and residence type and window types by climate zone are presented in Table 9-3 and Table 9-4, respectively.

Table 9-1: Distribution of Window Types – On-Site Data

	Clear Glass Double Pane Wood/Vinyl Frame Air Filled	Clear Glass Double Pane Metal Frame Air Filled	Clear Glass Double Pane Wood/Vinyl Frame Gas Filled	Low-e Glass Double Pane Wood/Vinyl Frame Air Filled	Reflective/Tint Glass Double Pane Wood/Vinyl Frame Air Filled
1998: 3-4	84.3%	4.5%	1.0%	4.1%	2.7%
1999: 1-2	83.7%	3.1%	0.4%	4.1%	5.2%

Figure 9-2: Distribution of Window Types – On-Site

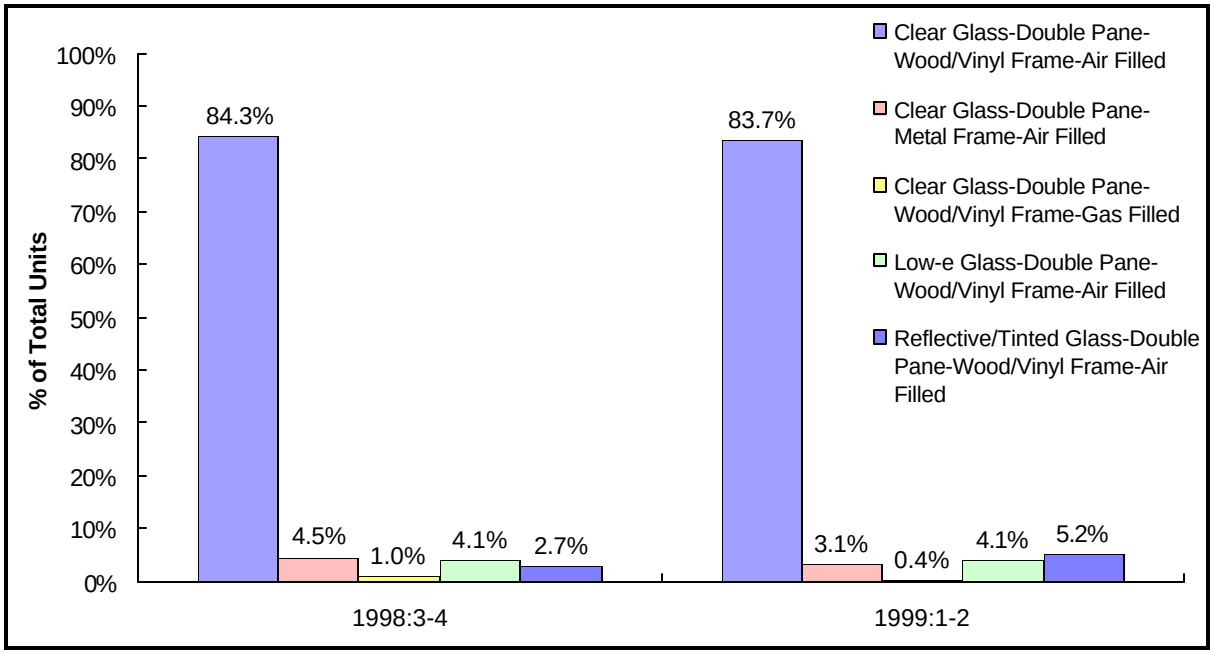


Table 9-2: Distribution of Window Types by Residence Type – On-Site Data

Residence Type		Clear Glass Double Pane Wood/Vinyl Frame Air Filled	Clear Glass Double Pane Metal Frame Air Filled	Clear Glass Double Pane Wood/Vinyl Frame Gas Filled	Low-e Glass Double Pane Wood/Vinyl Frame Air Filled	Reflective/Tint Glass Double Pane Wood/Vinyl Frame Air Filled
Single Family	**1998:3-4**	86.0%	3.9%	0.8%	3.5%	3.1%
	1999:1-2	84.5%	1.9%	0.5%	4.7%	6.2%
Multi-family	**1998:3-4**	77.0%	7.2%	1.6%	6.5%	1.1%
	1999:1-2	80.5%	8.3%	0.0%	1.5%	0.5%

Figure 9-3: Distribution of Window Types by Residence Type – On-Site Data

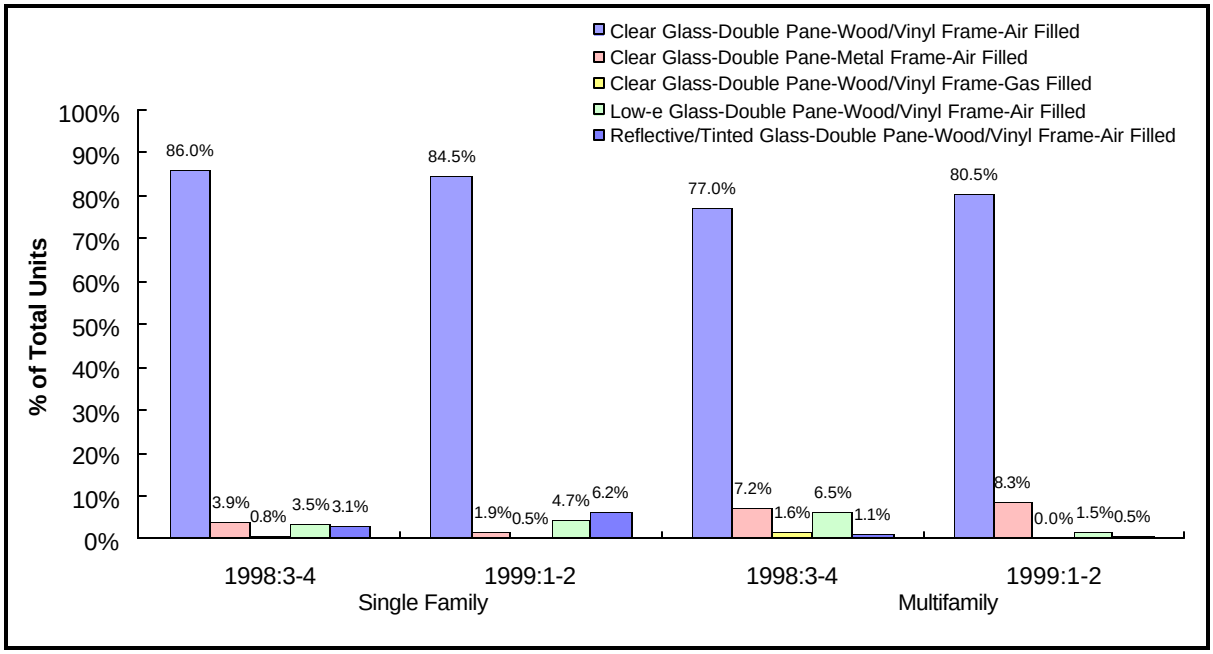


Table 9-3: Distribution of Window Type by Utility, by Residence Type – On-Site Data

Residence Type & Utility Area		Clear Glass Double Pane Wood/Vinyl Frame Air Filled	Clear Glass Double Pane Metal Frame Air Filled	Clear Glass Double Pane Wood/Vinyl Frame Gas Filled	Low-e Glass Double Pane Wood/Vinyl Frame Air Filled	Reflective/Tint Glass Double Pane Wood/Vinyl Frame Air Filled
Single Family						
PG&E	**1998:3-4**	84.8%	3.8%	1.7%	4.9%	1.3%
	1999:1-2	81.2%	0.7%	0.7%	7.7%	5.9%
SCE	**1998:3-4**	86.4%	3.3%	0.0%	2.8%	5.5%
	1999:1-2	88.6%	2.4%	0.0%	0.8%	7.9%
SDG&E	**1998:3-4**	91.2%	2.1%	0.0%	0.0%	3.6%
	1999:1-2	92.2%	4.1%	2.1%	0.0%	0.1%
Multifamily						
PG&E	**1998:3-4**	74.9%	7.8%	2.6%	10.4%	1.7%
	1999:1-2	89.7%	2.5%	0.0%	2.5%	0.0%
SCE	**1998:3-4**	94.2%	0.0%	0.0%	0.0%	0.0%
	1999:1-2	67.7%	17.5%	0.0%	0.0%	0.0%
SDG&E	**1998:3-4**	78.4%	0.0%	0.0%	0.0%	0.0%
	1999:1-2	35.6%	11.1%	0.0%	0.0%	0.0%

Table 9-4: Distribution of Window Types by Climate Zone

CEC Climate Zone		Clear Glass Double Pane Wood/Vinyl Frame Air Filled	Clear Glass Double Pane Metal Frame Air Filled	Clear Glass Double Pane Wood/Vinyl Frame Gas Filled	Low-e Glass Double Pane Wood/Vinyl Frame Air Filled	Reflective/Tint Glass Double Pane Wood/Vinyl Frame Air Filled
CZ:1	**1998:3-4**	81.8%	5.8%	1.1%	9.0%	0.0%
	1999:1-2	81.6%	1.1%	1.2%	5.6%	4.6%
CZ:2	**1998:3-4**	89.4%	1.8%	0.0%	1.4%	5.6%
	1999:1-2	82.4%	4.3%	1.0%	2.6%	3.4%
CZ:3	**1998:3-4**	84.7%	5.9%	0.0%	1.6%	2.5%
	1999:1-2	85.6%	5.6%	0.0%	0.0%	6.4%
CZ:4	**1998:3-4**	83.9%	3.3%	2.6%	3.1%	3.0%
	1999:1-2	85.3%	1.0%	0.0%	7.2%	4.4%
CZ:5	**1998:3-4**	84.6%	3.4%	0.0%	4.0%	8.0%
	1999:1-2	78.8%	7.8%	0.0%	3.2%	8.8%

CF-6R Results

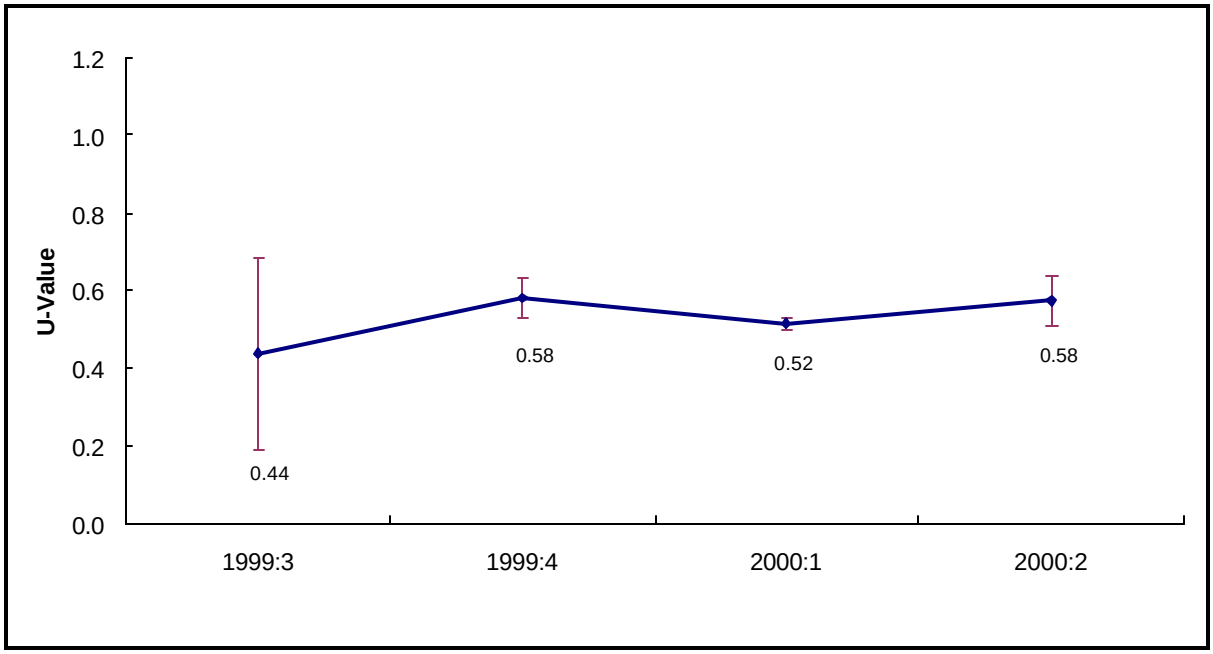
Table 9-5 shows the average percent-above-standard efficiency by utility and by quarter. Figure 9-4 presents the average percent-above-standard efficiency over the past year (1999:3–2000:2).

Table 9-5: Window Average U-Value – CF-6R Data

	PG&E	SCE	All
1999:3	**0.44** (0.1493) n = 2	**-** - n = 0	**0.44** (0.1493) n = 2
1999:4	**0.60** (0.0424) n = 6	**0.52** (0.0045) n = 3	**0.58** (0.0316) n = 9
2000:1	**0.50** (0.0117) n = 50	**0.55** (0.0112) n = 46	**0.52** (0.0087) n = 96
2000:2	**0.69** (0.0000) n = 1	**0.53** (0.0220) n = 4	**0.58** (0.0406) n = 5

Standard errors in parentheses.
CF-6R forms were not obtained for sites in SDG&E's service area for this analysis.

Figure 9-4: Window Average U-Value – CF-6R Data



10

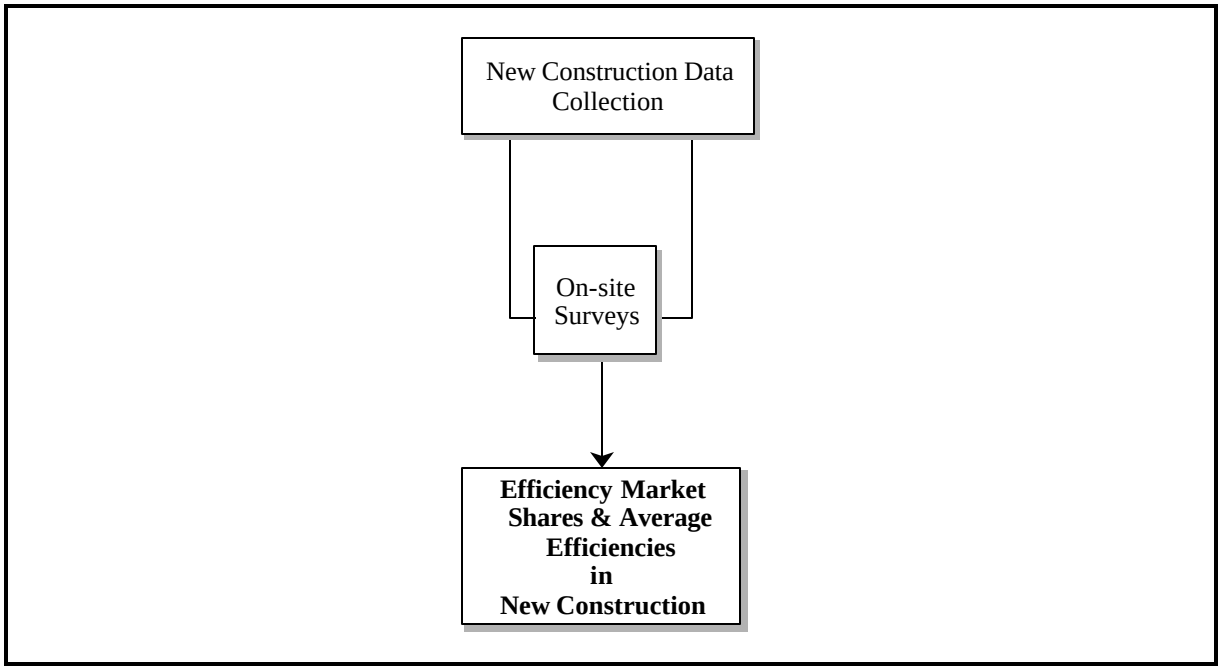
Interior and Exterior Lighting

10.1 Overview

This section presents the efficiency market shares of high efficiency lighting in California's residential sector. This subsection includes a review of the data sources for the analysis, and Subsection 10.2 presents market share estimates of interior and exterior lighting bulbs and fixtures. Figure 10-1 provides an overview of the data sources for the lighting analysis. As shown, data from new construction on-site surveys was used to estimate the shares of high efficiency lighting installed in residential new construction. Expansion weights were developed to expand the sample data to represent the California market. A detailed discussion of the data collection and analysis of CAC efficiencies is provided in Section 2.2.

Also note that RER has also purchased point-of-sale bulb data from lighting product retailers. The analysis of this data will be released under separate cover. RER is also currently negotiating the development of point-of-sale fixture data.

Figure 10-1: Overview of Data Sources for Lighting Analysis



10.2 Interior and Exterior Lighting in New Construction

Interior Lighting

Through the on-site survey, RER obtained a considerable amount of detailed information collected for all lighting fixtures, bulbs, and lighting controls observed in each home. This section discusses the data issues associated with the lighting data collection effort, defines the groupings of lighting measures, and presents the results of the tracking analysis. The discussion is organized into three subsections:

- Interior Fixture Data
- Interior Bulb Data
  - Type 1: This group includes incandescent (Medium Base), CFLs and Halogen "A" types.
  - Type 2: This group includes incandescent PAR/Reflectors, CFL Reflectors, and Halogen PAR/Reflectors
- Torchieres and Floor/Table Lamps

Interior Fixtures

Table 10-1 presents the average number of interior fixtures by residence type by six-month period. Figure 10-2 classifies fixture by the type of bulb installed in the fixture. These include only hard-wired fixtures and distinguish between dedicated and non-dedicated CFL fixtures. As shown, on average roughly 10% of the fixtures are fitted with CFL bulbs. The same distributions for single family and multifamily homes are shown in Figure 10-3. Comparing results by residence type indicates that multifamily homes on average have a greater percentage of CFL lighting.

Table 10-2 through Table 10-5 present the number of interior fixtures installed by bulb type, residence type, and six-month period. Figure 10-4 presents the percent of fixtures installed by mount type. As shown, roughly 35% of the fixture types are recessed or downlights (cans). The same information by residence type is presented in Figure 10-5 and Figure 10-6, respectively.

Table 10-1: Average Number of Fixtures per Household – On-Site Data

	Multifamily	Single Family
1998:3-4	12.9	25.7
1999:1-2	10.6	26.5

Figure 10-2: Interior Fixtures by Installed Bulb Type – On-Site Data

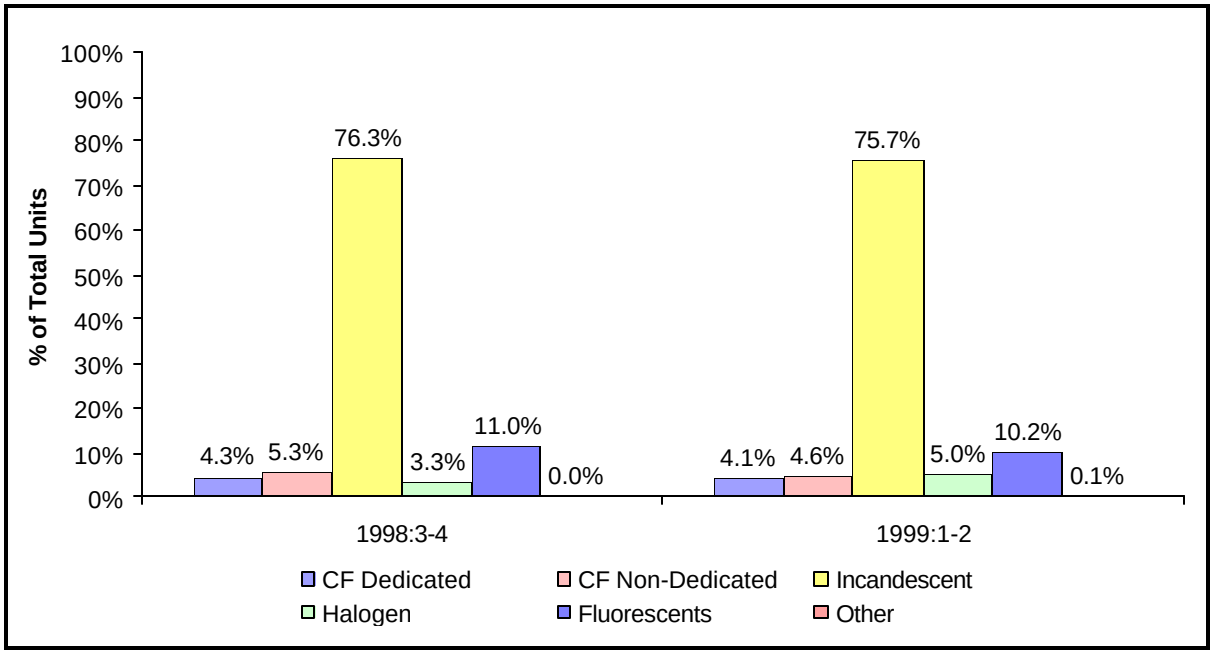


Figure 10-3: Interior Fixtures by Installed Bulb Type by Residence Type – On-Site Data

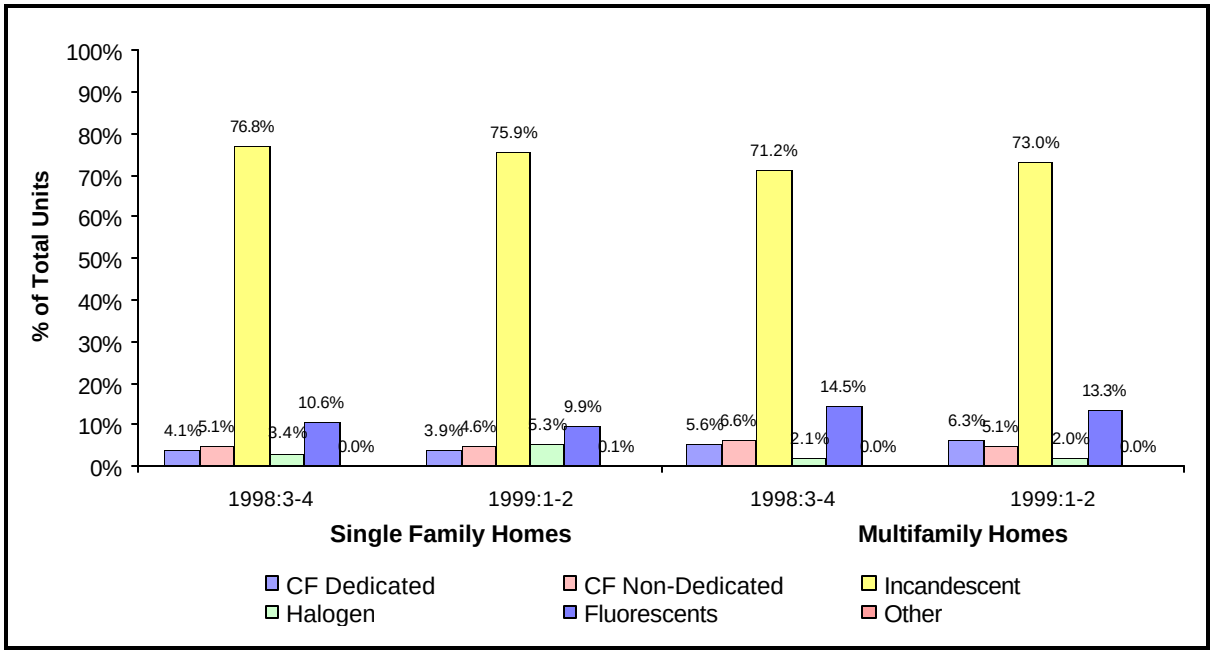


Table 10-2: Number of Interior Fixtures by Installed Bulb Type, Single Family – On-Site Data (1998:3-4)

Location	CF Dedicated	CF Other	Incandescent	Halogen	Fluorescent	Other	Total
Kitchen	0.1	0.1	4.1	0.3	1.4	0.01	**6.0**
Family/Living	0.0	0.0	1.8	0.1	0.0	0.00	**1.9**
Bedrooms	0.0	0.1	3.0	0.1	0.0	0.00	**3.2**
Dining	0.0	0.0	1.0	0.0	0.0	0.00	**1.1**
Bath	0.9	1.0	3.9	0.1	0.3	0.00	**6.2**
Halls	0.0	0.0	4.7	0.3	0.0	0.00	**5.0**
Garage	0.0	0.0	0.6	0.0	0.8	0.00	**1.5**
Other	0.0	0.0	0.6	0.0	0.1	0.00	**0.8**
Total	**1.1**	**1.3**	**19.7**	**0.9**	**2.7**	**0.01**	**25.7**

Table 10-3: Number of Interior Fixtures by Installed Bulb Type, Single Family – On-Site Data (1999:1-2)

Location	CF Dedicated	CF Other	Incandescent	Halogen	Fluorescent	Other	Total
Kitchen	0.1	0.1	4.3	0.4	1.5	0.00	**6.4**
Family/Living	0.0	0.0	2.3	0.2	0.0	0.02	**2.6**
Bedrooms	0.0	0.0	3.2	0.2	0.0	0.00	**3.5**
Dining	0.0	0.0	1.0	0.1	0.0	0.00	**1.1**
Bath	0.9	1.0	3.6	0.2	0.2	0.00	**5.8**
Halls	0.0	0.0	4.7	0.4	0.0	0.00	**5.2**
Garage	0.0	0.0	0.6	0.0	0.6	0.00	**1.2**
Other	0.0	0.0	0.4	0.0	0.2	0.00	**0.6**
Total	**1.0**	**1.2**	**20.1**	**1.4**	**2.6**	**0.02**	**26.40**

Table 10-4: Interior Fixtures by Installed Bulb Type by Room, Multifamily – On-Site Data (1998:3-4)

Location	CF Dedicated	CF Other	Incandescent	Halogen	Fluorescent	Other	Total
Kitchen	0.1	0.0	1.2	0.0	0.9	0.00	**2.1**
Family/Living	0.0	0.0	0.6	0.1	0.0	0.00	**0.8**
Bedrooms	0.0	0.0	1.6	0.1	0.0	0.00	**1.7**
Dining	0.0	0.0	0.6	0.0	0.0	0.00	**0.6**
Bath	0.6	0.4	1.6	0.0	0.4	0.00	**3.0**
Halls	0.0	0.0	1.9	0.0	0.0	0.00	**1.9**
Garage	0.0	0.0	0.1	0.0	0.1	0.00	**0.2**
Other	0.0	0.0	0.2	0.0	0.0	0.00	**0.2**
Total	**0.7**	**0.5**	**7.7**	**0.2**	**1.4**	**0.00**	**10.52**

Table 10-5: Interior Fixtures by Installed Bulb Type by Room, Multifamily – On-Site Data (1999:1-2)

Location	CF Dedicated	CF Other	Incandescent	Halogen	Fluorescent	Other	Total
Kitchen	0.0	0.1	1.7	0.1	1.4	0.00	**3.3**
Family/Living	0.0	0.1	1.2	0.0	0.0	0.00	**1.3**
Bedrooms	0.0	0.1	1.3	0.0	0.0	0.00	**1.5**
Dining	0.0	0.0	0.7	0.0	0.0	0.00	**0.7**
Bath	0.7	0.5	2.0	0.0	0.3	0.00	**3.5**
Halls	0.0	0.0	1.9	0.1	0.0	0.00	**2.0**
Garage	0.0	0.0	0.2	0.0	0.1	0.00	**0.4**
Other	0.0	0.0	0.1	0.0	0.0	0.00	**0.2**
Total	**0.7**	**0.8**	**9.2**	**0.3**	**1.9**	**0.00**	**12.84**

Figure 10-4: Interior Fixtures by Mounted Type – On-Site Data

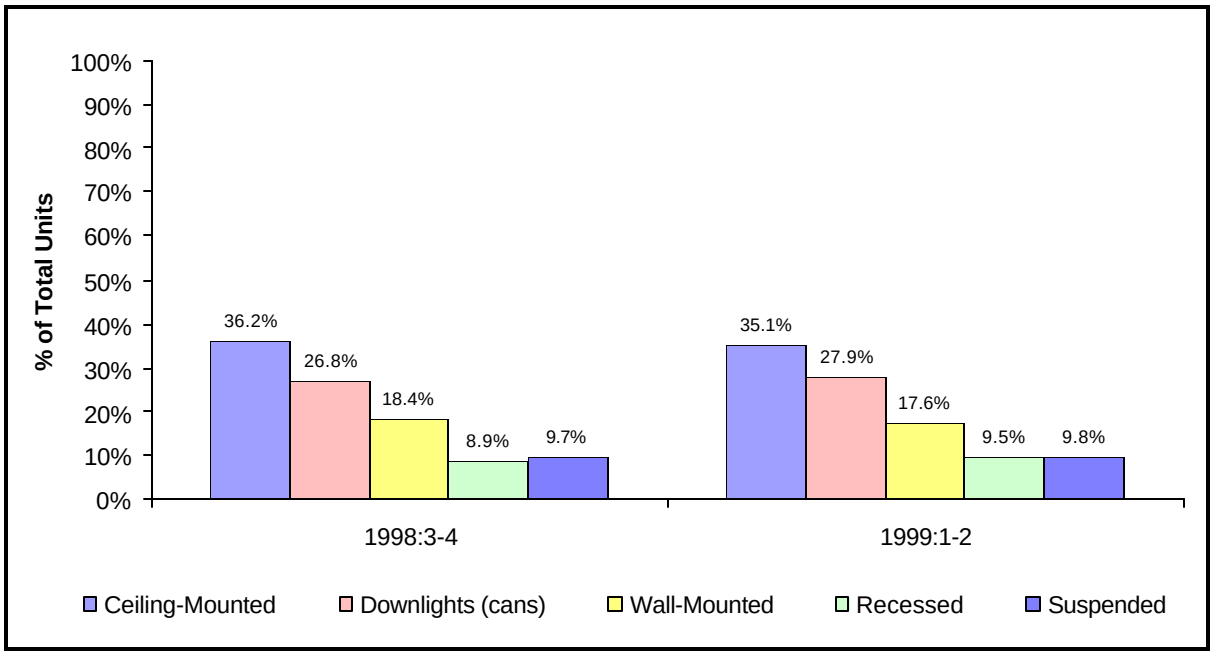


Figure 10-5: Interior Fixtures by Mounted Type, Single Family – On-Site Data

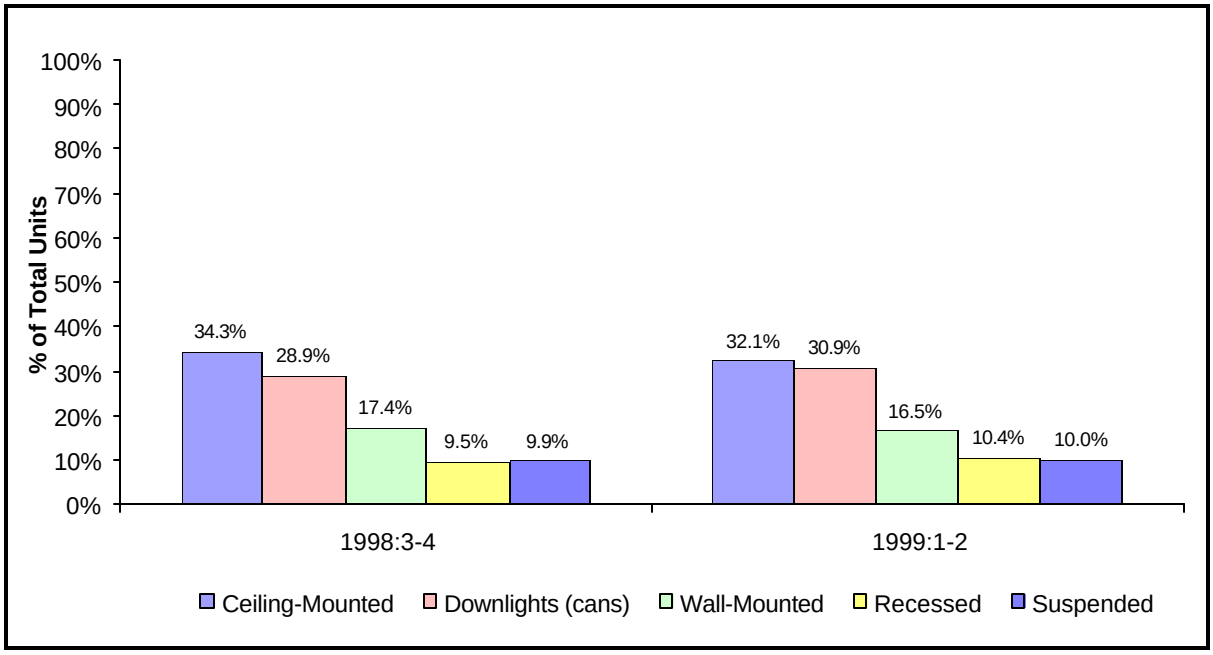
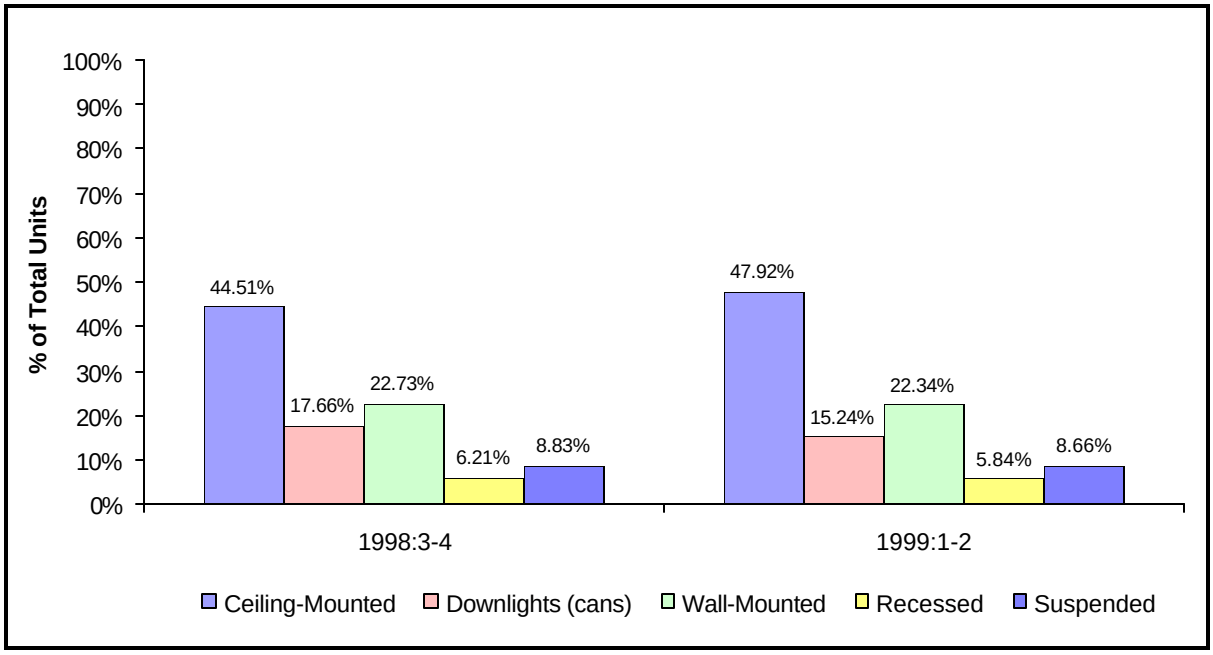


Figure 10-6: Interior Fixtures by Mounted Type, Multifamily – On-Site Data



Interior Bulbs

Table 10-6 presents the average number of Type 1 and Type 2 bulbs per household by residence type. Figure 10-7 presents the distribution of Type 1 bulbs by six-month period. As expected, incandescent bulbs represent the largest percentage of bulbs with over 90% in each period. CFLs represent a share of roughly 6%. The same information by residence type is presented in Figure 10-8.

The distribution of Type 2 bulbs is shown in Figure 10-9. The share of CF reflectors varies from about 7.6% to 11.5% across periods. Figure 10-10 presents similar data for Type 2 bulbs by residence type. As depicted in these figures, multifamily homes have a larger share of CFL reflectors than single family residences.

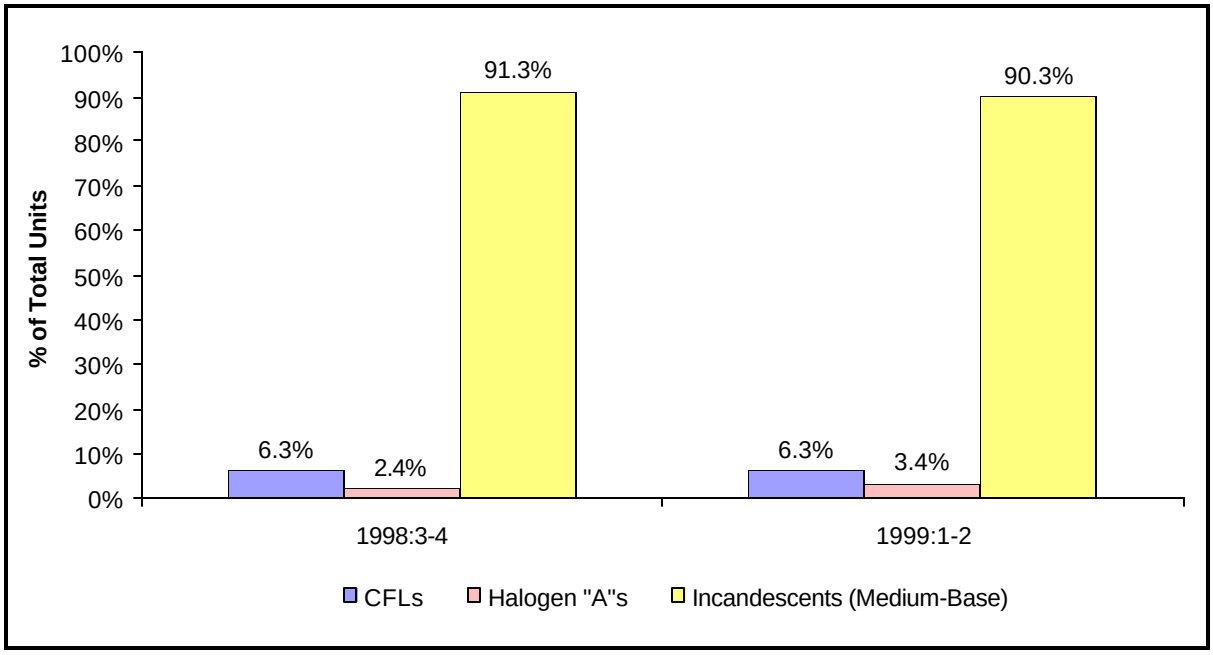
Table 10-7 and Table 10-8 present the average number of Type 1 bulbs by room type for single family and multifamily residences, respectively. Most Type 1 bulbs are found in bathroom areas. CFLs are predominately found in bathroom and kitchen applications. Table 10-9 and Table 10-10 present the average number of Type 2 bulbs by room type for single family and multifamily residences.

Table 10-6: Average Number of Type 1 and Type 2 Bulbs per Household – On-Site Data

	Multifamily		Single Family	
	Type 1	**Type 2**	**Type 1**	**Type 2**
1998:3-4	15.3	3.7	33.2	5.0
1999:1-2	14.9	1.2	33.5	6.1

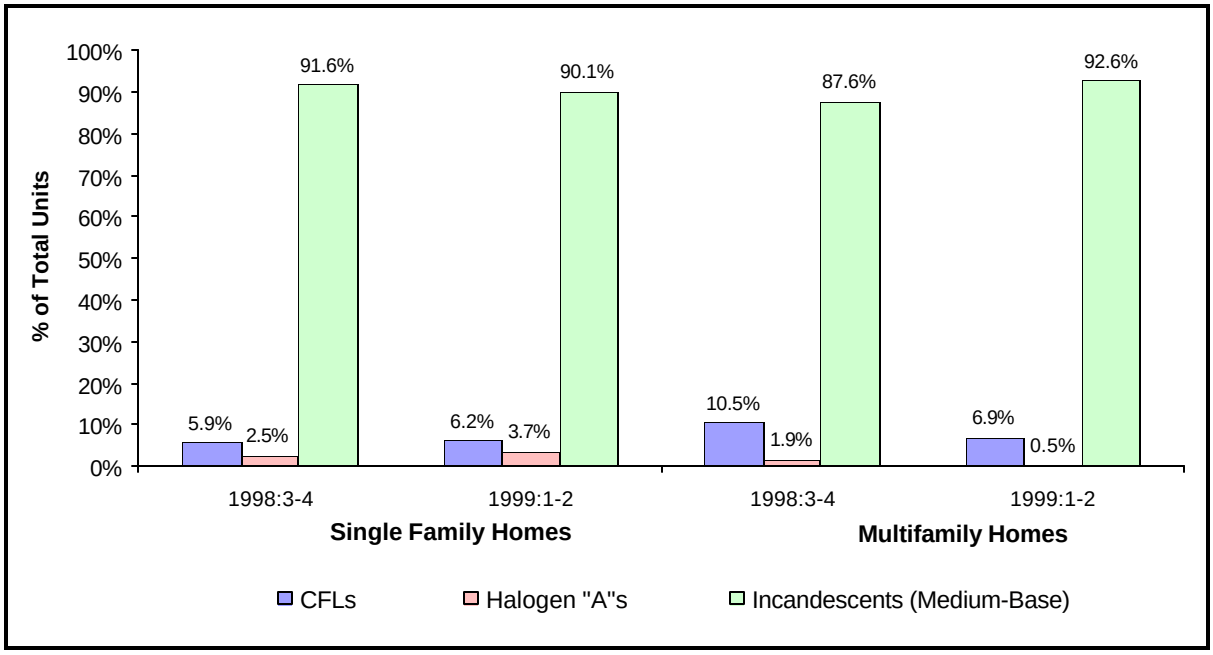
Type 1 bulbs are CFLs or are interchangeable with medium-based CFLs.
Type 2 bulbs are CF reflectors or are interchangeable with incandescent or halogen PAR/Reflector bulbs.

Figure 10-7: Distribution of Type 1 Bulbs – On-Site Data



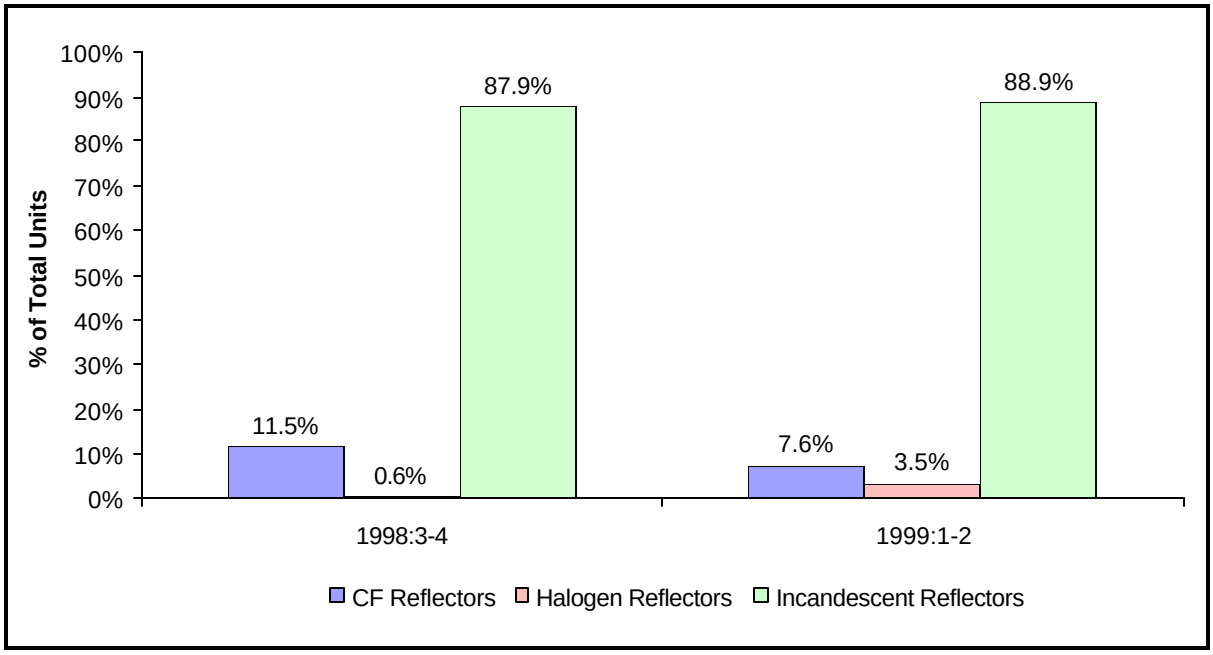
Type 1 bulbs are CFLs or are interchangeable with medium-based CFLs.

Figure 10-8: Distribution of Type 1 Bulbs by Residence Type – On-Site Data



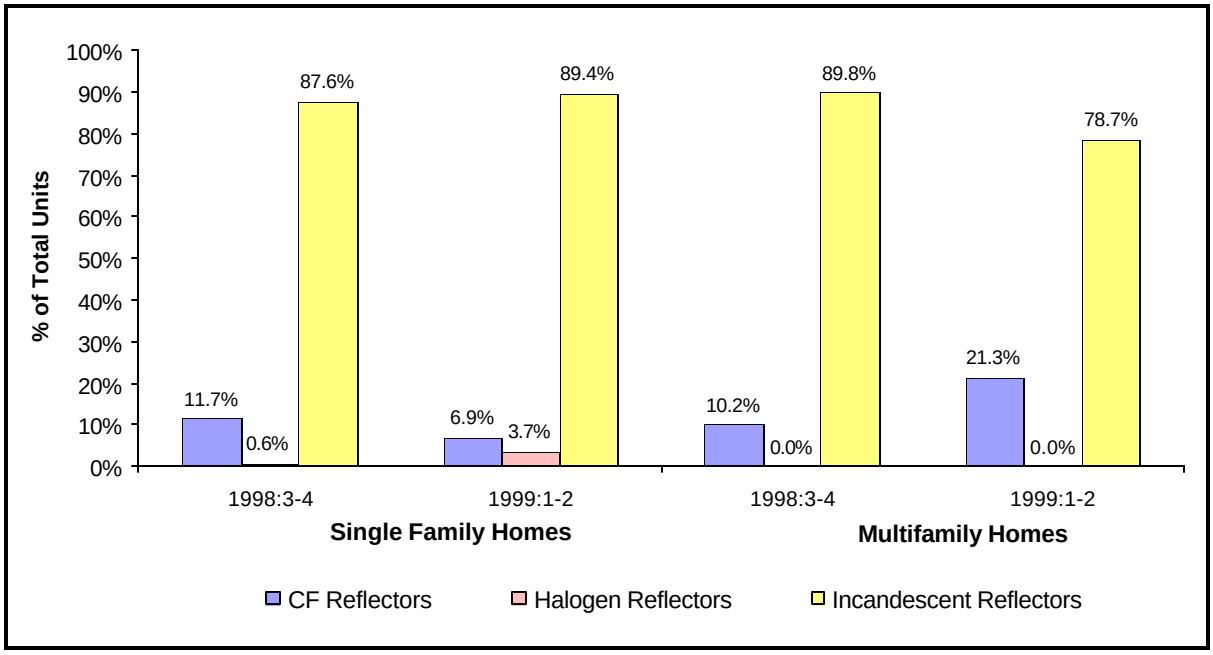
Type 1 bulbs are CFLs or are interchangeable with medium-based CFLs.

Figure 10-9: Distribution of Type 2 Bulbs – On-Site Data



Type 2 bulbs are CF reflectors or are interchangeable with incandescent or halogen PAR/Reflector bulbs.

Figure 10-10: Distribution of Type 2 Bulbs by Residence Type – On-Site Data



Type 2 bulbs are CF reflectors or are interchangeable with incandescent or halogen PAR/Reflector bulbs.

Table 10-7: Average Number of Type 1 Bulbs, Single Family – On-Site Data (1998:3-4)

Location	CFLs	Halogen	Incandescent	Total
Kitchen	0.2	0.2	2.7	3.1
Family/Living	0.0	0.1	2.0	2.2
Bedrooms	0.1	0.1	4.7	4.8
Dining	0.0	0.0	1.6	1.6
Bath	1.6	0.1	14.1	15.8
Halls	0.0	0.3	4.0	4.3
Garage	0.0	0.0	0.6	0.7
Other	0.0	0.0	0.7	0.7
Total	**2.0**	**0.8**	**30.4**	**33.2**

Type 1 bulbs are CFLs or are interchangeable with medium-based CFLs.

Table 10-8: Average Number of Type 1, Multifamily – On-Site Data (1998:3-4)

Location	CFLs	Halogen	Incandescent	Total
Kitchen	0.1	0.1	0.9	1.1
Family/Living	0.1	0.1	1.0	1.1
Bedrooms	0.2	0.0	1.9	2.2
Dining	0.0	0.0	1.1	1.1
Bath	1.1	0.0	6.5	7.6
Halls	0.1	0.1	1.6	1.8
Garage	0.0	0.0	0.3	0.3
Other	0.0	0.0	0.1	0.1
Total	**1.6**	**0.3**	**13.4**	**15.3**

Type 1 bulbs are CFLs or are interchangeable with medium-based CFLs.

Table 10-9: Average Number of Type 2 Bulbs, Single Family – On-Site Data (1998:3-4)

Location	CF Reflector	Halogen	Incandescent	Total
Kitchen	0.1	0.0	1.7	1.8
Family/Living	0.0	0.0	0.6	0.6
Bedrooms	0.0	0.0	0.3	0.4
Dining	0.0	0.0	0.1	0.1
Bath	0.4	0.0	0.6	1.0
Halls	0.0	0.0	1.0	1.1
Garage	0.0	0.0	0.0	0.0
Other	0.0	0.0	0.0	0.1
Total	**0.6**	**0.0**	**4.4**	**5.0**

Type 2 bulbs are CF reflectors or are interchangeable with incandescent or halogen PAR/Reflector bulbs.

Table 10-10: Average Number of Type 2 Bulbs, Multifamily – On-Site Data (1998:3-4)

Location	CF Reflector	Halogen	Incandescent	Total
Kitchen	0.0	0.0	1.0	1.0
Family/Living	0.0	0.0	0.6	0.6
Bedrooms	0.0	0.0	0.4	0.4
Dining	0.0	0.0	0.3	0.3
Bath	0.3	0.0	0.4	0.7
Halls	0.0	0.0	0.6	0.6
Garage	0.0	0.0	0.0	0.0
Other	0.0	0.0	0.1	0.1
Total	**0.4**	**0.0**	**3.3**	**3.7**

Type 2 bulbs are CF reflectors or are interchangeable with incandescent or halogen PAR/Reflector bulbs.

Torchieres and Floor/Table Lamps

This section discusses the saturation and shares of torchieres and floor/table lamps. The shares of torchieres are analyzed from two perspectives. The first is the relative shares of torchieres by bulb types. This perspective provides a means of evaluating the shares of CFL torchieres. The second perspective is the share of torchieres relative to the share of floor/table lamps.

Table 10-11 presents the saturation of torchieres (the percent of homes with at least one) and the average number of torchieres in homes that have at least one torchiere. The saturation and number per household for floor/table lamps is shown in Table 10-12.

Figure 10-11 depicts the relative shares of torchieres and floor/table lamps by six-month period.[1] These data suggest that, from the perspective of all floor/table lamps and torchieres combined, torchieres represent from about 12% to 14% of all lamps.

[1] Note that we have included the time element of the analysis. However, it could be argued that torchieres and floor/table lamps could be purchased at any time since the construction of the home. As such, these data are less useful as a tracking source, and instead provide a snapshot of torchiere and floor/table lamp stocks as of late 1999.

Table 10-11: Saturations and Average Number of Torchieres per Household – On-Site Data

	Multifamily		Single Family	
	Saturation	Average Number/Home*	Saturation	Average Number/Home*
1998:3-4	40.8%	1.6	33.1%	1.7
1999:1-2	37.0%	1.7	35.5%	1.4

* Average number per home is average number per home with at least one torchiere.

Table 10-12: Saturation and Average Number of Floor/Table Lamps per Household – On-Site Data

	Multifamily		Single Family	
	Saturation	Average Number per Home*	Saturation	Average Number per Home*
1998:3-4	83.5%	3.3	88.7%	5.3
1999:1-2	74.7%	5.3	88.8%	2.9

* Average number per home is average number per home with at least one floor/table lamp.

The distribution of torchieres by bulb type is shown in Figure 10-12. As shown, halogen-type torchieres constitute the vast majority of torchieres with a share of about 70% of the lamps. CFLs have a relatively small share at under 2%. Figure 10-13 presents similar data by residence type. The distribution of floor/table lamps by bulb type is illustrated in Figure 10-14. As shown, incandescent-type lamps have an overwhelming share at more than 96% of all lamps.

Figure 10-11: Relative Shares of Torchieres and Floor/Table Lamps – On-Site Data

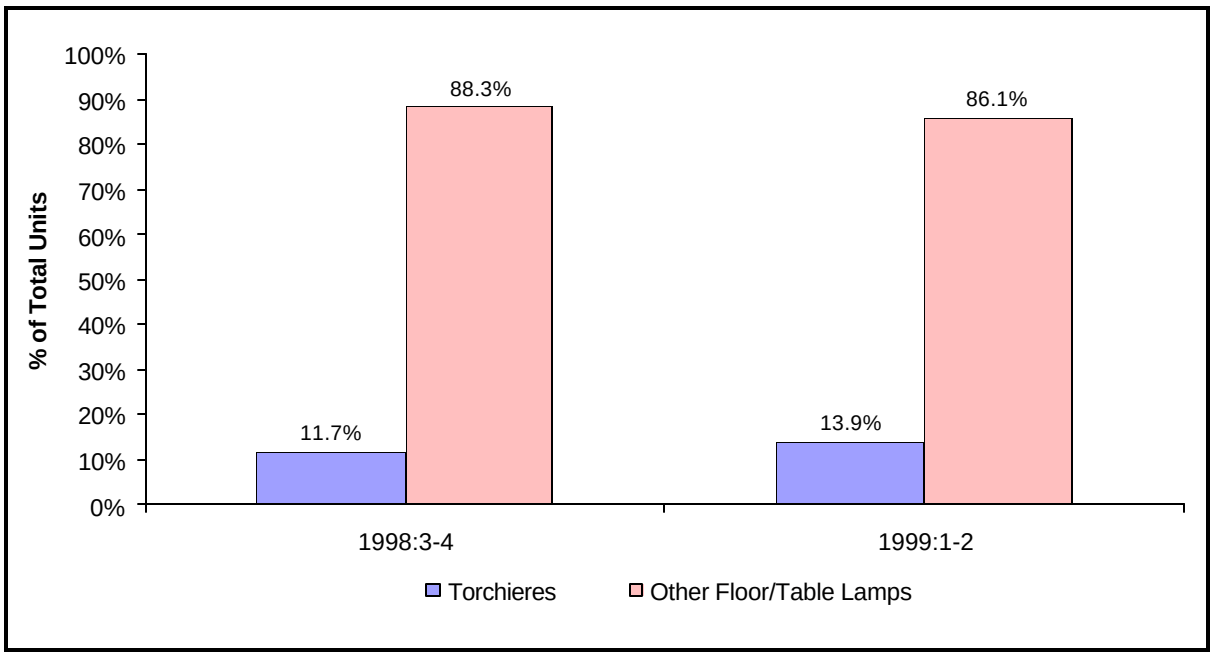


Figure 10-12: Distribution of Torchieres by Bulb Type – On-Site Data

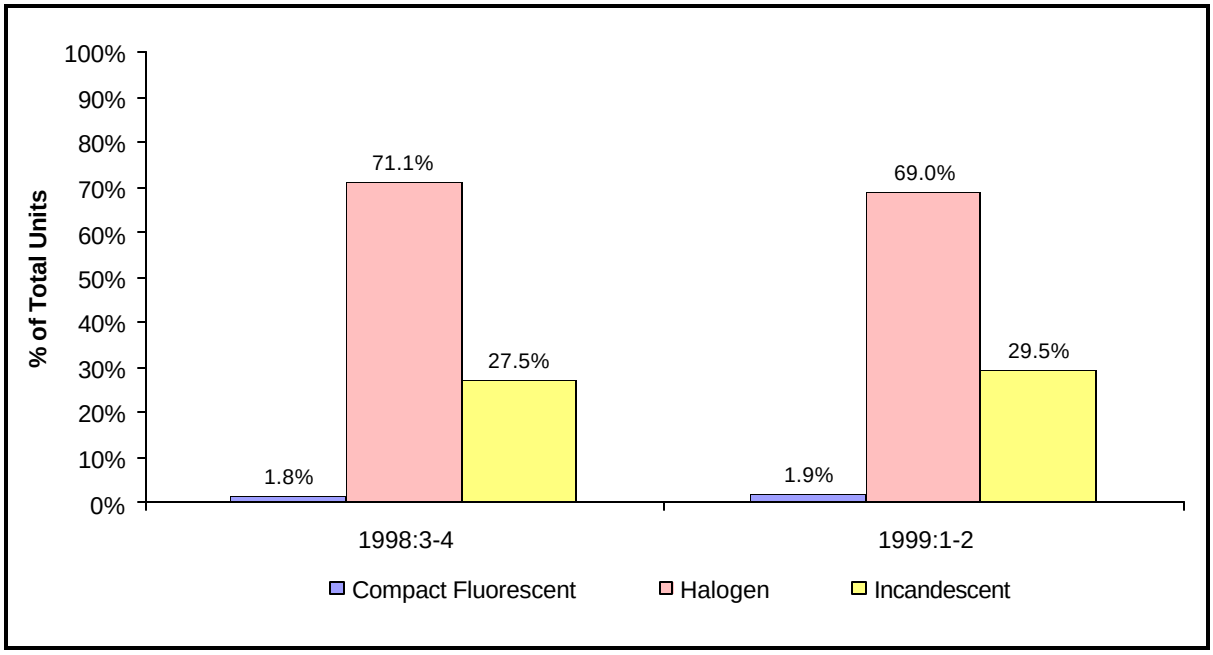


Figure 10-13: Distribution of Torchieres by Bulb Type and by Housing Type – On-Site Data

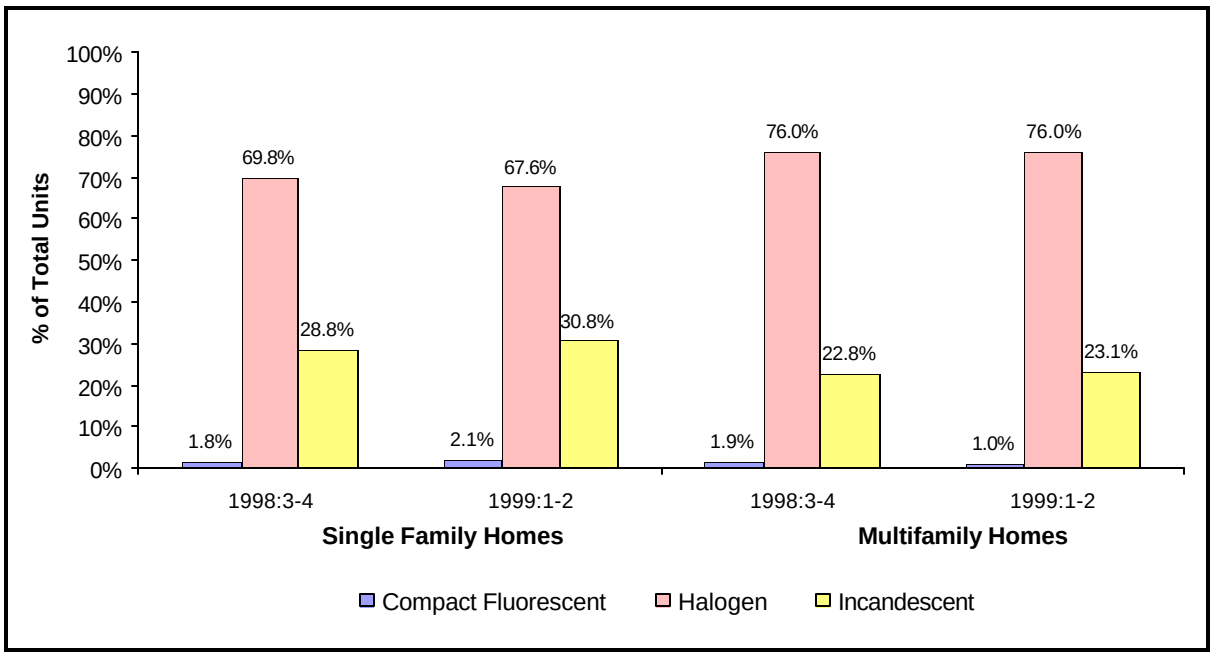
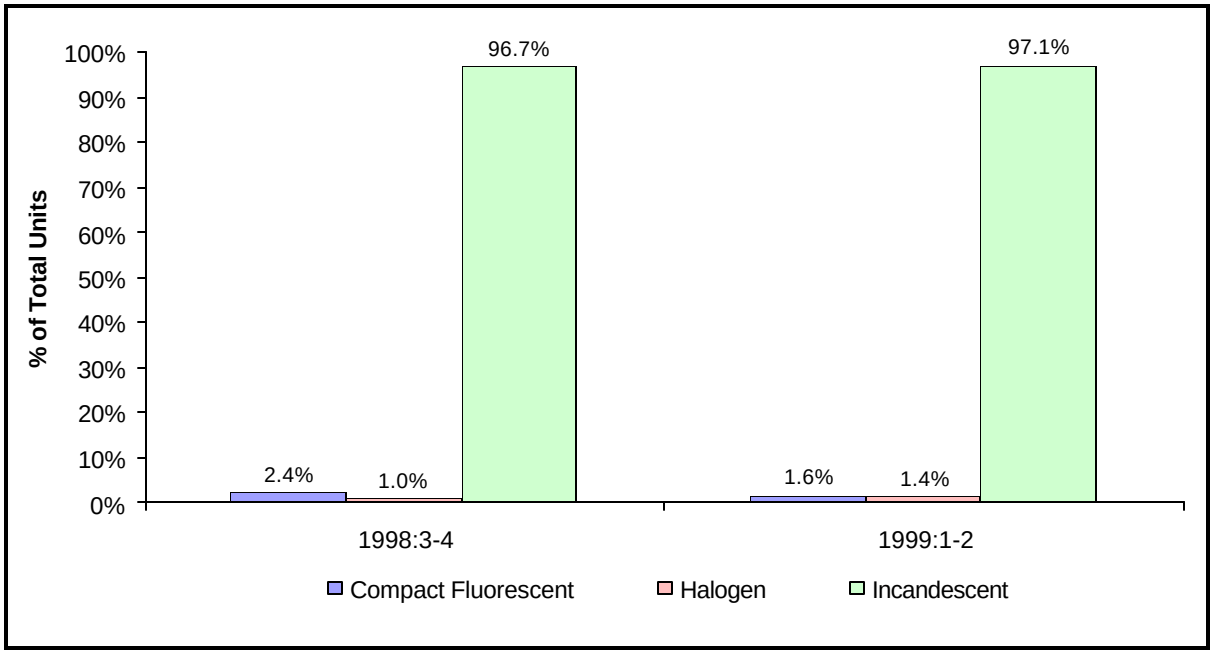


Figure 10-14: Distribution of Floor/Table Lamps by Bulb Type – On-Site Data



Exterior Lighting

This section discusses exterior lighting and is organized into two subsections:

- Exterior Fixture Data
- Exterior Bulb Data
  - Type 1: This group includes incandescent (Medium Base), CFLs and Halogen "A" type.
  - Type 2: This group includes incandescent PAR/Reflectors, CFL Reflectors, and Halogen PAR/Reflectors

Exterior Fixtures

The analysis of exterior lighting fixtures is based upon the type of bulb installed in each fixture, the mount type of the fixture, and the distinction between hard-wired dedicated CFL fixtures and non-dedicated CFL fixtures.

Table 10-13 presents the average number of exterior fixtures per household. In the case of multifamily homes, this might be misleading as it pertains only to lighting controlled by an individual unit. That is, these averages do not include common area lighting.

Figure 10-15 presents the distribution of exterior fixtures by bulb type. As shown, the majority of exterior fixtures are incandescent, comprising roughly 90% of fixtures. The results by mount type is depicted in Figure 10-16, while Figure 10-17 and Figure 10-18 present the same results for single family and multifamily residences, respectively. Figure 10-19 presents the distribution of exterior fixtures by control type. As expected, wall mounts account for the majority of applications.

Table 10-13: Average Number of Exterior Fixtures per Household – On-Site Data

	Multifamily	Single Family
1998:3-4	2.6	4.5
1999:1-2	2.0	4.4

Figure 10-15: Distribution of Exterior Fixtures by Bulb Type – On-Site Data

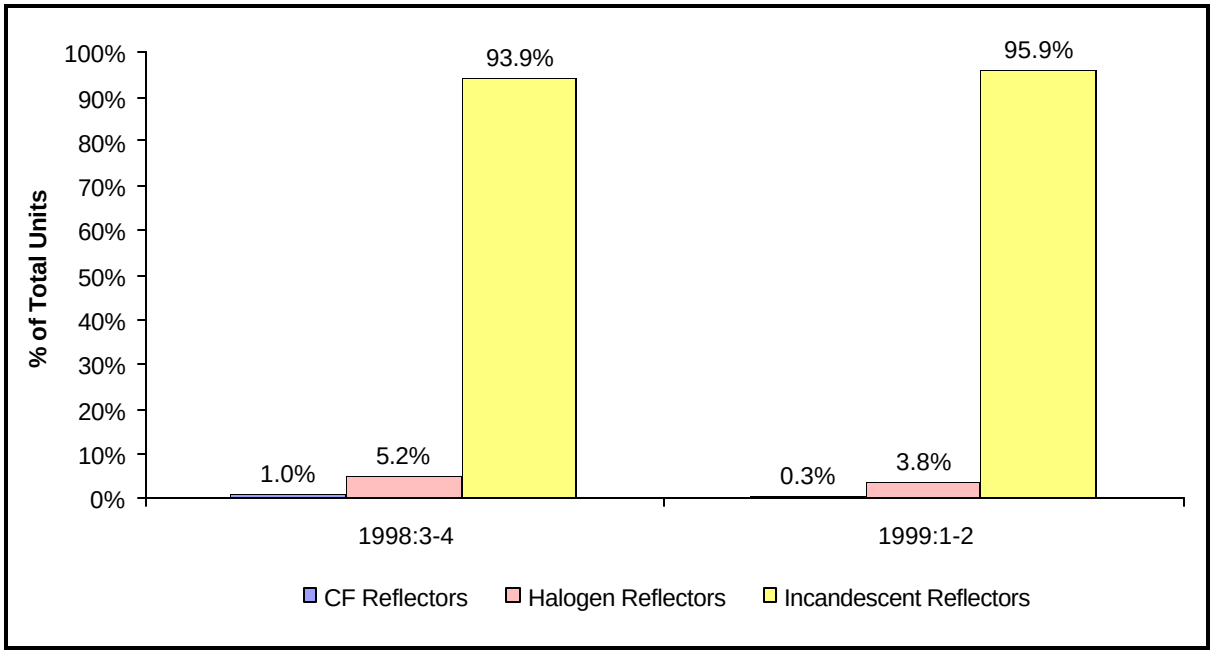


Figure 10-16: Distribution of Exterior Fixtures by Mounted Type – On-Site Data

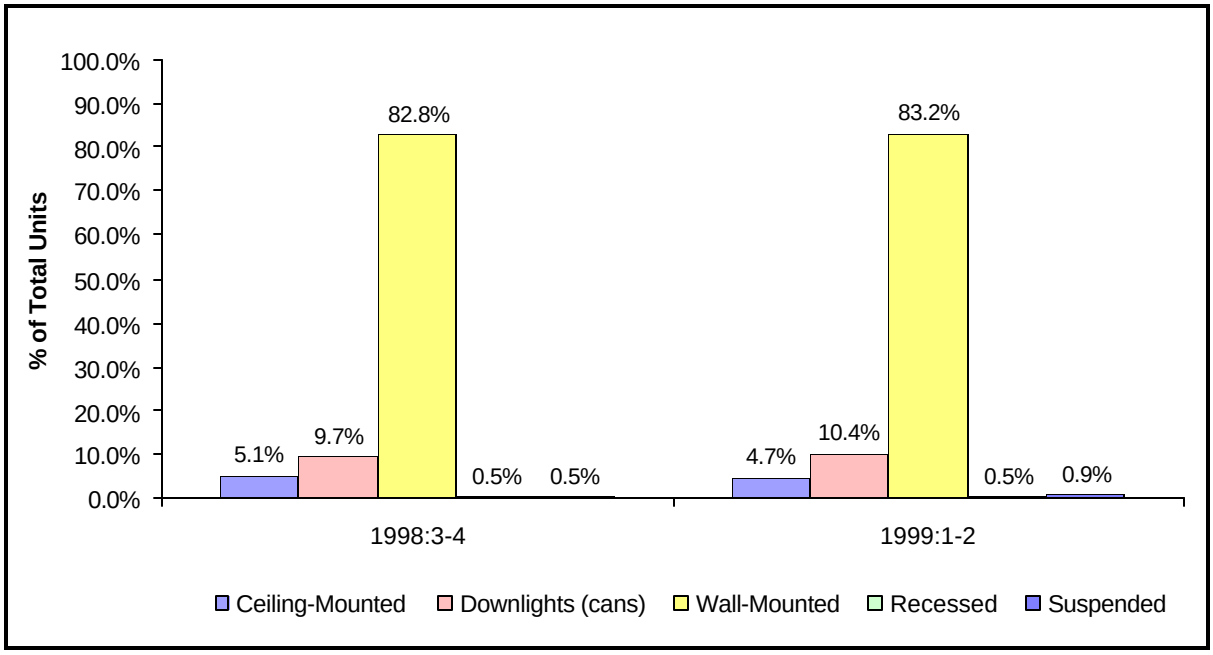


Figure 10-17: Exterior Fixtures by Mounted Type, Single Family – On-Site Data

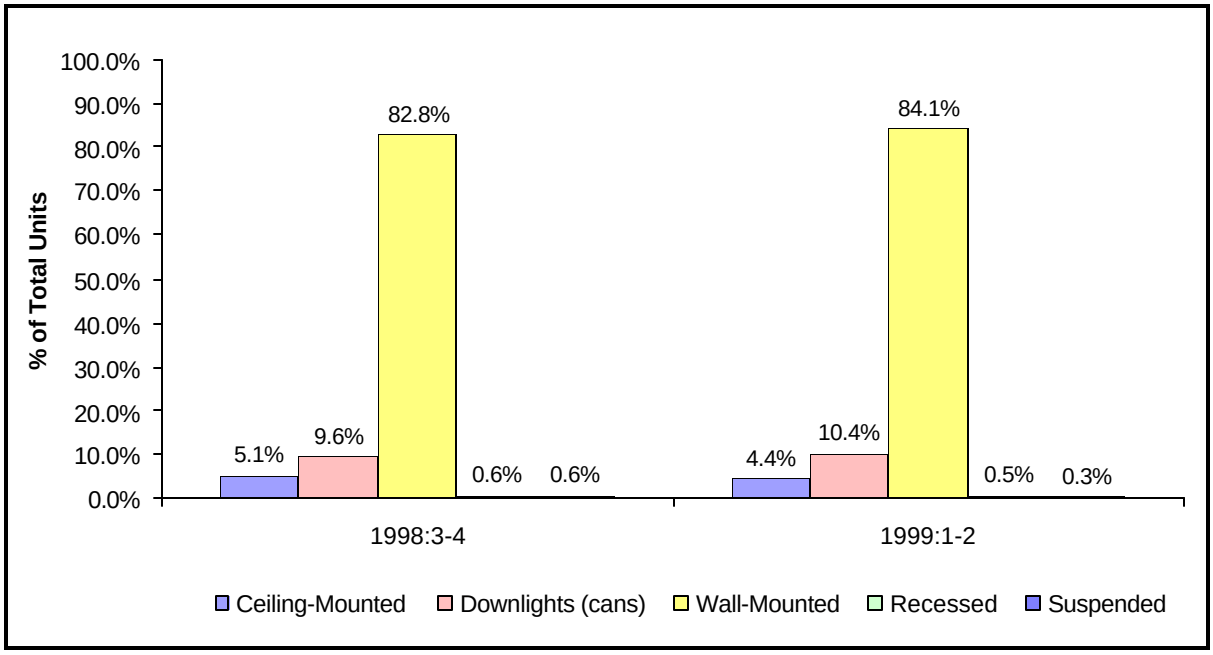


Figure 10-18: Exterior Fixtures by Mounted Type, Multifamily – On-Site Data

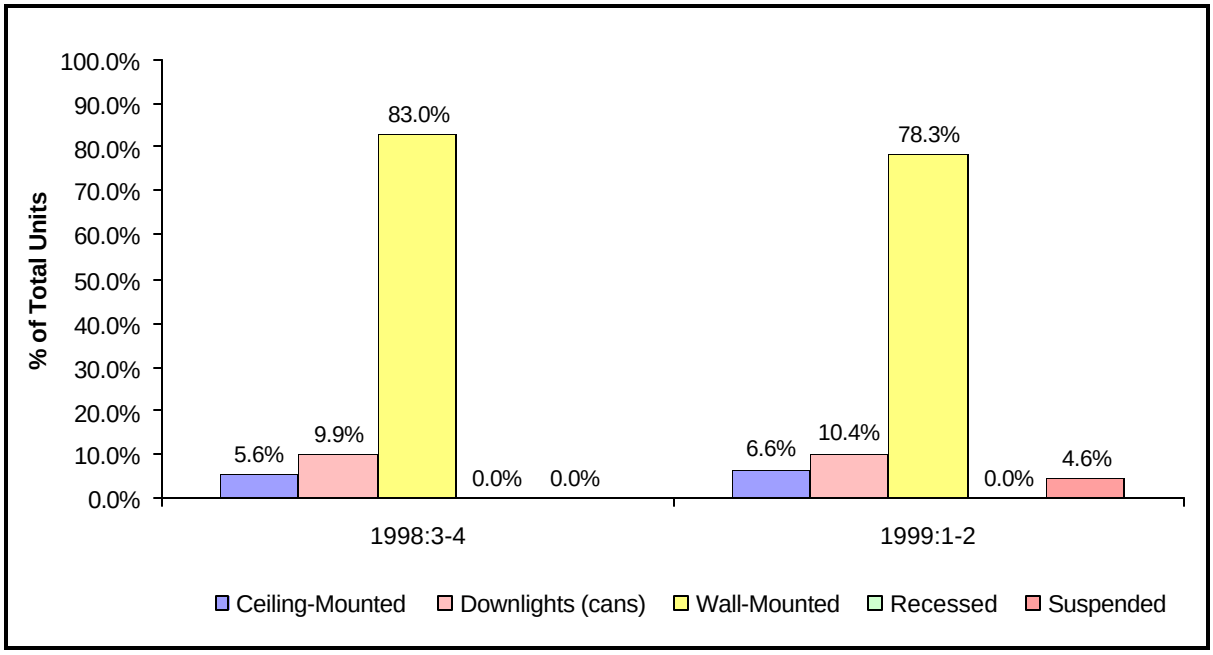
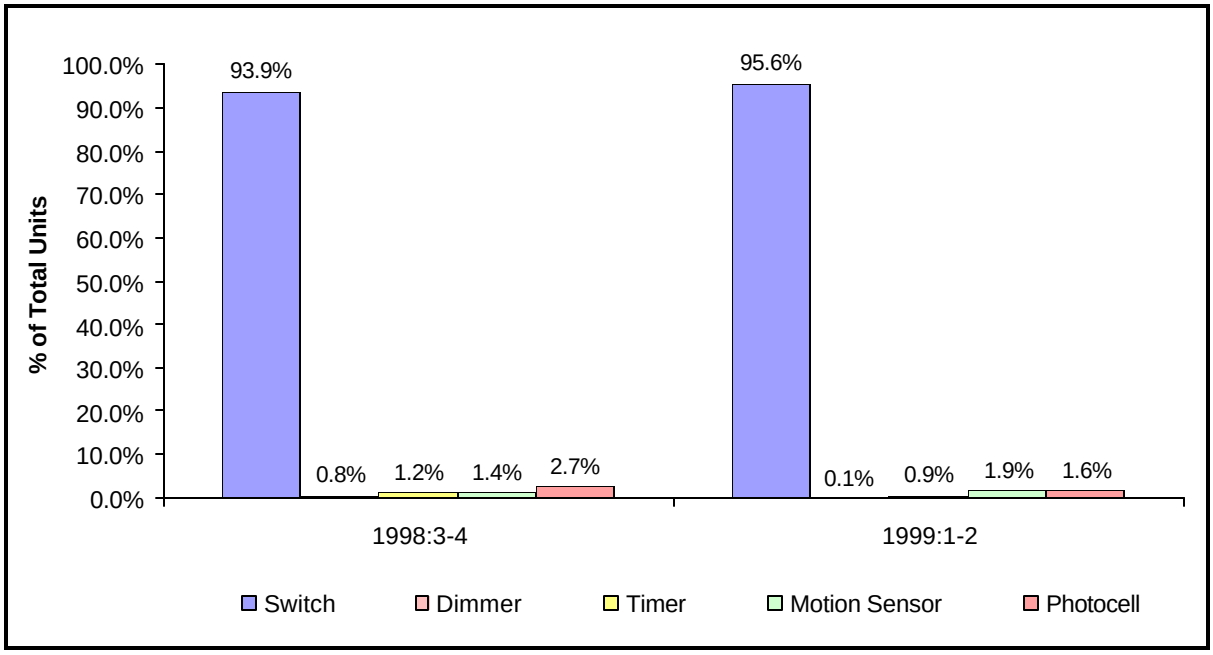


Figure 10-19: Distribution of Exterior Fixtures by Control Type – On-Site Data



Exterior Bulbs

Analysis of exterior bulb data is based upon interchangeable bulb types. That is, to estimate the share of CFLs, it is necessary to determine the share of CFLs relative to the number of bulb *applications* that can use a CFL. Based on this approach, RER developed two groupings of bulbs:

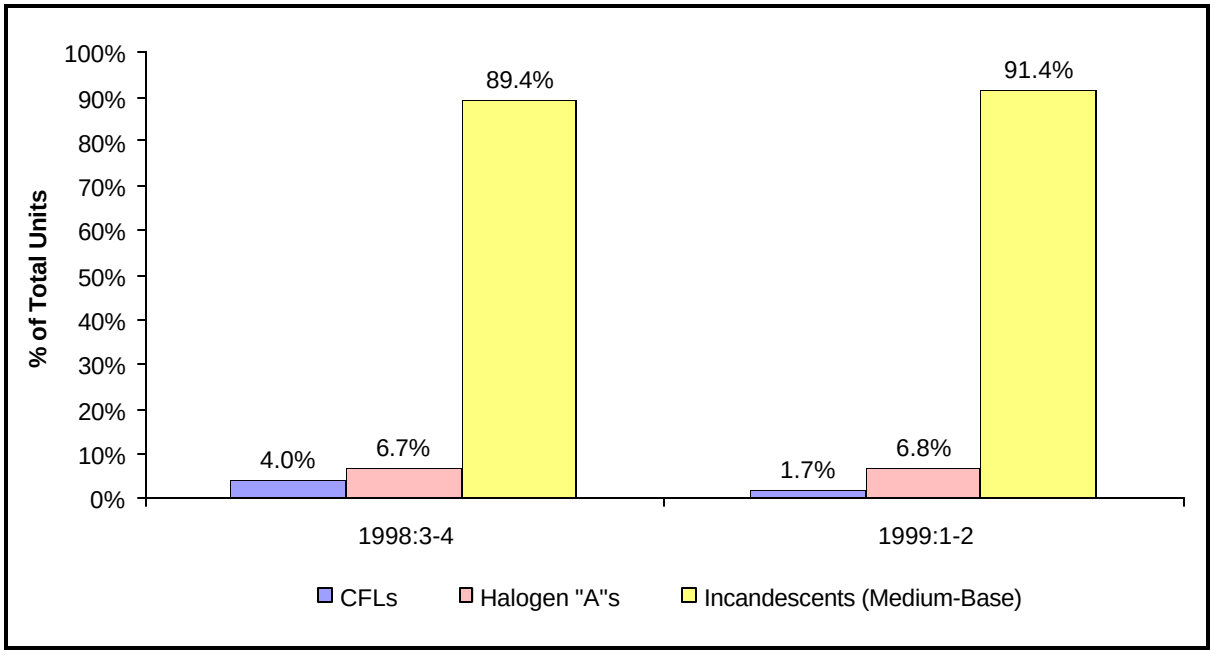
- ***Type 1:*** This includes the following interchangeable types of bulbs:
  - Incandescent (Medium Base),
  - CFLs, and
  - Halogen "A"s.
- ***Type 2:*** This includes the following interchangeable types of bulbs:
  - Incandescent PAR/Reflectors,
  - CF Reflectors, and
  - Halogen PAR/Reflectors.

Table 10-14 presents the average number of Type 1 and Type 2 bulbs per household by residence type and Figure 10-20 presents the distribution of Type 1 bulbs by six-month period. As expected, incandescent bulbs represent the majority of exterior of bulbs within each period. CFLs represent a share of roughly 2% to 4%. As shown in Figure 10-21, the share of CF reflectors is less than 1%.

Table 10-14: Average Number of Type 1 Exterior Bulbs per Household – On-Site Data

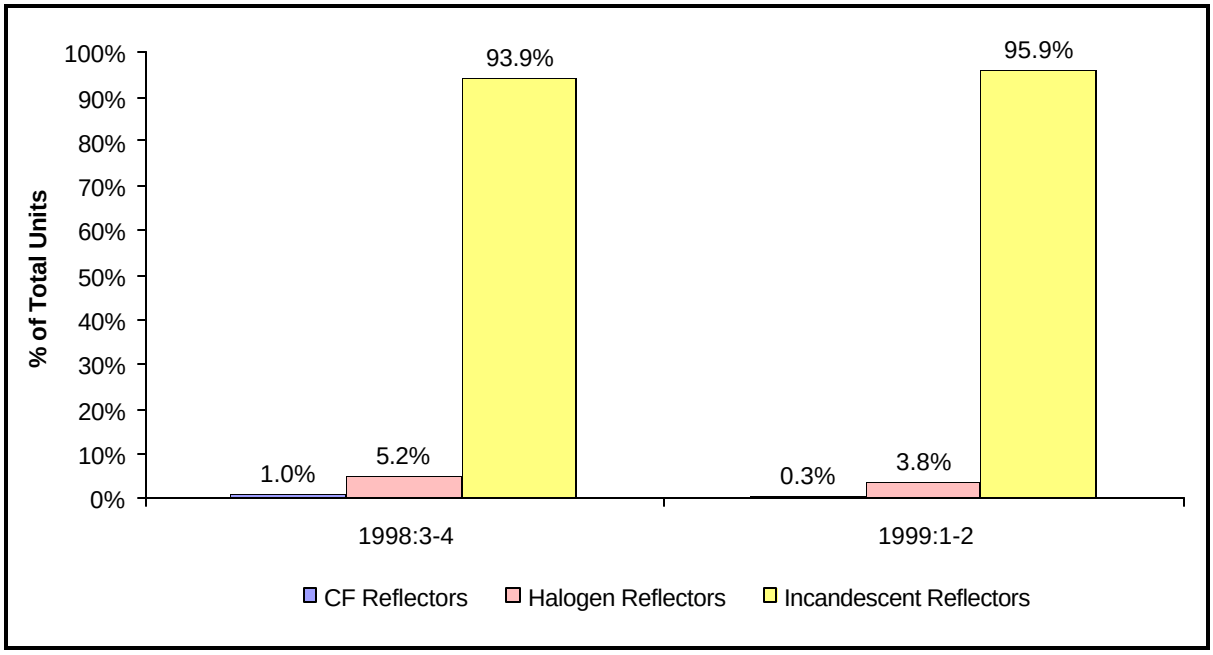
	Multifamily		Single Family	
	Type 1	**Type 2**	**Type 1**	**Type 2**
1998:3-4	2.2	0.1	3.8	0.3
1999:1-2	2.0	0.0	4.0	0.3

Figure 10-20: Distribution of Type 1 Exterior Bulbs – On-Site Data



Type 1 bulbs are CFLs or are interchangeable with medium-based CFLs.

Figure 10-21: Distribution of Type 2 Exterior Bulbs – On-Site Data



Type 2 bulbs are CF reflectors or are interchangeable with incandescent or halogen PAR/Reflector bulbs.

Lighting Connected Loads

RER was not charged with reviewing the issue of connected lighting load under the scope of the RMST project. However, some experts in the lighting industry have shown interest in this subject. Therefore, we present the following connected load analysis as an indication of baseline connected load in new construction.

The data collected contains a description of each fixture, which includes the wattage and number of bulbs per fixture. The following equation was used to find the total connected load per household (*h*) by summing across fixture items (*i*):

$$Connected\ Load_h = \sum_i \left(\#of\ \ fixtures_{h,i} * \#\ of\ bulbs\ per\ fixture_{h,i} * wattage\ per\ bulb_{h,i} \right)$$

Results. Table 10-15 presents the average interior and exterior connected load per household by residence type. Figure 10-22 and Figure 10-23 show the average distribution of the interior lighting connected load by room for single family and multifamily households, respectively.

Table 10-15: Average Total Connected Load (Watts) by Residence Type – On-Site Data

	Multifamily		Single Family	
	Interior	Exterior	Interior	Exterior
1998:3-4	1,478	167	2,746	320
1999:1-2	1,216	164	2,790	164

Figure 10-22: Distribution of Average Interior Connected Load, Single Family – On-Site Data

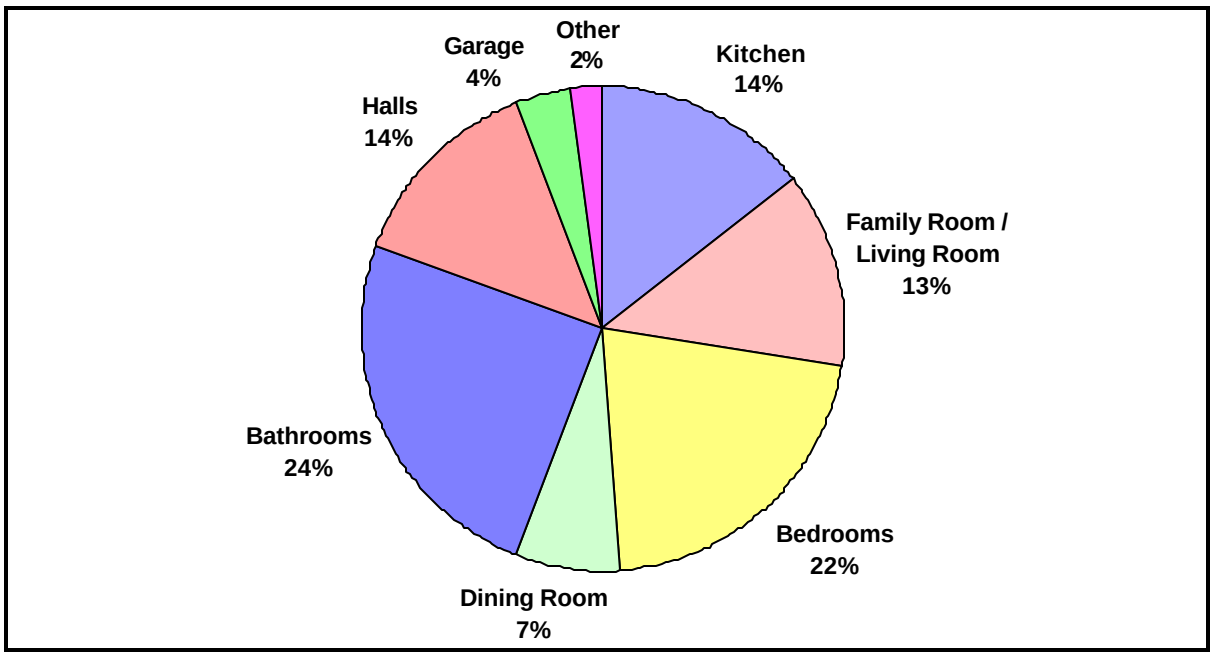
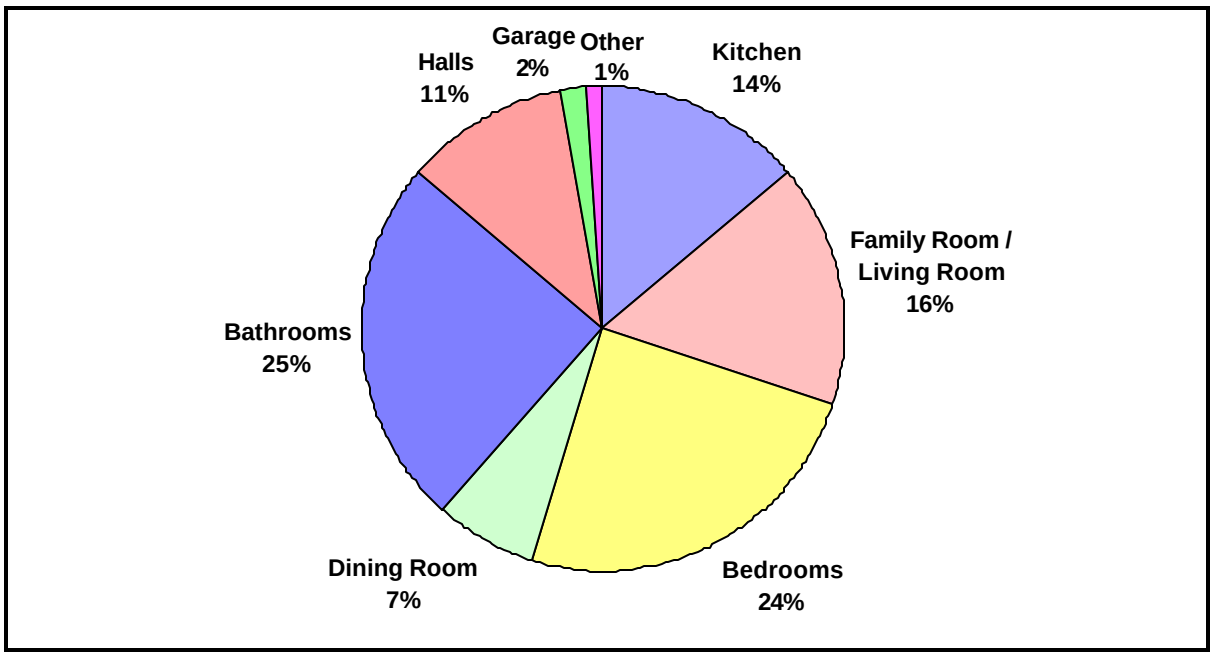


Figure 10-23: Distribution of Average Interior Connected Load, Multifamily – On-Site Data



11

Retrospective, Work In Progress and Second-Year Tracking Activities

11.1 Introduction

Residential market share tracking in California is an ongoing, long-term effort designed to support publicly funded energy efficiency program planning and related policy decisions over the next several years. This report represents the first of many interim reports for the RMST project – subsequent reports will be prepared on a periodic basis yet to be determined. In many respects, the first year was devoted to developing the RMST project to operate on a long-term basis. RMST is a dynamic project in the sense that efforts to recruit retailers, distributors, building departments, and others will be ongoing throughout the project's lifetime.

Preparation of this first interim report was the opportune time to evaluate the project's successes and failures, and to make mid-course corrections if necessary. This first report also serves as an appropriate conduit for communicating our course of action for the upcoming year.

This section presents our thoughts on some of the highlights and lowlights of the RMST project during the past year and briefly previews work in progress and our objectives for the second year. Specifically, development strategies are examined for the four primary components of the project: new construction on-site surveys, the collection of CF-6R installation forms, the collection of HVAC and water heating equipment sales data from distributors, and the collection of appliance sales data from retailers.

11.2 New Construction Sector Data Collection

As discussed in Section 3.8, the project team's primary focus with respect to data collection in the new construction sector is to administer the second round of 800 on-site surveys, continue to expand coverage of CF-6R installation forms and recruit contractors to provide installation data for units installed in new homes.

Second-Year On-Site New Construction Survey

RER anticipates conducting on-site surveys for 800 homes constructed between July 1, 1999 and June 30, 2000 during the second project year. These data will populate the current new construction market tracking database and will provide valuable data for other statewide MA&E projects, including the baseline assessment of practices relating to Title 24 compliance. There has also been considerable interest in the appliance and lighting information gathered in the first-year of the on-site survey effort. RER will work with interested parties to refine the on-site data collection form to obtain key data of interest for these parties. For example, RER anticipates expanding the lighting and appliance section of the survey to include collecting data on ceiling fan lighting and ceiling fan efficiency. We will also institute changes in the survey protocol based on our first-year experience. A prime example of this is in the multifamily sector where a number of HVAC and water units were found to be inaccessible. Screening homes to ensure that all of the key appliances are accessible for inspection can overcome this shortfall.

Building Department Data

RER has developed a good working relationship with a number of building departments to the point that they send CF-6R forms on a regular basis. We will continue to foster these relationships and strive to increase participation by other building departments. In particular, a number of meetings have been set up in an attempt to recruit building departments that have shown interest in participating. Our focus will be in areas where there is currently relatively poor coverage, such as SDG&E's service area.

Builder and Contractor Data

As described in Section 3, RER was fairly successful in recruiting building departments throughout California to submit CF-6R installation forms for efficiency tracking. However, most building departments are not collecting the CF-6R forms for a number of reasons. First, building departments are typically short-staffed and overburdened (in part due to the strong economy and new housing boom). Second, building departments strive to keep the building permitting and compliance process and streamlined as possible for builders and contractors.

For these reasons, RER's goal for the second year is to target market actors, in addition to building departments, that complete different portions of the CF-6R forms (i.e., builders, HVAC and/or DHW contractors).

- ***Builders.*** CF-6R forms are typically posted in the garage of the home being built. Therefore, RER contacted a sample of residential builders and developers to determine if builders kept a copy of the form after the house is complete. RER contacted 18 prominent builders throughout California to learn builder practices with respect to record keeping and to request CF-6R forms. RER then attempted a

variety of methods to recruit builder participation including telephone calls, letters, and faxes. Even though the builders contacted were not willing to assist with this effort, RER staff continues to contact builders that are still considering participation. However, based on conversations to date, it is unlikely that they retain the CF-6R forms and it is unlikely that they will collect them for this effort in the future.

- ***Contractors.*** Contractors are a very valuable source of information. Most contractors work with many builders, spanning several building department territories. Therefore, a single contractor can provide data that would otherwise need to be collected from many sources. RER staff first contacted contractors that signed the installation forms already provided by building departments. RER also developed new project marketing materials to specifically target contractors. This process revealed that some companies do not retain the CF-6R forms, but instead maintain records on the equipment installed in an alternative format (i.e., electronic database). RER emphasized that data on installed measures, in any format, will certainly be acceptable.

  To date, RER has contacted 18 HVAC contractors and 15 DHW contractors for this effort. Overall, the contractors were much more willing to assist with this effort than the builders. One of the largest residential HVAC contracting companies in California has agreed to participate in the project by providing past installation data (via CF-6R forms), and will likely provide data on an ongoing basis. Another very large company will provide qualitative and "semi-quantitative" information on a regular basis. In addition, several others have agreed to provide RER with installation data on a monthly basis. RER continues to maintain contacts with all participants, and is continuously working to recruit additional contractors.

11.3 HVAC and Water Heating Equipment Distributor Data Collection

The HVAC and water heating data collection effort had mixed success during the first project year. RER successfully recruited some companies to provide data, but there were, and will continue to be, significant obstacles to overcome during the second year. These include the following:

- The HVAC wholesale market remains intensely competitive. This leaves distributors to be very protective and wary about releasing competitively sensitive information, despite our assurances of confidentiality.
- HVAC and water heating equipment distributors are extremely busy and have serious resource constraints. This is partly or mostly due to the strong economy and booming new construction market in California. As a result, some distributors want to, but cannot participate in the RMST project (despite offers to compensate for their time and resources required).

Our primary objectives for the distributor data collection effort during the second year are to continue to develop relationships with equipment distributors and increase the coverage of data in the database, particularly coverage at the utility service area. Specific goals include, but are not limited to, the following:

- Provide summaries to current panel members, as promised during the recruiting process.
- Review project marketing materials and revise if deemed necessary.
- Continue to work with companies not in the first-year panel that have expressed an interest in participating.
- Maintain relationships with retailers in the current panel.
- Expand efforts to recruit manufacturer dealers and large nationally based equipment wholesalers.
- Investigate options for discerning sales for new construction from replacement units in the data provided by the panel.

11.4 Retail Appliance Data Collection

The retail data collection effort was fairly successful during the first project year. RER developed a positive and mutually beneficial working relationship with D&R to obtain national appliance retail data, and successfully recruited small, independent retailers to represent this somewhat elusive market channel. Several retailers in the panel provide sales reports automatically on a monthly basis, and most retailers seemed interested in the project and willing to learn more about the project's goals and objectives. Similar to the distributor recruiting efforts, time and resource constraints are the most prominent obstacles to overcome in expanding the panel during the second year.

Our primary objectives for the appliance retail data collection effort during the second year is to continue to develop relationships with retailers and increase the coverage, particularly the utility service area. In particular, these goals include the following:

- Provide summaries to current panel members, as promised during the recruiting process.
- Review project marketing materials and revise if deemed necessary.
- Continue to work with companies not in the first-year panel that have expressed an interest in participating.
- Maintain relationships with retailers in the current panel.

- Expand efforts to recruit regional chains and large independently owned companies.

11.5 Retail Lighting Equipment Data Collection

Tracking lighting bulb and fixture sales has been the most time consuming and frustrating element of the study. Our initial approach followed the steps outlined in our Scoping Study and was refined in the workplan for this study.[1] The approach included recruiting major lighting retailers and coordinating data collection efforts with the California statewide lighting program. While these approaches showed some promise in the early stages of the project, it was obvious that they would not be able to provide the detailed market share tracking information needed for this study. Although there are a number of reasons for the failure of an approach to collect data through retailers and manufacturers, the overarching hurdle was the proprietary nature of the data. In particular, no amount of disclaimers or confidentiality agreements could overcome the skepticism of retailers and manufacturers to disclose their sales data.

The project team then returned to purchasing point of sale data. Our initial inquiries into purchasing these data during the scoping study and at the beginning of this study led us to believe that this would be a cost prohibitive option. However, we spent considerable time meeting with the national market research companies and negotiated to receive California utility service territory level data, and national data that could be used for comparisons. To date, we have purchased detailed information on bulb sales for the following market channels:

- Drug Stores,
- Food Stores,
- Mass Merchandizers,
- Major Home Improvement Chains, and
- Regional Hardware and Home Improvement Stores.

The bulb data from these sources includes detailed monthly sales data on over 10,000 line items and will be delivered to RER semi annually. We are, however, required by our agreements to report only market share data on efficiencies and sales volumes by bulb types and not to disclose any manufacturer or retailer level statistics. This requirement is consistent with the objectives of this study.

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[1] Regional Economic Research, Inc. *Efficiency Market Share Tracking Needs Assessment and Feasibility Scoping Study*. Prepared for the California Board for Energy Efficiency and Pacific Gas & Electric. May 10, 1999.

RER is currently working with the first set of data and we expect to develop and release the first lighting report by the middle of September 2000. We are working closely with members of the lighting community to ensure that we are developing useful information beyond the scope of the RMST project.

In addition to this effort, we are working with point of sales data vendors to develop a sales tracking system for lighting fixtures. Insofar as this is not a line of business offered by the firms, the project team is spending a substantial amount of time helping to design a lighting fixtures point of sales monitoring system with them. Our goal is to develop a workable fixture tracking system by the end of the year.

11.6 Database Construction and Process Automation

Collecting data is just half the battle for tracking efficiencies over time. Once data is collected – whether through on-site surveys or from panels of retailers and distributors – a considerable level of effort is required to transform data into information useful for efficiency tracking. For example, most data obtained from retailers and distributors included manufacturer model numbers and the quantity of each sold in a given period. Technical information on energy use for each model needed to be merged to the data for each unique model number. The resources available for merging this information electronically are not comprehensive, and are only updated on a periodic basis. Model numbers for which no data can be found must be dealt with by hand on a case-by-case basis. Similarly, the new construction data collection effort involves a series of quality control measures to ensure the accuracy of the data recorded during on-site surveys.

While data processing will become more efficient over time, RER has already begun to review current procedures and data processing routines to automate the data processing and reporting as much as possible, without forgoing the integrity and accuracy of the data. Topics of discussion include the following:

- Investigate means to further automate the process of adding new data from panel members.
- Assess the practicality of combining the supporting measure efficiency databases (those maintained by ARI, GAMA, AHAM, and CEC) to simplify and further automate the process of merging efficiency parameters to the sales data obtained from panel members.
- Evaluate supporting measure efficiency databases to determine how the RMST database could be updated automatically as new technical data for available equipment and/or new equipment becomes available.

- Because the format and notation of models numbers differs across panel members and organizations that maintain the directories, merging efficiency parameters to the RMST database is a formidable and lengthy process. Thus, RER will investigate means to mitigate these obstacles so the process is more efficient, accurate, and successful.
- Evaluate constructing a common database to store (and update) all the supporting efficiency databases.
- Develop a common database in which the new construction data (on-site and CF-6R) and the retail and distributor appliance and HVAC equipment data would be stored. This would help RER achieve the goal of reporting results where the data could be interacted in appropriate ways to discern the efficiency levels of new construction installations from those of retrofits and replacements.

11.7 Develop Streamlined Reporting

This first interim report includes considerable detail relating to the development of the RMST project components. However, preparing a report of this detail periodically over the next several years would be uneconomical and considerably repetitive. Over the next several weeks, RER will investigate alternatives for a streamlined reporting process. RER will likely solicit feedback from the RMST project manager, utility MA&E managers, and other future audiences of these analyses.

Furthermore, RER will investigate ways of making the RMST reports and data available for review and/or distribution through other means, such as the Internet or CD-ROM. While proprietary data will not be available to the public, tracking data could be available at some aggregated level. RER and the RMST project manager will discuss all viable options.