California Residential Efficiency Market Share Tracking

HVAC 2002

Prepared for:

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Introduction

This report is part of the California Residential Market Share Tracking project (RMST)[1], which includes examinations of appliances,[2] HVAC equipment, lamps,[3] and new construction.[4] The objective of each report is to present the market share of high efficiency products as well as average efficiencies of the examined groups of products over time within the California residential market. Currently, full reports with their coordinating executive summaries are published annually. The biannual executive summaries, which contain mid-year updates, are published in the interim six-month period. This report presents the results for three types of HVAC equipment: Central Air Conditioners (CAC), Air-Source Heat Pumps (HP) and Central Gas Furnaces (FUR) from 1999 through 2002.

This report also contains general market information as well as estimates and analysis of HVAC equipment installed in newly constructed homes throughout California. The information from the new construction portion of the RMST also allows for analysis that estimates the average efficiencies of the retrofit/replacement market for central air conditioners and central gas furnaces. Additionally, efficiency standards information is also included for each type of HVAC equipment examined, including federal energy use standards, national ENERGY STAR® program standards, and California efficiency standards.

An analysis of the efficiency characteristics (either Seasonal Energy Efficiency Ration (SEER) or Annual Fuel Utilization Efficiency (AFUE)) of all central air conditioners, air-source heat pumps, and central gas furnace models available throughout the U.S. marketplace is included. To estimate market share of high efficiency HVAC units, this report contains an analysis based on the ENERGY STAR standard. The new construction data has not been updated in this report. Therefore, the data pertaining to new construction only details through the first half of 2001.

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1 RER, Inc. May 1999. Efficiency Market Share Needs Assessment and Feasibility Scoping Study. Prepared for the California Board for Energy Efficiency and Pacific Gas and Electric.

2 RER, Inc. July 2001. California Residential Efficiency Market Share Tracking: New Construction 2000. Prepared for Southern California Edison.

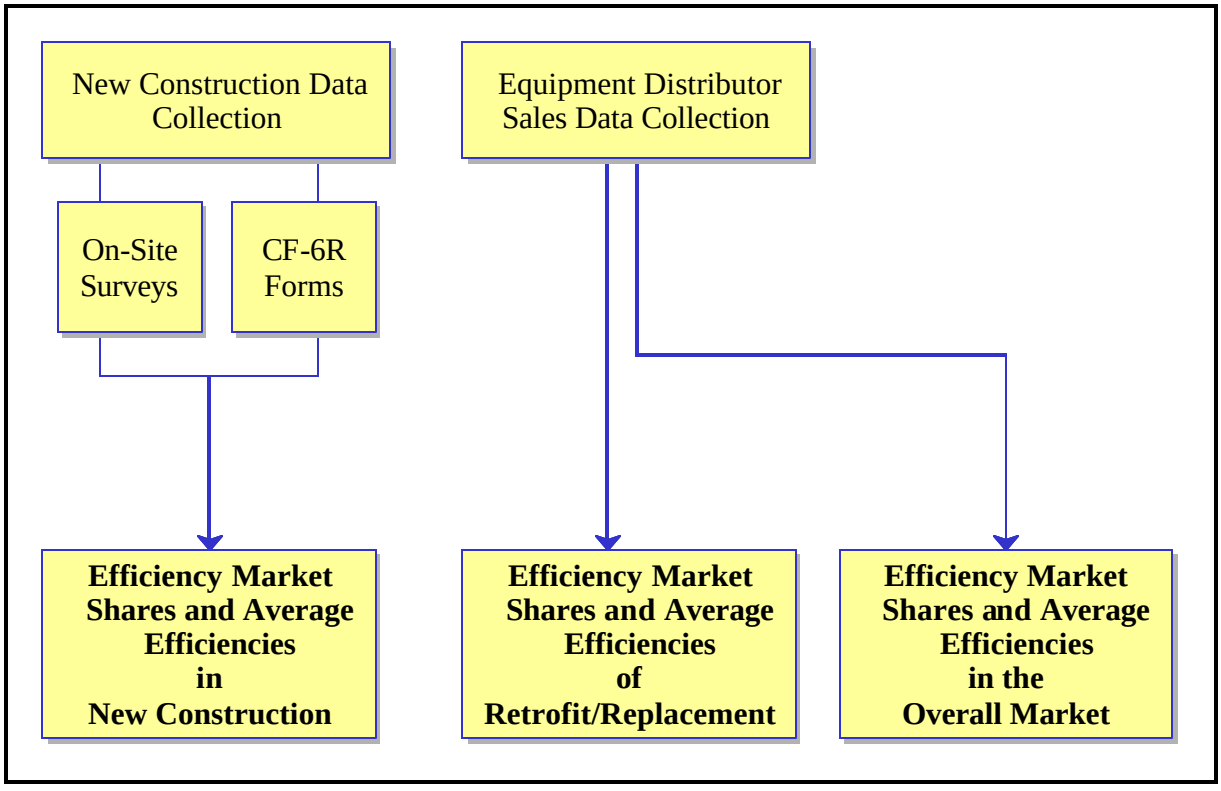
3 RER, Inc. October 2001. *California Residential Efficiency Market Share Tracking: Lamps 2001*. Prepared for Southern California Edison.

4 RER, Inc. September 2001. *California Residential Efficiency Market Share Tracking: Appliances 2000*. Prepared for Southern California Edison.

In order to obtain the necessary information for this analysis, a panel of HVAC distributors have been recruited to share their sales data. There are two possible formats for the data. One format has the data detail the units sold by manufacturer model number. The other is a general quantity of units sold, grouped by type and efficiency rating, for each quarter of the year. The data are then analyzed in order to estimate the market shares and average efficiencies of HVAC equipment sold in California.

Figure 1-1 presents central air conditioner and central gas furnace data sources used in this analysis. The new construction results do not include any analysis of heat pumps, therefore the information in that section of the report is based on strictly on distributor sales data. Consequently, heat pump data reflect overall market information only. This data collection strategy was developed as a result of the Efficiency Market Share Needs Assessment and Feasibility Scoping Study.[5]

Figure 1-1: Overview of Data Sources for HVAC Analysis



Lastly, the results presented in this report focus on the overall California market with utility-level analysis available where possible. The new construction analysis includes information

[5] RER, Inc. 1999. *Efficiency Market Share Needs Assessment and Scoping Study*.

based on utility service area, climate zone, and residence type. The details on the new construction data analysis are contained within Appendix A.

1.1. Organization of Report

This report is organized as follows.

- Section 2 details the data collection and analysis methodology for developing the market share and average efficiency estimates.
- Section 3 presents the RMST results for CACs.
- Section 4 presents the RMST results for heat pumps.
- Section 5 presents the RMST results for central gas furnaces.
- Section 6 previews work in progress.
- Appendix A provides new construction data detail and analysis.

2

Data Collection and Methodology

2.1. Overview

This section details the data collection strategy and approach used for estimating market shares of high efficiency HVAC measures, and average efficiencies of HVAC units sold throughout California.

2.2. Heating and Cooling Equipment Distributor Sales Data Collection

The project team recruited a panel of equipment distributors to provide sales data for use in estimating efficiency market shares of HVAC equipment in California. The Efficiency Market Share Tracking Needs Assessment and Scoping Study determined that HVAC equipment distributors would be the best data source for tracking HVAC efficiencies in the marketplace.[6] In this earlier study, Itron found that distributor-level data can be limiting due to the inability to distinguish the market event (e.g., new construction versus replacement installations), since both builders and contractors purchase equipment from HVAC distributors. Furthermore, distributors are unable to identify new construction versus retrofit/replacement sales. Thus, the data collected from distributors for this study are used to estimate average energy efficiency ratings in the overall market. In addition, where available, new construction estimates are removed from the distributor data in order to develop an estimate for the retrofit/replacement market.

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

Itron developed the frame of equipment distributors from a variety of resources, including contacts developed from past residential sector research, referrals from other distributors,

6 *Ibid.*

HVAC equipment manufacturer web sites, and the North American Heating, Refrigeration & Air Conditioning Wholesalers Association's (NRHAW) on-line membership directory. Distributors in the frame represent all major residential equipment manufacturers and brands, including Bryant, Carrier, Goodman, Lennox, Payne, Trane, and York. Distributors in the sample were segmented according to their primary service area.

As shown below in Table 2-1, the RMST distributor sample frame consists of 16 companies whose primary business is the wholesale of residential space heating and cooling equipment.[7] The companies in the frame represent well over 200 branch/warehouse locations throughout California. This frame consists of independent equipment wholesalers, independently owned manufacturer dealerships, and manufacturer-owned dealers. HVAC distributors have underwent some consolidation after the publication of the First-Year Interim Report.[8] For the purposes of consistency, the project team decided to count these subsidiaries as separate entities for the 2000-2002 HVAC reports, despite that they may be owned by the same parent company. This change affected the way that some service territories were attributed.

Table 2-1: HVAC Distributor Sample Frame

	1999 Companies	2000-2002 Companies
Total in Frame	**16**	**16**
with Statewide Service Areas	7	4
with Primarily Southern California Service Area	3	7
with Primarily Northern California Service Area	6	5
Manufacturer Dealers	4	4
Independent Dealers	12	12

Sample Design

The project team targeted distributors with relatively large shares of the residential HVAC market for recruitment in order to have adequate representation for all utility service areas and climate regions. Currently, Itron receives data from five HVAC distributors whose sales approximate 20% of the statewide CAC, heat pump, and gas furnace market.

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7 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.

8 RER, Inc. 2000. *California Residential Efficiency Market Share Tracking: First-Year Interim Report.* Prepared for Southern California Edison.

Distributor Panel Recruiting Protocol and Current Panel

There have been some challenges with regard to recruiting the HVAC distributors. Due to the aforementioned centralized decision-making authority, the parent companies may have as many as three subsidiaries, each with a multitude of warehouses, throughout different regions of California, all of which may have a single point of contact. This contact may control a significant portion of the California market depending on the number and size of the subsidiaries involved. In addition, all direct manufacturers' distributors' participation must be approved through the corporate office.

The project team has contacted all 16 companies in the sample frame. The objectives for recruiting HVAC distributors continue to be 1) recruiting distributors with relatively large shares of the residential HVAC market, and 2) having adequate representation for all utility service areas and climate regions. Recruiting continues to be an on-going effort. The long-term goal continues to be increasing participation and market coverage of the wholesale market.

The recruiting strategy follows these principles.

- ***Develop Long-Term Relationship.*** The distributor data collection efforts must be considered a long-term, ongoing process. Most distributors are only willing to participate if there is a long-term commitment. Due to the sensitive nature of the data provided, trust and a positive working relationship between project staff and the distributors have proven to be paramount.
- ***Guarantee Confidentiality.*** Itron, formerly Itron, guarantees the confidentiality of all information and sales data provided by distributors. To ensure this, the team agreed to report efficiency market shares and any other information only at an aggregated level (statewide and by utility service area if possible).
- ***Minimize Burden and Be Flexible.*** Participation has been tailored to great extent in consideration of the convenience and needs of each distributor.
- ***Provide Value.*** Itron prepares a confidential vendor level sales summary report for each participating distributor. This report, in particular, has shown to be of great interest and value.

The protocol for recruiting distributors as data suppliers for the HVAC equipment distributor tracking system has changed since the initial process. Originally, Itron provided project details and began discussions with distributors to determine challenges facing a particular company's participation. Then, the project team focused on building those initial relationships. Currently, there is an additional attempt to recruit additional HVAC distributors to further improve the accuracy of the analysis. The greatest challenge to recruitment continues to be obtaining corporate-level approval where necessary. The project

team continues to address these issues as they affect each distributor specifically. Additionally, Itron maintains regular contact with the participating distributors in order to address any needs or concerns that may arise.

Table 2-2 presents the status of recruiting HVAC distributors to share sales data for the RMST. It reflects recruiting and maintenance efforts that correspond to data for 1999 through 2002.

Table 2-2: Recruiting Disposition

	1999 Distributors	2000 Distributors	2001 Distributors	2002 Distributors
Companies Contacted	13	16	16	16
Declined to Participate	2	3	2	2
Agreed to Supply Data	5	5	5	5
Current Panel	3 (19 locations)	5 (54 locations)	5 (54 locations)	5 (54 locations)

As shown in Table 2-2, The project team contacted all 16 major distributors in California to provide data for the RMST project. The current panel consists of five distributors with 54 warehouse locations in California, and approximately 20% of the estimated total CAC, heat pump, and gas furnace sales in California.

All distributors in the panel provided data for CACs, furnaces, and heat pumps. The project team creates a customized, confidential report for each distributor. This individualized report compares their sales of high efficiency measures against the state average as well as their average efficiency of units sold.

2.3. Overview of HVAC New Construction Sector Data Collection and Analysis

Another component of the HVAC analysis involved data on new construction installations. Sections 3 and 4, which examine CACs and gas furnaces, respectively, include this information. To develop accurate efficiency market shares and average efficiencies of measures installed in California's new construction sector, Itron implemented two major data collection efforts.

- ***On-Site Surveys.*** This element entailed completing comprehensive on-site surveys of a representative sample of 800 newly constructed homes in California per year. Detailed data on equipment efficiencies as well as building shell characteristics were gathered from both single family and multifamily residences. The original implementation of the surveys allowed for data reflecting late 1998

through early 2000. However, there has been a temporary halt in the collection of the in-site surveys. The on-site surveys resume in 2003.

- ***CF-6R Installation Forms.*** This element consisted of developing a systematic collection procedure for CF-6R installation forms from building departments and contractors 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 equipment, and window efficiencies.

Details on the on-site surveys and CF-6R forms are found in Appendix A.

Distributor Data Analysis and Processing

Sales data obtained from HVAC equipment distributors illustrates the market from the first quarter of 1999 through the last quarter of 2002. Distributors provided Itron with data in many different formats with varying levels of detail. Some provided quarterly summary reports of sales segmented by predetermined efficiency ranges. Others provided detailed quarterly sales reports that included manufacturer model number, quantity, and date sold.

After converting all data files into a common format, Itron linked efficiency parameters to each observation in the database. Two different methods were used to link the appropriate efficiencies to the sales data provided. In cases where the distributor provided the manufacturer's model number, Itron merged AFUE and SEER information through a matching process with the California Energy Commission's appliance efficiency database.[9] When the team could not match efficiency parameters electronically to the provided model number, further investigation took place through the manufacturers' websites and/or by contacting the manufacturer directly. The second method used occurred when distributors provided more generalized sales data, which was already grouped by type and efficiency level. For these cases, the project team used a table to attach the appropriate efficiencies to these units for analysis.

Details regarding the development and use of expansion weights are located in Appendix A.

[9] California Energy Commission. March 2000-November 2001. *Database of Energy Efficient Appliances*. http://www.energy.ca.gov/appliances/appliance/

Unit Sales on Market Share Analysis

The team analyzed HVAC equipment in two ways. The project team estimated the market share of CACs, air-source heat pumps, and central gas furnaces sold that met or exceeded the ENERGY STAR® qualification threshold from 2000 through 2002. Additionally, the project team analyzed ENERGY STAR qualified CACs and central gas furnaces by utility service area or region. Please note that Section 5 (heat pumps) does not contain the more detailed utility or regional ENERGY STAR analysis because of insufficient information regarding the overall installations or sales of heat pumps in new construction. As a result, Itron could not develop accurate weights for that type of analysis. Furthermore, for all HVAC products tracked by the RMST, Itron examined the percentage of statewide sales by efficiency categories. The project team did this in order to analyze overall average SEER levels for CACs and heat pumps, and AFUE levels for gas furnaces. Utility level analysis is shown in the graphs for CACs and central gas furnaces. Because the tables provide more detailed information, it was necessary to combine results for the Southern California Edison (SCE) and San Diego Gas and Electric (SDG&E) areas. This was necessary to protect the confidentiality of the HVAC distributors.

Combining the New Construction On-Site Survey Analysis with the CF-6R Analysis

On-site surveys were conducted for 1,600 newly constructed single family and multifamily residences in California from mid-1998 through mid-2000. The team combined efficiency data obtained from the on-sites with data extracted from nearly 3,200 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 the team developed a set of weights in order to combine data from the two different sources. It should also be noted that the tracking system is a dynamic process. For instance, data from the third year of the project will be used to backfill the database and thus increase the sample sizes for some of the under-represented periods.

3

Central Air Conditioners

3.1. Overview

This section presents the efficiency market shares and average efficiencies of central air conditioners (CACs) installed or 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, new construction, and retrofit/replacement are presented in Subsections 3.5, 3.6, and 3.7, respectively.

The project team used data from new construction on-site surveys and building department installation forms (CF-6Rs) to estimate the shares and average efficiencies of CACs installed in residential new construction through the first half of 2001. Data collected from a panel of HVAC equipment distributors were used to estimate 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.

3.2. Efficiency Standards

The cooling efficiency rating used to rate CACs is the SEER level. This measure assesses a unit's efficiency over the length of the cooling season by comparing total cooling to total energy input—the higher the SEER rating, the more efficient the cooling equipment. SEER ratings range from 9.7 to over 15. Current national efficiency standards for CACs are 10 SEER (for split system units) and 9.7 SEER (for packaged units).[10,11] To qualify for the ENERGY STAR label, CACs must be at least 12 SEER.

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[10] Required efficiency for residential central air conditioners less than 65 kBtu/hr.

[11] Department of Energy, Office of Energy Efficiency and Renewable Energy. 2000. *Federal Register. Energy Conservation Program for Consumer Products: Central Air Conditioners and Heat Pumps Energy Conservation Standards; Proposed Rule.* Title 10, Chapter II, Subpart C, Part 430, Section 430.32.

The current federal standard has been in place since 1992. The Department of Energy (DOE) finalized an amended proposed rule to update the federal efficiency standards for CACs on May 23, 2002. The new standard will increase to 12 SEER for both split system and packaged units. This new standard should become effective January 23, 2006. This increase would cause split system air conditioners to be 20% more efficient. Packaged systems would be 24% more efficient.[12]

In addition to the potential changes to the federal standard, the ENERGY STAR specification for residential CACs has been updated. This new standard went into effect on October 1, 2002. The ENERGY STAR program is also changing to a combined SEER and Energy Efficiency Ratio (EER) rating system. EER computes the instantaneous efficiency of any cooling unit. It is considered to be the "steady-state rate of heat energy removal (e.g., cooling capacity) by the equipment in Btuh divided by the steady-state rate of energy input to the equipment in watts."[13] The ENERGY STAR program decided to include EER as part of the new specification because it addresses peak load energy performance issues, which are not included in SEER ratings.

The California Energy Commission (Commission) has also published proposed increases to the standards for CAC units.[14] [15] At this time, the new standards have been finalized by the Commission. Table 3-1 provides details on these changes.

The current California energy use standard for air- cooled CACs, with less than 65,000 Btu, has been in place since January 1, 1995. These efficiency standards match the current federal energy use standards. The new Commission standards will take effect on January 23, 2006. These standards will increase the minimum SEER level for CAC units sold statewide. Please note that the new 2006 California standards will create substantial increases in efficieincy, as they are more stringent that the national 2002 ENERGY STAR standards for single package units.

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12 DOE. *Federal Register. Central Air Conditioners and Heat Pumps.* 10 CFR Part 430.

13 http://yosemite1.epa.gov/estar/consumers.nsf/attachments/HVACSpec2.pdf/$File/HVACSpec2.pdf?OpenElement, pp 4.

14 This action occurred to comply with Assembly Bill 970- California Energy Security and Reliability Act of 2000, which was signed into law on September 6, 2000. Section 399.15 of this legislation required evaluation and improvement of energy efficiency and DSM programs throughout the State. In response, the Commission decided to increase the standards for a multitude of appliances.

15 California Energy Commission. *California Code of Regulations, Title 20: Division 2, Chapter 4: Energy Conservation, Article 4: Appliance Efficiency Regulations, Section 1601-1608*. January 22, 2002.

Table 3-1: Comparison of Federal, ENERGY STAR, and Commission Energy Standards for Residential CACs

	Split Systems (SEER)	Split Systems (EER)	Single Package Equipment (SEER)	Single Package Equipment (EER)
NAECA				
Current/ 1992 Standard	10	n/a	9.7	n/a
January 23, 2006 Standard	12	n/a	12	n/a
Percent Improved	20%	n/a	24%	n/a
ENERGY STAR				
Former Standard	12	n/a	12	n/a
October 1, 2002 Standard	13	11	12	10.5
California Standards				
Current/1995 Standard	10	n/a	9.7	n/a
January 23, 2006 Standard	13	n/a	13	n/a

3.3. Characteristics of Nationally Available Central Air Conditioner Models

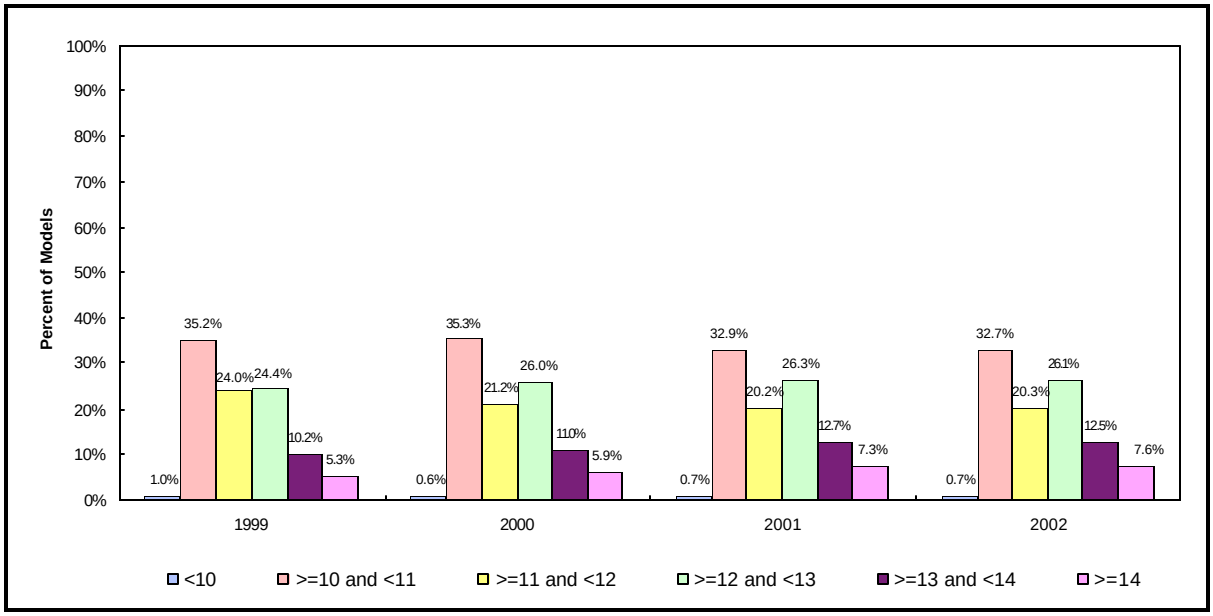
To develop distributions of available CAC models, Itron relied on information maintained by prominent trade organizations such as the Air-Conditioning and Refrigeration Institute (ARI). Itron has included examinations of model availability for 1999 through 2002. This information will continue to be updated in future HVAC RMST reports.

Figure 3-1 shows the distribution of nationally available CAC models by SEER.[16,17] Note that the efficiency buckets shown in this graph were chosen in order to help illustrate potential trends in the availability of high efficiency models. For the past three years, less than 1% of all manufactured models have had SEERs of less than 10. This lower SEER level corresponds only to single packaged units. From 1999-2002, slightly more than 50% of all CAC units had SEERs between 10.0 and 12.0. It is interesting to note that in 2000 and 2001, 20% of available units had SEER levels of 13 or higher.

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

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

Figure 3-1: CAC National Model Availability by SEER



Source: ARI and California Energy Commission

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

Table 3-2 presents estimates of total unit sales for CACs. There is no definitive source of annual unit sales by measure, which includes information about whether the unit was sold as a retrofit/replacement or for new construction. Hereafter, the ability to distinguish the final use for equipment will be referred to as decision type. However, Itron developed estimates of retrofit/replacement decision type unit sales by backing out estimates of sales in the new construction sector. Nationwide sales for CACs were obtained from ARI and Appliance Magazine.[18] These data were scaled to estimate California's annual sales based on number of households and measure type saturations. In particular, the national sales figure was multiplied by a ratio developed from the number of California households with the measure divided by the number of national households with the measure.

Cooling equipment typically experiences seasonal sales trends or cycles. The data obtained by Itron illustrate the trend of overall CAC sales increasing as warmer weather becomes more common and decreasing as the weather cools. Figure 3-2, using statewide data, depicts these trends.

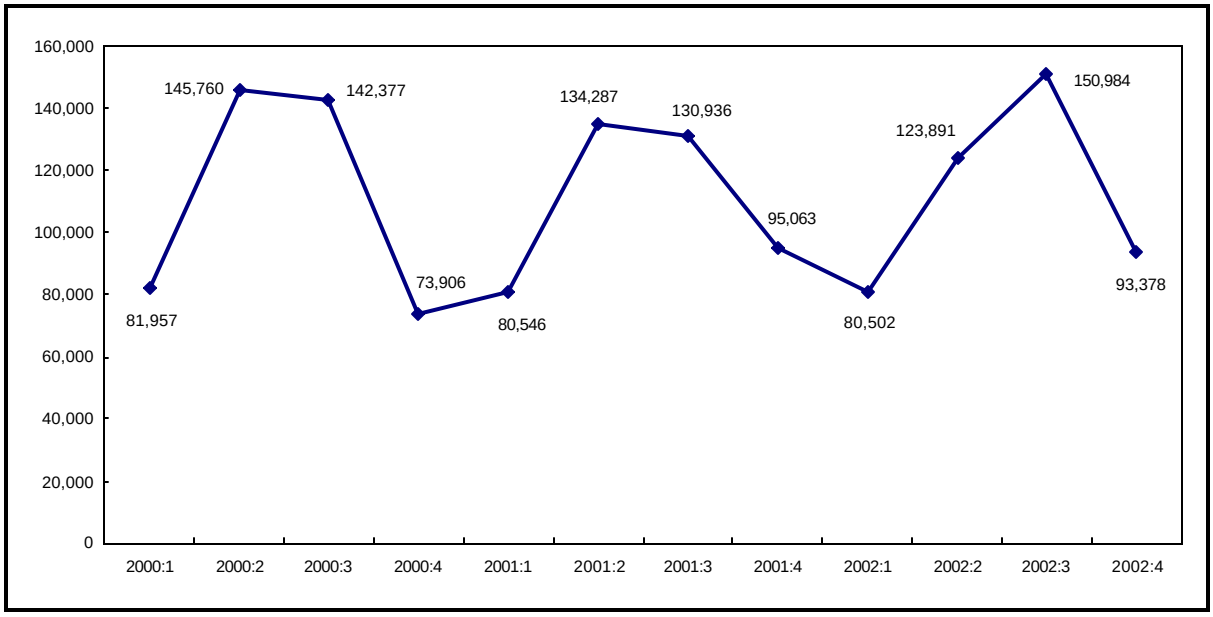
[18] Air-Conditioning and Refrigeration Institute. Appliance Magazine.

Table 3-2: Estimates of California's Annual CAC Sales by Decision Type

Year	Total Unit Sales[1]	New Construction[2]	Retrofit/ Replacement
1999	441,000	80,936	360,064
2000	444,000	99,126	344,874
2001	440,831	95,881	344,950
2002	448,755	115,660	333,095

1 Total unit sales data developed from information provided by statistics from ARI and Appliance Magazine.
2 Estimates of new construction from new construction on-site surveys (1999 = 1998:3-4 through 1999:1-2 and 2000 = 1999:3-4 through 2000:1-2) and new housing starts (last half of 2000 and 2001).

Figure 3-2: California CAC Quarterly Sales Trends



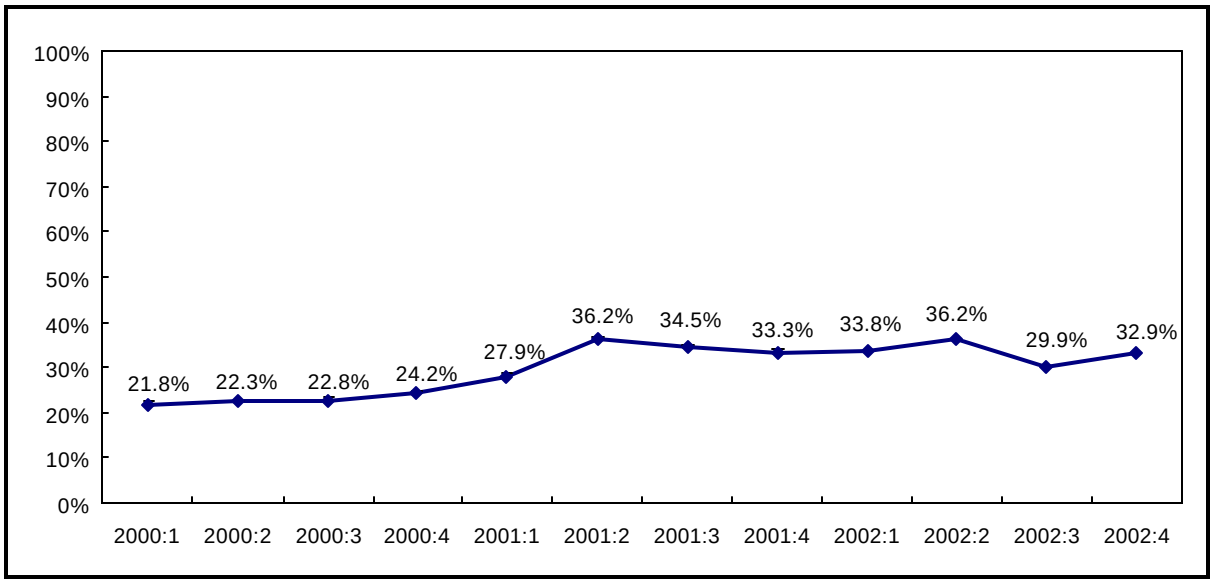
Error bands for 90% confidence interval.

3.5. Market Share of ENERGY STAR Central Air Conditioners

Beginning in 2000, the sample size was sufficient to allow the project team to estimate the percentages of ENERGY STAR qualified CACs sold in California. Figure 3-3 presents the percentage of ENERGY STAR qualified CACs sold in California throughout 2002. Figure 3-4 illustrates the percent of ENERGY STAR CAC sales by utility. As shown, the statewide market share of ENERGY STAR qualified CAC units increased slightly from a low of 21.8% in the first quarter of 2000 to a high of 36.2% in the second quarter of 2002.

Table 3-3 illustrates state-level data for the market share of ENERGY STAR qualified CAC units both annually and by quarter. Additionally, Table 3-4 shows the same data broken out by utility/region.

Figure 3-3: CAC Sales, Percent of ENERGY STAR Qualified Units



Error bands for 90% confidence interval.

Figure 3-4: CAC Sales, Percent of ENERGY STAR Qualified Units by Utility

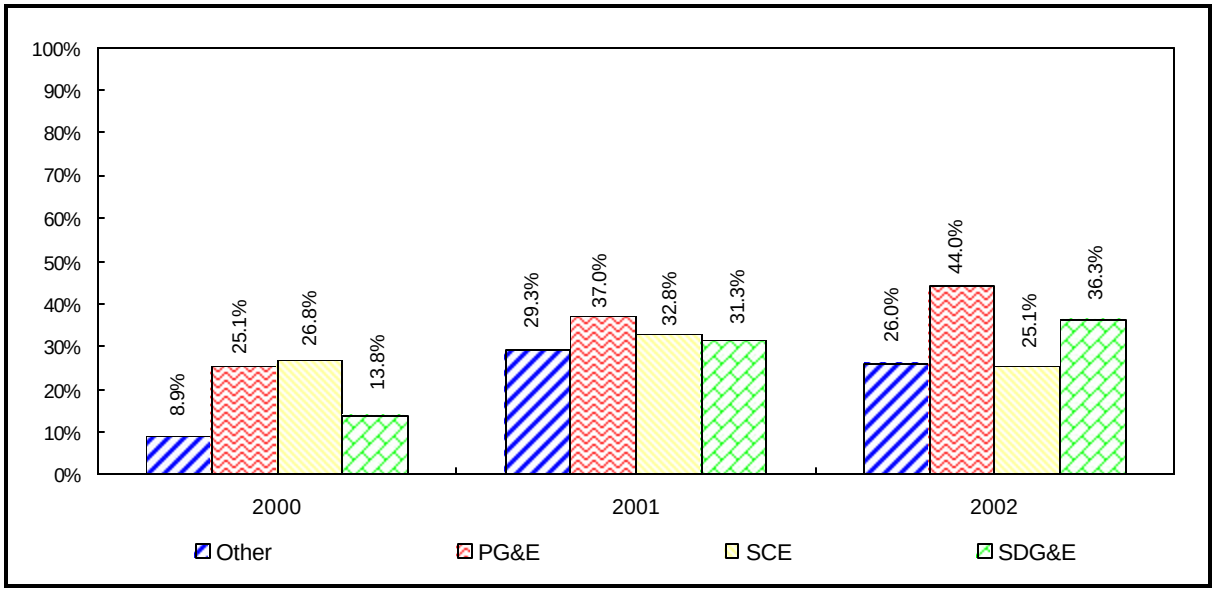


Table 3-3: CAC Sales, Percent of ENERGY STAR Qualified Units (Statewide)

Year	Percent of ENERGY STAR Qualified CACs				
	Annual	**Q1**	**Q2**	**Q3**	**Q4**
2000	**22.71%** (.0014) n=90,369	**21.8%** (.0032) n=16,297	**22.34%** (.0024) n=30,078	**22.82%** (.0025) n=28,339	**24.25%** (.0034) n=15,655
2001	**33.56%** (.0016) n=89,150	**27.95%** (.0035) n=16,518	**36.22%** (.0029) n=27,245	**34.51%** (.0029) n=25,477	**33.3%** (.0033) n=19,910
2002	**32.60%** (.0016) n=87,209	**33.76%** (.0038) n=15,374	**35.08%** (.0030) n=24,844	**29.88%** (.0027) n=29,752	**32.87%** (.0036) n=17,239

1 Standard errors in parentheses.

Table 3-4: CAC Sales, Percent of ENERGY STAR Qualified Units by Utility Service Area/Region

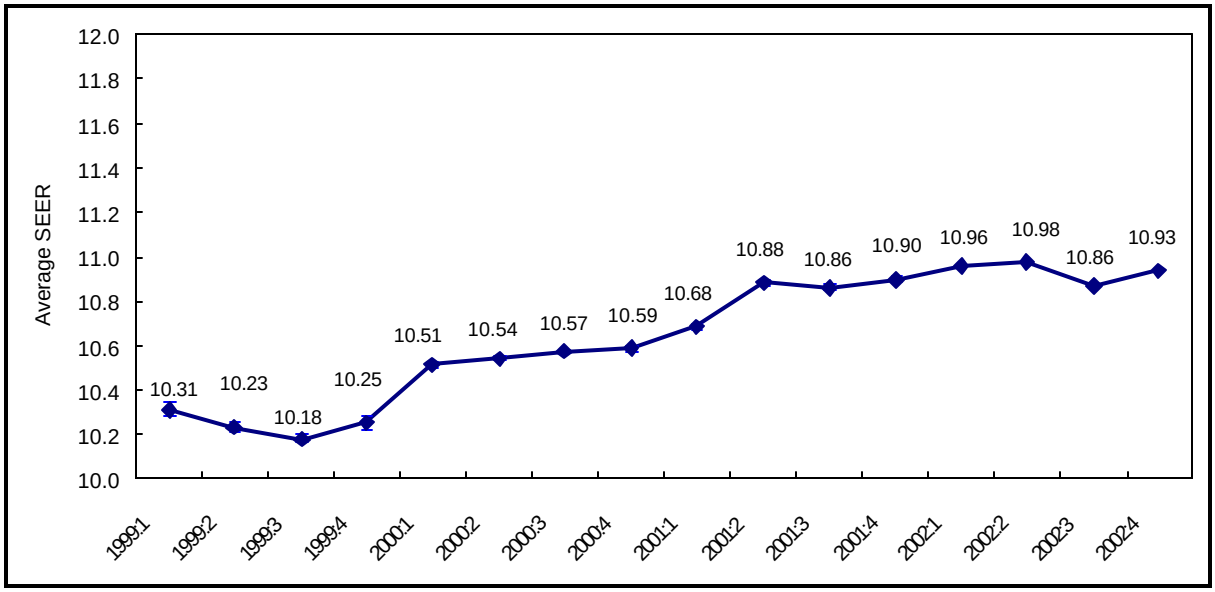
Utility	Year	Percent of ENERGY STAR Qualified CACs [1,2]				
		Annual	Q1	Q2	Q3	Q4
PG&E	2000	**25.13%** (.0021) n=42,366	**22.79%** (.0051) n=6,807	**23.76%** (.0034) n=15,257	**26.63%** (.0039) n=12,770	**27.48%** (.0051) n=7,532
Southern California[3]	2000	**25.0%** (.0021) n=42,362	**24.64%** (.0047) n=8,370	**25.3%** (.0038) n=12,901	**25.5%** (.0037) n=13,536	**24.1%** (.0049) n=7,555
Other	2000	**8.92%** (.0038) n=5,641	**9.91%** (.0089) n=1,120	**9.48%** (.0067) n=1,920	**6.89%** (.0056) n=2,033	**12.32%** (.0138) n=568
PG&E	2001	**36.98%** (.0024) n=39,837	**29.12%** (.0050) n=8,142	**36.45%** (.0042) n=13,024	**41.09%** (.0047) n=10,849	**40.34%** (.0055) n=7,822
Southern California[3]	2001	**32.61%** (.0031) n=22,976	**27.86%** (.0071) n=3,956	**37.32%** (.0058) n=6,961	**32.45%** (.0056) n=7,102	**30.15%** (.0065) n=4,957)
Other	2001	**29.29%** (.0028) n=26,337	**25.07%** (.0065) n=4,420	**31.38%** (.0054) n=7,260	**28.47%** (.0052) n=7,526	**30.63%** (.0055) n=7,131
PG&E	2002	**44.00%** (.0024) n=41,449	**41.16%** (.0059) n=7,034	**47.24%** (.0045) n=12,105	**41.32%** (.0041) n=14,152	**46.26%** (.0055) n=8,158
Southern California[3]	2002	**27.01%** (.0029) n=22,714	**30.76%** (.0074) n=3,892	**28.92%** (.0058) n=6,182	**24.52%** (.0049) n=7,852	**25.83%** (.0063) n=4,788
Other	2002	**26.03%** (.0029) n=23,046	**27.95%** (.0067) n=4,448	**26.92%** (.0055) n=6,557	**23.01%** (.0048) n=7,748	**28.12%** (.0069) n=4,293

1 Standard errors in parentheses.
2 "Other" includes municipal utilities such as Los Angeles Department of Water and Power, Sacramento Municipal Utility District, and others.
3 Southern California is a combination of Southern California Edison and San Diego Gas & Electric.

3.6. Average Efficiency of Central Air Conditioners in California

Figure 3-5 and Table 3-5 present the average SEER of CAC units sold in California from 1999 through 2002 by quarter. As shown, the average SEER ranged from 10.31 in the first quarter of 1999 to 10.93 by the end of 2002.

Figure 3-5: CACs, Average SEER by Quarter



Error bands for the 90% confidence interval.

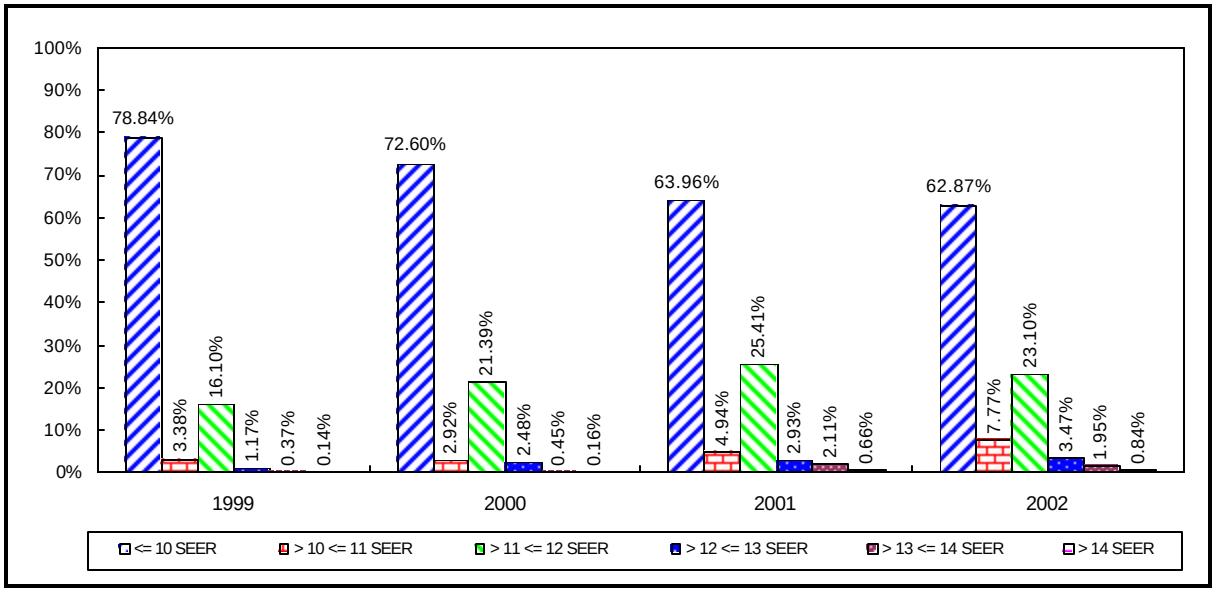
Table 3-5: CACs, Average SEER by Quarter

Period Year	Average SEER			
	1st Quarter	**2nd Quarter**	**3rd Quarter**	**4th Quarter**
1999	**10.31** (0.0196) n = 1,358	**10.23** (0.0126) n = 2,589	**10.18** (0.0105) n = 2,956	**10.25** (0.0179) n = 1,360
2000	**10.51** (0.0078) n = 16,231	**10.54** (0.0056) n = 30,000	**10.57** (0.0058) n = 28,243	**10.59** (0.0080) n = 15,599
2001	**10.73** (0.0039) n = 16,524	**10.98** (0.0034) n = 27,259	**10.92** (0.0034) n = 25,502	**10.90** (0.0041) n = 19,949
2002	**10.96** (0.0047) n=15,385	**10.98** (0.0037) n=24,872	**10.86** (0.0031) n=29,780	**10.93** (0.0042) n=17,244

Standard errors in parentheses .

Figure 3-6 illustrates the distribution of CACs sold by SEER efficiency categories. These efficiency categories combine general efficiency groups. As shown, 78% of units sold throughout 1999 were 10.0 SEER or less. In 2000, these percentages begin to decline. Fewer than three-quarters of all units sold in 2000 were less than or equal to 10 SEER. Additionally in 2000, there was also a noticeable increase over 1999 in the percentage of sales occurring of CAC units between 11.0 and 12.0 SEER. These trends continued throughout 2001 and 2002 with decreasing percentages of 10 SEER units and increasing percentages of higher efficiency unit sales. In particular, the sales of units with efficiencies of 13 SEER and higher showed noticeable increases in 2001 and 2002.

Figure 3-6: CACs, Percent of Sales by SEER Level



3.7. 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. Due to a temporary gap in the collection of on-site surveys, that portion of the analysis has not been updated since the 2000 New Construction report. However, wherever possible, all other information has been updated through the end of 2001. The 2002 data will be updated in the 2003 HVAC report. See Subsection 2.3 for an explanation of the differences between the on-site survey data and the CF-6R data.

New Construction On-Site Survey Results

Table 3-6 presents the average efficiency of CACs by utility and six-month period. In the time period examined, the average SEER did not change significantly for any of the three IOUs nor for the combined utility average. Figure 3-7 presents the distribution of CACs by efficiency. Over 95% of all CAC units sold were less than or equal to12 SEER in all periods.

Table 3-6: CACs, Average SEER Rating – On-Site Data

	PG&E	SCE	SDG&E	All
1998:3-4	**10.80** (0.0846) n = 103	**10.31** (0.0546) n = 137	**10.25** (0.1042) n = 29	**10.52** (0.0471) n = 269
1999:1-2	**10.78** (0.0887) n = 102	**10.27** (0.0523) n = 136	**10.20** (0.1090) n = 29	**10.51** (0.0489) n = 267
1999:3-4	**10.87** (0.0817) n = 141	**10.31** (0.0651) n = 76	**10.13** (0.0721) n = 33	**10.63** (0.0555) n = 250
2000:1-2	**10.69** (0.0769) n = 142	**10.27** (0.048) n = 92	**10.04** (0.0641) n = 33	**10.52** (0.0493) n = 267

Standard Errors in parentheses.

Figure 3-7: CAC Shares by SEER – On-Site Data

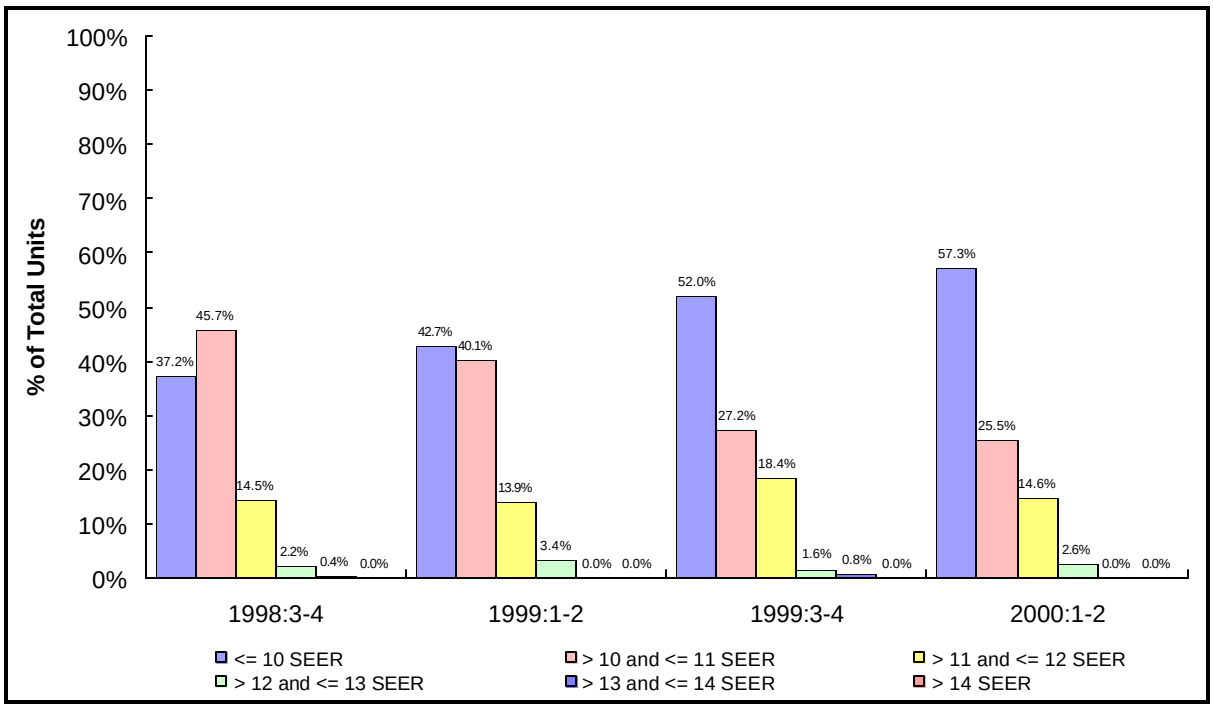


Table 3-7 and Table 3-8 present the saturation of CACs by utility and climate zone for single family and multifamily homes, respectively. The saturations illustrate the percentages of homes, by strata, with at least one CAC.

Table 3-7: Saturations of CACs – On-Site Data – Single Family Homes

Period	RMST Climate Zone	PG&E	SCE	SDG&E	CA
1998:3-4 – 1999:1-2					
	CZ:1	**47.5%** n = 118	**-** n = 0	**-** n = 0	**47.5%** n = 118
	CZ:2	**-** n = 0	**47.0%** n = 30	**45.0%** n = 62	**45.9%** n = 96
	CZ:3	**-** n = 0	**98.7%** n = 154	**91.4%** n = 14	**98.4%** n = 179
	CZ:4	**91.7%** n = 145	**100.0%** n = 15	**-** n = 0	**92.3%** n = 160
	CZ:5	**50.0%** n = 2	**90.1%** n = 31	**-** n = 0	**88.1%** n = 43
1999:3-4 – 2000:1-2					
	CZ:1	**45.9%** n = 96	**-** n = 0	**-** n = 0	**45.9%** n = 96
	CZ:2	**-** n = 0	**69.2%** n = 26	**58.4%** n = 53	**64.2%** n = 84
	CZ:3	**-** n = 0	**100.0%** n = 118	**100.0%** n = 18	**100.0%** n = 144
	CZ:4	**98.4%** n = 198	**100.0%** n = 12	**-** n = 0	**98.5%** n = 210
	CZ:5	**100.0%** n = 3	**100.0%** n = 27	**40.7%** n = 2	**99.3%** n = 41

The sample size is zero when a utility area does not have any home in the corresponding climate zone.

Table 3-8: Saturations of CACs – On-Site Data – Multifamily Homes

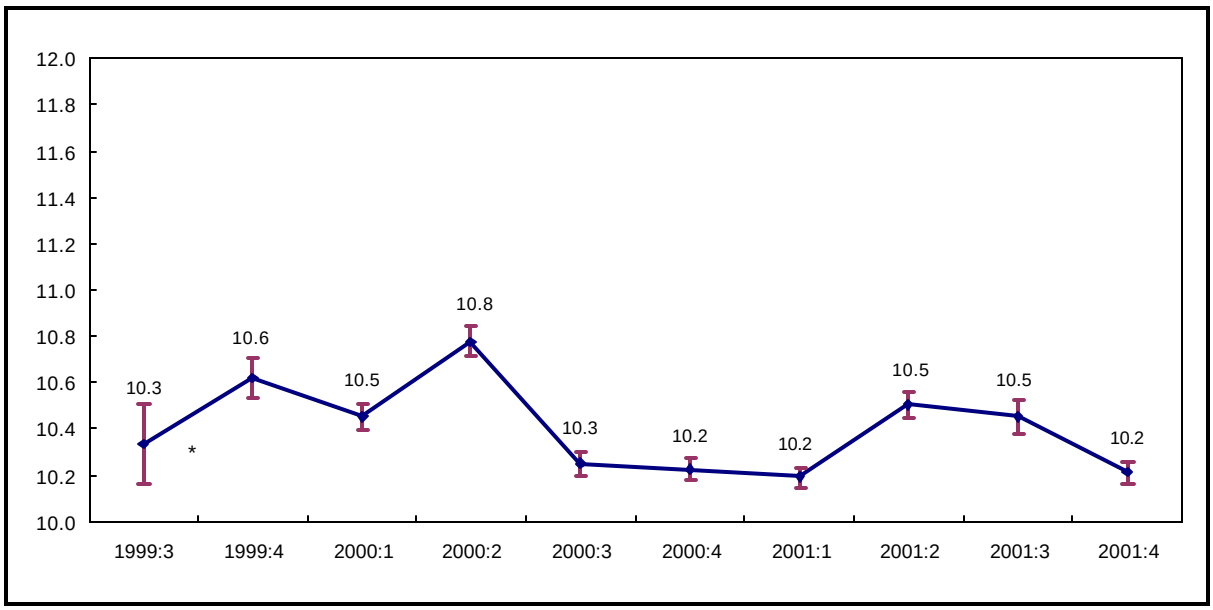
Period	RMST Climate Zone	PG&E	SCE	SDG&E	CA
1998:3-4 – 1999:1-2					
	CZ:1	**4.0%** n = 66	**-** n = 0	**-** n = 0	**4.0%** n = 66
	CZ:2	**-** n = 0	**22.4%** n = 13	**8.4%** n = 28	**17.1%** n = 42
	CZ:3	**-** n = 0	**48.3%** n = 30	**51.5%** n = 4	**48.4%** n = 48
	CZ:4	**46.7%** n = 34	**100.0%** n = 1	**-** n = 0	**47.2%** n = 35
	CZ:5	**0.0%** n = 1	**35.1%** n = 10	**-** n = 0	**34.6%** n = 13
1999:3-4 – 2000:1-2					
	CZ:1	**12.9%** n = 51	**-** n = 0	**-** n = 0	**12.9%** n = 51
	CZ:2	**-** n = 0	**43.5%** n = 16	**16.0%** n = 42	**24.4%** n = 62
	CZ:3	**-** n = 0	**56.6%** n = 25	**20.7%** n = 8	**49.0%** n = 45
	CZ:4	**29.3%** n = 55	**-** n = 0	**-** n = 0	**29.3%** n = 55
	CZ:5	**0.0%** n = 1	**100.0%** n = 8	**100.0%** n = 1	**86.6%** n = 13

CF-6R Data Analysis Results

Figure 3-8 presents the average SEER for CAC units installed in residential new construction in California from mid-1999 through 2001. As shown, the average SEER for new construction in California has varied significantly by quarter. For instance, the average SEER value has ranged from 10.0 in the third quarter of 1999 to 10.8 during the second quarter of 2000. Then, it decreased again, until both the fourth quarter of 2000 and the first quarter of 2001 had an average SEER of 10.2. Table 3-9 presents the average SEER by utility and by quarter.

Figure 3-9 illustrates how the percentage of CACs that fall into various efficiency levels has changed over time.

Figure 3-8: CAC Average SEER – CF-6R Data



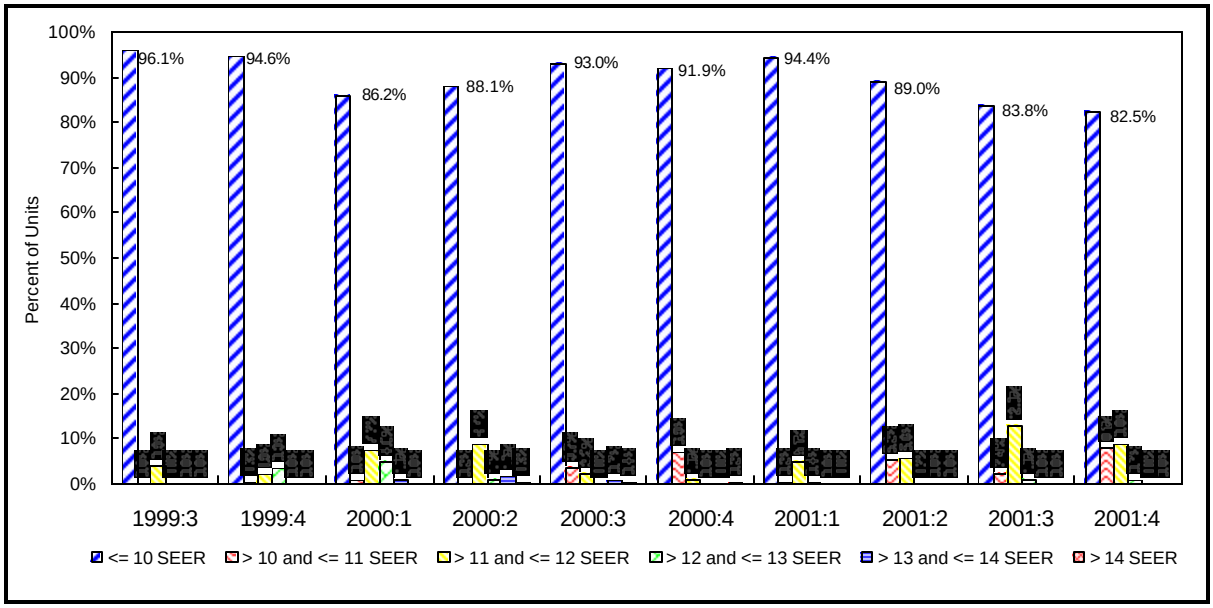
Error bands for the 90% confidence interval.

Table 3-9: CAC Average SEER – CF-6R Data

	PG&E	SCE	All
1999:3	**10.44** (0.3692) n = 6	**10.00** (0.0000) n = 45	**10.34** (0.1058) n = 51
1999:4	**11.04** (0.2791) n = 17	**10.17** (0.0325) n = 351	**10.62** (0.0526) n = 368
2000:1	**10.51** (0.0848) n = 116	**10.25** (0.0357) n = 506	**10.45** (0.0359) n = 622
2000:2	**11.27** (0.1252) n = 59	**10.21** (0.0339) n = 564	**10.78** (0.0415) n = 623
2000:3	**10.28** (0.0664) n = 108	**10.10** (0.0272) n = 434	**10.25** (0.0289) n = 542
2000:4	**10.35** (0.1164) n = 44	**10.04** (0.0112) n = 474	**10.22** (0.0275) n = 518
2001:1	**10.24** (0.0873) n = 57	**10.10** (0.0203) n = 474	**10.19** (0.0258) n = 531
2001:2	**10.68** (0.0980) n = 97	**10.04** (0.0093) n = 524	**10.50** (0.0351) n = 621
2001:3	**10.69** (0.0735) n = 178	**10.02** (0.0081) n = 242	**10.45** (0.0418) n = 420
2001:4	**10.28** (0.0591) n = 140	**10.06** (0.0176) n = 282	**10.21** (0.0296) n = 422

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

Figure 3-9: CACs by Efficiency Level – CF-6R Data



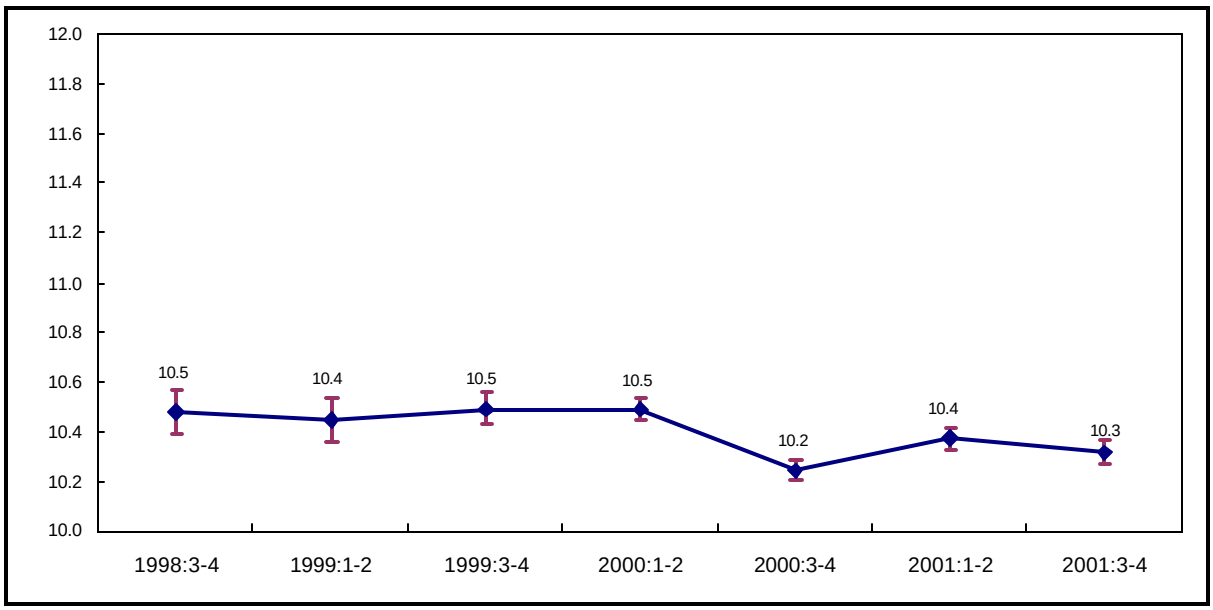
Combined New Construction Results

Figure 3-10 presents the average efficiency of CACs. Note that there has been no significant change in average efficiencies over the last three years, except for the decrease in average SEER value for the last six months of 2000.[19] The average SEER values do not vary by more than 2% between different periods. Table 3-10 presents the average CAC efficiency by climate zone. As depicted in this table, average SEER values are higher in the relatively hotter RMST Climate Zones 4 and 5 in nearly every quarter.[20]

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

[20] A significance test at the 90% confidence level reveals that the estimates of the average SEER values for RMST Climate Zones 4 and 5 are significantly different from the average SEER values for the remaining three climate zones during each period. (There are two exceptions to this: 1) the average SEER for RMST Climate Zone 1 during the second six-month period of 1999 is not significantly different from the average SEER values for RMST Climate Zone 5 during the same period, and 2) the average SEER for RMST Climate Zone 3 during the first six-month period of 2001 is not significantly different from the average SEER values for RMST Climate Zone 5 during the same period.)

Figure 3-10: CAC Average SEER in New Construction



Error bands for the 90% confidence interval.

Table 3-10: CAC Average SEER in New Construction by Climate Zone

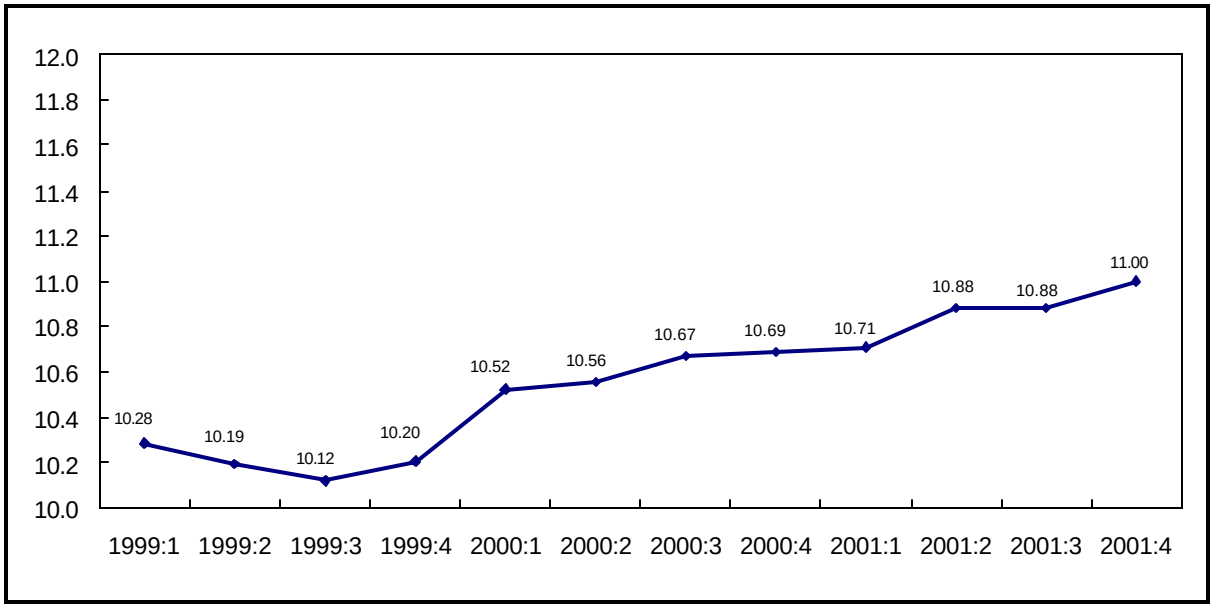
	RMST Climate Zone					
	CZ:1	**CZ:2**	**CZ:3**	**CZ:4**	**CZ:5**	**All**
1998:3-4	**10.46** (0.1067) n = 34	**10.20** (0.0743) n = 31	**10.20** (0.0427) n = 112	**10.80** (0.0999) n = 80	**10.97** (0.2615) n = 19	**10.48** (0.0446) n = 276
1999:1-2	**10.18** (0.0552) n = 40	**10.14** (0.0800) n = 29	**10.10** (0.0232) n = 120	**10.92** (0.1049) n = 98	**11.07** (0.2141) n = 28	**10.45** (0.0452) n = 315
1999:3-4	**10.46** (0.1211) n = 33	**10.27** (0.0966) n = 36	**10.02** (0.0052) n = 428	**10.95** (0.0877) n = 137	**10.73** (0.185) n = 35	**10.49** (0.0327) n = 669
2000:1-2	**10.10** (0.0425) n = 52	**10.07** (0.0270) n = 34	**10.03** (0.0058) n = 960	**10.90** (0.0612) n = 271	**11.05** (0.1039) n = 197	**10.49** (0.0227) n = 1514
2000:3-4	**10.00** (0.0000) n = 62	- - n = 0	**10.01** (0.0023) n = 747	**10.39** (0.0832) n = 90	**10.34** (0.0768) n = 161	**10.24** (0.0202) n = 1060
2001:1-2	**10.22** (0.1233) n = 27	- - n = 0	**10.05** (0.0101) n = 858	**10.59** (0.0823) n = 127	**10.14** (0.0431) n = 140	**10.37** (0.0231) n = 1152
2001:3-4	**10.00** (0.0000) n = 4	- - n = 0	**10.02** (0.0027) n = 383	**10.61** (0.0529) n = 314	**10.18** (0.0473) n = 141	**10.32** (0.0253) n = 842

Standard errors in parenthesis.

3.8. Efficiencies of Retrofit/Replacement Central Air Conditioners

Figure 3-11 depicts the estimate of sales for retrofits/replacements for 1999 through 2001. This will be updated again with the results of the 2003 on-site survey data. As shown, the average SEER goes from 10.28 in the first quarter of 1999 to 11.00 at the end of 2001. During the three years examined, there has been a steady increase in the average SEER of retrofit/replacement CAC units. The project team obtained this estimate of the average SEER sold in the retrofit/replacement market by backing out new construction data from the overall market data from the HVAC distributors. The difference in average SEER level between 1999 and 2000/2001 for these replacement units may be due in part to the smaller overall market sample size in 1999.

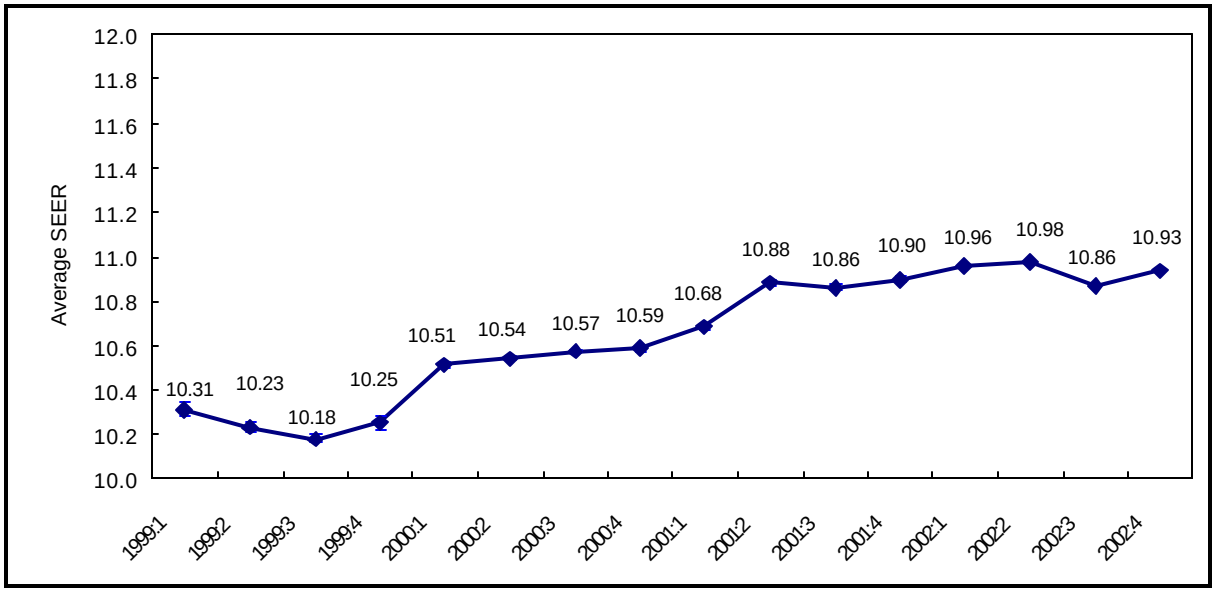
Figure 3-11: CAC Average Efficiencies (SEER) – Retrofit, Replacement, and Acquisition



3.9. Summary of Average SEER Levels by Market Type

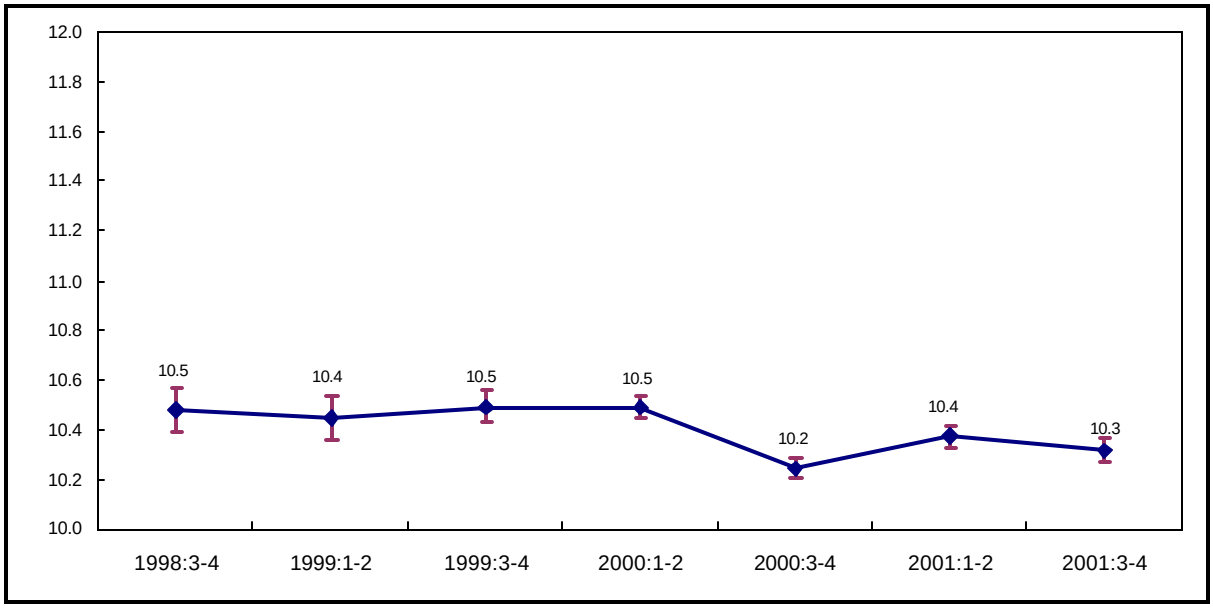
In order to best illustrate the three market segments covered by the project, the graphs that illustrate the average SEER levels of CAC units in the residential market in California are repeated below for easy reference and comparison.

Figure 3-12: CACs, Average SEER by Quarter



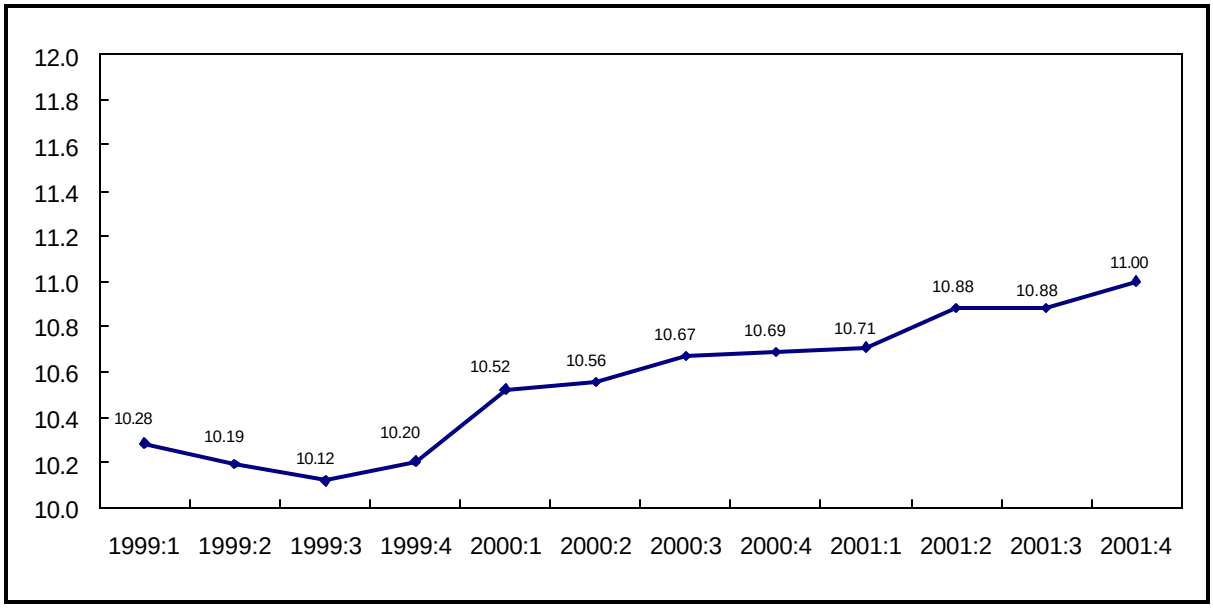
Error bands for the 90% confidence interval.

Figure 3-13: CAC Average SEER in New Construction



Error bands for the 90% confidence interval.

Figure 3-14: CAC Average Efficiencies (SEER) – Retrofit, Replacement, and Acquisition



4

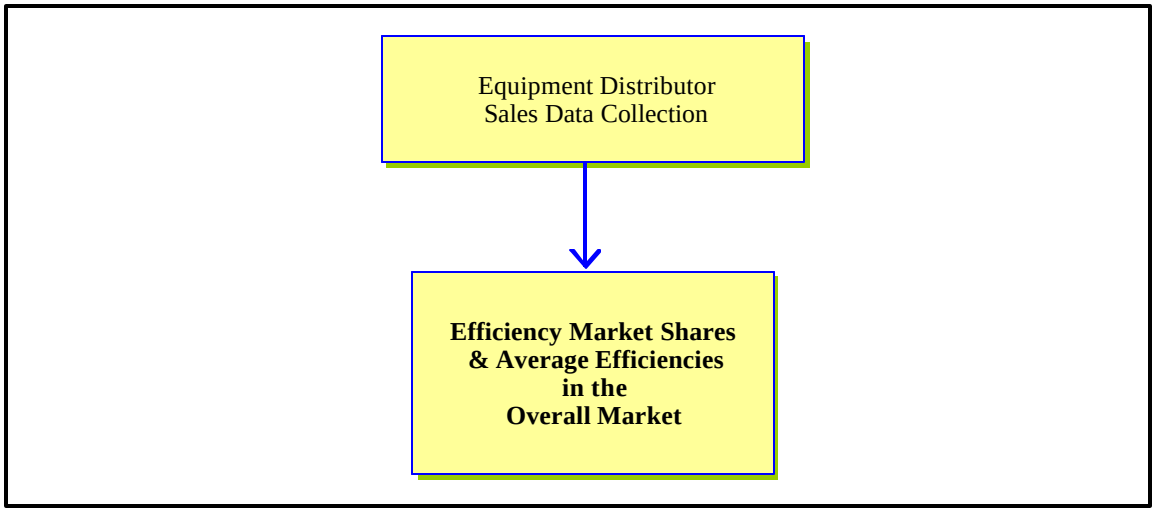
Heat Pumps

4.1. 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 4.2 summarizes energy efficiency standards for heat pumps and Subsection 4.3 summarizes the availability of models by efficiency level. Subsection 4.4 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.

Figure 4-1 provides an overview of the data sources for the heat pump efficiency analysis. As shown, data collected from a panel of HVAC equipment distributors were used to estimate shares of high efficiency heat pumps and average heat pump efficiencies in the overall market. For heat pumps, as for central air conditioners (CACs) and gas furnaces, the overall market information is obtained through sales data from HVAC distributors. These distributors sell to both the retrofit market and to the new construction market.

Figure 4-1: Overview of Data Sources for Heat Pump Analysis



4.2. Heat Pump Efficiency Standards

Air-source heat pumps have both cooling and heating efficiency ratings. Similar to CACs, cooling efficiency is expressed as SEER value. Heat pump heating efficiency ratings are expressed as Heating Seasonal Performance Factor (HSPF). As with SEER, the higher the HSPF, the more efficiently the heat pump will perform. The current minimum federal standard efficiency for heat pumps is 10 SEER/6.8 HSPF for split systems and 9.7 SEER/6.6 HSPF for single package systems. Units must be 13 SEER/8.0 HSPF for split systems and 12 SEER/7.6 HSPF for single package systems to qualify for the ENERGY STAR® program.

The current federal standard has been in place since 1992. The Department of Energy (DOE) finalized an amended proposed rule to update the federal efficiency standards for heat pumps on May 23, 2002. This amendment changed the previously proposed standards from January 2001, where were scheduled to take effect January 1, 2006. Those rules, published by the DOE, would have increased the standard to 13 SEER/7.7 HSPF for both split system and packaged units. On May 23, 2002, the DOE published new standards. These revised standards will become effective January 23, 2006, and will require heat pumps to be 12 SEER/7.4 HSPF.

These finalized standards will cause split system heat pumps to become 20% more efficient in cooling and 9% more efficient in heating. Packaged systems will become 24% more efficient in cooling and 12% more efficient in heating.[21]

In addition to the potential increase to the federal standard, the ENERGY STAR specification for residential electric air-source heat pumps changed. The new standard took effect October 1, 2002. It requires split system heat pumps to be 13 SEER/11 EER/8.0 HSPF. Packaged units must be 12 SEER/10.5 EER/7.6 HSPF. The ENERGY STAR program will change to the aforementioned combined SEER, HSPF, and EER (Energy Efficiency Ratio) for the new criterion. EER computes the instantaneous efficiency of any cooling unit. It is considered to be the "steady-state rate of heat energy removal (e.g., cooling capacity) by the equipment in Btuh divided by the steady-state rate of energy input to the equipment in watts."[22] The ENERGY STAR program included EER as part of the new specification because it addresses peak load energy performance issues, which are not included in SEER ratings.

The California Energy Commission (Commission) has also published increases to the state energy efficiency standards for air-source heat pump units. This action is part of the entire evaluation of state appliance standards, which occurred to comply with the California Energy Security and Reliability Act of 2000.

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[21] DOE. *Federal Register. Central Air Conditioners and Heat Pumps.* 10 CFR Part 430.

[22] http://yosemite1.epa.gov/estar/consumers.nsf/attachments/HVACSpec2.pdf/$File/HVACSpec2.pdf?OpenElement, pp 4.

The current California energy use standard for air-source heat pumps with less than 65,000 Btu has been in place since January 1, 1995. The new standards will take effect on January 23, 2006. These standards increase the minimum SEER and HSPF levels. The new California standards will require higher efficiency units to be sold throughout the State than the rest of the nation. The California standards will exceed the new federal standards scheduled to begin on the same date for the same equipment.

Table 4-1: Comparison of Federal and ENERGY STAR Air Source Heat Pump Energy Standards

	Split Systems (SEER)	Split Systems (EER)	Split Systems (HSPF)	Single Package Equipment (SEER)	Single Package Equipment (EER)	Single Package Equipment (HSPF)
NAECA						
Current/1992 Standard	10	n/a	6.8	9.7	n/a	6.6
January 23, 2006 Standard	12	n/a	7.4	12	n/a	7.4
Percent Improved	20%	n/a	9%	24%	n/a	12%
ENERGY STAR						
Former Standard	12	n/a	7.6	12	n/a	7.6
October 1, 2002 Standard	13	11	8.0	12	10.5	7.6
California Standard						
Current 1995 Standard	10	n/a	6.8	9.7	n/a	6.6
January 23, 2006 Standard	13	n/a	7.7	13	n/a	7.7

4.3. Characteristics of Available Heat Pump Models

To develop distributions of available HVAC equipment models, Itron relied on information maintained by prominent trade organizations, such as the Air-Conditioning and Refrigeration Institute (ARI) and the Commission. Itron has included examinations of model availability for 1999 through 2002. This information will continue to be updated in future HVAC RMST reports.

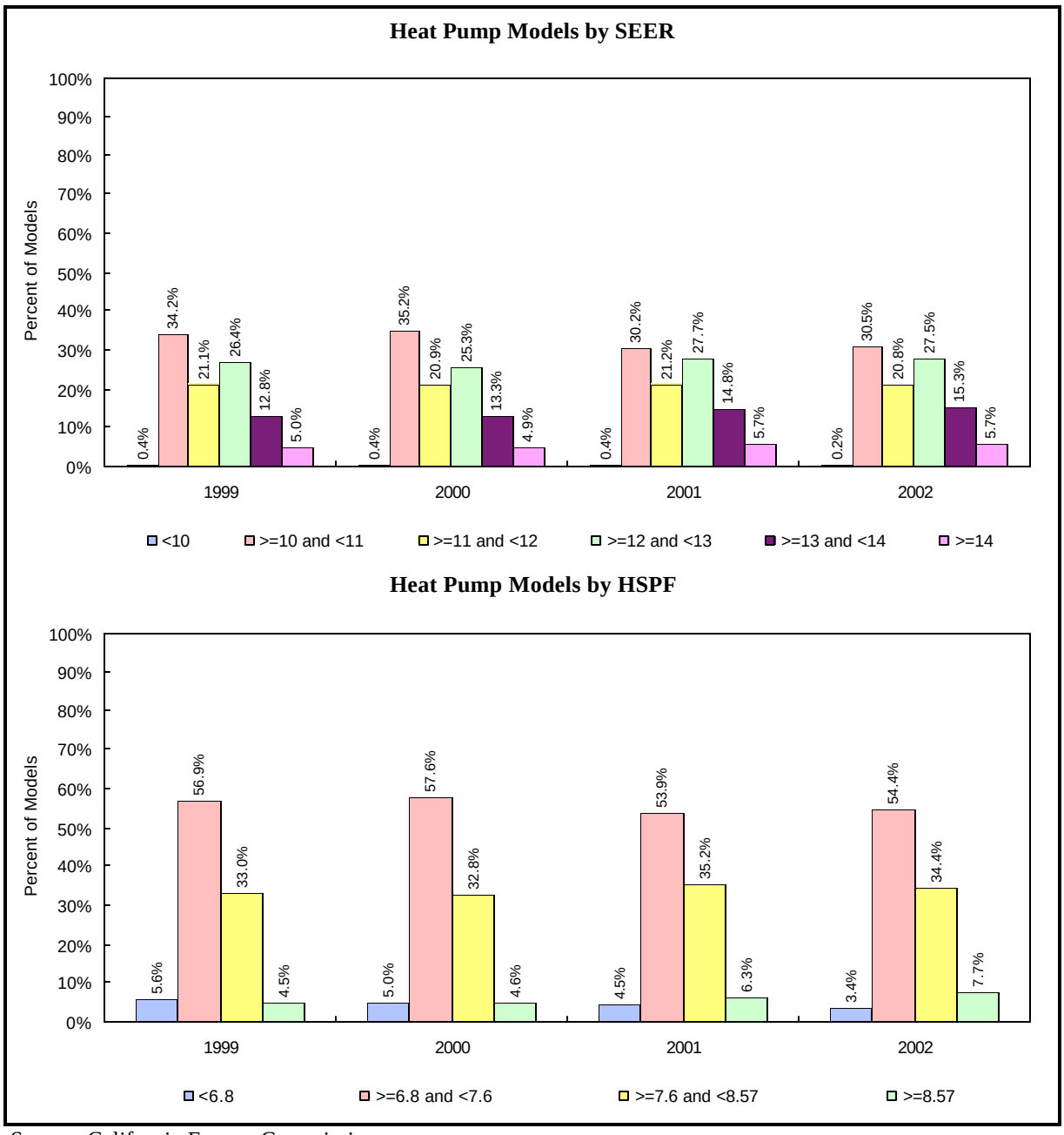
Figure 4-2 illustrates the distribution of all heat pump models manufactured for sale in the United States by efficiency level for 1999 through 2002. This figure shows the distribution of both cooling and heating efficiency ratings of available heat pumps.[23,24] The distribution of heat pumps by SEER is very similar to that of CACs—over half of the units have an average cooling efficiency between 10.0 and 12.0 SEER. A difference between heat pumps and CAC units is seen when comparing efficiencies above 13 SEER for 2001 and 2002. In this instance, there is a larger percentage of heat pumps with a SEER equal to or greater than 13 but less than 14, when compared to CACs. Additionally, there is a smaller percentage of heat pumps with SEERs of 14 or more, when compared to central air conditioners. However, when overall units above 13 SEER are examined, the two equipment types show similar percentages of manufactured models.

When examining the HSPF of heat pumps manufactured for sale in the U.S., over 50% have an average heating efficiency rating between 6.8 and 7.5 HSPF. It is interesting to note that over one-third of all types of heat pumps manufactured qualified for the ENERGY STAR specification (7.6 HSPF) in effect during the first three quarters of 2002.

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

[24] Air-Conditioning and Refrigeration Institute. 1996 through 2002. *ARI Electronic Unitary Directory, ARIUD2000 V1.5.*

Figure 4-2: Heat Pump Availability, by SEER and HSPF



Source: California Energy Commission

4.4. Total Unit Sales

Table 4-2 presents estimates of total unit sales for residential heat pumps. There is no available definitive source for data regarding annual unit sales, nor sales information about decision type. However, Itron developed California sales estimates by examining national shipment data from Appliance Magazine,[25] shipments estimates from ARI,[26] and subsequently cross-referencing that information from the Commission.[27] In addition, data regarding life expectancy of these units were included.[28]

Table 4-2: Estimates of California's Annual HP Sales

Year	Total Unit Sales[1]
2000	82,500
2001	88,084
2002	90,318

1 Total unit sales data developed from information provided by ARI, Appliance Magazine, EPRI 1998, and compared with information on life expectancies and saturations.

4.5. Market Share of ENERGY STAR Heat Pumps

The increased sample data collected allowed the project team to develop estimates of the percentages of ENERGY STAR qualified heat pumps sold in California. Figure 4-3 presents the percentage of ENERGY STAR qualified heat pumps sold in California from the first quarter of 2000 through the last quarter of 2002. As shown, the statewide market share of ENERGY STAR qualified heat pumps increased slightly from over 9.74% in the first quarter of 2000 to 16.6% by the end of 2002. The second quarter of 2002 showed the highest market share of ENERGY STAR qualified heat pumps to date.

Table 4-3 details the statewide percentages of qualified units.

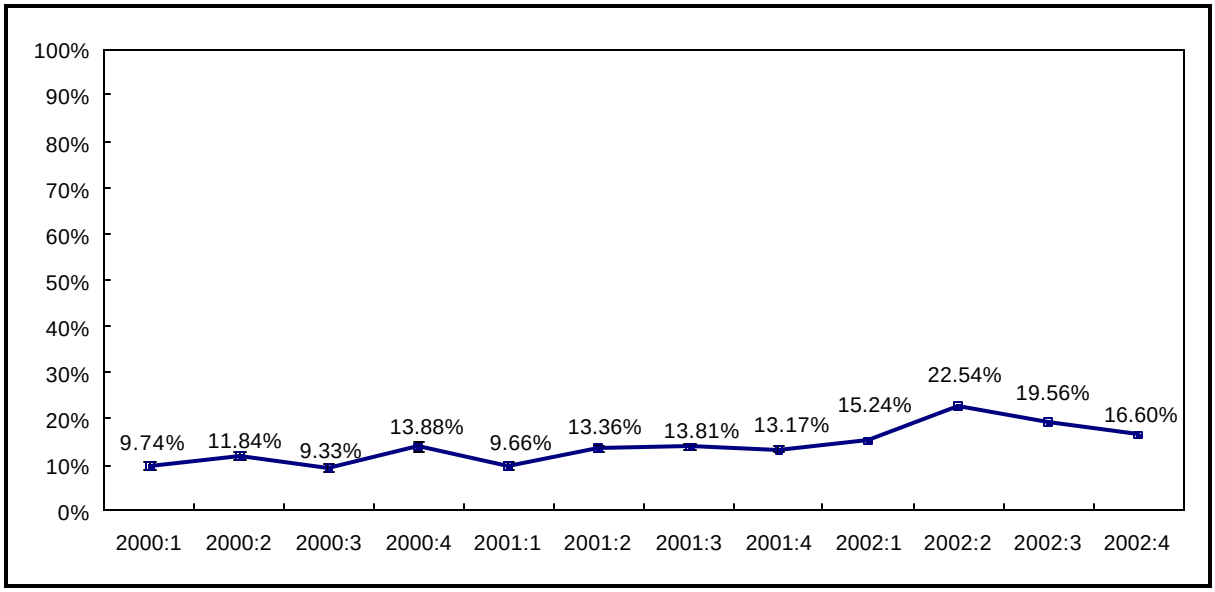
25 http://www.appliancemagazine.com/mm/stats/html/december_1999.html.

26 http://www.ari.org/sr/1999/sr9912.pdf.

27 California Energy Commission. July 1995. *Staff Report California Energy Demand: 1995-2015*.

28 Appliance Magazine. "A Portrait of the U.S. Appliance Industry: The Saturation Picture; The Share-of-Market Picture; The Life Expectancy/Replacement Picture; Who's Who in the Appliance Industry." September 1998. pp. 68-90.

Figure 4-3: Heat Pump Sales, Percent of ENERGY STAR Qualified Units



Error bands for the 90% confidence interval.

Table 4-3: Heat Pump Sales, Percent of ENERGY STAR Qualified Units (Statewide)

Year	Percent of ENERGY STAR Qualified Heat Pumps				
	Annual	Q1	Q2	Q3	Q4
2000	**11.13%**	**9.74%**	**11.84%**	**9.33%**	**13.88%**
	(.0025)	(.0051)	(.0047)	(.0043)	(.0059)
	n=16,154	n=3,356	n=4,789	n=4,566	n=3,443
2001	**12.55%**	**9.66%**	**13.36%**	**13.81%**	**13.17%**
	(.0024)	(.0044)	(.0049)	(.0048)	(.0050)
	n=19,136	n=4,565	n=4,864	n=5,077	n=4,630
2002	**18.66%**	**15.24%**	**22.54%**	**19.56%**	**16.60%**
	(.0029)	(.0055)	(.0062)	(.0053)	(.0059)
	n=18,515	n=4,273	n=4,566	n=5,664	n=4,012

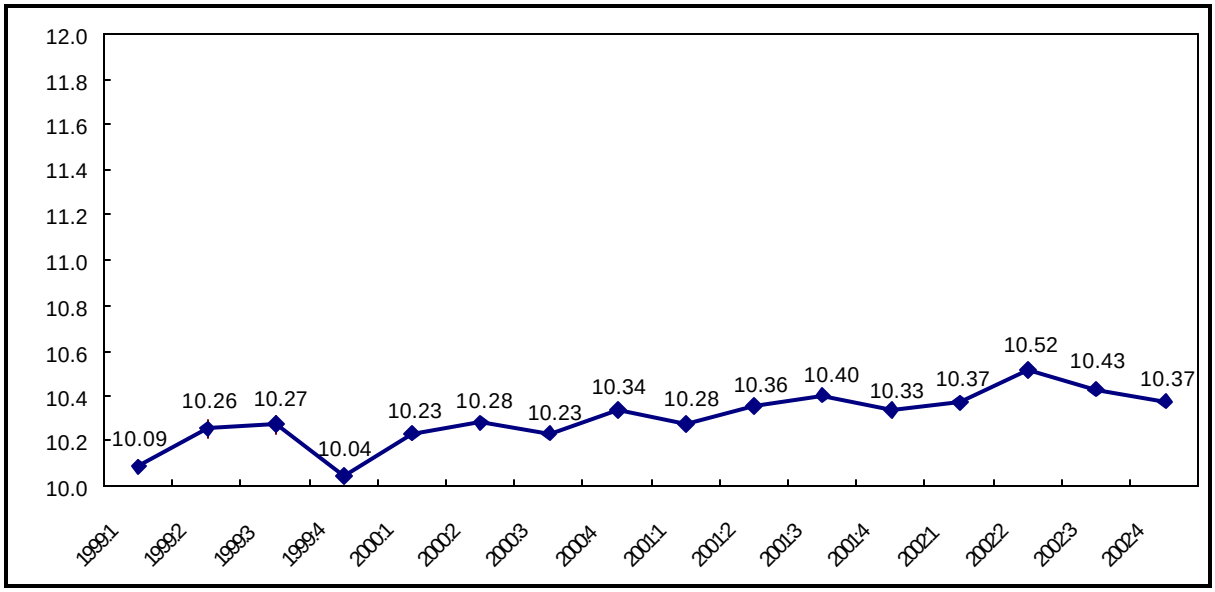
Standard errors in parentheses.

4.6. Average Efficiency of Heat Pumps in California

Figure 4-4 and Table 4-4 present the average cooling efficiency ratings (SEER) of heat pumps sold in California from 1999 through 2002, by quarter. As shown, the average SEER ranged from 10.09 in the first quarter of 1999 to 10.37 by the end of 2002.

Figure 4-5 illustrates the distribution of heat pumps sold by SEER level. As shown, most units sold had cooling efficiency ratings just above 10.0 SEER.

Figure 4-4: Heat Pumps, Average Cooling Efficiency (SEER)



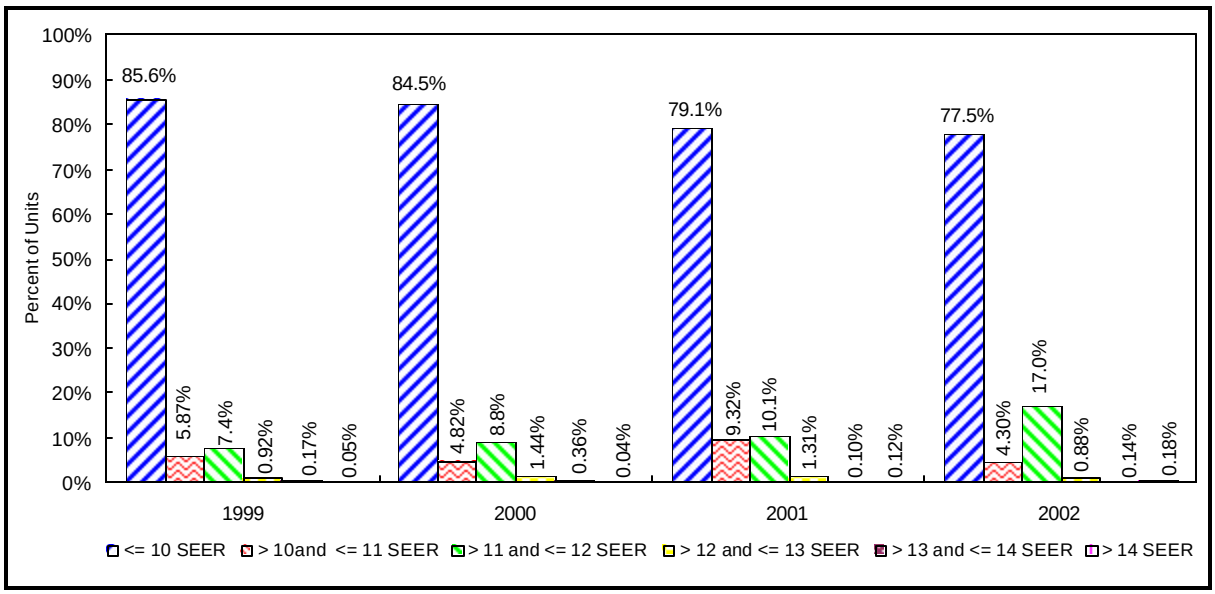
Error bands for the 90% confidence interval.

Table 4-4: Heat Pumps, Average Cooling Efficiency (SEER)

Period Year	Average SEER			
	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
1999	**10.0860** (0.0176) n = 535	**10.2573** (0.0249) n = 723	**10.2723** (0.0229) n = 896	**10.0447** (0.0099) n = 894
2000	**10.2323** (0.0141) n = 3,268	**10.2843** (0.0116) n = 4,721	**10.2318** (0.0115) n = 4,487	**10.3359** (0.0162) n = 3,385
2001	**10.3476** (0.0112) n = 4,569	**10.4456** (0.0125) n = 4,873	**10.4716** (0.0125) n = 5,094	**10.4207** (0.0127) n = 4,634
2002	**10.4167** (0.0132) n = 4,279	**10.5860** (0.0145) n = 4,584	**10.5041** (0.0123) n = 5,720	**10.5272** (0.0149) n = 4,032

Standard errors in parentheses.

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



5

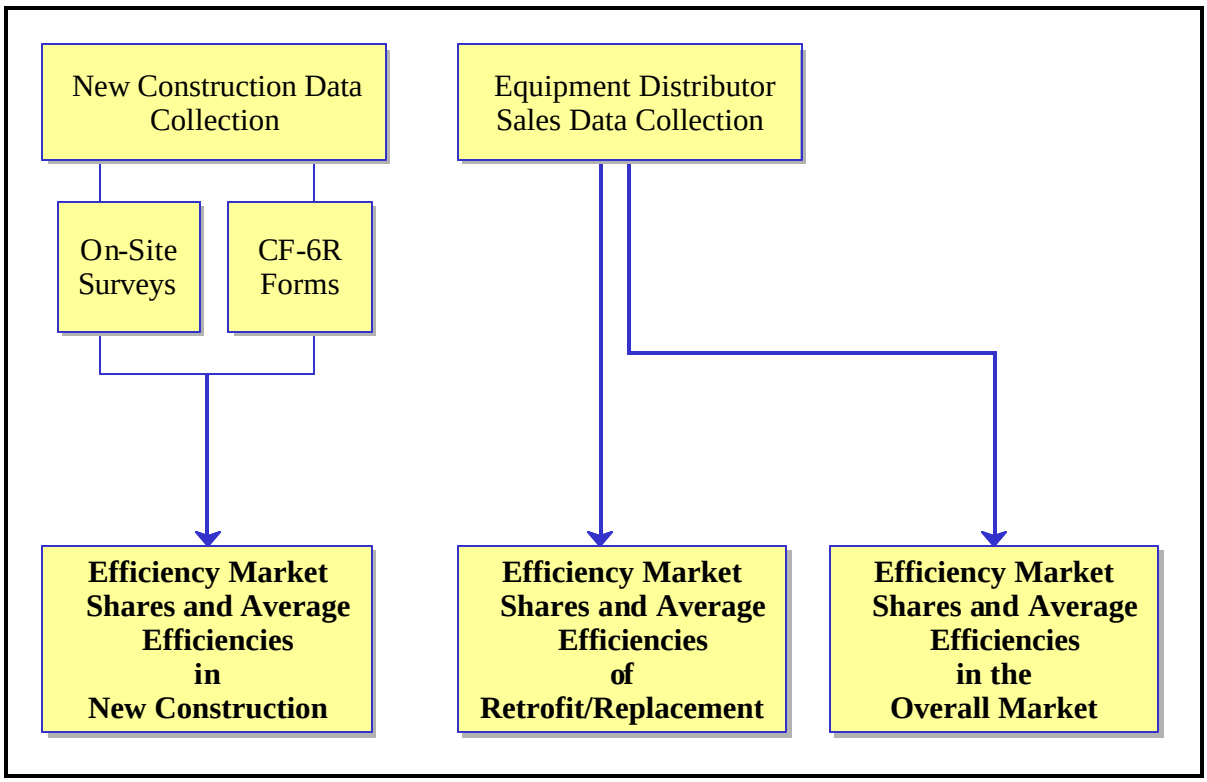
Central Gas Furnaces

5.1. 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 5.2 summarizes energy efficiency standards for gas furnaces and Subsection 5.3 summarizes the availability of models by efficiency level. Subsection 5.4 includes estimates of total gas furnace sales in California by decision type. Estimates of average efficiencies in the overall California market, new construction, and retrofit/replacement are presented in Subsections 5.5, 5.6, and 5.7, respectively.

Figure 5-1 provides an overview of the data sources for the gas furnace efficiency analysis. As shown, Itron used data from new construction on-site surveys and building department installation forms (CF-6Rs) to estimate the shares and average efficiencies of gas furnaces installed in residential new construction. Data collected from a panel of HVAC equipment distributors were used to estimate gas furnace efficiencies in California. 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 where possible.

Figure 5-1: Overview of Data Sources for Furnace Analysis



5.2. Furnace Efficiency Standards

The energy efficiency of furnaces is expressed as a percentage of Annual Fuel Utilization Efficiency (AFUE). Equipment AFUE levels increase as energy efficiency increases. The federal minimum AFUE standard for furnaces is 78%.[29,30] Units must have at least a 90% AFUE to qualify for the ENERGY STAR® label.

Currently, there are no anticipated changes to the federal standard. However, the ENERGY STAR program is evaluating their current standard for furnaces. Any developments with regard to a potential change to the ENERGY STAR specification will be reported in future versions of the HVAC RMST. Additionally, the California Energy Commission (Commission) decided not to increase the state standards for central gas furnaces.

[29] DOE. *Federal Register*. *Central Air Conditioners and Heat Pumps*. Title 10, Chapter II, Subpart C, Part 430, Section 430.32.

[30] Required efficiency for residential central gas furnaces that are less than 225 kBtu/hr.

Table 5-1: Comparison of Federal, ENERGY STAR, and Commission Energy Standards for Residential Central Gas Furnaces

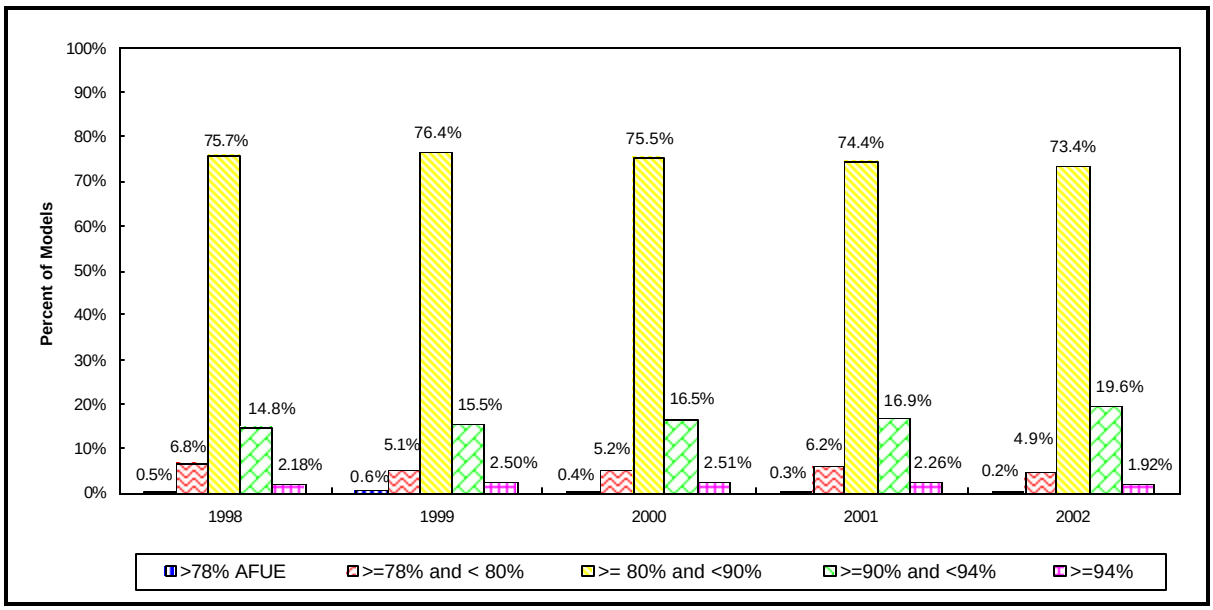
	Less than 225,000 Btuh	More than 225,000 Btuh
NAECA		
Current/ 1992 Standard	10	n/a
January 23, 2006 Standard	12	n/a
Percent Improved	20%	n/a
ENERGY STAR		
Former Standard	12	n/a
October 1, 2002 Standard	13	11
California Standards		
Current/1995 Standard	78 AFUE	70 AFUE
January 23, 2006 Standard	13	n/a

5.3. Characteristics of Available Models

To develop distributions of available forced-air furnace equipment models, Itron relied on information maintained by the Commission. Itron has included examinations of model availability for 1998 through 2002. This information will continue to be updated in future RMST HVAC reports.

Figure 5-2 shows that from 1998 through 2002 approximately three-quarters of the available gas furnace models have an AFUE between 80 and 90. In all years shown, less than 1% of models have an AFUE of 78. In 2002, one-fifth of available models would qualify for the ENERGY STAR specification due to an AFUE of 90 or greater.

Figure 5-2: Gas Furnace Availability by AFUE



Source: Gas Appliance Manufacturers Association

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

Table 5-2 presents estimates of total unit sales for gas furnaces. There is no definitive public source of annual sales of gas furnaces in California. However, nationwide sales for central gas furnaces were obtained from Appliance Magazine and GAMA.[31,32] These data were scaled to California annual sales based on number of households and measure type saturations. In particular, the national sales figure was multiplied by a ratio developed from the number of California households with the measure divided by the number of national households with the measure.

It is generally thought that heating equipment typically experiences seasonal sales trends or cycles. In the second year of this analysis, the expected sales trend, i.e. increased sales in the first and fourth quarters of the year when the weather is cooler, is revealed. The fourth quarter of 2000, the first quarter of 2001, and the fourth quarter of 2001 all show sales estimates above 100,000 units. This compares to the second quarters of 2000 and 2001, where the sales estimates are below 90,000 units. The project team will continue to evaluate the overall sales trends for gas furnaces. Figure 5-3 illustrates the statewide sales trend.

[31] GAMA's website: http://www.gamanet.org.

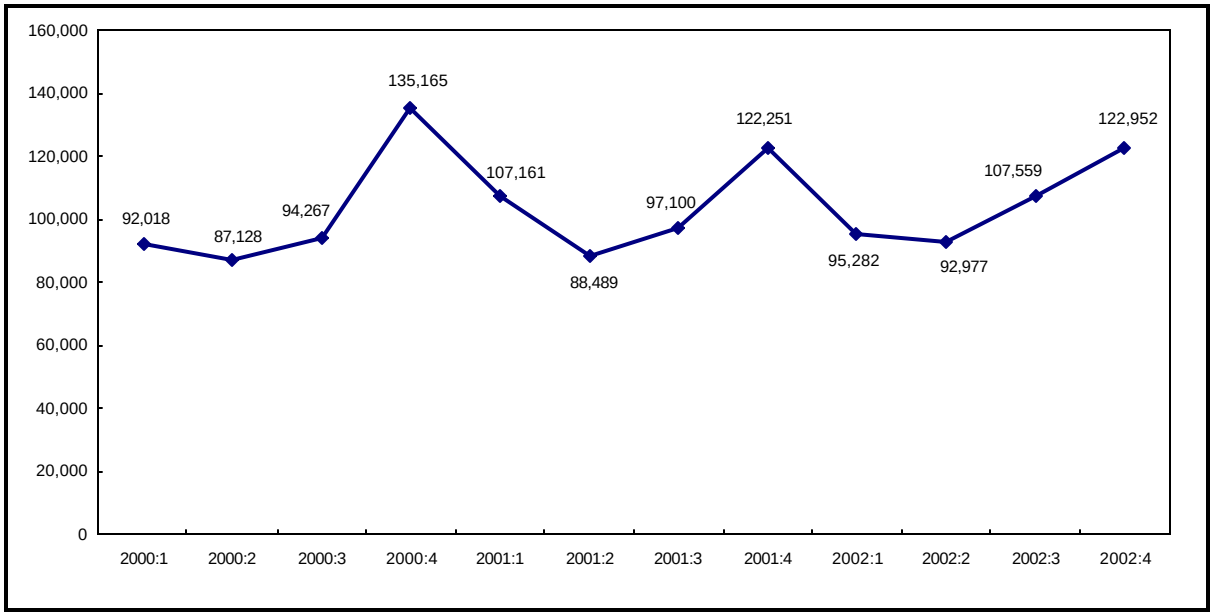
[32] Appliance Magazine. U.S. Shipment Statistics. 2001.

Table 5-2: Estimates of Annual Central Gas Furnaces Sales by Decision Type

Year	Total Units Sales [1,2]	New Construction[3]	Retrofit/ Replacement
1999	413,387	102,785	310,602
2000	408,578	115,415	293,162
2001	415,000	113,000	308,077
2002	418,769	116,769	302,000

1 National annual appliance sales from GAMA, scaled to the California market.
2 National annual appliance sales from Appliance Magazine, scaled to the California market.
3 Estimates of new construction from new construction on-site surveys (1999 = 1998:3-4 through 1999:1-2 and 2000 = 1999:3-4 through 2000:1-2) and new housing starts (last half of 2000 and 2001).

Figure 5-3: Overall Gas Furnace 2000 Quarterly Sales



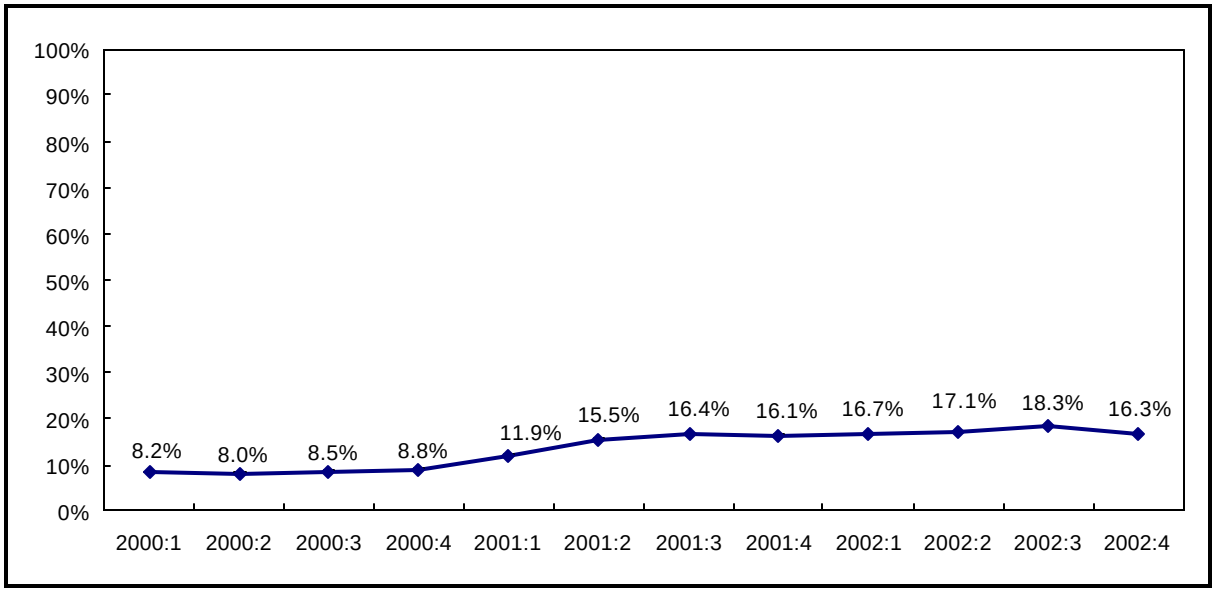
Error bands for 90% confidence interval.

5.5. Market Share of ENERGY STAR Gas Furnaces

The project team continues to estimate the percentages of ENERGY STAR qualified gas furnaces sold in California. Figure 5-4 presents the percentage of ENERGY STAR qualified gas furnaces sold in California from 2000 through 2002. Figure 5-5 illustrates the percent of ENERGY STAR gas furnace sales by utility. As shown, the statewide market share of ENERGY STAR qualified gas furnace units increased from 2.4% in the first quarter of 2000 to 16.3% by the end of 2002.

Table 5-3 illustrates state-level data for the market share of ENERGY STAR qualified gas furnace units both annually and by quarter. Additionally, Table 5-4 shows the same data broken out by utility/region.

Figure 5-4: Central Gas Furnace Sales, Percent of ENERGY STAR Qualified Units



Error bands for 90% confidence interval.

Figure 5-5: Central Gas Furnace Sales, Percent of ENERGY STAR Qualified Units by Utility

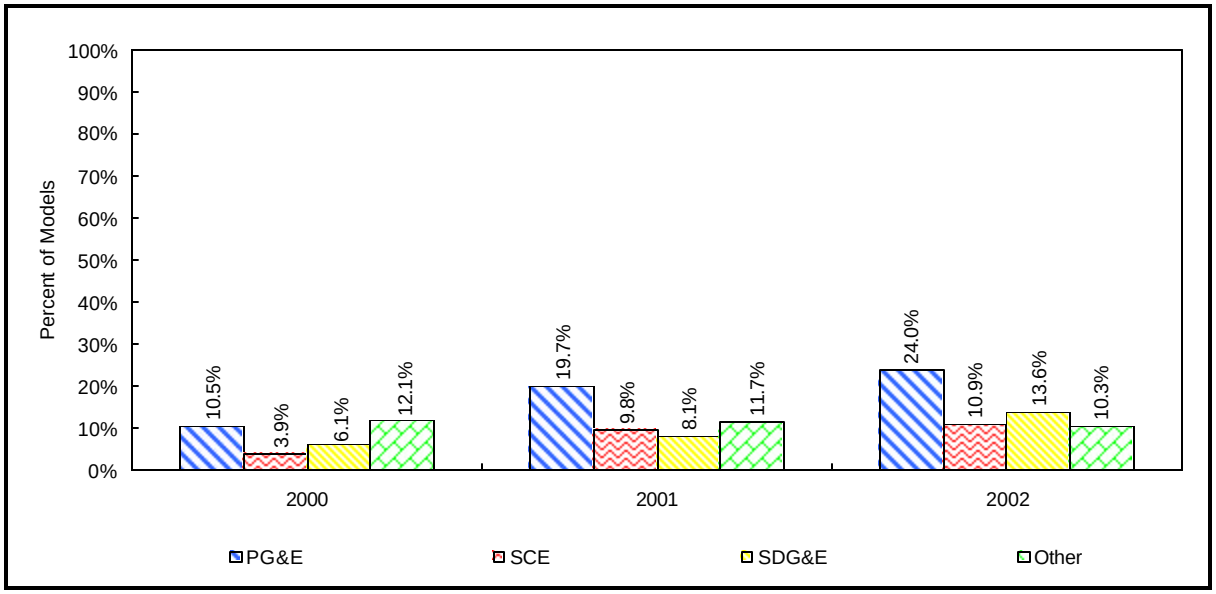


Table 5-3: Gas Furnace Sales, Percent of ENERGY STAR Qualified Units (Statewide)

Year	Percent of ENERGY STAR Qualified Gas Furnaces				
	Annual	**Q1**	**Q2**	**Q3**	**Q4**
2000	**8.45%**	**8.24%**	**8.02%**	**8.54%**	**8.81%**
	(.0009)	(.0020)	(.0020)	(.0019)	(.0017)
	n=88,309	n=19,854	n=19,207	n=21,052	n=28,196
2001	**14.96%**	**11.87%**	**15.52%**	**16.41%**	**16.09%**
	(.0010)	(.0018)	(.0023)	(.0022)	(.0020)
	n=117,053	n=29,978	n=25,145	n=27,291	n=34,639
2002	**17.09%**	**16.72%**	**17.06%**	**18.32%**	**16.31%**
	(.0011)	(.0022)	(.0022)	(.0021)	(.0020)
	n=127,572	n=30,007	n=29,302	n=32,508	n=35,755

Standard errors in parentheses.

Table 5-4: Gas Furnace Sales, Percent of ENERGY STAR Qualified Units by Utility Service Area

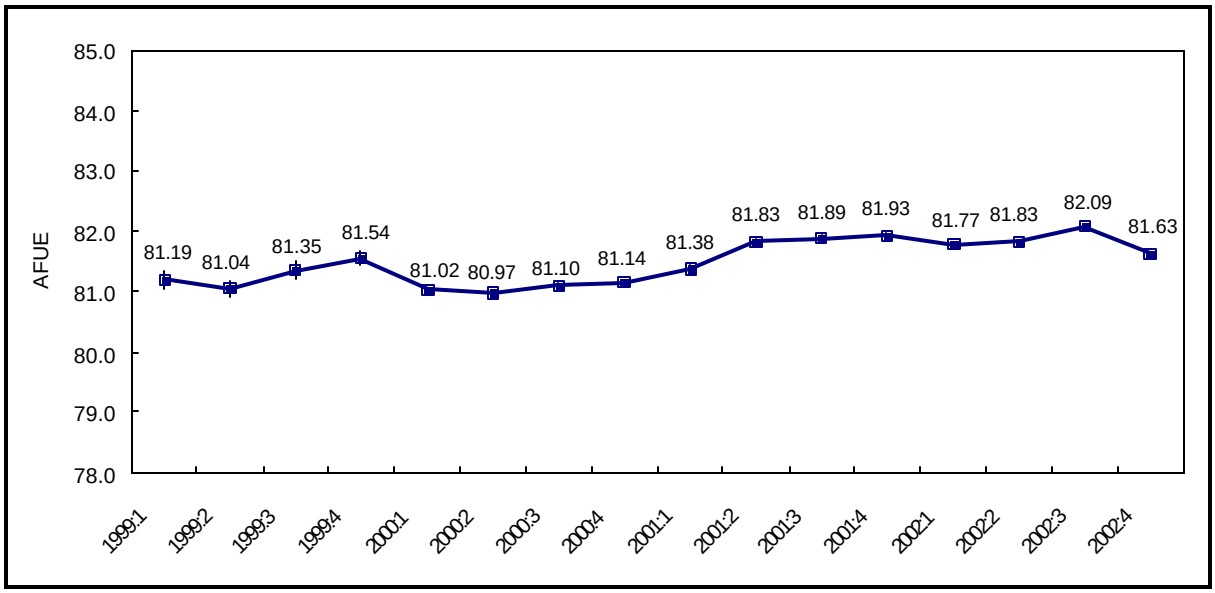
Utility	Year	Percent of ENERGY STAR Qualified Furnaces [1, 2]				
		Annual	Q1	Q2	Q3	Q4
PG&E	2000	**10.47%** (.0012) n=59,874	**9.43%** (.0025) n=13,598	**9.29%** (.0025) n=13,589	**10.78%** (.0025) n=14,865	**11.91%** (.0024) n=17,822
Southern California[3]	2000	**4.54%** (.0013) n=23,639	**4.70%** (.0029) n=5,196	**4.15%** (.0029) n=4,668	**4.37%** (.0028) n=5,228	**4.75%** (.0023) n=8,547
Other	2000	**12.07%** (.0047) n=4,796	**14.25%** (.0107) n=1,060	**14.00%** (.0113) n=950	**10.85%** (.0100) n=959	**10.45%** (.0072) n=1,827
PG&E	2001	**19.73%** (.0016) n=61,409	**16.76%** (.0030) n=15,807	**19.96%** (.0035) n=13,254	**21.94%** (.0035) n=14,316	**20.40%** (.0030) n=18,032
Southern California[3]	2001	**9.29%** (.0016) n=31,247	**5.88%** (.0026) n=8,150	**10.43%** (.0038) n=6,614	**9.79%** (.0035) n=7,041	**11.03%** (.0032) n=9,442
Other	2001	**11.66%** (.0021) n=24,397	**9.07%** (.0037) n=6,021	**11.60%** (.0044) n=5,277	**12.18%** (.0042) n=5,934	**13.44%** (.0040) n=7,165
PG&E	2002	**24.00%** (.0016) n=68,037	**21.28%** (.0033) n=15,800	**22.86%** (.0034) n=15,664	**27.24%** (.0034) n=17,124	**24.27%** (.0031) n=19,449
Southern California[3]	2002	**11.61%** (.0018) n=33,215	**13.83%** (.0039) n=7,683	**12.42%** (.0037) n=7,817	**11.17%** (.0034) n=8,401	**9.53%** (.0030) n=9,314
Other	2002	**10.32%** (.0019) n=26,320	**10.34%** (.0038) n=6,524	**11.30%** (.0042) n=5,821	**10.57%** (.0037) n=6,983	**9.22%** (.0035) n=6,992

1. Standard errors in parentheses.
2. "Other" includes municipal utilities such as LADWP, LMUD, PP&L, SMUD, and others.
3. Southern California is a combination of SCE and SDG&E.

5.6. Efficiencies of Gas Furnaces in the Overall Market

Figure 5-6 and Table 5-5 present the average AFUE of central gas furnaces sold in California by quarter from 1999 through 2002. As shown, the average AFUE ranged from 81.19% in the first quarter of 1999 to 81.63% during the last quarter of 2002.

Figure 5-6: Central Gas Furnaces, Average AFUE



Error bands for the 90% confidence interval.

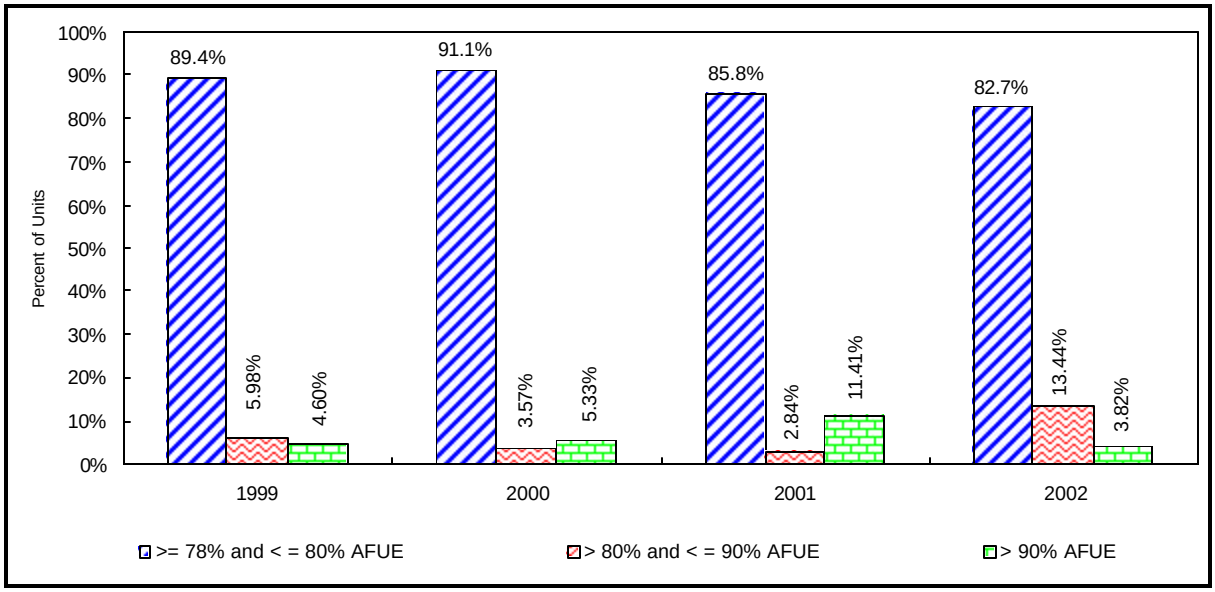
Table 5-5: Central Gas Furnaces, Average AFUE

Period Year	Average AFUE			
	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
1999	**81.19** (0.0821) n = 1,556	**81.04** (0.0846) n = 1,300	**81.35** (0.0909) n = 1,414	**81.54** (0.0780) n = 2,147
2000	**81.02** (0.0240) n = 19,755	**80.97** (0.0235) n = 19,207	**81.10** (0.0241) n = 21,049	**81.14** (0.0211) n = 28,195
2001	**81.41%** (0.0119) n = 30,014	**81.84%** (0.0145) n = 25,181	**81.93%** (0.0142) n = 27,317	**81.89%** (0.0124) n = 34,676
2002	**81.91%** (0.0118) n = 30,013	**81.93%** (0.0119) n = 29,313	**82.03%** (0.0114) n = 32,511	**81.84%** (0.0105) n = 35,759

Standard errors in parentheses.

Figure 5-7 illustrates the distribution of gas furnaces sold by AFUE level. As shown, over 80% of units sold throughout the past three years had AFUEs between 78% and 80%. As expected, higher efficiency units generally increase over time. The exception to this is the decrease in furnaces with an AFUE above 90 seen in 2002 from the 2001 level.

Figure 5-7: Gas Furnaces, Percent of Sales by AFUE Level



5.7. 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. Presented below are the results from the on-site survey analysis, the CF-6R data analysis, and the combined analysis. Due to a temporary gap in the collection of on-site surveys, that portion of the analysis has not been updated since the 2000 New Construction report. However, wherever possible, all other information has been updated through the end of 2001. The 2002 data will be updated in the 2003 HVAC report. See Subsection 2.3 for an explanation of the differences between the on-site survey data and the CF-6R data.

On-Site Survey Data Analysis Results

Table 5-6 presents the average AFUE for central gas furnaces by utility service area. There is little variation in AFUE over time in the PG&E and SCE service territories. However, the average AFUE for homes in the SDG&E service territory increased significantly.[33] Overall AFUEs increased slightly because of the increase in SDG&E's territory. Figure 5-8 shows

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

the distribution of gas furnaces by efficiency level. Of the central gas furnaces installed for all periods, over 90% had an AFUE of 78 to 80.

Table 5-6: Central Gas Furnace Average AFUE – On-Site Survey Data

	PG&E	SCE	SDG&E	All
1998:3-4	**80.61** (0.2481) n = 117	**80.43** (0.1669) n = 115	**80.03** (0.0326) n = 38	**80.48** (0.1341) n = 270
1999:1-2	**80.62** (0.2486) n = 112	**80.01** (0.0076) n = 123	**80.00** (0.0000) n = 33	**80.32** (0.1154) n = 268
1999:3-4	**80.67** (0.2334) n = 139	**80.03** (0.0193) n = 97	**80.17** (0.0663) n = 44	**80.39** (0.1229) n = 280
2001:1-2	**80.59** (0.2171) n = 143	**80.46** (0.2112) n = 99	**81.52** (0.5718) n = 51	**80.59** (0.1488) n = 293

Standard errors in parentheses.

Figure 5-8: Central Gas Furnace Shares by AFUE – On-Site Data

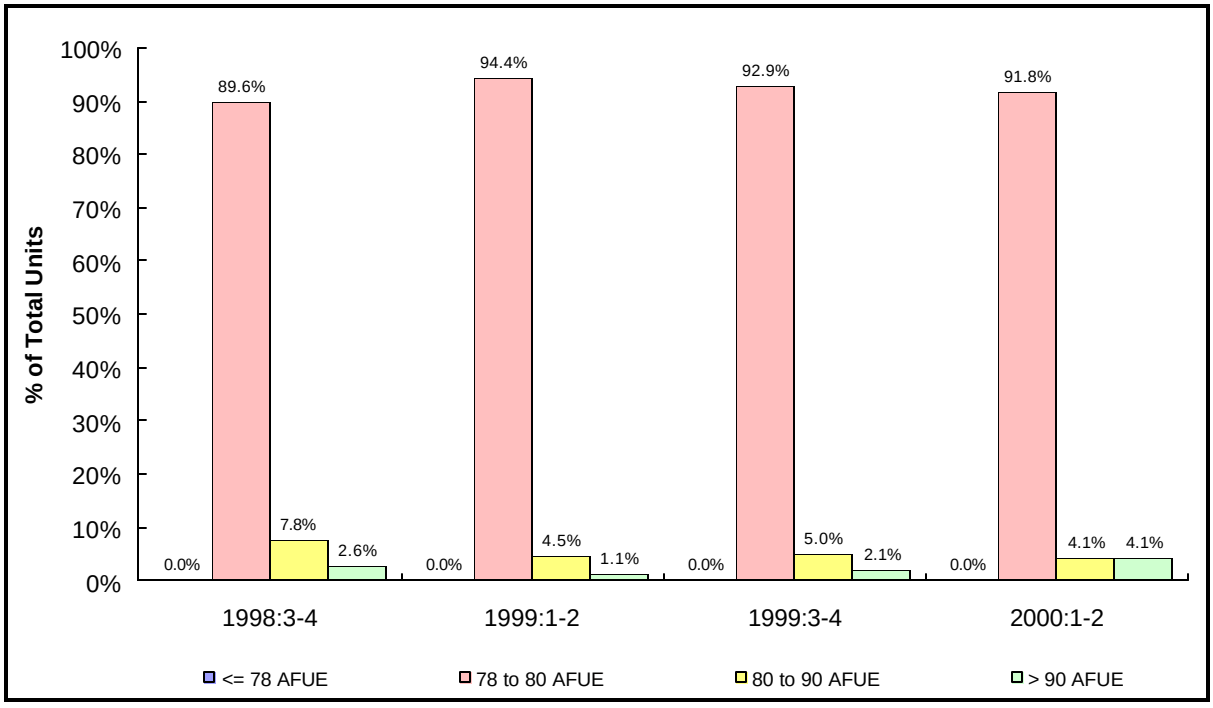


Table 5-7 and Table 5-8 present the saturation of gas furnaces by utility and climate zone for single family and multifamily homes, respectively. The saturations illustrate the percentages of homes, by strata, with at least one gas furnace.

Table 5-7: Saturations of Central Gas Furnaces – On-Site Data – Single Family Homes

Period	RMST Climate Zone	PG&E	SCE	SDG&E	CA
1998:3-4 – 1999:1-2					
	CZ:1	**96.6%** n = 118	**-** n = 0	**-** n = 0	**96.6%** n = 118
	CZ:2	**-** n = 0	**100.0%** n = 30	**100.0%** n = 62	**100.0%** n = 96
	CZ:3	**-** n = 0	**99.3%** n = 154	**100.0%** n = 14	**99.3%** n = 179
	CZ:4	**96.6%** n = 145	**100.0%** n = 15	**-** n = 0	**96.8%** n = 160
	CZ:5	**100.0%** n = 2	**100.0%** n = 31	**-** n = 0	**100.0%** n = 43
1999:3-4 – 2000:1-2					
	CZ:1	**94.8%** n = 96	**-** n = 0	**-** n = 0	**94.8%** n = 96
	CZ:2	**-** n = 0	**96.2%** n = 26	**100.0%** n = 53	**97.9%** n = 84
	CZ:3	**-** n = 0	**100.0%** n = 118	**100.0%** n = 18	**100.0%** n = 144
	CZ:4	**98.4%** n = 198	**100.0%** n = 12	**-** n = 0	**98.5%** n = 210
	CZ:5	**100.0%** n = 3	**100.0%** n = 27	**40.7%** n = 2	**99.3%** n = 41

Table 5-8: Saturations of Central Gas Furnaces – On-Site Data – Multifamily Homes

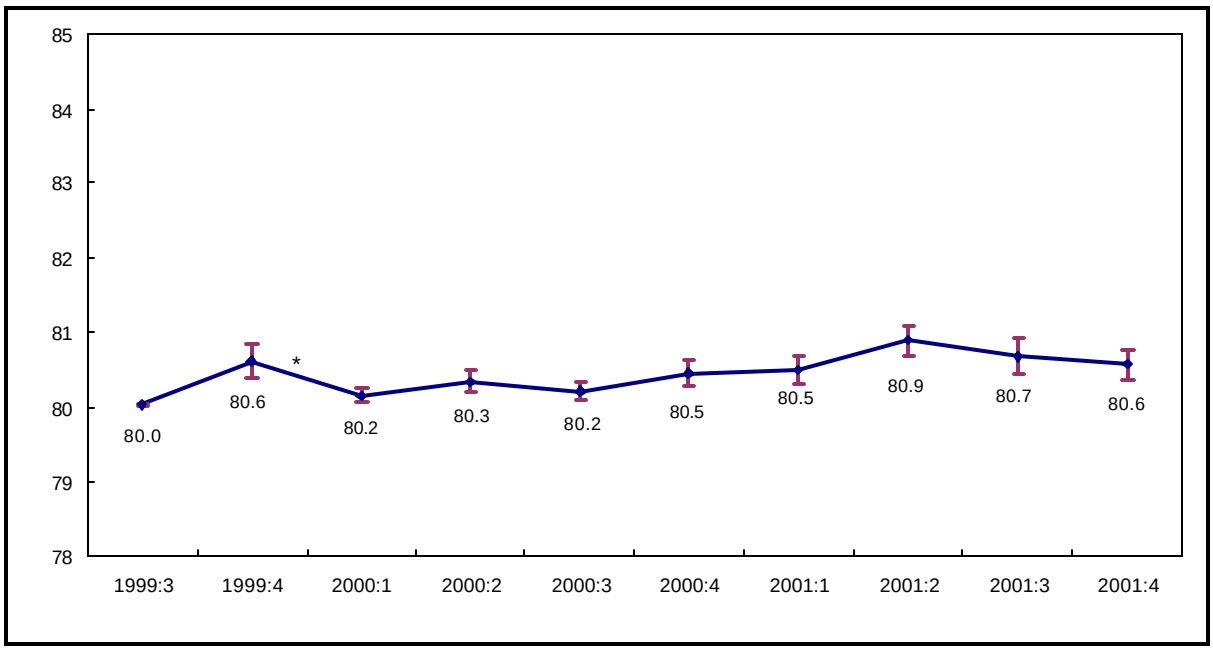
Period	RMST Climate Zone	PG&E	SCE	SDG&E	CA
1998:3-4 – 1999:1-2					
	CZ:1	**31.0%** n = 66	**-** n = 0	**-** n = 0	**31.0%** n = 66
	CZ:2	**-** n = 0	**60.2%** n = 13	**37.9%** n = 28	**51.7%** n = 42
	CZ:3	**-** n = 0	**55.0%** n = 30	**75.8%** n = 4	**55.3%** n = 48
	CZ:4	**55.2%** n = 34	**100.0%** n = 1	**-** n = 0	**55.6%** n = 35
	CZ:5	**0.0%** n = 1	**47.5%** n = 10	**-** n = 0	**46.9%** n = 13
1999:3-4 – 2000:1-2					
	CZ:1	**31.2%** n = 51	**-** n = 0	**-** n = 0	**31.2%** n = 51
	CZ:2	**-** n = 0	**50.0%** n = 16	**32.5%** n = 42	**37.9%** n = 62
	CZ:3	**-** n = 0	**61.4%** n = 25	**36.6%** n = 8	**56.2%** n = 45
	CZ:4	**33.0%** n = 55	**-** n = 0	**-** n = 0	**33.0%** n = 55
	CZ:5	**100.0%** n = 1	**100.0%** n = 8	**100.0%** n = 1	**100.0%** n = 13

CF-6R Data Analysis Results

Figure 5-9 presents the average AFUE by quarter. As shown, the average AFUE for new construction in California ranged from a low of 80.0% in the third quarter of 1999 to a high of 80.9% during the second quarter of 2001. Table 5-9 shows the average AFUE by utility and by quarter. While the average AFUE for SCE's territory remains near 80%, average AFUEs in PG&E's service area range from 80% in the third quarter of 1999 to just over 81% during the second quarter of 2001.

Figure 5-10 illustrates the share of gas furnaces for each efficiency group, by quarter. As shown, the percentage of gas furnaces with an AFUE above 80 that were installed in new homes throughout 2001 increased noticeably in comparison to 1999 and 2000.

Figure 5-9: CF-6R Central Gas Furnace Data (Average AFUE by Quarter)



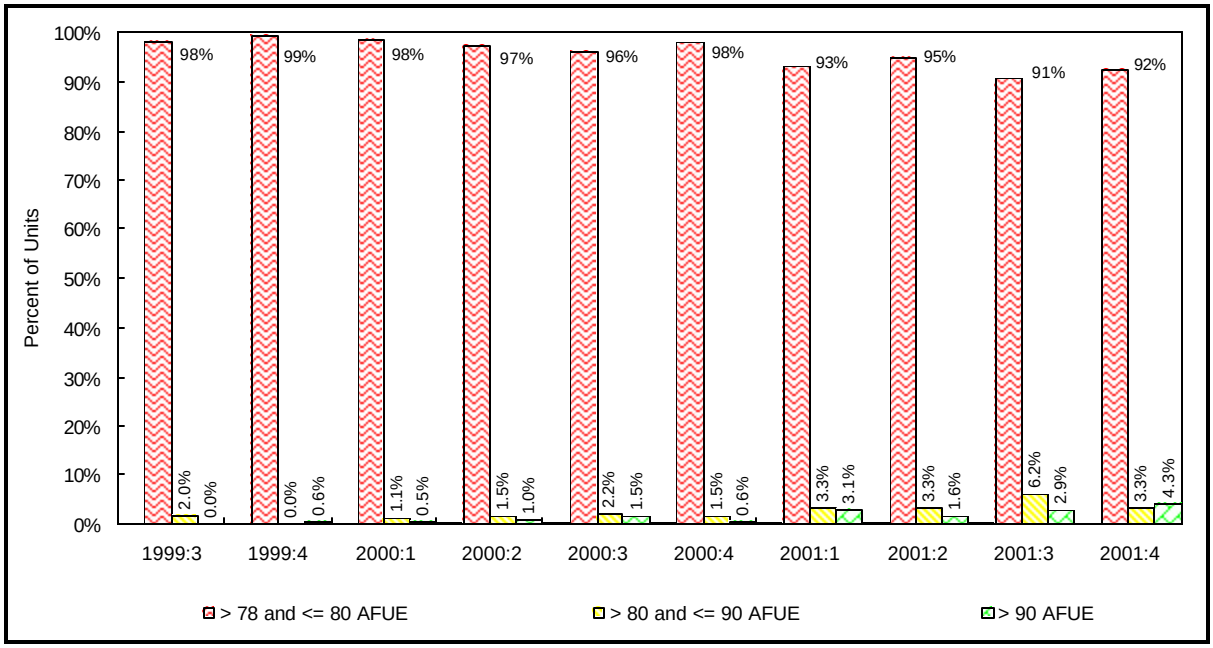
Error bands for the 90% confidence interval.

Table 5-9: CF-6R Central Gas Furnace Data (Average AFUE)

	PG&E	SCE	All
1999:3	**80.03** (0.0285) n = 8	**80.00** (0.0000) n = 43	**80.03** (0.0098) n = 51
1999:4	**81.13** (0.8253) n = 19	**80.00** (0.0000) n = 330	**80.62** (0.1422) n = 349
2000:1	**80.20** (0.1445) n = 116	**80.01** (0.0043) n = 521	**80.16** (0.0547) n = 637
2000:2	**80.53** (0.3209) n = 76	**80.06** (0.0315) n = 529	**80.34** (0.0902) n = 605
2000:3	**80.21** (0.1555) n = 108	**80.20** (0.0695) n = 435	**80.21** (0.0680) n = 543
2000:4	**80.74** (0.4342) n = 45	**80.02** (0.0324) n = 500	**80.46** (0.1000) n = 545
2001:1	**80.53** (0.3245) n = 62	**80.40** (0.1006) n = 448	**80.49** (0.1073) n = 510
2001:2	**81.21** (0.3830) n = 97	**80.08** (0.0301) n = 531	**80.89** (0.1293) n = 628
2001:3	**81.00** (0.2457) **n = 189**	**80.05** (0.0154) **n = 229**	**80.68** (0.1367) **n = 418**
2001:4	**80.77** (0.2540) n = 143	**80.08** (0.0496) n = 277	**80.57** (0.1265) n = 420

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

Figure 5-10: CF-6R Central Gas Furnace Data (AFUE Groups by Quarter)



Combined New Construction Results

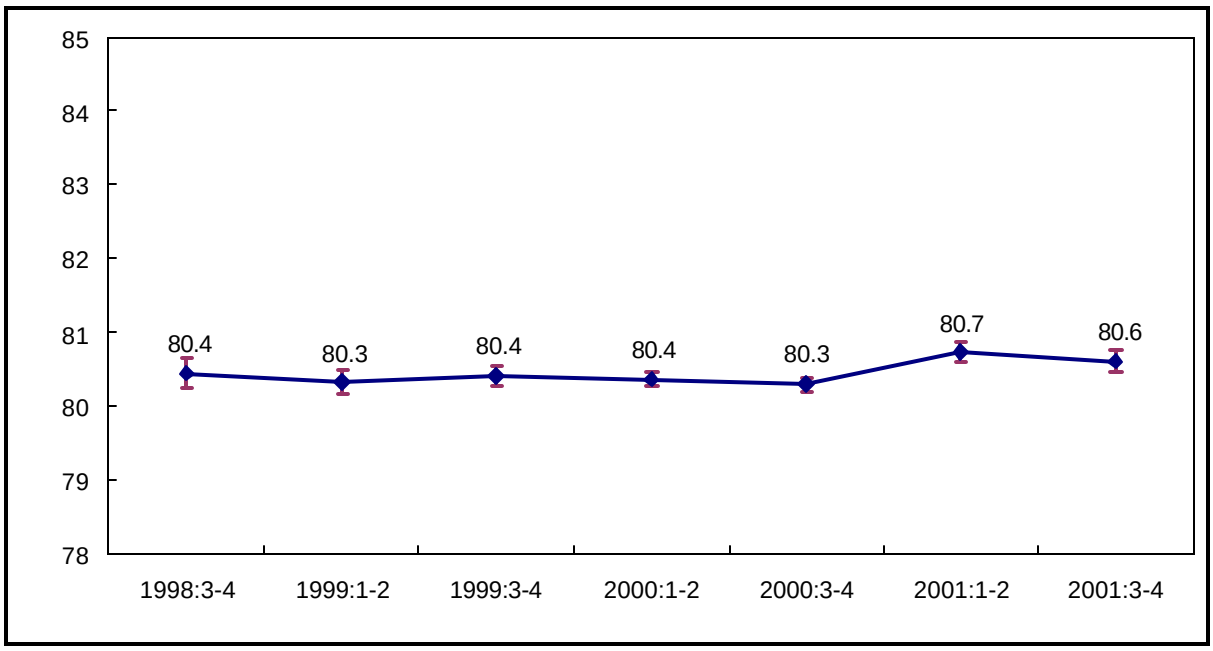
Figure 5-11 presents the average gas furnace efficiency by six-month period. Included in this figure is a 90% confidence interval around the estimated average efficiency. These results indicate that there has been little change in the overall average efficiency of gas furnaces statewide until 2001.[34]

Table 5-10 presents the average efficiency by climate zone. The statewide average AFUE in 2001 is significantly higher than the previous periods.[35] This is primarily attributable to the increase in the average AFUE in RMST Climate Zone 4.

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

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

Figure 5-11: Central Gas Furnace Average AFUE in New Construction



Error bands for the 90% confidence interval.

Table 5-10: Central Gas Furnace Average AFUE in New Construction by Climate Zone

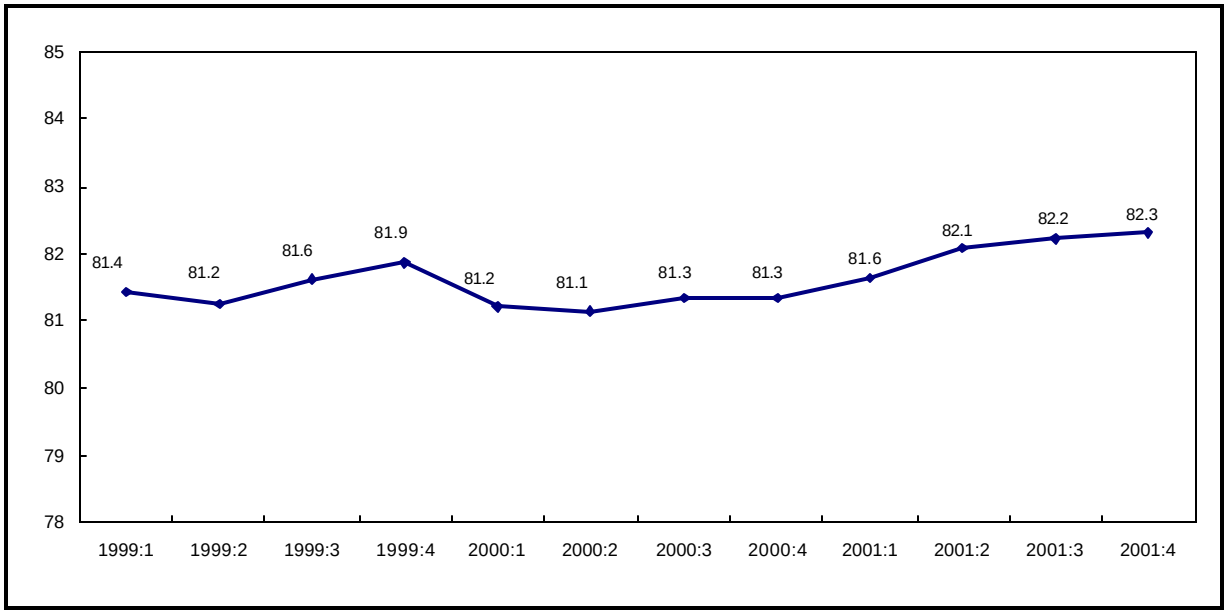
	RMST Climate Zone					
	CZ:1	**CZ:2**	**CZ:3**	**CZ:4**	**CZ:5**	**All**
1998:3-4	**80.33** (0.2314) n = 67	**80.08** (0.0449) n = 43	**80.45** (0.2069) n = 91	**80.70** (0.3563) n = 67	**80.33** (0.1272) n = 18	**80.43** (0.1238) n = 286
1999:1-2	**80.19** (0.1560) n = 64	**80.04** (0.0222) n = 44	**80.00** (0.0000) n = 102	**80.79** (0.3151) n = 84	**80.48** (0.4845) n = 26	**80.32** (0.1031) n = 320
1999:3-4	**80.78** (0.3761) n = 61	**80.09** (0.0495) n = 46	**80.04** (0.0100) n = 425	**80.68** (0.2702) n = 109	**80.03** (0.0304) n = 39	**80.40** (0.0811) n = 680
2000:1-2	**80.16** (0.1201) n = 86	**80.63** (0.3432) n = 54	**80.07** (0.0278) n = 953	**80.59** (0.1668) n = 252	**80.16** (0.0814) n = 190	**80.37** (0.0519) n = 1535
2000:3-4	**80.00** (0.0000) n = 63	- - n = 0	**80.00** (0.0000) n = 773	**80.49** (0.2529) n = 90	**80.64** (0.1951) n = 161	**80.30** (0.0563) n = 1087
2001:1-2	**80.00** (0.0000) n = 27	- - n = 0	**80.17** (0.0496) n = 838	**81.30** (0.3343) n = 131	**80.54** (0.1618) n = 141	**80.73** (0.0864) n = 1137
2001:3-4	**80.00** (0.0000) n = 4	- - n = 0	**80.03** (0.0341) n = 369	**81.23** (0.2057) n = 328	**80.25** (0.0408) n = 137	**80.61** (0.0925) n = 838

Standard errors in parentheses.

5.8. Gas Furnace Retrofit/Replacement Efficiency

Figure 5-12 depicts the estimate of sales for retrofits/replacement/acquisition sector. As shown, the average AFUE goes from 81.45 in the first quarter of 1999 to 82.3 in the last quarter of 2001. The project team obtained this estimate of the average AFUE sold in the retrofit/replacement market by backing out new construction data from the overall market data from the HVAC distributors.

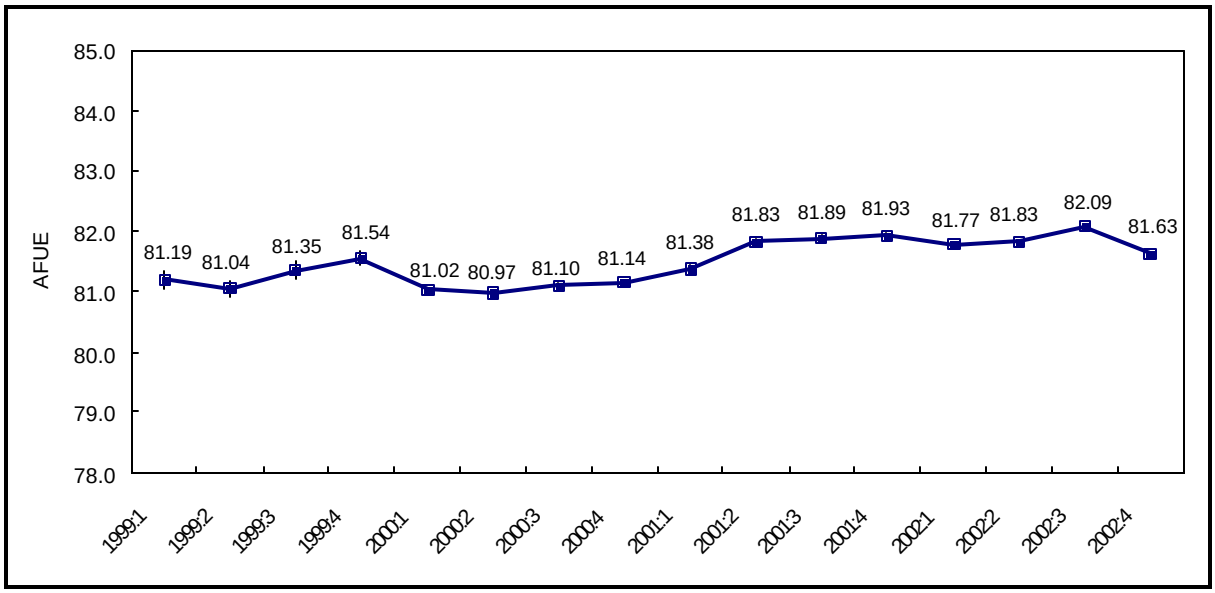
Figure 5-12: Central Gas Furnace Average Efficiencies (AFUE) – Retrofit, Replacement, and Acquisition



5.9. Summary of Average AFUE Levels by Market Type

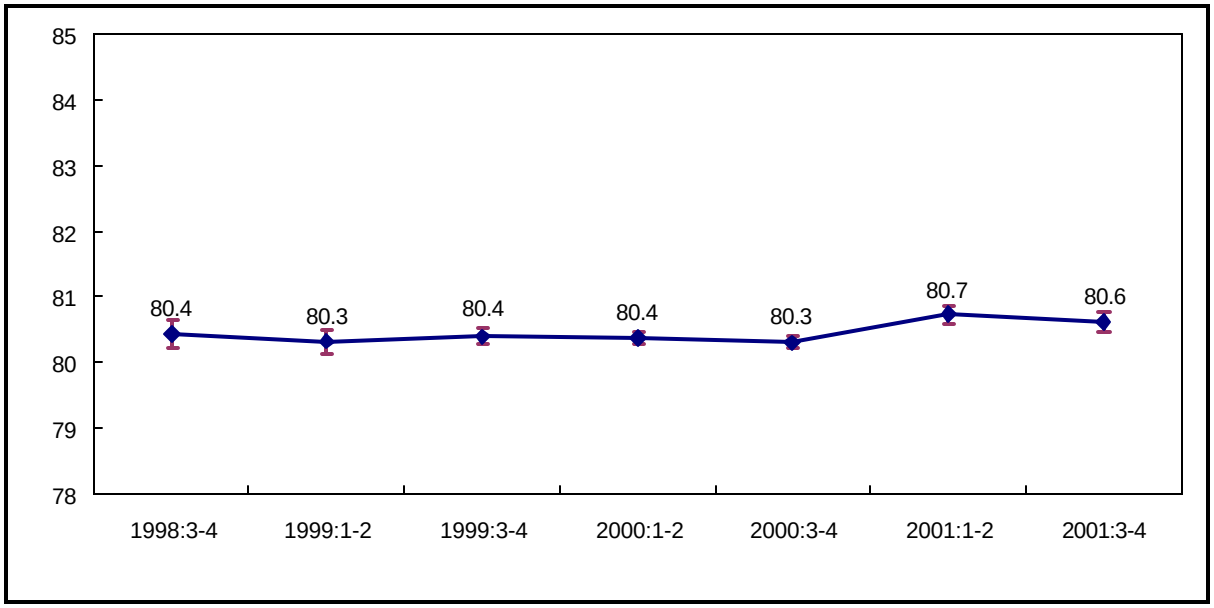
To best illustrate the three market segments covered by the project, the graphs that illustrate the average AFUE levels of gas furnaces in the residential market in California are repeated below for easy reference and comparison.

Figure 5-13: Central Gas Furnaces, Average AFUE



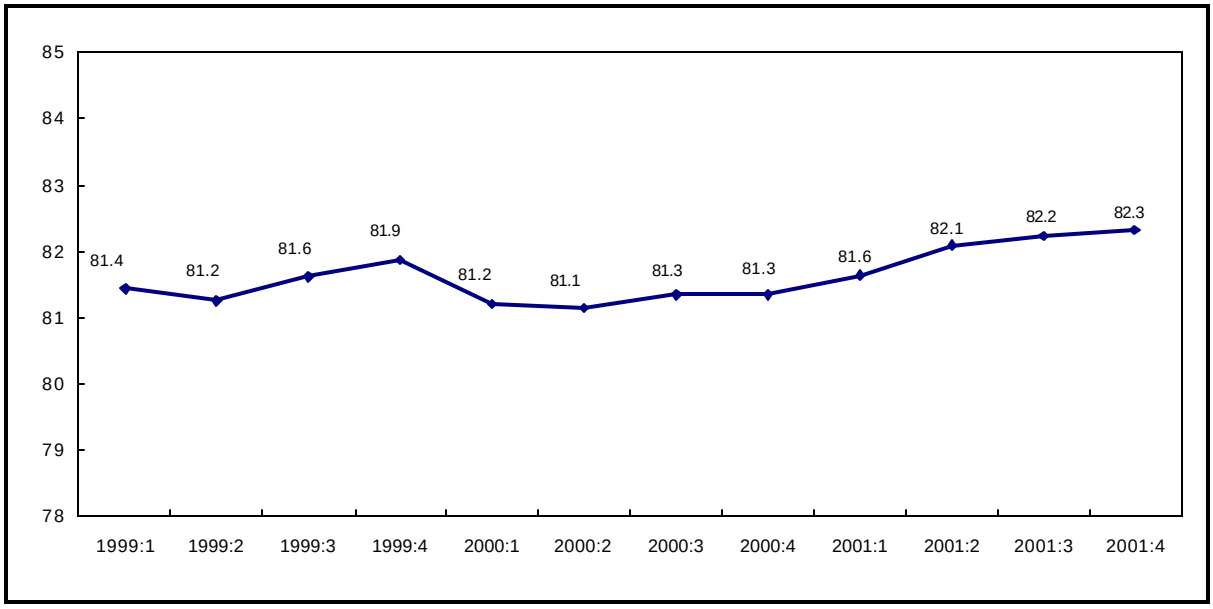
Error bands for the 90% confidence interval.

Figure 5-14: Central Gas Furnace Average AFUE in New Construction



Error bands for the 90% confidence interval.

Figure 5-15: Central Gas Furnace Average Efficiencies (AFUE) – Retrofit, Replacement, and Acquisition



6

Work in Progress and Fifth-Year Tracking Activities

The project team has shifted to the publication of a semi-annual update in the form of an executive summary. This next update should be published near the end of 2003. In addition, Itron will continue its recruitment efforts in order to increase the sample size, which will improve the precision of the analysis. Itron strives to improve geographic coverage. Within this overall effort to enlarge the sample, Itron will pay special attention to slightly under-represented utility areas, such as SDG&E. The continuing fifth-year efforts will also focus on the following:

- Producing the third round of individual summaries for participating distributors, and
- Maintaining the sample distributor base by regular contact/relationship building.

Additionally, Itron will continue to monitor changes in federal standards (National Appliance Energy Consumption Act, or NAECA), and evaluate the impact of these changes as appropriate. In addition, the ENERGY STAR® specification changes will also be monitored.

Appendix A

New Construction Data Detail and Analysis

A.1 New Construction Building Department Recruiting Protocol for CF-6R Forms

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 whether each building department retained copies of CF-6R forms in its 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. 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 can 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 other departments wrap the CF-6Rs with building plans and warehouse them offsite.
- Some only kept the forms for a limited time (90 days, 180 days, one year, etc.).

For these and other diverse reasons, it was impossible to devise a single collection system that would work for all departments. Thus, 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.

In some cases, recruiting building departments warranted in-person visits either to 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.

A.2 New Construction Building Department Participation Status

To date, RER has received nearly 4,700 CF-6R forms from 27 building departments and three contractors. As shown in Table A-1, Fontana and Temecula have been, by far, the most active participants. Table A-2 summarizes the CF-6R forms by California Energy Commission climate zone (CEC climate zone), utility service area, and the year in which the home was built. Approximately 81% of forms are from houses built in SCE's service territory, with only 19 % built within PG&E's territory. Currently, no CF-6R forms have been obtained for SDG&E's territory.

Table A-1: Participation – Number of CF-6R Forms

Building Department/ Contractor	RMST Climate Zone	1998	1999	2000	2001
Alameda County Unincorporated Area	1		1		
Angels Camp	4				14
Apple Valley Town	5		15	288	279
Beutler	4				96
Beutler HVAC	4				28
Chico	4	1	14		
Cobra	3				15
Cobra Plumbing	3			109	27
Davis	4		17	135	5
El Dorado	4				5
Empire Swift	1				18
Folsom	4	3	9	53	
Fontana	3		22	523	1024
Fremont	1			120	28
Hanford	4			2	205
Indian Wells	5		7	33	
Irvine	3	1			
Livermore	4				
Morgan Hill	1	5			
Murrieta	3			17	
Napa	1		5		
Petaluma	1	7	15	2	
Pittsburg	1				3
Pleasanton	4		4	10	28
Rocklin	4	3	3		
Roseville	4				25
Sacramento	4				23
Simi Valley	3	4	19	137	
Stockton	4				
Temecula	3	2	222	903	174
Tracy	4				
Turlock	4				5
Total		**26**	**353**	**2332**	**2002**

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

Utility	RMST Climate Zone	1998	1999	2000	2001
PG&E	1	12	21	122	56
	4	7	47	200	427
	Total	**19**	**68**	**322**	**483**
SCE	2			38	
	3	7	263	1651	1240
	5		22	321	279
	Total	**7**	**285**	**2010**	**1519**

A.3 CF-6R Installation Forms

To augment the data obtained during the on-site surveys, RER obtained CF-6R installation forms from various building departments and contractors throughout California. The CF-6R forms, filed by builders upon completion of construction, include detailed data on various measures installed in new homes, including HVAC equipment. 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.

Description of 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 include descriptions, efficiency ratings, and model numbers for the previously mentioned equipment, 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 require that builders provide the completed CF-6R to the new homeowner, but do not require them to be submitted to or retained by the presiding building department. CF-6R forms typically are posted in the garage of a home 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 local 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 remains on file. In many instances, if the CF-6R

form is filed at all, the department retains it only 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.4 On-Site Surveys

The objective of the on-site surveys was to collect efficiency data for equipment and shell measures installed in 800 single family and multifamily homes in California for two years of the project. As the RMST study is an ongoing multi-year project, on-site surveys will continue to be conducted to develop a time trend of efficiencies in this important market sector. The new construction survey frame was developed using customer frame data provided by California's independently owned utilities (IOUs). To ensure that the case weights represented new home populations by residence type and climate zone, data on total building permits by type and climate zone also provided a sanity check for the frame estimates.

The survey was updated in the second year of the RMST to better capture the desired data. These changes did improve the information collected about HVAC equipment.

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.

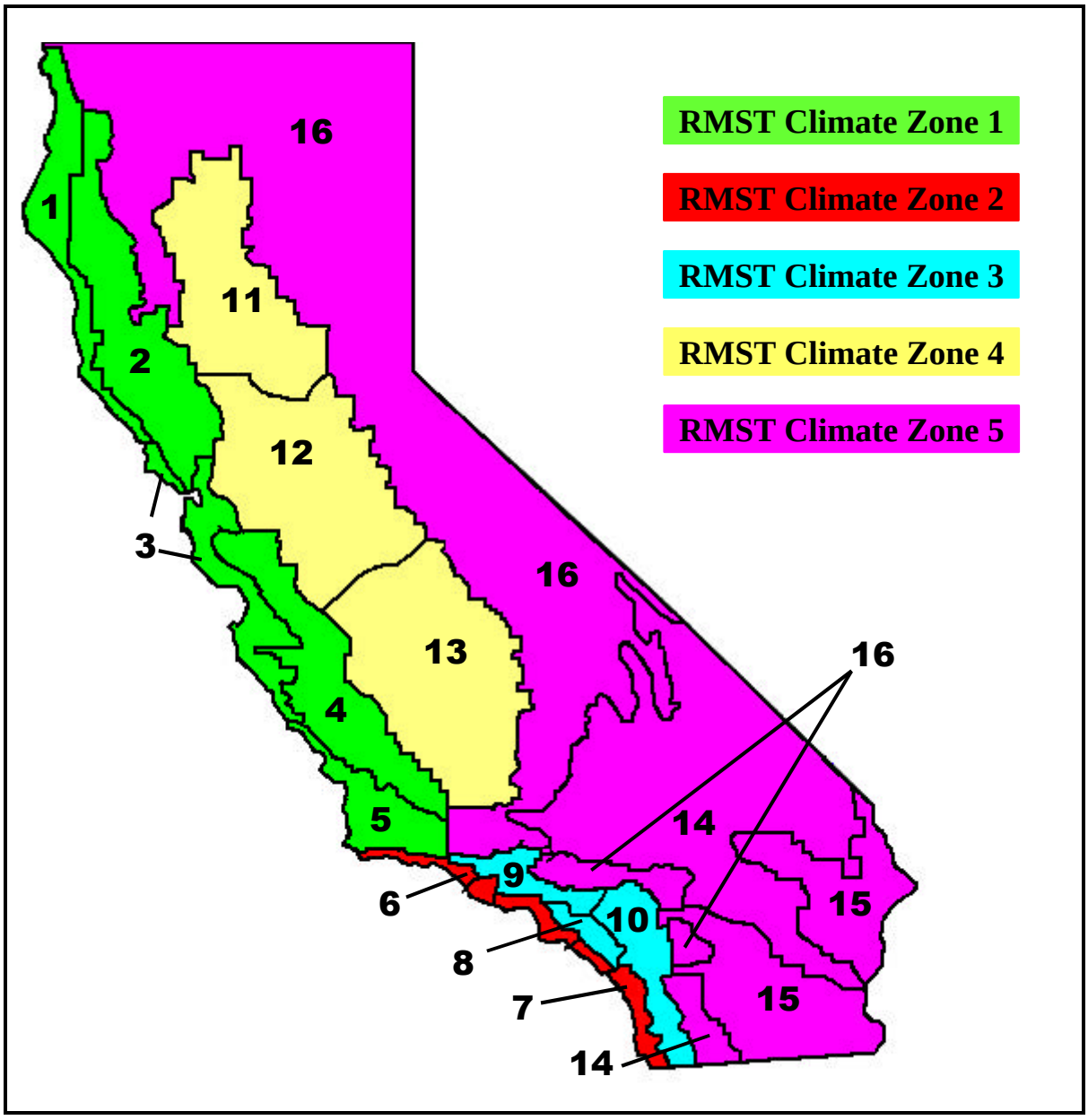
Sample Frame Overview. The new construction survey frame was developed using customer frame data provided to RER by California's IOUs. To ensure that the case weights represent new home populations by residence type and climate zone, data on total building permits by type and climate zone were also used 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 for the first year of data and those homes first occupied between June 30, 1999 and July 1, 2000 for the second year. Further, it was essential that the frame data include information on residence type and California Energy Commisison climate zone (CEC climate zone).

- ***Residence Type.*** Each utility has a residence type indicator in its 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 A-1. For this study, these zones were collapsed into five regions. The criterion for the aggregating 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 A-1: CEC Climate Zones



A.5 Distributor Expansion Weights

To estimate total HVAC sales in each utility area, RER developed an estimate of units sold for residential use by utility area. To do this, RER combined data from the new construction portion of the RMST with information about replacement units based on saturations and expected lifetime data.[1] RER used this estimate to create an appropriate expansion weight for the utility level data.

The expansion weights for CACs and central gas furnaces sold in each utility area for sales by the HVAC distributors are computed as the ratio of total units sold to the units sold in the analysis sample.

Shares of ENERGY STAR qualifying heating and cooling equipment 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.

A ratio of the total number of households in each utility service area to the total number of households in California was used to estimate the proportion of total sales of each type of HVAC equipment in each utility service area for each year. The ratio was applied to estimates of HVAC shipments to California.

Expansion weights were calculated as follows:

$$N_{uh} = R_u + NC_u$$

where:

N_{uh} = an estimate of total sales of HVAC equipment *h* for utility *u* in 2002.

NC_{uh} = an estimate of new construction HVAC equipment *h* for utility *u* in 2002.

R_{uh} = total number of replacement HVAC units *h* in each utility's *u* service area in 2002. R_u was developed from:

$$T_{uh} \times L$$

where T_{uh} is the total number of household HVAC units *h* in each utility's service area *u* and *L* is the expected lifetime in years for the appropriate HVAC equipment. T_{uh} was determined by:

$$P_u \times Saturation_{ue}$$

[1] Appliance Magazine. A Portrait of the U.S. Appliance Industry: The Saturation Picture; The Share-of-Market Picture; The Life Expectancy/Replacement Picture; Who's Who in the Appliance Industry. September 1998. pp. 68-90.

where P_u is the total number of households in each utility service area *u* in 2002 and S_{ue} is the saturation by each utility service area *u* and by HVAC equipment type *e* in 2002. The total number of households in the utility service areas is derived from household numbers reported by the three IOUs in California, as well as the Los Angeles Department of Water and Power and the Sacramento Municipal Utility District.

A.6 On-Site Survey Expansion Weights

RER developed expansion weights to expand the on-site data to represent the total number of homes built within the three electric IOU territories between July 1, 1998 and June 30, 2000. The expansion weights for HVAC equipment were based on the number of households in each utility service area and CEC climate zones shown in Table A-3.[2]

Table A-3: New Homes Built in California (by Utility and Climate Zone)

	RMST Climate Zone	PG&E	SCE	SDG&E	All
July 1, 1998 - June 30, 1999	CZ:1	28,387	-	-	28,387
	CZ:2	4	5,864	6,215	12,083
	CZ:3	-	25,797	1,169	26,966
	CZ:4	29,022	2,149	-	31,171
	CZ:5	589	4,658	15	5,262
	Total	**58,002**	**38,468**	**7,399**	**103,869**
July 1, 1999 - June 30, 2000	CZ:1	27,459	0	0	27,459
	CZ:2	0	6,782	7,750	14,532
	CZ:3	0	23,599	2,125	25,724
	CZ:4	46,305	1,851	0	48,156
	CZ:5	524	4,865	65	5,454
	Total	**74,288**	**37,097**	**9,940**	**121,325**

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

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

$N_{U,CZ,HT,SA}$ = the total number of houses built between July 1, 1999 and June 30, 2000, by utility (*U*), climate zone (*CZ*), housing type (*HT*) , and semi-annual classification (*SA*), and

$n_{U,CZ,HT,SA}$ = the number of completed samples points for houses built between July 1, 1998 and July 30, 2000, by utility, climate zone, housing type, and semi-annual classification.

A.7 CF-6R Data Processing and Expansion Weights

Expansion weights were developed to expand the data obtained from the installation forms to represent the total number of homes built within the three electric IOU territories between July 1, 1998 and December 31, 2001. The expansion weights are based on the number of households in each utility service area and CEC climate zone.[3] In particular, the expansion weights for HVAC equipment are based on utility and climate zone.

Central Air Conditioners. The CF-6R form contains CAC data that usually include model number and efficiency rating (SEER). RER verified efficiency ratings by checking the minimum values and then ensuring that data with the same model numbers had identical efficiencies attributed to them. RER staff also identified efficiencies for each observation where that information had not been provided. RER used the CEC appliance database and manufacturer information to research these efficiencies.[4]

Expansion weights were used to expand the number of observations up to the total number of homes with CACs built within the three electric IOU territories between July 1, 1998 and December 31, 2001. These expansion weights were constructed using information 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 with CACs and the percentage of homes with room air conditioners. These percentages were calculated by utility service territory and climate zone.

Expansion weights were calculated as follows:

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

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

[4] CEC. *Database of Energy Efficient Appliances.*

where

$N_{U,CZ}$ = the total number of houses built between July 1, 1998 and December 31, 2001, by utility, and climate zone,

$n_{U,CZ}$ = the number of CF-6R forms for houses built between July 1, 1998 and December 31, 2001, by utility and climate zone, and

$Saturation_{U,CZ}$ = the percent of homes in the on-site database built between July, 1998 and December 31, 2001 that have a CACs, by utility and climate zone.

Furnaces. The CF-6R form contains central gas furnace data that usually includes model number and efficiency rating (AFUE). RER verified the efficiency ratings by checking the minimum AFUE values, and then ensuring that data with the same model numbers had identical efficiencies attributed to them. RER staff also identified the efficiencies for each observation where that information had not been provided. The CEC appliance database and manufacturer information was used to research these efficiencies.[5]

Expansion weights were developed to expand the number of observations up to the total number of homes with central gas furnace built within the each utility service territory between July 1, 1998 and December 31, 2001. 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:

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

[5] *Ibid.*

where

$N_{U,CZ}$ = the total number of houses built between July 1, 1998 and December 31, 2001, by utility and climate zone,

$n_{U,CZ}$ = the number of CF-6R forms for houses built between July 1, 1998 and December 31, 2001, by utility and climate zone, and

$Saturation_{U,CZ}$ = the percent of homes in the on-site database built between July 1, 1998 and December 31, 2001 that have a central gas furnace, by utility and climate zone .

A.8 New Construction Building Department Recruiting Protocol for CF-6R Forms

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 whether each building department retained copies of CF-6R forms in its 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. 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 can 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 other departments wrap the CF-6Rs with building plans and warehouse them offsite.
- Some only kept the forms for a limited time (90 days, 180 days, one year, etc.).

For these and other diverse reasons, it was impossible to devise a single collection system that would work for all departments. Thus, 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.

In some cases, recruiting building departments warranted in-person visits either to 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.

A.9 New Construction Building Department Participation Status

To date, RER has received nearly 4,700 CF-6R forms from 27 building departments and three contractors. As shown in Table A-1, Fontana and Temecula have been, by far, the most active participants. Table A-2 summarizes the CF-6R forms by California Energy Commission climate zone (CEC climate zone), utility service area, and the year in which the home was built. Approximately 81% of forms are from houses built in SCE's service territory, with only 19 % built within PG&E's territory. Currently, no CF-6R forms have been obtained for SDG&E's territory.

Table A-4: Participation – Number of CF-6R Forms

Building Department/ Contractor	RMST Climate Zone	1998	1999	2000	2001
Alameda County Unincorporated Area	1		1		
Angels Camp	4				14
Apple Valley Town	5		15	288	279
Beutler	4				96
Beutler HVAC	4				28
Chico	4	1	14		
Cobra	3				15
Cobra Plumbing	3			109	27
Davis	4		17	135	5
El Dorado	4				5
Empire Swift	1				18
Folsom	4	3	9	53	
Fontana	3		22	523	1024
Fremont	1			120	28
Hanford	4			2	205
Indian Wells	5		7	33	
Irvine	3	1			
Livermore	4				
Morgan Hill	1	5			
Murrieta	3			17	
Napa	1		5		
Petaluma	1	7	15	2	
Pittsburg	1				3
Pleasanton	4		4	10	28
Rocklin	4	3	3		
Roseville	4				25
Sacramento	4				23
Simi Valley	3	4	19	137	
Stockton	4				
Temecula	3	2	222	903	174
Tracy	4				
Turlock	4				5
Total		**26**	**353**	**2332**	**2002**

Table A-5: Number of CF-6R Forms Collected to Date, by Climate Zone

Utility	RMST Climate Zone	1998	1999	2000	2001
PG&E	1	12	21	122	56
	4	7	47	200	427
	Total	**19**	**68**	**322**	**483**
SCE	2			38	
	3	7	263	1651	1240
	5		22	321	279
	Total	**7**	**285**	**2010**	**1519**