California Residential Efficiency Market Share Tracking

New Construction 2001

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TURNING DATA INTO INFORMATION

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Introduction

1.1 Introduction

This report presents the results from the first two years of the new construction portion of the California Residential Market Share Tracking (RMST) project.[1] The project, conducted by Regional Economic Research, Inc. (RER) under Southern California Edison (SCE) management, plays a significant role in market assessment, planning, and evaluation activities supporting California's publicly funded energy efficiency programs.

The annual collection and analysis of 800 on-site surveys represents an important element of the RMST project. It is important to note that these data also support and enhance other statewide studies and provide valuable information to other entities interested in new construction energy efficiency issues. For example, these data are an integral part of the study of Baseline practices in the Residential New Construction sector[2] and provide valuable data to California Energy Commission (CEC) staff investigating new standards.

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

1.2 Background

Residential efficiency market share tracking in California is an ongoing, long-term effort designed to support publicly funded energy efficiency program planning, evaluation, and related policy decisions over the next several years. Tracking systems (including those specifically tracking market shares) are needed for program development, program redesign, and broader policy-making decisions:

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1 Regional Economic Research, Inc. *California Residential Efficiency Market Share Tracking - First-Year Interim Report.* Prepared for Southern California Edison. October 20, 2000.

2 Regional Economic Research, Inc. *Residential New Construction Study.* Prepared for Pacific Gas & Electric. May 17, 2001.

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

RER's approach to developing and implementing the residential sector efficiency tracking closely follows recommendations developed from a publicly funded scoping study, conducted by RER (referred to hereinafter as the tracking scoping study) under the direction of the California Board for Energy Efficiency.[3,4] RER based the tracking scoping study upon specific tracking system requirements: 1) that data represent unit sales, so levels and percentages of shipments of energy efficiency measures could be estimated, 2) that data be segmented by efficiency type, so the share of efficient products could be tracked continuously even in the face of shifts in the overall distribution of efficiency and changes to energy efficiency standards, and 3) that data be available at the state level and, if possible, at finer levels of geographic aggregation. RER also recommended that data be collected to support efficiency tracking by decision type (new construction, net acquisition, retrofit, and replacement). It is necessary to distinguish decision type in market share tracking in order to accommodate the assessment of programs that are designed to influence choices under specific market events.

Change in Reporting Format

This report represents the second of many interim reports for the RMST project focused on residential new construction. The first efficiency tracking report was an all-inclusive report that included the results for each measure of interest.[5] In an effort to produce reports in a timely and targeted manner, multiple reports for the second year of the tracking project are being developed instead of one all-inclusive report. The measures covered in each report are grouped based on the type of equipment and by the type of data – new construction vs. overall market. The main advantage of having four individual reports is that each can be published based on the timing of the data collection. Table 1-1 lists each of the second year reports, along with details about each report.

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

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

5 Regional Economic Research, Inc. *California Residential Efficiency Market Share Tracking - First-Year Interim Report.* Prepared for Southern California Edison. October 20, 2000.

Table 1-1: Second Year Reports

Report	Data	Measures	Next Report Due Date
Lighting*	Point-of-Sales Data	Light Bulbs Torchieres	April 2001 August 2001
Appliances	Distributor Data	Refrigerators Dish Washers Clothes Washers/Dryers	July 2001
New Construction	New Construction Data	Gas Furnaces Central Air Conditioning Gas Water Heaters Ducts Lighting Windows	June 2001
HVAC and Water Heating	New Construction & Distributor Data	Gas Furnaces Central Air Conditioning Gas Water Heaters	July 2001

* Semiannual report

Overview of California's Residential New Construction Market

Having an understanding of the level of new construction activity in California is useful when tracking the efficiencies of measures installed in newly constructed homes. As shown in Table 1-2, and illustrated in Figure 1-1, new construction activity decreased significantly in the early 1990s. After remaining fairly constant for several years, the number of new homes built in California has been consistently increasing since 1995.

Figure 1-1: New Construction in California

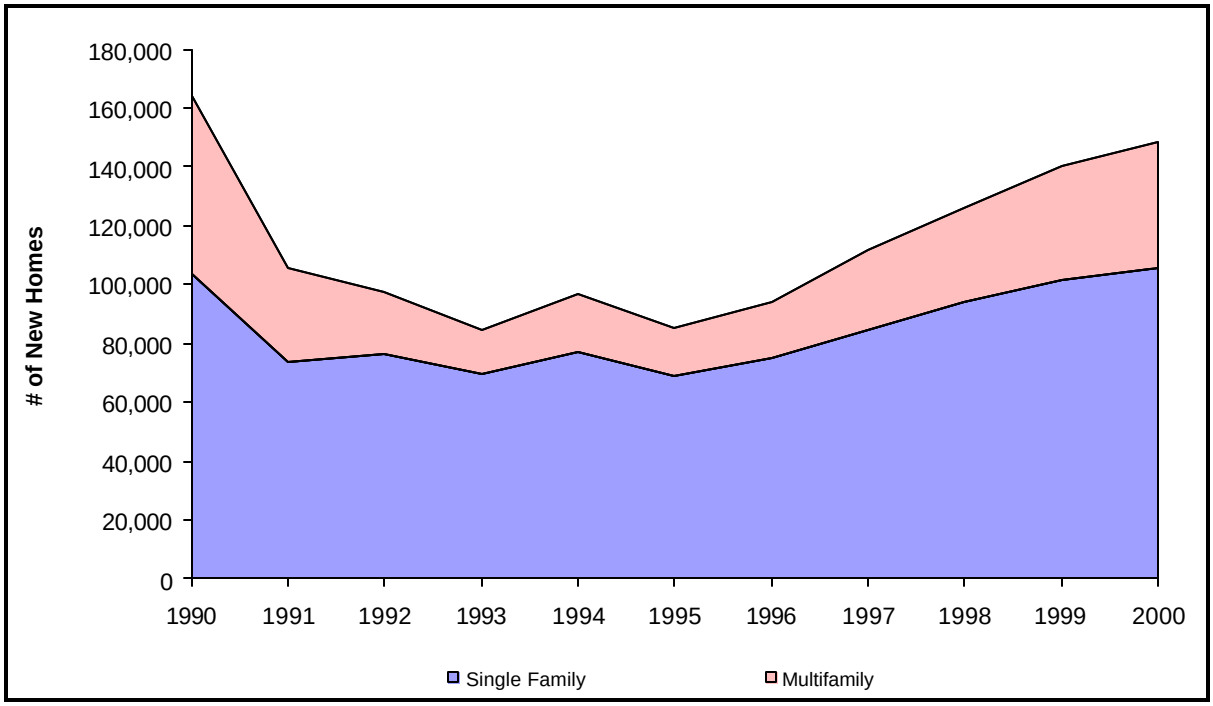

Table 1-2: New Construction in California (by Building Type)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Single Family	103,819	73,809	76,187	69,901	77,115	68,689	74,923	84,780	94,298	101,670	105,595
Multi-family	60,494	32,110	21,220	14,755	19,932	16,604	19,360	26,936	31,409	38,381	42,945
Total	**164,313**	**105,919**	**97,407**	**84,656**	**97,047**	**85,293**	**94,283**	**111,716**	**125,707**	**140,051**	**148,540**

1.3 Project Overview

Measure Coverage

The ultimate objective of the RMST project is to estimate and track the market shares of high efficiency measures purchased and installed in California's residential sector over the next several years. Table 1-3 includes the specific measures currently covered by the RMST and the decision type levels for which market share analysis is possible for each. The reports in which the efficiency tracking results are presented are also indicated.

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

- ***New Construction*** refers to installations in newly constructed buildings that were not previously occupied by a building owner or tenant.

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

Table 1-3: Measures Currently Covered by the RMST Project

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

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

Data Collection

As revealed during the tracking scoping study, tracking the share of high efficiency measures requires substantial amounts of data that are not generally collected by other entities.[6] The data collection approach developed for the RMST represents a comprehensive strategy enabling us to track efficiencies of the identified measures. RER's approach for new construction involves two major components, described below.

Data collection in the new construction sector includes new construction on-site surveys of single and multi-family residential buildings and the collection of building department installation forms throughout California. To supplement the on-site survey data, RER obtained installation forms containing data on key measures installed in new homes throughout the State. Builders and installation contractors are required to complete these forms under California's Title 24 energy efficiency standards. These forms are sometimes publicly available from local building departments or from HVAC and plumbing contractors.

Data from the on-site surveys and the CF-6R forms were combined to estimate the market shares and average efficiencies of a variety of measures in California's residential new construction sector. A third round of on-site surveys will begin in the fall of 2001. Additionally, RER is continuing to work with building departments and contractors to obtain installation data on key measures from CF-6R forms to support the RMST project.

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

1.4 Highlights of Major Findings

This report provides considerable detail on the market shares of high efficiency equipment and shell measures since June of 1998 in the residential new construction market. The following are some highlights of the findings.

- Roughly 105,600 single family homes and 42,900 multifamily homes were built in California in 2000. This equates to approximately a 55% increase in single family homes and a 160% increase in multifamily homes over the number built in 1995.
- Averages efficiencies for central air conditioners have remained steady at approximately 10.5 SEER since 1998. However, not surprisingly, average SEER levels are significantly higher in hotter climate zones (RMST Climate Zones 4 and 5) compared to the cooler climate zones (RMST Climate Zones 1 and 2).
- Average central gas furnace efficiencies (AFUE levels) have varied little between the last half of 1998 and the last half of 2000—the average has ranged from 80.3 to 80.4. However, the average AFUE increased significantly between the last half of 2000 and the first half of 2001, when the average was 81.0.
- Water heater efficiencies continue to rise. In particular, *percent-above-standard efficiency* for gas water heaters has steadily risen from 14.2% in the second half of 1998 to 16.3% in the first half of 2001.
- Clear glass, double-pane, wood/vinyl-framed, air-filled windows are by far the most common windows used in new construction, consistently representing over 70% of all installations during the life of this study.
- Duct sealing practices in single family homes may be improving—the average percent duct leakage rates have been steadily decreasing over the last two years, though not significantly. In addition, average percent duct leakage rates in single family homes are significantly lower than those in multifamily homes.
- The share of CFL-dedicated fixtures as a percent of all interior hard-wired fixtures ranges from 4% to 7% over the last two years.
- Lighting in hard-wired interior fixtures are dominated by incandescents, however CFLs consistently represent 9%-10% of bulbs in these fixtures.
- Lighting in exterior fixtures are dominated by incandescents, consistently representing over 90% of all bulbs in these fixtures
- Although overall connected lighting load in single family homes is approximately 3 kW and approximately 1.3 kW in multifamily homes, the distributions of connected load by room type in single family and multifamily homes are similar.

1.5 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.
- Sections 3 and 4 present the RMST results for central air conditioners and gas furnaces, respectively.
- Section 5 presents the results of duct construction and air flow leakage in new construction
- Section 6 includes the RMST results for water heating equipment.
- Sections 7 present results of the windows.
- Sections 8 present results of the interior and exterior lighting.
- Appendices include the following:
  - Appendix A - acknowledges those who supported and contributed to the development of the RMST,
  - Appendix B - the on-site survey form,
  - Appendix C - the duct blaster survey form and testing protocols, and
  - Appendix D - a copy of a CF-6R form.

2

Data Collection and Methodology

2.1 Overview

This section details the data collection strategies and the methodologies for estimating market shares of high efficiency measures in the new construction market in California. Data collection in the new construction sector included new construction on-site surveys of single and multi-family residential buildings. To supplement the on-site survey data, installation forms were also obtained. These installation forms contain data on key measures installed in new homes. Required to be completed by builders and installation contractors under California's Title 24 energy efficiency standards, these forms (CF-6R forms) are sometimes publicly available from local building departments. Data from the on-site surveys and the CF-6R forms were combined to estimate market shares and average efficiencies of a variety of measures in California's residential new construction sector.

The on-site survey and CF-6R data were analyzed to estimate the market share and average efficiency of the following measures:

- Space Heating Equipment,
- Space Cooling Equipment,
- Duct Construction,
- Water Heaters,
- Windows,
- Interior and Exterior Lighting Fixtures, and
- Interior and Exterior Bulbs.

2.2 Data Collection and Analysis

Overview of California's Residential New Construction Market

Having an understanding of the level of new construction activity in California is useful when tracking the efficiencies of measures installed in newly constructed homes. After remaining fairly constant for several years, the number of new homes built in California has been slowly increasing since 1995.

Single Family New Construction

As illustrated in Figure 2-1 and Table 2-1, there has been little change in the relative number of new single family homes built across utilities in the last 3½ years. New homes in PG&E's service territory account for approximately 50% of new homes built in the State, while new homes in SCE's and SDG&E's service areas account for 38% and 12%, respectively.

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

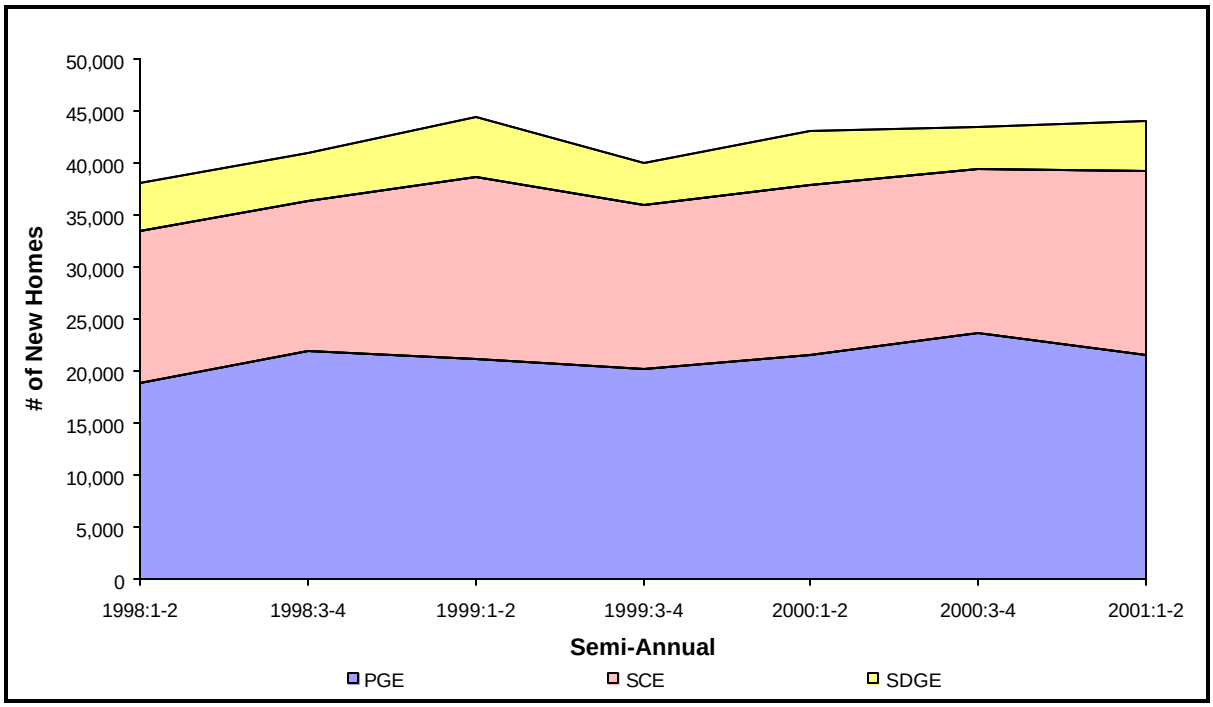


Table 2-1: Single Family New Construction in California (by Utility)

Utility	1998:1-2	1998:3-4	1999:1-2	1999:3-4	2000:1-2	2000:3-4	2001:1-2*
PG&E	18,893	21,917	21,282	20,234	21,604	23,762	21,554
SCE	14,582	14,570	17,457	15,710	16,410	15,759	17,754
SDG&E	4,631	4,529	5,824	4,169	5,157	4,010	4,898
Total	**38,107**	**41,016**	**44,564**	**40,113**	**43,171**	**43,531**	**44,206**

* Estimates based on January – April 2001.

Multifamily New Construction

Figure 2-2 and Table 2-2 present multifamily construction activity. As shown, the number of multifamily homes built in California has slowly increased from late 1998 until early 2000. During the last year, however, the total number of multifamily buildings built is at approximately the same level as it was during the last six months of 1999 - when 17,942 multifamily units were built within PG&E's, SCE's, and SDG&E's service territories.

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

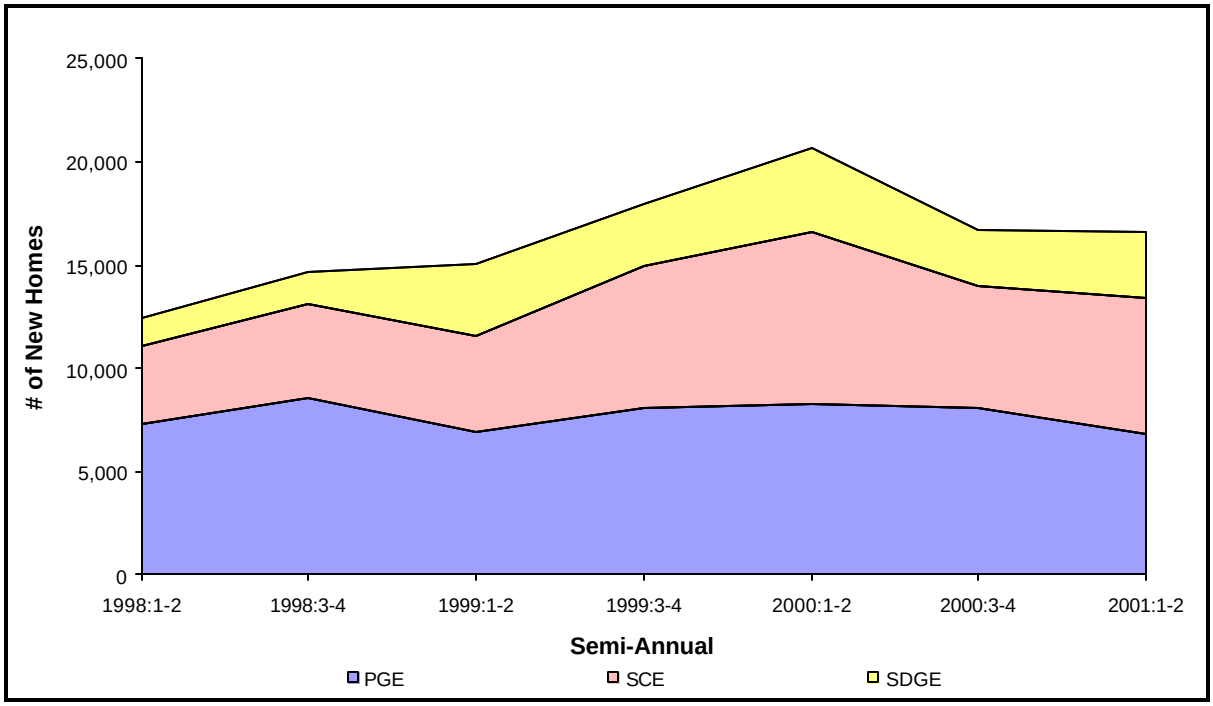


Table 2-2: Multifamily New Construction in California (by Utility)

Utility	1998:1-2	1998:3-4	1999:1-2	1999:3-4	2000:1-2	2000:3-4	2001:1-2*
PG&E	7,283	8,572	6,902	8,047	8,287	8,034	6,780
SCE	3,759	4,535	4,671	6,966	8,319	5,997	6,668
SDG&E	1,426	1,587	3,505	2,929	4,082	2,678	3,170
Total	**12,468**	**14,694**	**15,078**	**17,942**	**20,688**	**16,709**	**16,618**

* Estimates based on January – April 2001.

Overview of Data Collection

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

- ***On-Site Surveys.*** This element entailed 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.
- ***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 and water heating equipment, and window efficiencies.

On-Site Survey Development and Implementation

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

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

- On-site survey sample design,
- Design of the on-site survey instrument and survey protocol,
- Modifications of the RMST on-site survey form for the second year,
- Duct blaster test sample development, and
- On-site survey expansion weights development.

On-Site Survey Sample Design

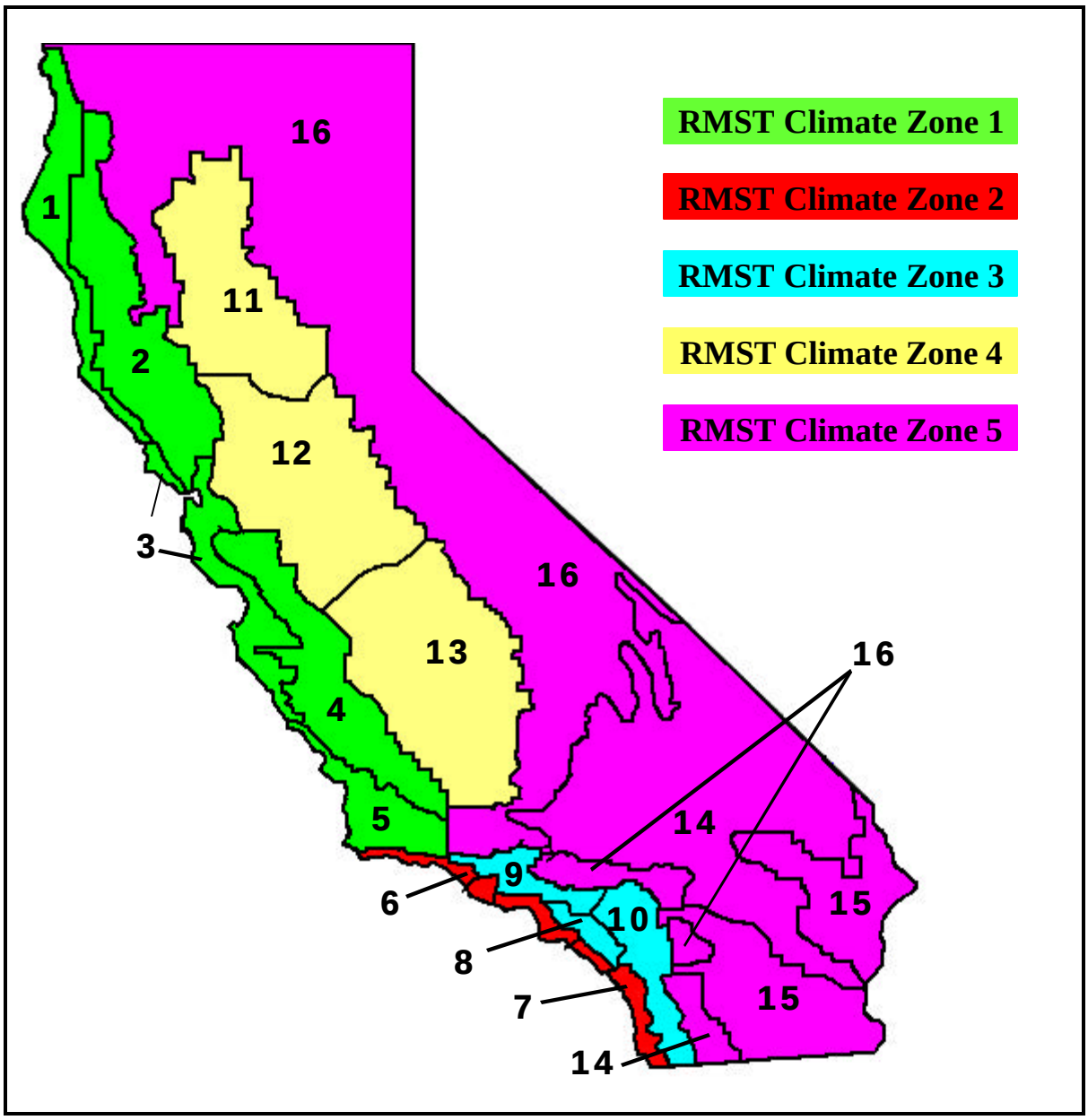
The on-site sample frame, the comparison with building department permit data, on-site sampling plan, and sample selection are discussed below.

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

For purposes of developing the new construction sample frame, newly constructed homes are defined 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 CEC climate zone.

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

Figure 2-3: CEC Climate Zones



Source: California Energy Commission.

On-Site Survey Sample Frame Summary. Table 2-3 presents a summary of the combined frame used for developing the new construction survey sampling plan. Note that when developing the sample, the data was further segmented by six-month period.

Table 2-3: On-Site Survey Sample Frame

Res. Type & Climate Zone	PG&E		SCE		SCG		SDG&E	
	1998:3-4 to 1999:1-2	1999:3-4 to 2000:1-2	1998:3-4 to 1999:1-2	1999:3-4 to 2000:1-2	1998:3-4 to 1999:1-2	1999:3-4 to 2000:1-2	1998:3-4 to 1999:1-2	1999:3-4 to 2000:1-2
SF.CZ1	18,693	19,223	0	0	0	1	0	0
SF.CZ2	4	0	4,487	5,427	148	795	5,370	4,673
SF.CZ3	0	0	22,061	21,366	2,094	2,270	1,103	1,532
SF.CZ4	26,354	40,095	2,089	1,833	0	0	0	0
SF.CZ5	579	441	4,313	4,611	1,415	1,817	15	59
SF Total	**45,630**	**59,759**	**32,950**	**33,237**	**3,657**	**4,883**	**6,488**	**6,264**
MF.CZ1	9,694	8,236	0	0	0	0	0	0
MF.CZ2	0	0	1,377	1,355	119	175	845	3,077
MF.CZ3	0	0	3,736	2,233	1,452	1,102	66	593
MF.CZ4	2,668	6,210	60	18	0	0	0	0
MF.CZ5	10	83	345	254	198	62	0	6
MF Total	**12,372**	**14,529**	**5,518**	**3,860**	**1,769**	**1,339**	**911**	**3,676**
All Total	**58,002**	**74,288**	**38,468**	**37,097**	**5,426**	**6,222**	**7,399**	**9,940**

SF = Single Family
MF = Multifamily

Sampling Plan and Sample Selection. Next, the sampling plan for the on-site survey was developed. The sample was stratified by residence type, CEC climate zone, and by six-month periods of construction to allow representation across the year.[1] The sample targets were allocated proportionally with the exception of some oversampling for the SDG&E service territory. Table 2-4 presents the number of on-site surveys completed by residence type, utility, climate zone, and report year. Note that the completed targets were divided equally across six-month period of construction.[2]

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

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

2 A summary of the on-site survey sample design can be found in Appendix B.

Table 2-4: Completed Targets for the On-Site Survey

Res. Type & Climate Zone	PG&E		SCE		SCG		SDG&E	
	1998:3-4 to 1999:1-2	1999:3-4 to 2000:1-2	1998:3-4 to 1999:1-2	1999:3-4 to 2000:1-2	1998:3-4 to 1999:1-2	1999:3-4 to 2000:1-2	1998:3-4 to 1999:1-2	1999:3-4 to 2000:1-2
SF.CZ1	118	104	-	-	-	1	-	-
SF.CZ2	-	-	34	32	2	4	78	54
SF.CZ3	-	-	160	130	14	13	16	18
SF.CZ4	164	216	16	12	-	-	-	-
SF.CZ5	4	4	32	28	10	10	-	4
SF Total	**286**	**324**	**242**	**202**	**26**	**28**	**94**	**76**
MF.CZ1	62	42	-	-	-	-	-	-
MF.CZ2	-	-	10	8	2	4	12	36
MF.CZ3	-	-	28	14	12	4	2	8
MF.CZ4	18	34	-	4	-	-	-	-
MF.CZ5	-	4	4	4	2	4	-	4
MF Total	**80**	**80**	**42**	**30**	**16**	**12**	**14**	**48**
All Total	**366**	**366**	**284**	**284**	**42**	**42**	**108**	**108**

SF = Single Family
MF = Multifamily

Design of the On-Site Survey Instrument and Survey Protocol

The on-site survey instrument was developed to obtain two primary types of information: efficiency parameters for the covered measures and basic demographic and structural data.

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

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

Once the on-site surveyors were trained, the on-site survey instrument was pre-tested on a small sample of new homes. Senior staff from VIEWtech and RER accompanied small groups of surveyors to on-site visits. The pre-test revealed some small problems with the on-

site survey instrument that resulted in minor format changes. A final on-site survey instrument is provided in Appendix B.

Modifications of the RMST On-Site Survey Form For the Second Year

A number of modifications were made to the second year RMST on-site survey form. These changes were made to improve data availability and quality for the MICROPAS[3] analysis, and also to capture data requested by CEC personnel and other statewide RNC program managers. The changes are summarized below:

- Detailed information on kitchen lighting and diffuser types, bathroom lighting, and ceiling fan lighting systems were added.
- Ceiling fans that do not have lights are counted as miscellaneous equipment.
- Information on HVAC system location and an estimate of the distance between the HVAC system and water heating system was added. HVAC system equipment types were also expanded.
- Several changes were made to the water heating equipment page. A more direct way to specify a combination space/water heating type unit was added. Control types and features reflecting the various credits/debits available in MICROPAS were also added. Finally, additional fields needed to record performance and efficiency information for large water heaters and water heaters used in hydronic systems were added.
- Information on the location of supply and return ducts was added. Duct and duct-sealing types were expanded. A field for recording the duct sealing tape UL label information and brand name was also added (although, this data was gathered last year, there was no dedicated field to capture the data).
- Building shell data changes were made to enhance the MICROPAS runs. More detailed information on door shading, roof areas, roof insulation type, ground floor area, exposed/covered floor percentages and floor area above an unconditioned garage were added.
- For windows, interior and exterior shading details were separated and expanded to better reflect MICROPAS options. In addition, glass type options were revised to reflect the use of the ETEKT+ AE1600 Low-E Coating Detectors,[4] which were used to detect after-market window films as well as low-E coatings. In addition, surveyors measured the home's three largest windows and then used those measurements as the basis for estimating the areas of other windows (surveyors do not measure every window in the home due to time and budget constraints).

[3] MICROPAS is a computer software tool used for performing Title 24 compliance analysis on low-rise residential buildings.

[4] ETETKT+ Low-E Coating Detectors were obtained from Electronic Design to Market, Inc. (www.edtm.com). These meters detect the presence of metal surface coatings on the outer or inner sides of single-paned or dual-paned glass windows.

Duct Blaster Test Sample Development

To obtain data on duct sealing and duct construction practices, the RMST project was expanded from its original scope to include 100 duct blaster tests per year. The duct blaster tests were conducted by the California Home Energy Efficiency Rating System (CHEERS). CHEERS worked closely with the on-site surveyors (VIEWtech) to qualify and schedule homes for the duct blaster tests.[5]

The CHEERS team conducted duct blaster tests following the protocol used by the Title 24 requirements. A copy of the survey form and testing protocol used for the duct blaster tests is provided in Appendix C.

Table 2-5 presents a summary of the completed sample targets for the duct blaster tests. The sample design for this effort follows the distribution of the on-site surveys with some oversampling of multifamily homes.

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

Table 2-5: Completed Targets for the Duct Blaster Tests

Res. Type & Climate Zone	PG&E		SCE		SCG		SDG&E	
	1998:3-4 to 1999:1-2	1999:3-4 to 2000:1-2	1998:3-4 to 1999:1-2	1999:3-4 to 2000:1-2	1998:3-4 to 1999:1-2	1999:3-4 to 2000:1-2	1998:3-4 to 1999:1-2	1999:3-4 to 2000:1-2
SF.CZ1	14	14	-	-	-	-	-	-
SF.CZ2	-	-	4	4	-	-	10	8
SF.CZ3	-	-	20	16	2	2	2	2
SF.CZ4	20	20	2	2	-	-	-	-
SF.CZ5	-	-	4	4	2	-	-	-
SF Total	**34**	**34**	**30**	**26**	**4**	**2**	**12**	**10**
MF.CZ1	8	6	-	-	-	-	-	-
MF.CZ2	-	-	2	2	-	-	2	4
MF.CZ3	-	-	4	4	2	2	-	2
MF.CZ4	2	8	-	-	-	-	-	-
MF.CZ5	-	-	-	-	-	-	-	-
MF Total	**10**	**14**	**6**	**6**	**2**	**2**	**2**	**6**
All Total	**44**	**48**	**36**	**32**	**6**	**4**	**14**	**16**

SF = Single Family
MF = Multifamily

On-Site Survey Expansion Weights

Expansion weights were developed to expand the on-site data to represent to the total number of homes that were built within the three electric IOU territories between July 1, 1998 and June 30, 2000. The expansion weights are based on the number of households in each utility service area and CEC climate zone shown in Table 2-6.[6] In particular, the expansion weights for HVAC equipment are based on utility and climate zone, while the expansion weights for water heaters and windows are based solely on utility.

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

Table 2-6: 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**

Collection of Building Department CF-6R Forms

To augment the data obtained during the on-site surveys, CF-6R installation forms were obtained from various building departments and contractors throughout California. The CF-6R forms, filed by builders upon completion of construction, include detailed data on a variety of measures installed in new homes, including HVAC and water heating equipment, and window efficiencies. Data from the on-site surveys and CF-6R forms were combined to track the market shares and average efficiencies of a variety of measures.

To help obtain and analyze data pertaining to residential market shares, CF-6R forms will continue to be obtained from building departments and contractors throughout California. The data collected through this means helped characterize HVAC, water heating, and fenestration in California's residential new construction market. This information made it possible to characterize the market, establish baseline efficiency levels of the equipment being installed in residences today, and track the changes in the market over time to assess the impact of market transformation programs.

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 have HVAC, water heating, and fenestration information with descriptions, efficiency ratings, and model numbers, they are an excellent source of data for tracking average efficiencies and efficiency market shares in the residential new construction sector.

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

In some building department jurisdictions, the form (or a copy of it) is filed with the 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 is kept on file. In many instances, if the CF-6R form is filed at all, the department only retains it for a limited time (for example, 90 days after the home is completed). Although there are limitations in working with building departments to collect these forms, it was the most cost-effective option compared to obtaining them from homeowners.

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

Building Department Recruiting Protocol

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

The first objective of each contact was to determine if the building department retained copies of CF-6R forms in the office. Although this may seem a simple assessment, it is not without difficulty. Since CF-6R forms are not mandatory in most jurisdictions, many contacts were not immediately certain that they were familiar with the form. Once it was determined that a building department collected the CF-6R form, the decision maker was asked to participate in the project. RER remained very flexible to each building department's record keeping practices. The following provides some challenges that building departments face in participating in the RMST project:

- Many departments have limited staff and budget to perform non-routine work.
- Many departments could only perform non-routine work on occasion (during low-workload periods).

- Some departments' records are publicly available, and therefore they did not feel that they should perform the work of pulling and copying the forms.
- Some could not (or did not want to) accept an extra burden on top of an already full workload.
- Some departments track the forms well, while others do not have a formalized record keeping system for the CF-6Rs.
- Some departments can easily access the forms, while 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 situations, it was impossible to devise a single collection system that would work for all departments. Rather, to obtain the largest sample of CF-6R forms, RER staff worked closely with each department to develop a system that would overcome resource limitations.

In some cases, recruiting building departments warranted in person visits to either determine the feasibility of obtaining the CF-6Rs, or to copy or pick up the forms themselves. For example, RER staff members traveled to the County of San Diego and City of Irvine in an effort to establish relationships with local building departments that retain the CF-6R forms and network through them to reach other Southern California departments.

Building Department Participation Status

To date, nearly 3,200 CF-6R forms have been collected from 17 building departments and 2 contractors. As shown in Table 2-8, Temecula has been, by far, the most active participant. Temecula's CF-6R forms account for 40% of the total forms received so far. Table 2-7 summarizes the CF-6R forms by CEC climate zone, utility service area, and the year in which the home was built. Nearly 85% of forms are from houses built in SCE's service territory, with only 15% built within PG&E's territory. Currently, no CF-6R forms have been obtained for SDG&E's territory. Figure 2-4 provides a coverage map.

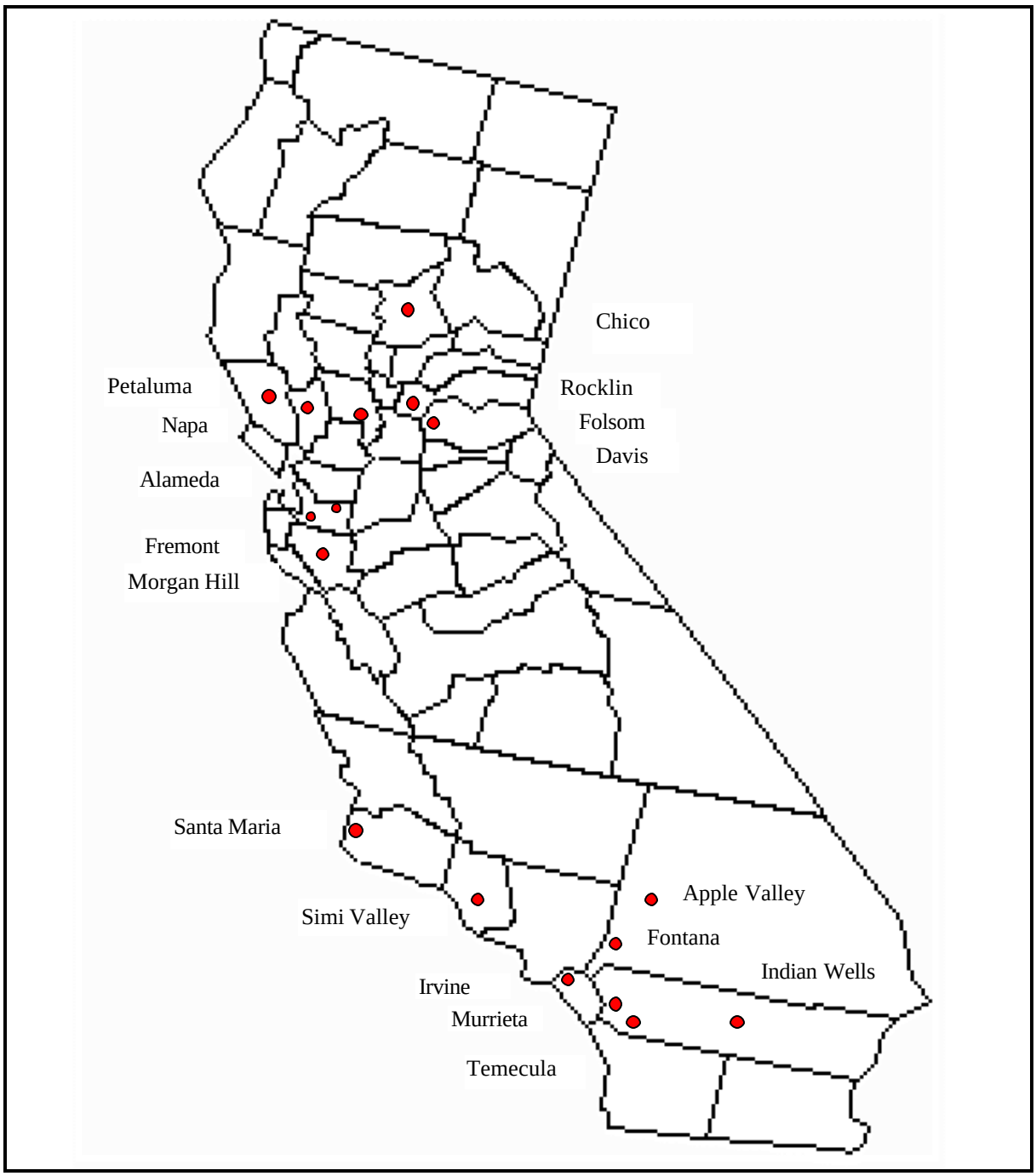
Table 2-7: Number of CF-6R Forms Collected to Date, by Climate Zone

Utility	RMST Climate Zone	1998	1999	2000	2001
PG&E	1	12	21	115	17
	4	9	56	196	37
	Total	**21**	**77**	**311**	**54**
SCE	2			38	
	3	7	244	1615	426
	5		21	292	87
	Total	**7**	**265**	**1945**	**513**

Table 2-8: Participation – Number of CF-6R Forms

Building Department/ Contractor	RMST CZ	1998	1999	2000	2001
Alameda County	1		1		
Apple Valley town	5		14	259	87
Chico	4	1	14		
Davis	4		17	135	5
Folsom	4	3	9	53	
Fontana	3		3	487	225
Fremont	1			113	14
Hanford	4	2	13	8	7
Indian Wells	5		7	33	
Irvine	3	1			
Morgan Hill	1	5			
Murrieta	3			17	
Napa	1		5		
Petaluma	1	7	15	2	
Rocklin	4	3	3		
Simi Valley	3	4	19	137	
Temecula	3	2	222	903	174
Buetler HVAC	4				28
Cobra Plumbing	3			109	27
Total		**28**	**342**	**2256**	**567**

Figure 2-4: Statewide Coverage of Building Department Participation



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 that were built within the three electric IOU territories between July 1, 1998 and June 30, 2001. The expansion weights are based on the number of households in each utility service area and CEC climate zone.[7] In particular, the expansion weights for HVAC equipment are based on utility and climate zone, while the expansion weights for water heaters and windows are based solely on utility.[8]

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

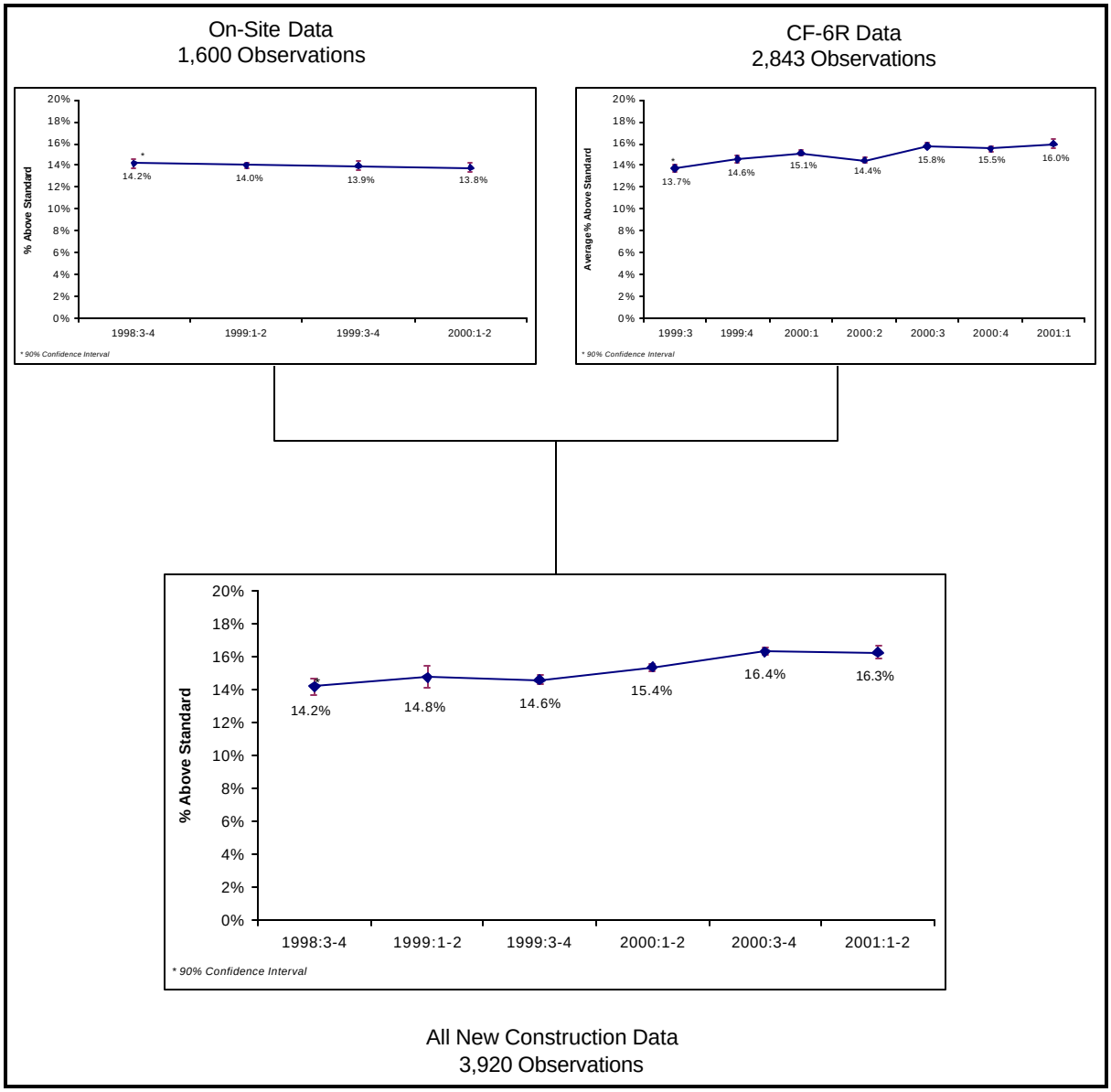
Figure 2-5 illustrates the framework for developing the market share estimates from the on-site surveys and CF-6R data. As shown, on-site surveys were conducted for 1,600 newly constructed single family and multifamily residences in California. Efficiency data obtained from the on-sites were combined with the 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 a set of weights was developed for purposes of combining the data from the two different sources. It should also be noted that the tracking system is a dynamic process. For instance, data from the third year of the project will be used to backfill the database and thus increase the sample sizes for some of the underrepresented periods. This feature will be especially true for the next round of on-site surveys, which will cover the second half of 2000 and the first half of 2001.

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

[8] While the CF-6R data spans July 1, 1998 to the June 30, 2001, at this time the expansion weights are based on the number of new homes built between July 1, 1998 and June 30, 2000.

Figure 2-5: New Construction Sector Data Analysis Overview



3

Central Air Conditioners

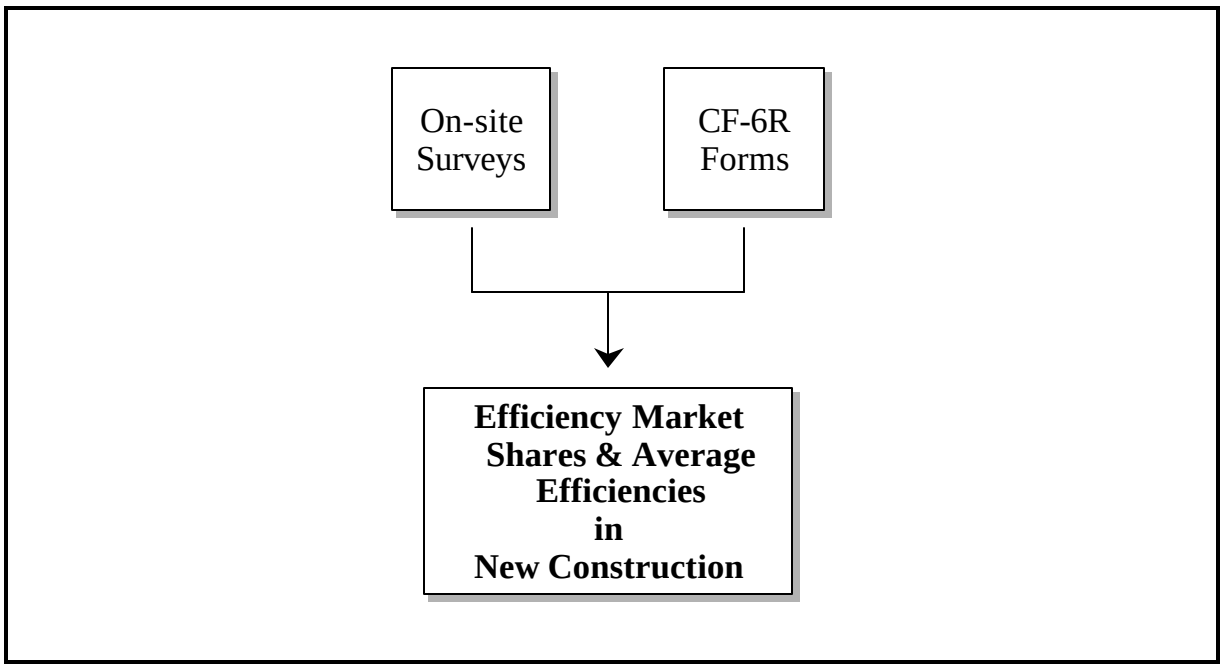
3.1 Overview

This section presents the efficiency market shares and average efficiencies of central air conditioners (CACs) installed in new homes throughout California. Subsection 3.2 provides an overview of the data sources for the CAC analysis while Subsection 3.3 summarizes energy efficiency standards for CACs and Subsection 3.4 provides estimates of annual unit sales by all decision types. Subsection 3.5 includes estimates of average efficiencies of CACs and saturations by utility and climate zone.

3.2 Data

As shown in Figure 3-1, data from new construction on-site surveys and building department installation forms (CF-6Rs) are used to estimate the shares and average efficiencies of CACs installed in residential new construction. Expansion weights were developed to expand the sample data to represent the California market. A detailed discussion of the data collection and analysis of CAC efficiencies is provided in Section 2.2 and 2.3.

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



3.3 Central Air Conditioner Efficiency Ratings

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

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

Table 3-1 presents estimates of total unit sales for central air conditioners. There is no definitive source of annual unit sales, however, estimates were developed using information obtained from large manufactures and the Air-conditioning and Refrigeration Institute (ARI).

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

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

Table 3-1: Estimates of Annual Central Air Conditioner Sales by Decision Type

Year	Total Units Sales [1]	New Construction [2]	Retrofit/ Replacement
1999	441,000	80,936	360,064
2000	444,000	99,126	344,874

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

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)

3.5 Central Air Conditioners

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.

On-Site Survey Data Analysis Results

Table 3-2 presents the average efficiency of central air conditioners by utility and six-month period. Average SEER has not changed significantly over time for any utility or overall. Figure 3-2 presents the distribution of CACs by efficiency. Over 95% of all CAC units were less than 12 SEER in all time periods.

Table 3-2: Central Air Conditioners, 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 3-2: Central Air Conditioner Shares by SEER – On-Site Data

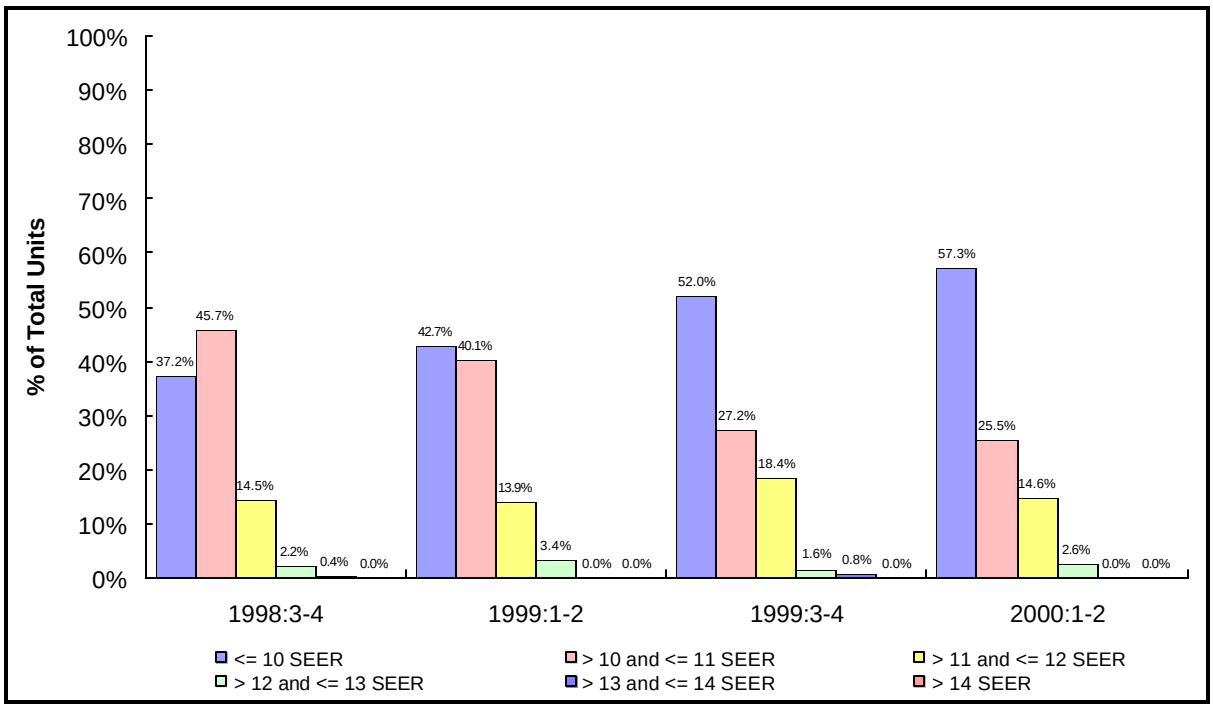


Table 3-3 and Table 3-4 present the saturation of central air conditioners by utility and climate zone, for single family and multifamily homes respectively. The saturations illustrate the percentages of homes, by strata, which have at least one central air conditioner.

Table 3-3: Saturations of Central Air Conditioners – On-Site Data – Single Family Homes

Time 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

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

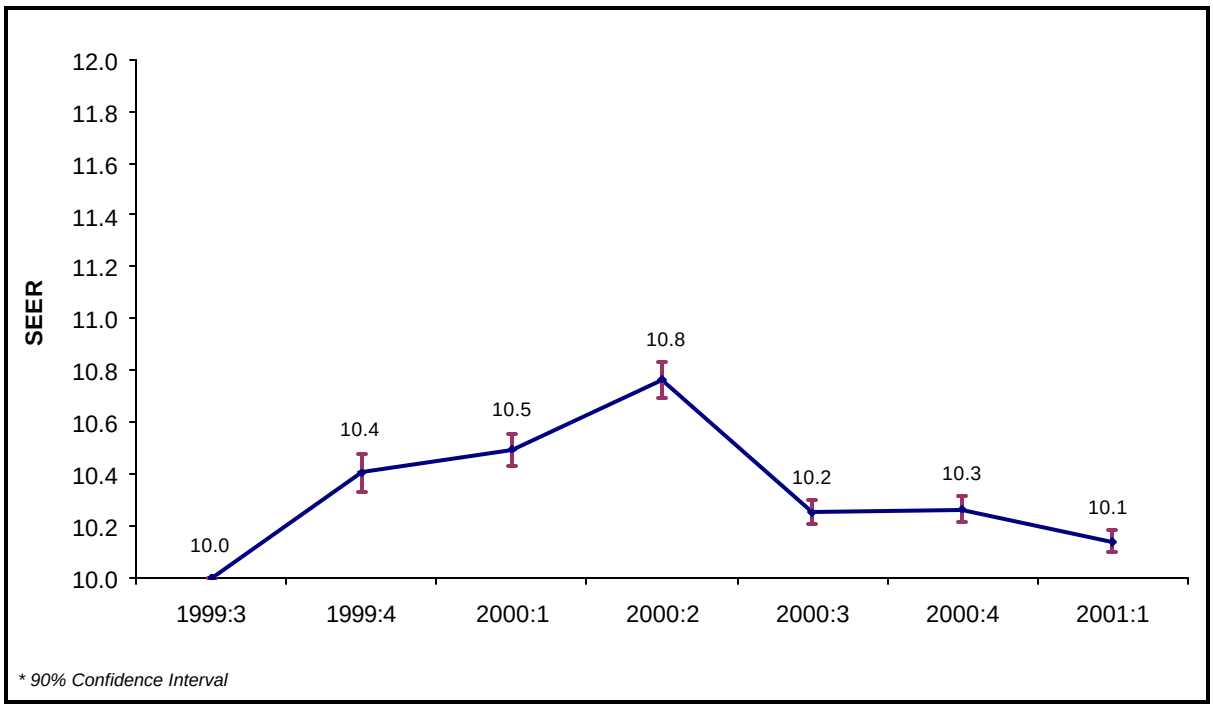
Time Period	RMST Climate Zone	PG&E	SCE	SDG&E	CA
1998:3-4 – 1999:1-2					
	CZ:1	**4.0%** n = 66	**-** n = 0	**-** n = 0	**4.0%** n = 66
	CZ:2	**-** n = 0	**22.4%** n = 13	**8.4%** n = 28	**17.1%** n = 42
	CZ:3	**-** n = 0	**48.3%** n = 30	**51.5%** n = 4	**48.4%** n = 48
	CZ:4	**46.7%** n = 34	**100.0%** 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 3-3 presents the average SEER over the past two years. As shown, the average SEER for new construction in California has varied significantly by quarter. Specifically, the average SEER value has ranged from 10.0 in the third quarter of 1999 to 10.8 during the second quarter of 2000 to 10.1 in the first quarter of 2001. Table 3-5 includes the average SEER by utility and by quarter.

Figure 3-4 illustrates how the percentage of central air conditioners that fall into various efficiency levels has changed over time.

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



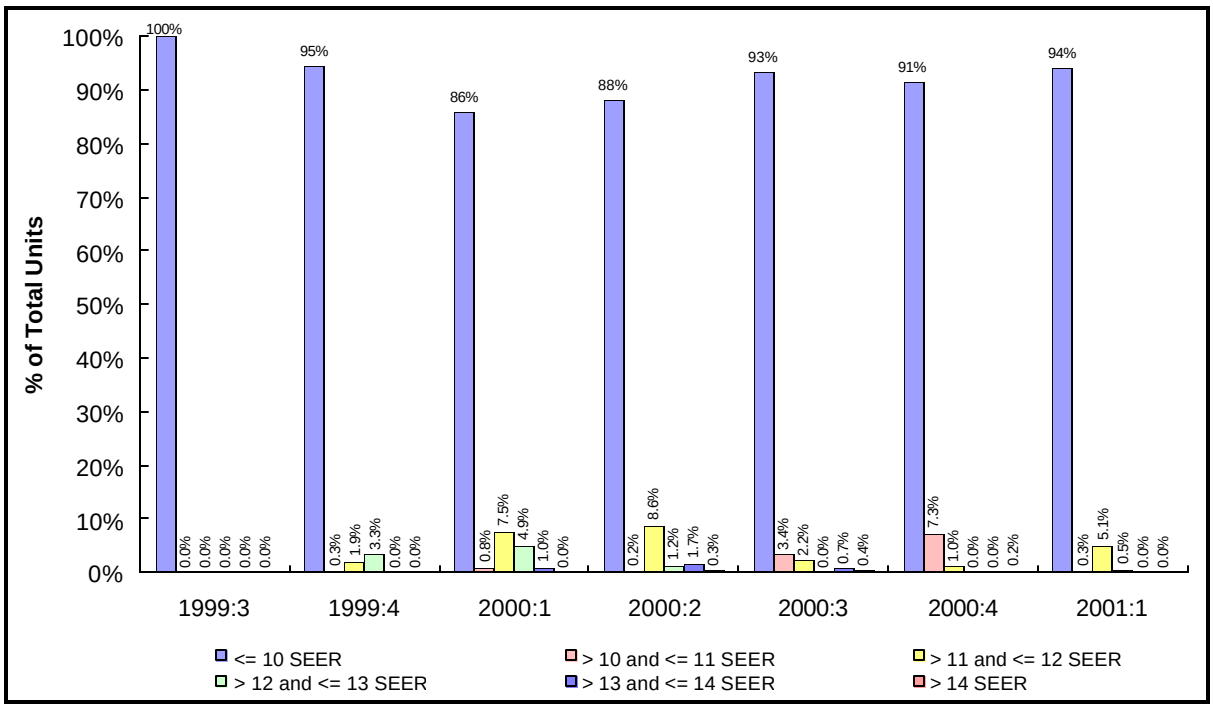
** 90% Confidence Interval*

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

	PG&E	SCE	All
1999:3	**10.00** (0.0000) n = 4	**10.00** (0.0000) n = 34	**10.00** (0.0000) n = 38
1999:4	**10.61** (0.1882) n = 29	**10.17** (0.0336) n = 337	**10.40** (0.0454) n = 366
2000:1	**10.57** (0.0923) n = 105	**10.25** (0.0355) n = 506	**10.49** (0.0373) n = 611
2000:2	**11.22** (0.1279) n = 58	**10.21** (0.0349) n = 544	**10.76** (0.0421) n = 602
2000:3	**10.28** (0.0665) n = 107	**10.10** (0.0273) n = 430	**10.25** (0.0290) n = 537
2000:4	**10.45** (0.1476) n = 33	**10.04** (0.0116) n = 457	**10.26** (0.0303) n = 490
2001:1	**10.17** (0.1663) n = 12	**10.12** (0.0248) n = 382	**10.14** (0.0259) n = 394

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

Figure 3-4: Central Air Conditioners by Efficiency Level – CF-6R Data



Combined New Construction Results

Figure 3-5 presents the average efficiency of central air conditioners. As shown, 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.[3] The average SEER values do not vary by more than 2 percent between different time periods. Table 3-6 presents the average CAC efficiency by climate zone. As depicted in this table, average SEER values are higher in the relatively hotter RMST Climate Zones 4 and 5 in nearly every quarter.[4]

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

[4] 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 time 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 time 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 time period.)

Figure 3-5: Central Air Conditioner Average SEER in New Construction

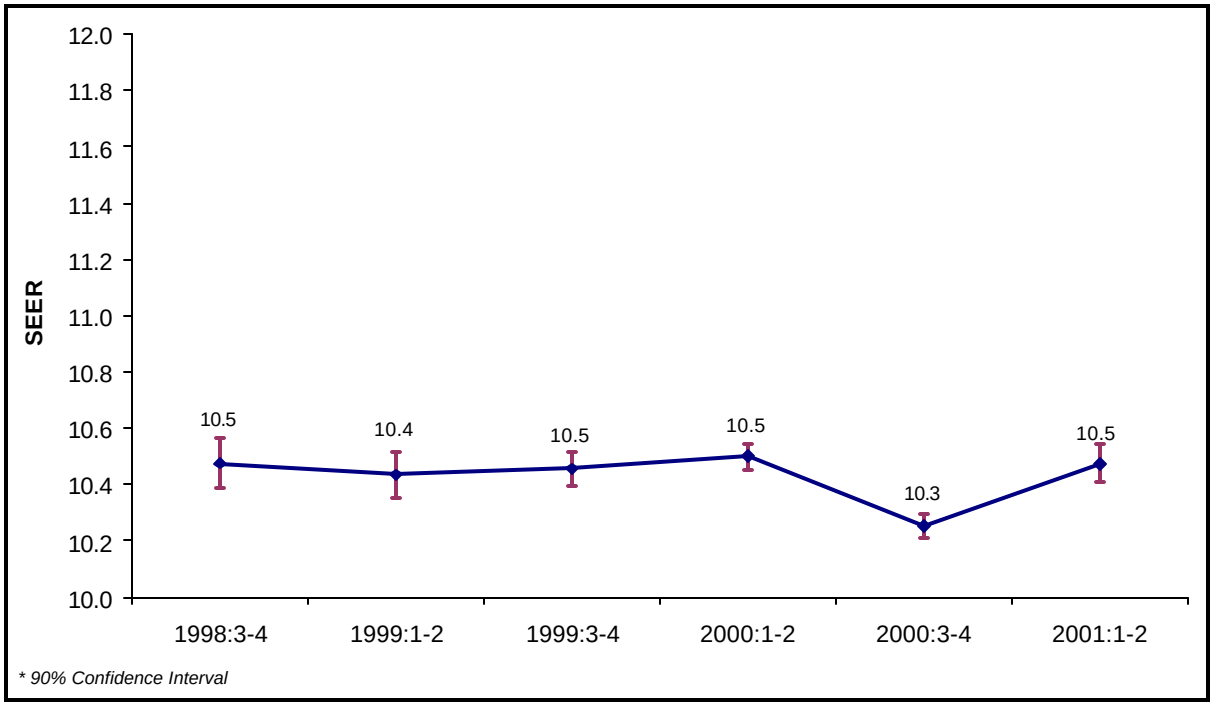


Table 3-6: Central Air Conditioner Average SEER in New Construction by Climate Zone

	RMST Climate Zone					
	CZ:1	**CZ:2**	**CZ:3**	**CZ:4**	**CZ:5**	**All**
1998:3-4	**10.45** (0.1087) n = 33	**10.20** (0.0738) n = 31	**10.20** (0.0425) n = 113	**10.80** (0.0973) n = 84	**10.92** (0.2527) n = 20	**10.48** (0.0442) n = 281
1999:1-2	**10.18** (0.0552) n = 40	**10.13** (0.0760) n = 30	**10.10** (0.0234) n = 120	**10.86** (0.0972) n = 95	**11.07** (0.2141) n = 28	**10.43** (0.0428) n = 313
1999:3-4	**10.46** (0.1211) n = 33	**10.27** (0.0966) n = 36	**10.02** (0.0055) n = 404	**10.86** (0.0838) n = 147	**10.76** (0.1893) n = 34	**10.46** (0.0321) n = 654
2000:1-2	**10.10** (0.0425) n = 52	**10.07** (0.0270) n = 34	**10.03** (0.0059) n = 942	**10.93** (0.0628) n = 259	**11.06** (0.1046) n = 195	**10.50** (0.0231) n = 1482
2000:3-4	**10.00** (0.0000) n = 55	**-** - n = 0	**10.01** (0.0014) n = 730	**10.41** (0.0874) n = 85	**10.35** (0.0786) n = 157	**10.25** (0.0209) n = 1027
2001:1-2	**10.00** (0.0000) n = 13	**-** - n = 0	**10.09** (0.0198) n = 432	**10.86** (0.1571) n = 40	**10.15** (0.0565) n = 92	**10.48** (0.0353) n = 577

Standard errors in parentheses.

4

Central Gas Furnaces

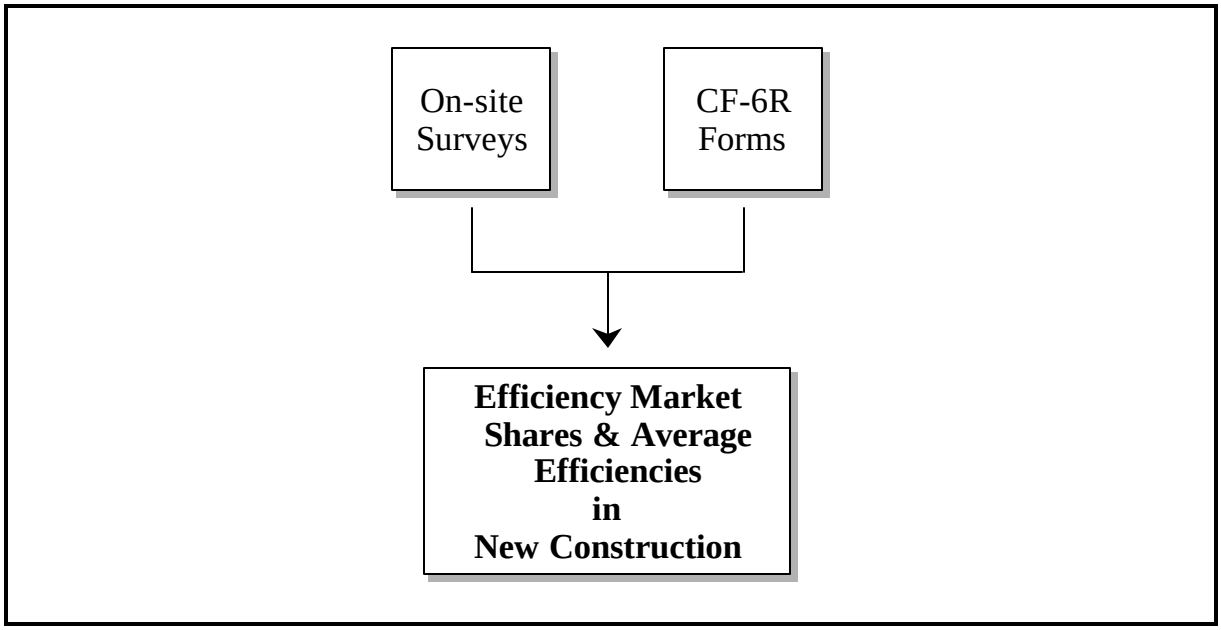
4.1 Overview

This section presents the efficiency market shares and average efficiencies of central gas furnaces installed in new homes throughout California. Subsection 4.2 provides an overview of the data sources for the window analysis while Subsection 4.3 summarizes energy efficiency standards for gas furnaces and Subsection 4.4 includes estimates of total gas furnace sales in California by decision type. Estimates of average efficiencies in the overall California new construction are presented in Subsection 4.5.

4.2 Data

As shown in Figure 4-1, data from new construction on-site surveys and building department installation forms (CF-6Rs) was used to estimate the shares and average efficiencies of gas furnaces installed in residential new construction. Expansion weights were developed to expand the sample data to represent the California market. A detailed discussion of the data collection and analysis of gas furnace efficiencies is provided in Section 2.2 and 2.3.

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



4.3 Gas Furnace Efficiency Ratings

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

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

Table 4-1 presents estimates of total unit sales for gas furnaces. There is no definitive source of annual sales of gas furnaces in California. However, nationwide sales for central gas furnaces were obtained from GAMA.[3] These data were then scaled to California annual sales based on number of households and measure saturations. In particular, the national sales figure was multiplied by the ratio of the number of California households with the measure divided by the number of national households with the measure.

Table 4-1: Estimates of Annual Central Gas Furnaces Sales by Decision Type

Year	Total Units Sales [1]	New Construction [2]	Retrofit/ Replacement
1999	413,387	102,785	310,602
2000	408,578	115,415	293,162

1 National annual appliance sales from *GAMA*, scaled to the California market.

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)

4.5 Gas Furnaces

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

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

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

3 GAMA's website: http://www.gamanet.org

On-Site Survey Data Analysis Results

The results of the analysis of the gas furnace data obtained from the on-site surveys are presented below. Table 4-2 presents the average AFUE for central gas furnaces by utility service area. There is little variation in the 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.[4] The overall AFUE level increased slightly as a result of the increase in the SDG&E service territory. Figure 4-2 illustrates the distribution of gas furnaces by efficiency level. Of the central gas furnaces installed for all time periods, over 90% had an AFUE of 80 or lower.

Table 4-2: 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.

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

Figure 4-2: Central Gas Furnace Shares by AFUE – On-Site Data

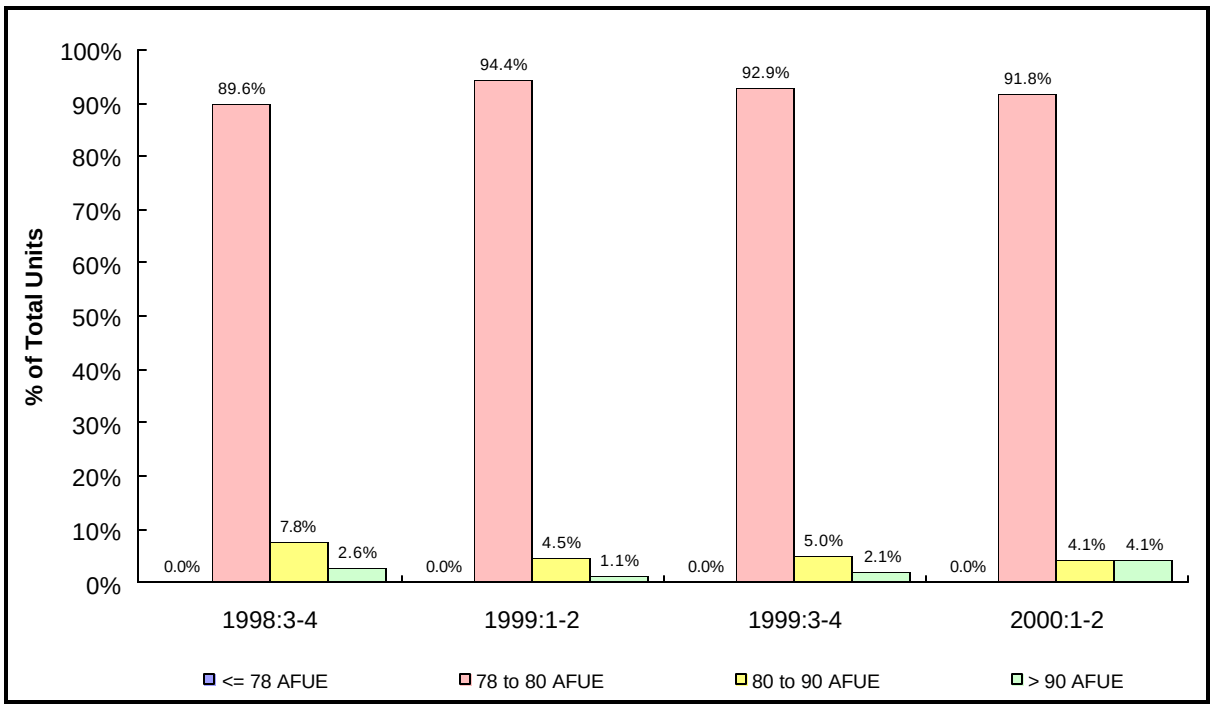


Table 4-3 and Table 4-4 present the saturation of gas furnaces by utility and climate zone, for single family and multifamily homes respectively. The saturations illustrate the percentages of homes, by strata, which have at least one gas furnace.

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

Time 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 4-4: Saturations of Central Air Conditioners – On-Site Data – Multifamily Homes

Time 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

CR-6R Data Analysis Results

Figure 4-3 presents the average AFUE by quarter. As shown, the average AFUE for new construction in California ranged from as low as 80.0% in the third quarter of 1999 to as high as 80.5% during the fourth quarter of 2000. Table 4-5 shows the average AFUE by utility and by quarter. While the average AFUE for SCE's territory remains near 80%, the average AFUEs in PG&E's service area range from 80% in the third quarter of 1999 to just under 81% during the fourth quarter of 2000.

Figure 4-4 illustrates how the percentage of central gas furnaces that fall into various efficiency levels has changed over the last year. Of the furnaces installed in the first quarter of 2001, 5.2% had an AFUE greater than 80%. The highest such percentage before was 3.7% in the third quarter of 2000.

Figure 4-3: CF-6R Central Gas Furnace Data (Average AFUE by Quarter)

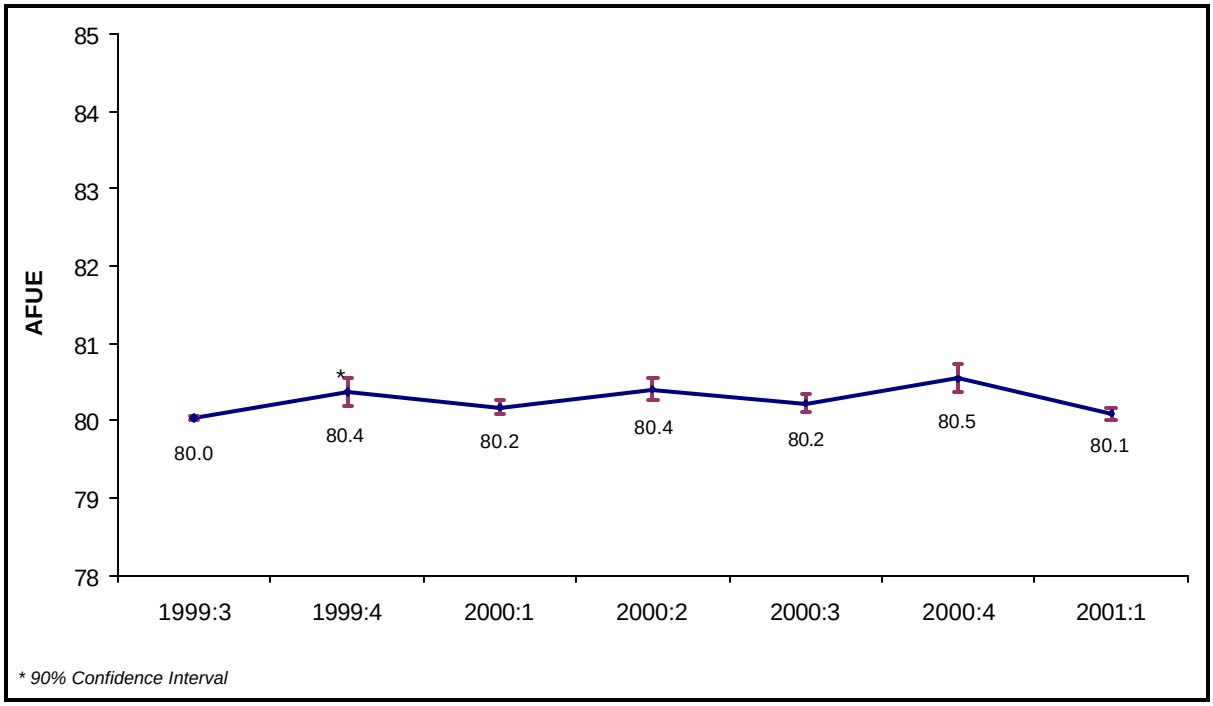
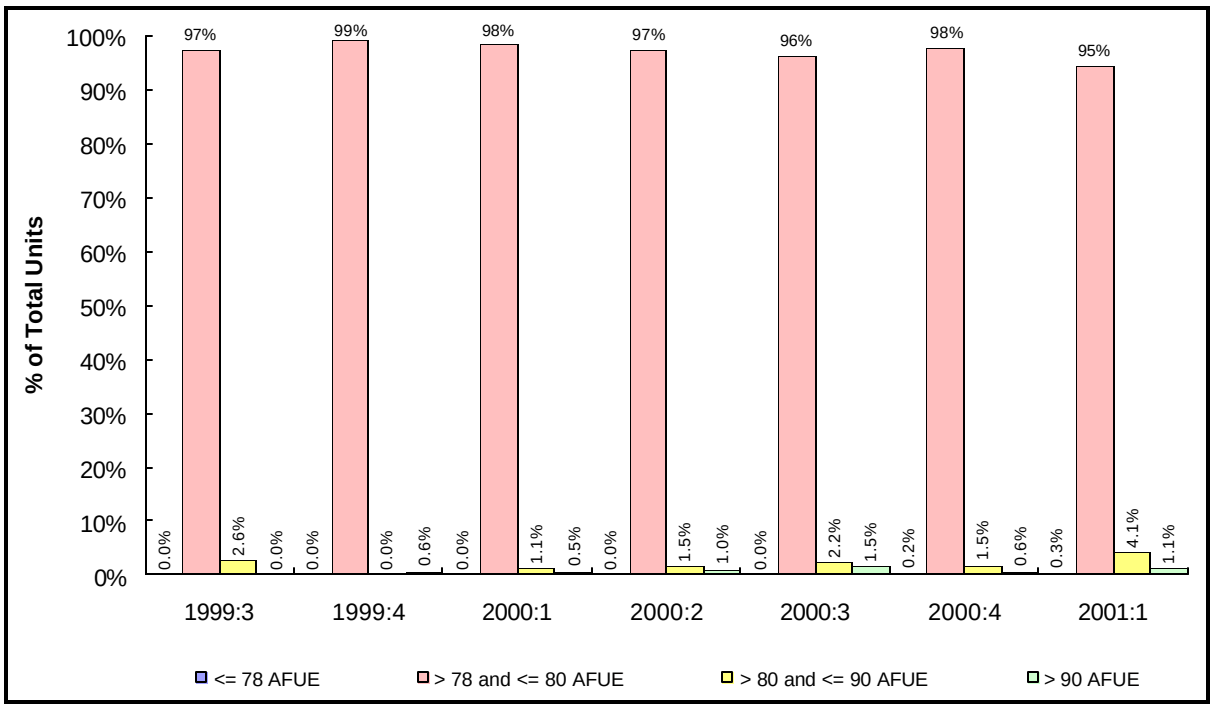


Table 4-5: CF-6R Central Gas Furnace Data (Average AFUE)

	PG&E	SCE	All
1999:3	**80.05** (0.0383) n = 6	**80.00** (0.0000) n = 33	**80.04** (0.0126) n = 39
1999:4	**80.65** (0.4880) n = 32	**80.00** (0.0000) n = 317	**80.37** (0.1110) n = 349
2000:1	**80.22** (0.1586) n = 106	**80.01** (0.0043) n = 521	**80.17** (0.0573) n = 627
2000:2	**80.62** (0.3055) n = 77	**80.06** (0.0327) n = 510	**80.41** (0.0891) n = 587
2000:3	**80.23** (0.1536) n = 107	**80.20** (0.0703) n = 431	**80.23** (0.0675) n = 538
2000:4	**80.92** (0.5563) n = 34	**80.02** (0.0336) n = 483	**80.54** (0.1107) n = 517
2001:1	**80.00** (0.0000) n = 12	**80.17** (0.0708) n = 356	**80.09** (0.0507) n = 368

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

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



Combined New Construction Results

Figure 4-5 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 the first quarter of 2001.[5]

Table 4-6 presents the average efficiency by climate zone. The average AFUE in the first half of 2001 jumped significantly over previous time periods.[6] This is primarily attributable to the increase in the average AFUE in RMST Climate Zone 4.

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

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

Figure 4-5: Central Gas Furnace Average AFUE in New Construction

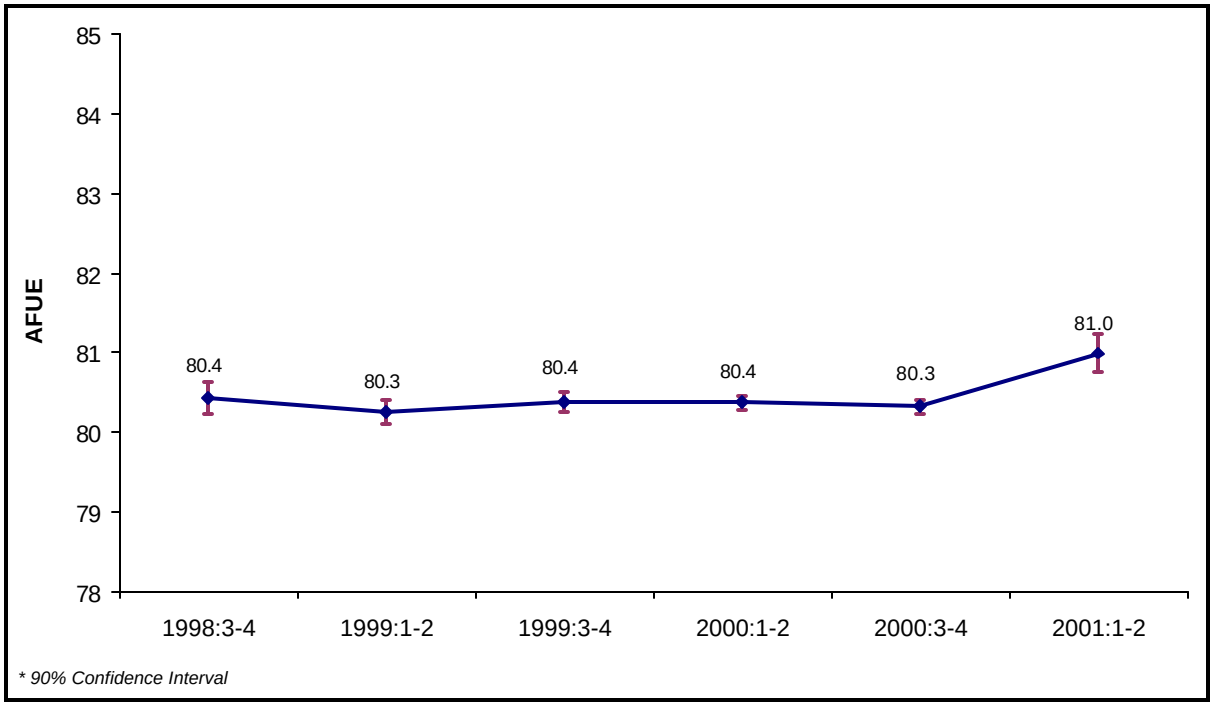


Table 4-6: Central Gas Furnace Average AFUE in New Construction by Climate Zone

	RMST Climate Zone					
	CZ:1	**CZ:2**	**CZ:3**	**CZ:4**	**CZ:5**	**All**
1998:3-4	**80.33** (0.2314) n = 67	**80.07** (0.0443) n = 44	**80.45** (0.2064) n = 91	**80.68** (0.3504) n = 68	**80.33** (0.1272) n = 18	**80.43** (0.1232) n = 288
1999:1-2	**80.19** (0.1560) n = 64	**80.04** (0.0223) n = 44	**80.00** (0.0000) n = 102	**80.58** (0.2863) n = 80	**80.48** (0.4845) n = 26	**80.26** (0.0945) n = 316
1999:3-4	**80.78** (0.3761) n = 61	**80.09** (0.0495) n = 46	**80.04** (0.0103) n = 402	**80.61** (0.2453) n = 120	**80.03** (0.0304) n = 39	**80.38** (0.0791) n = 668
2000:1-2	**80.16** (0.1201) n = 86	**80.63** (0.3432) n = 54	**80.07** (0.0283) n = 935	**80.61** (0.1714) n = 245	**80.16** (0.0816) n = 189	**80.37** (0.0526) n = 1509
2000:3-4	**80.00** (0.0000) n = 56	**-** - n = 0	**80.00** (0.0000) n = 756	**80.54** (0.2660) n = 85	**80.66** (0.1999) n = 157	**80.32** (0.0581) n = 1054
2001:1-2	**80.00** (0.0000) n = 13	**-** - n = 0	**80.06** (0.0429) n = 415	**81.89** (0.7204) n = 40	**80.55** (0.2194) n = 93	**80.99** (0.1427) n = 561

Standard errors in parentheses.

5

Forced-Air HVAC Duct System Leakage

5.1 Overview

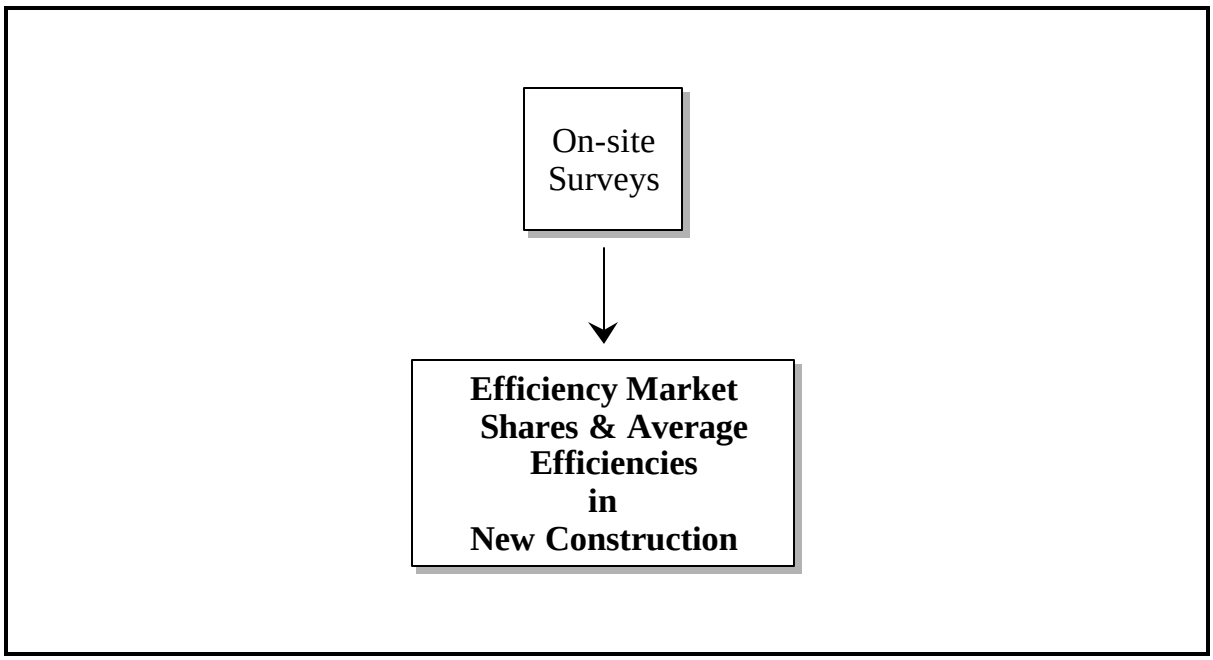
This section presents the use of duct blaster test results for the evaluation of duct leakage and duct construction in California's residential new construction sector. Subsection 5.2 provides an overview of the data sources for the duct leakage analysis and Subsection 5.3 discusses the Standards related to duct leakage. Subsection 5.4 presents the measured duct leakage rates and percent duct leakage results.

5.2 Data Sources

To obtain data on duct sealing and duct construction practices, the RMST project was expanded from its original scope to include duct blaster tests of 100 residences per year. The duct blaster tests were conducted by the California Home Energy Efficiency Rating System (CHEERS). The CHEERS team conducted duct blaster tests following the protocol used by the Title 24 requirements. A copy of the survey form and testing protocol used for the duct blaster tests is provided in Appendix C.

As shown in Figure 5-1, data from new construction on-site surveys were used to evaluate overall duct construction and average duct leakage in residential new construction. Expansion weights were developed to expand the sample data to represent the California market. A detailed discussion of the data collection and analysis of duct leakage is provided in Section 2.2 and 2.3.

Figure 5-1 Overview of Data Sources for Duct Blaster Test Analysis



5.3 Standards for Duct Construction and Duct Leakage

In the majority of residences, space conditioning is accomplished by transporting conditioned air via a forced-air duct system to each room of the residence. Poorly installed ducts can diminish heating and cooling efficiency. A duct blaster test is one method used to test duct integrity, or how well ducts are sealed. This test measures the duct leakage rate in cubic feet per minute (CFM). A duct system with a rating of 110 CFM is more efficient than one with a 500 CFM rating. A typical new home averages 400 CFM, while a home with more tightly sealed ducts should be near 110 CFM.[1]

Under AB 970, the Standards for duct construction have changed significantly. Recent changes include:

- Duct sealing was integrated into the Package D Prescriptive compliance approach, as well as the baseline used for the Performance method compliance approach, for all CEC climate zones.
- In addition, the duct sealing compliance option prohibits the use of building cavities as plenums, and prohibits the use of cloth-backed duct tape unless used with mastic and drawbands.
- Duct sealing credits are now allowed for multifamily residences - previously only applicable to single-family

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

Duct leakage requirements for the Standards are specified in terms of a percent duct leakage value, which is the ratio of the duct leakage rate to the total system supply fan flow rate. "Tight ducts" are characterized by the Standards as a 6% or less duct leakage value, while the assumed percent duct leakage for a typical home is about 22%.

5.4 Measured Duct Leakage Results

Duct leakage results from the duct blaster tests are presented on the basis of a *duct leakage rate* in CFM and a *percent duct leakage*.

Average Duct Leakage Rate

Table 5-1 summarizes the average duct leakage rate in new homes in California and for each utility area, by six-month period across utilities.[2] Based on our sample, there has been no significant change in average duct leakage rate across the four periods.[3] It should be noted, however, that the sample sizes in the SDG&E service territory are relatively small.

Figure 5-2 presents the distribution of duct leakage rate across the four six-month periods. Figure 5-3, Figure 5-4, and Figure 5-5 present the same information by utility service territory.

[2] A significance test at the 90% confidence level reveals that the estimates of the average duct leakage rate are not significantly different across time. (The only exception to this is that there is a significant difference between the average duct leakage rate in PG&E's territory during the first half of 1999 and the second half of 1999.)

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

Table 5-1: Average Duct Leakage Rate (CFM) by Utility

	PG&E	SCE	SDG&E	CA
1998:3-4	**186** (32.41) n = 22	**285** (48.00) n = 19	**267** (53.47) n = 7	**248** (28.62) n = 51
1999:1-2	**164** (24.46) n = 22	**206** (19.45) n = 18	**289** (61.22) n = 6	**202** (16.93) n = 49
1999:3-4	**257** (28.69) n = 24	**179** (22.62) n = 15	**203** (28.09) n = 8	**223** (17.09) n = 50
2000:1-2	**201** (24.95) n = 24	**253** (33.53) n = 15	**288** (64.1) n = 8	**238** (19.26) n = 50

Figure 5-2: Distribution of Average Duct Leakage Rate (CFM) – California (CA)

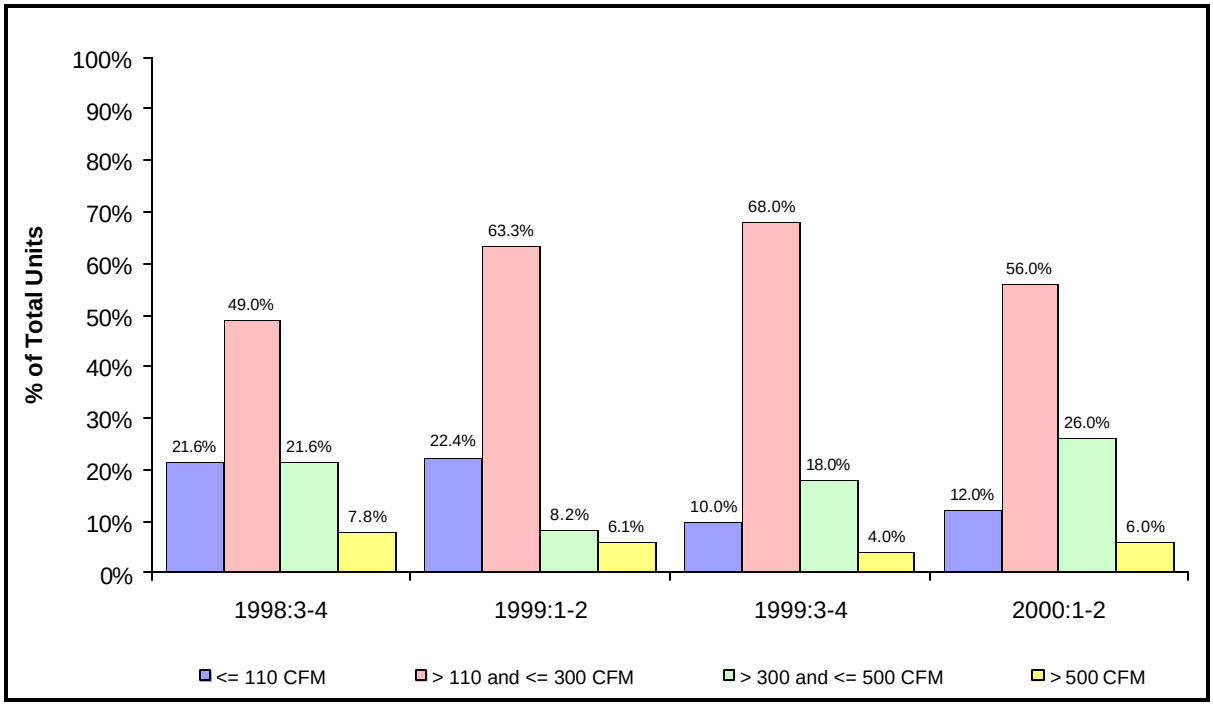


Figure 5-3: Distribution of Average Duct Leakage Rate (CFM) – PG&E

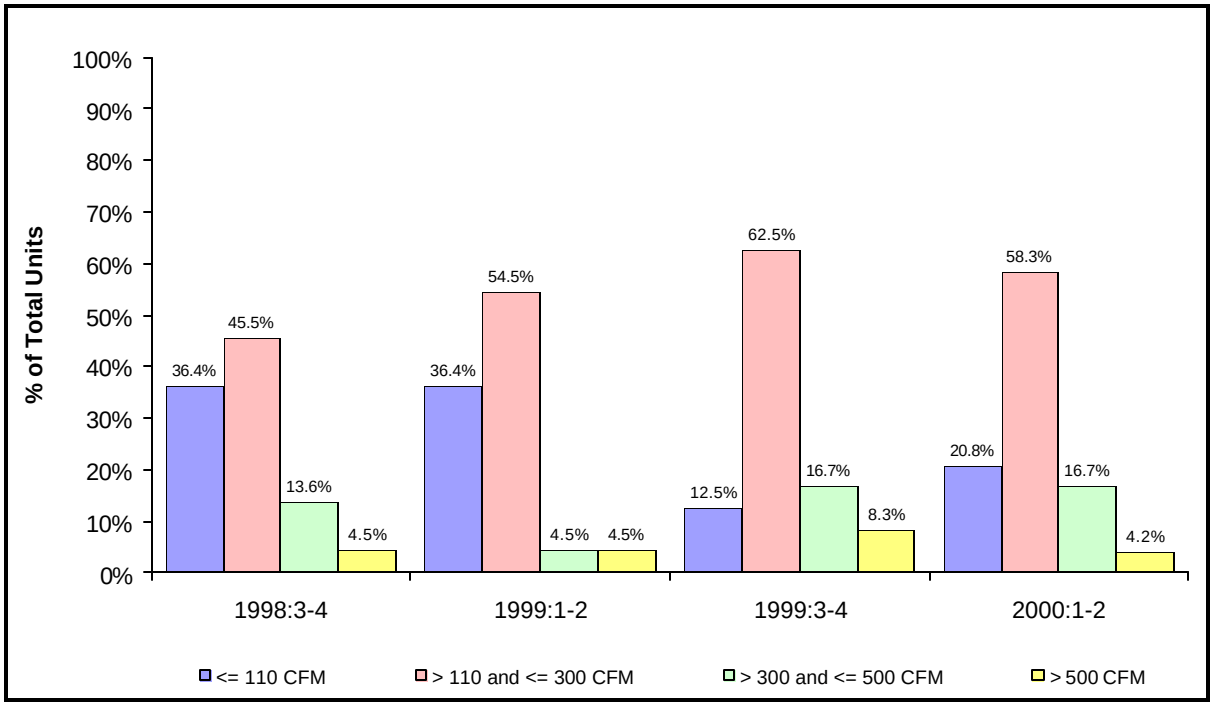


Figure 5-4: Distribution of Average Duct Leakage Rate (CFM) – SCE

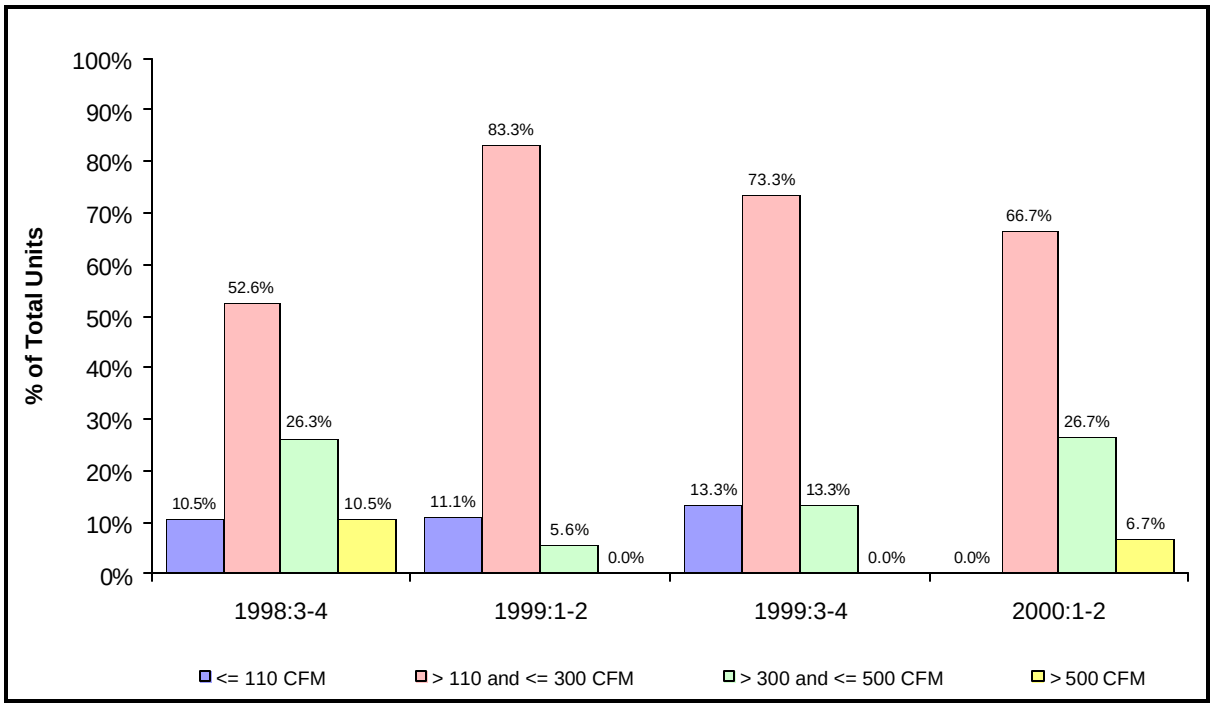


Figure 5-5: Distribution of Average Duct Leakage Rate (CFM) – SDG&E

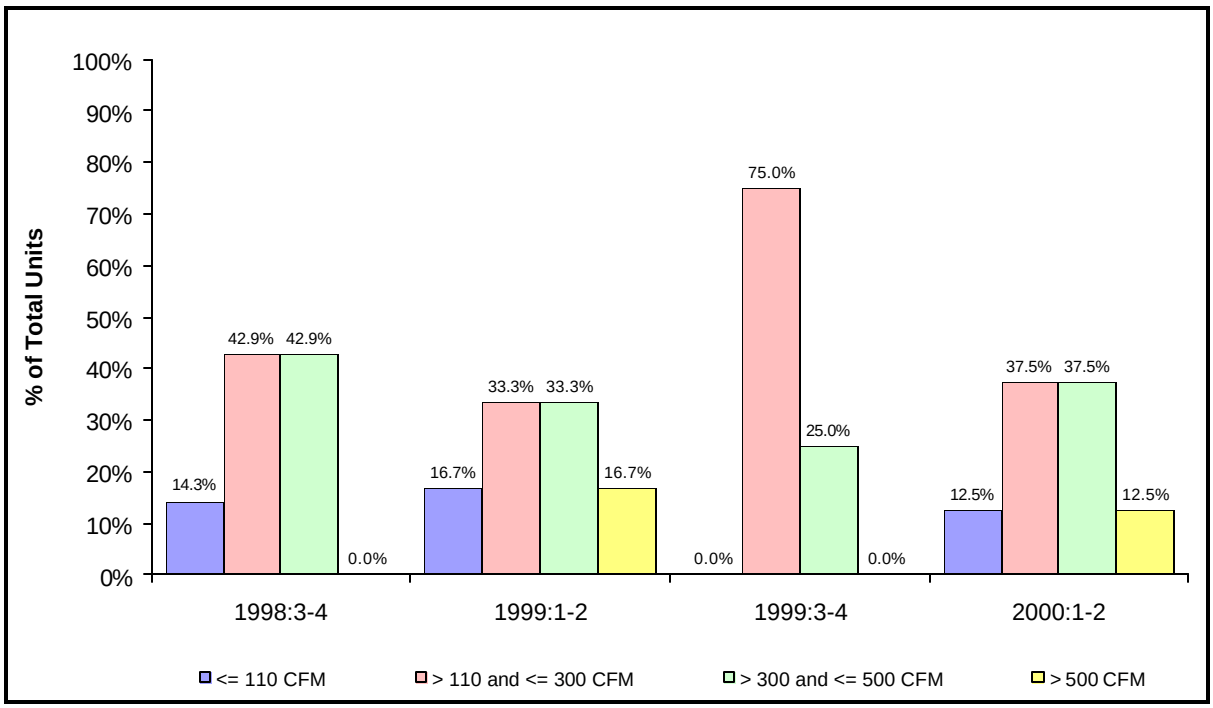


Table 5-2 presents the average duct leakage rates by RMST climate zone and Table 5-3 presents average duct leakage rates by residence type. As shown, the average duct leakage rate varies across time – there is no clear trend. Similarly, there is no evidence of decreases in average duct leakage rates across residence types or periods.

Table 5-2: Average Duct Leakage Rate (CFM) by Climate Zone

	RMST Climate Zone				
	CZ:1	**CZ:2**	**CZ:3**	**CZ:4**	**CZ:5**
1998:3-4	**179** (38.99) n = 11	**307** (56.85) n = 9	**195** (27.58) n = 14	**198** (49.33) n = 12	**562** (170.89) n = 5
1999:1-2	**191** (46.82) n = 11	**284** (59.4) n = 8	**218** (23.06) n = 14	**147** (15.27) n = 12	**177** (28.70) n = 4
1999:3-4	**287** (50.81) n = 10	**219** (32.54) n = 9	**197** (24.58) n = 13	**228** (32.46) n = 15	**112** (27.16) n = 3
2000:1-2	**284** (41.10) n = 10	**289** (53.82) n = 10	**272** (36.50) n = 12	**142** (18.49) n = 15	**263** (88.22) n = 3

Standard errors in parentheses.

Table 5-3: Average Duct Leakage Rate (CFM) by Residence Type

	Single Family	Multifamily
1998:3-4	**250** (33.93) n = 40	**242** (51.55) n = 11
1999:1-2	**210** (20.77) n = 34	**183** (29.45) n = 15
1999:3-4	**227** (19.5) n = 36	**214** (35.91) n = 14
2000:1-2	**193** (18.34) n = 34	**335** (36) n = 16

Standard errors in parentheses.

Average Percent Duct Leakage

An estimate of percent duct leakage requires that the total supply fan system flow rate be known. Percent duct leakage is then the ratio of the measured duct leakage rate over the total supply fan system flow rate. However, since this information was difficult to collect onsite, supply fan flows were estimated by utilizing cooling and heating capacity data, Title 24 Residential Standards sizing rules, and the following logic:

- For HVAC systems for which cooling capacities were available from the onsite survey, a value of 400 CFM per ton was used to estimate total supply CFM.
- For HVAC systems for which heating capacities were available from the onsite survey, a value of 21.7 CFM per kBtuh was used to estimate total supply CFM.
- For HVAC systems for which neither cooling nor heating capacities were available from the onsite survey, the following process was followed:
  - Default ft^2/ton and ft^2/kBtuh values were calculated for each building type (single-family detached homes and multifamily buildings) by computing and averaging these values for those residences that had capacities.
  - If the residence had a cooling system, the default ft^2/ton value and floor area of the residence were used to compute a default cooling capacity, and a value of 400 CFM per ton was used to estimate total supply CFM.
  - If the residence did not have a cooling system, the default ft^2/kBtuh value and floor area of the residence were used to compute a default heating capacity, and a value of 21.7 CFM per kBtuh was used to estimate total supply CFM.

Results of this process are displayed in Table 5-4, which presents the average percent duct leakage by utility and Table 5-5 which presents average percent duct leakage by residence type. These results suggest no evidence of significant differences across time periods. The results also reveal that single family homes have a significantly lower percent duct leakage than multifamily residences.[4] This is a major deviation from the common perception that duct leakage for multifamily residences would be less than that in single-family homes due to smaller duct run lengths. These results suggest instead that although duct runs are shorter, maybe duct construction/sealing for multifamily buildings is of lower quality. It might also suggest that there is more use of building cavities and other such unfinished air flow paths in multifamily buildings than in single-family detached homes.

[4] A significance test at the 90% confidence level reveals that the estimates of the average percent duct leakage for single family and multifamily homes are significantly different in all time periods except for the last six months of 1998..

Table 5-4: Average Percent Duct Leakage by Utility

	PG&E	SCE	SDG&E	CA
1998:3-4	**11.1%** (0.0180) n = 22	**26.2%** (0.0646) n = 19	**20.1%** (0.0602) n = 7	**19.5%** (0.0306) n = 51
1999:1-2	**13.6%** (0.0146) n = 22	**20.4%** (0.0598) n = 18	**26.9%** (0.0701) n = 6	**17.9%** (0.0250) n = 49
1999:3-4	**18.3%** (0.0194) n = 24	**10.7%** (0.0207) n = 15	**12.6%** (0.0205) n = 8	**14.8%** (0.0126) n = 50
2000:1-2	**14.6%** (0.0192) n = 24	**19.0%** (0.0469) n = 15	**29.4%** (0.1279) n = 8	**20.9%** (0.0318) n = 50

Standard errors in parentheses.

Table 5-5: Average Percent Duct Leakage by Residence Type and Utility

	Single Family	Multifamily
1998:3-4	**15.4%** (0.0242) n = 40	**34.5%** (0.1026) n = 11
1999:1-2	**13.3%** (0.0146) n = 34	**28.4%** (0.0690) n = 15
1999:3-4	**12.4%** (0.0116) n = 36	**20.7%** (0.0284) n = 14
2000:1-2	**11.2%** (0.0102) n = 34	**41.6%** (0.0752) n = 16

Standard errors in parentheses.

6

Water Heating Equipment

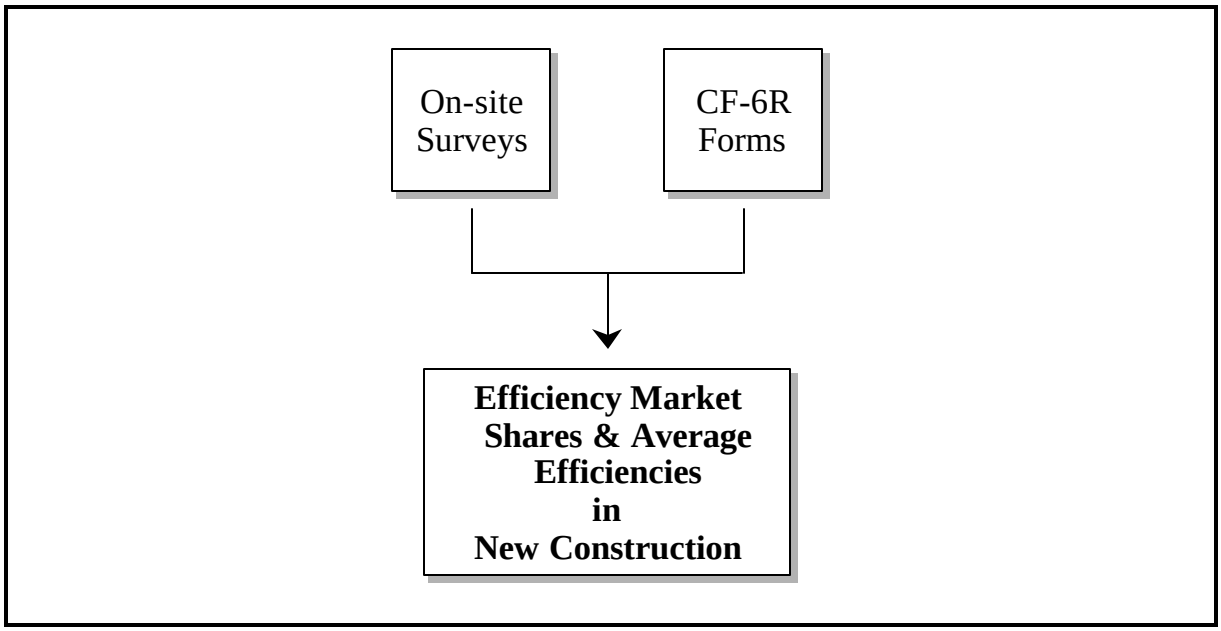
6.1 Overview

This section presents the efficiency market shares and average efficiencies of gas water heaters in the residential new construction sector. Subsection 6.2 provides an overview of the data sources for the water heater analysis while Subsection 6.3 summarizes energy efficiency standards for water heaters. Subsection 6.4 provides estimates of total gas water heater sales in California by decision type. Average percent-above-standard efficiency for gas water heaters in new construction are presented in Subsection 6.5.

6.2 Data

As shown in Figure 6-1, data from new construction on-site surveys and building department installation forms (CF-6Rs) were used to estimate the shares and average efficiencies of gas water heaters installed in residential new construction. Expansion weights were developed to expand the sample data to represent the California market. A detailed discussion of the data collection and analysis of gas water heater efficiencies is provided in Section 2.2 and 2.3.

Figure 6-1: Overview of Data Sources for Gas Water Heater Analysis



6.3 Gas Water Heater Efficiency Ratings

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

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

where

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

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

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

Table 6-1 presents estimates of total unit sales for gas and electric water heaters. National annual sales data for gas water heaters were obtained from GAMA.[3] These data were then scaled to California annual sales based on number of households and the saturations of gas water heaters. In particular, the national sales figure was multiplied by the ratio of the number of California households with a gas water heater divided by the number of national households with a gas water heater.

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

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

3 GAMA's website: http://www.gamanet.org

Table 6-1: Estimates of Annual Gas/Propane Water Heater Sales by Decision Type

Year	Total Units Sales [1]	New Construction [2]	Retrofit/ Replacement
1999	883,284	95,972	787,311
2000	880,870	116,253	764,618

1 National annual appliance sales from *GAMA*, scaled to the California market.[4]

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)

6.5 Gas Water Heaters

On-Site Data Analysis Results

Table 6-2 presents the average percent-above-standard efficiency for gas water heaters by utility territory and six-month period. The percent-above-standard efficiency does not vary significantly over time for any utility, except in the SDG&E service territory where the percent-above-standard efficiency decreased significantly in the first six-months of 2000. The distribution of the percent-above-standard is shown in Figure 6-2. In all periods, over 80% of all water heaters were at least 10% above standard.

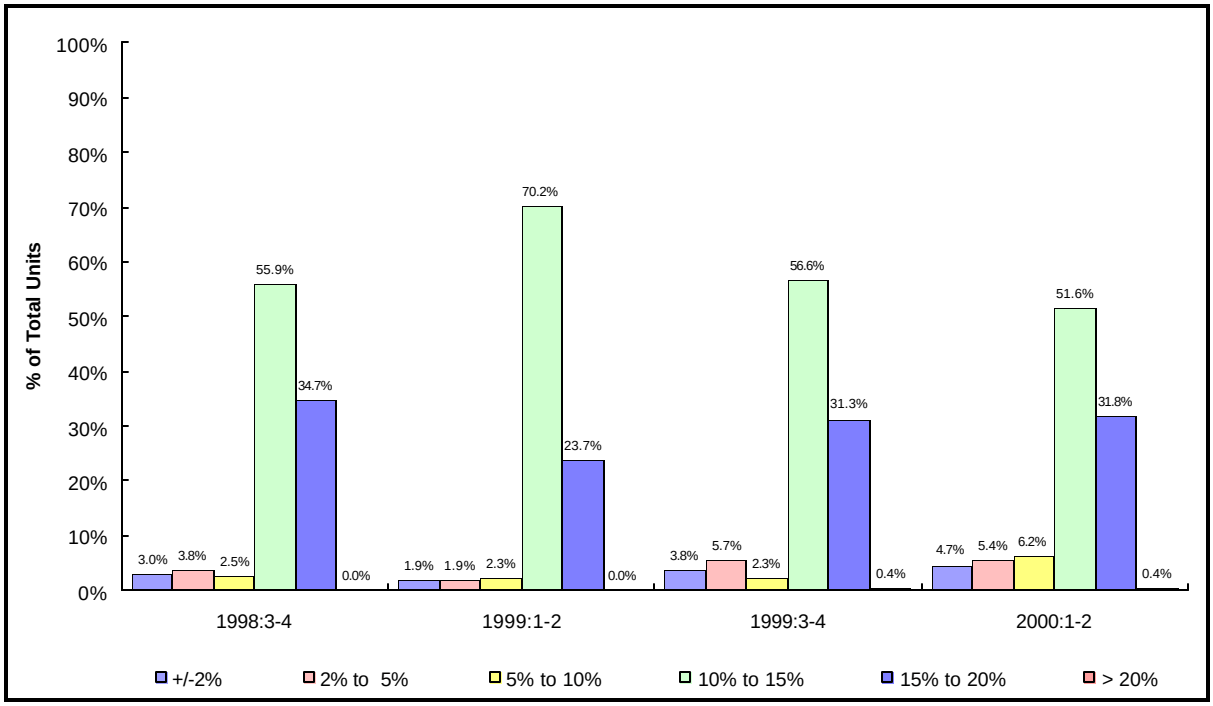
4 Scaled using a ratio based on the number of households in California with gas/propane water heaters divided by the number of national households with gas/propane water heaters. The data for these parameters were gathered from saturation estimates from utility residential energy use surveys and the most recent Residential Energy Consumption Survey (RECS).

Table 6-2: Gas Water Heating Average Percent-Above-Standard – On-Site Data

	PG&E	SCE	SDG&E	All
1998:3-4	**13.4%** (0.0037) n = 99	**14.5%** (0.0038) n = 101	**16.6%** (0.0034) n = 36	**14.2%** (0.0024) n = 236
1999:1-2	**13.5%** (0.0021) n = 115	**14.6%** (0.0036) n = 76	**15.8%** (0.0047) n = 24	**14.0%** (0.0018) n = 215
1999:3-4	**13.2%** (0.0029) n = 143	**14.6%** (0.0053) n = 82	**16.4%** (0.0049) n = 40	**13.9%** (0.0025) n = 265
2000:1-2	**13.5%** (0.0031) n = 142	**14.9%** (0.0048) n = 81	**11.5%** (0.0121) n = 35	**13.8%** (0.0026) n = 258

Standard errors in parentheses.

Figure 6-2: Gas Water Heater Distribution by Percent-Above-Standard – On-Site Data



Saturations of gas water heater by residence type and utility are presented in Table 6-3. As shown, approximately 99% of new homes in California have a gas water heater.

Table 6-3: Saturations of Gas Water Heaters

	PG&E	SCE	SDG&E	CA
Single Family Homes				
1998:3-4 - 1999:1-2	**99.6%** n = 265	**99.1%** n = 230	**100.0%** n = 76	**99.5%** n = 596
1999:3-4 - 2000:1-2	**99.6%** n = 297	**100.0%** n = 183	**99.4%** n = 73	**99.7%** n = 575
Multifamily Homes				
1998:3-4 - 1999:1-2	**97.4%** n = 101	**97.5%** n = 54	**98.1%** n = 32	**97.4%** n = 204
1999:3-4 - 2000:1-2	**100.0%** n = 107	**100.0%** n = 49	**97.8%** n = 51	**99.6%** n = 226

Standard errors in parentheses.

CF-6R Data Analysis Results

Figure 6-3 presents the average percent-above-standard efficiency for gas water heaters in California over the past two years by quarter. As shown, the average percent-above-standard efficiency for new construction in California has increased over the last two years - from 13.7% in the third quarter of 1999 to 16.0% during the first quarter of 2001. Table 6-4 shows the average percent-above-standard efficiency by utility.

Figure 6-3: Gas Water Heaters, Average Percent-Above-Standard – CF-6R Data

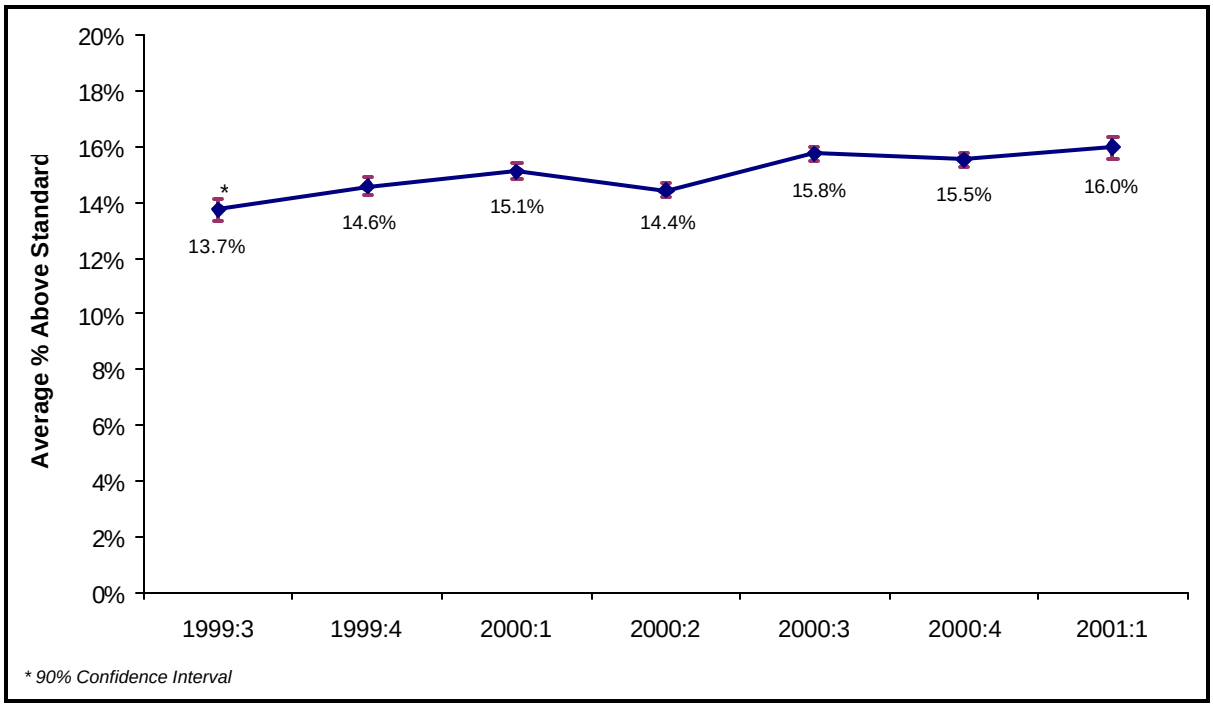


Table 6-4: Gas Water Heaters, Average Percent-Above-Standard – CF-6R Data

	PG&E	SCE	All
1999:3	**14.0%** (0.0016) n = 13	**11.6%** (0.0069) n = 20	**13.7%** (0.0024) n = 33
1999:4	**13.6%** (0.0039) n = 29	**16.3%** (0.0022) n = 218	**14.6%** (0.0019) n = 247
2000:1	**14.7%** (0.0023) n = 95	**16.3%** (0.0029) n = 378	**15.1%** (0.0016) n = 473
2000:2	**13.4%** (0.0040) n = 69	**16.2%** (0.0014) n = 465	**14.4%** (0.0015) n = 534
2000:3	**15.5%** (0.0045) n = 63	**16.6%** (0.0013) n = 462	**15.8%** (0.0015) n = 525
2000:4	**14.1%** (0.0005) n = 12	**16.3%** (0.0019) n = 480	**15.5%** (0.0016) n = 492
2001:1	**14.1%** (0.0016) n = 2	**16.8%** (0.0028) n = 390	**16.0%** (0.0024) n = 392

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

In addition to calculating the average percent-above-standard efficiency, it is important to notice the percentage of water heaters that falls into various efficiency levels. Several efficiency groups were selected to show this distribution. As shown in Figure 6-4, the first efficiency group is assumed to consist of water heaters with an efficiency close to standard. These units have an efficiency of ±2% of the federal requirement. Similar to the results found using the on-site data, in every quarter except the third quarter of 1999, more than 90% of the water heaters installed are at least 10% above standard.

Size groups were also developed to show the distribution of gas water heaters. See Figure 6-5 for the breakdown of water heaters by storage tank volume.

Figure 6-4: Gas Water Heaters, Percent-Above-Standard – CF-6R Data

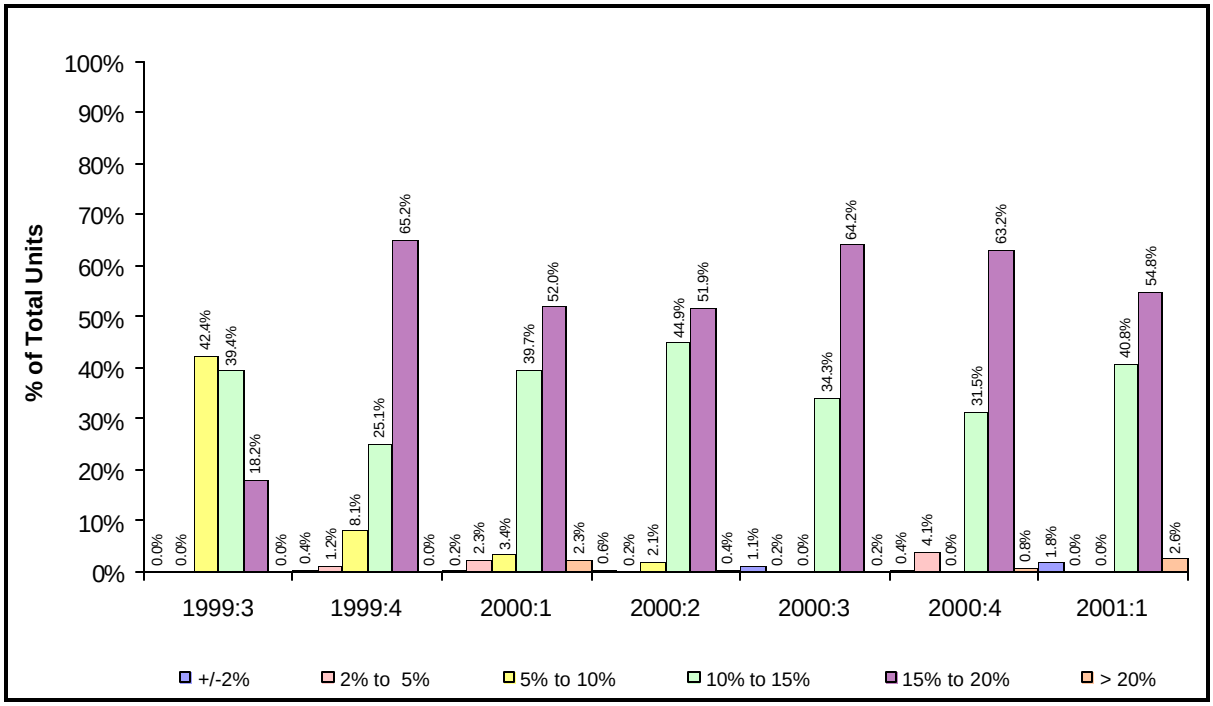
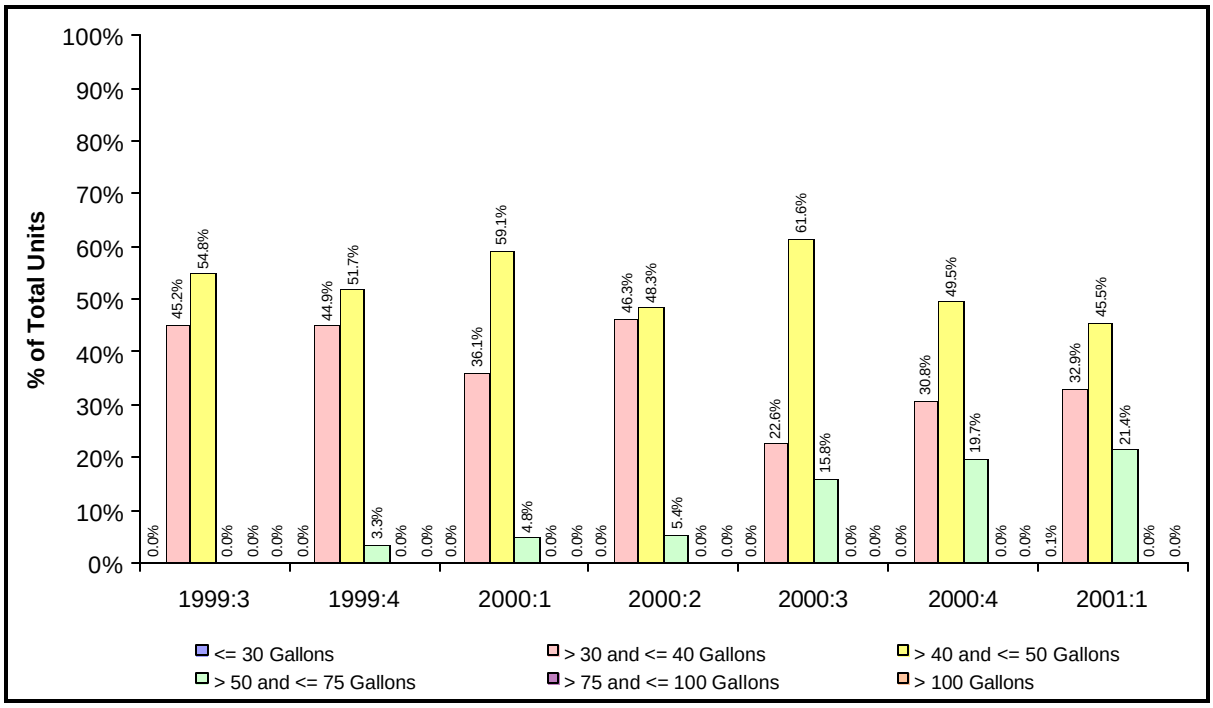


Figure 6-5: Gas Water Heaters by Storage Tank Volume (Gallons) – CF-6R Data

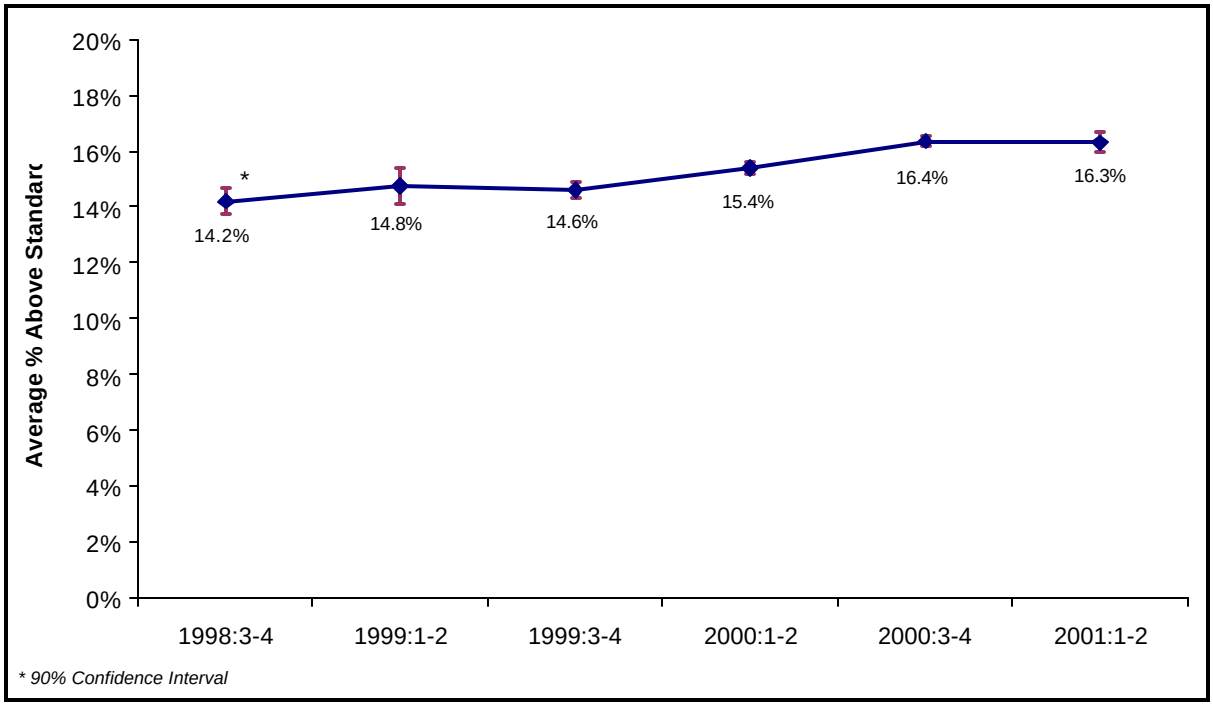


Combined New Construction Results

The average percent-above-standard for gas water heaters is shown in Figure 6-6. As shown, there has been a significant increase in the average percent-above-standard when comparing early 2001 to quarters before 2000.[5]

Table 6-5 presents the breakout of average percent-above-standard for gas water heaters by utility. The average percent-above-standard for gas water heaters within PG&E's territory have been significantly lower than the averages found for gas water heaters within SCE's territory over the last two years.[6]

Figure 6-6: Gas Water Heaters in New Construction, Average Percent-Above-Standard



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

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

Table 6-5: Gas Water Heaters in New Construction, Average Percent-Above-Standard

	PG&E	SCE	SDG&E	All
1998:3-4	**13.2%** (0.0036) n = 113	**14.7%** (0.0056) n = 107	**16.4%** (0.0034) n = 36	**14.2%** (0.0029) n = 265
1999:1-2	**14.0%** (0.0028) n = 142	**16.0%** (0.0105) n = 91	**15.8%** (0.0046) n = 24	**14.8%** (0.0040) n = 267
1999:3-4	**13.0%** (0.0026) n = 185	**15.5%** (0.0022) n = 320	**15.7%** (0.0063) n = 40	**14.6%** (0.0017) n = 557
2000:1-2	**13.7%** (0.0020) n = 306	**16.1%** (0.0015) n = 924	**12.0%** (0.0119) n = 35	**15.4%** (0.0013) n = 1275
2000:3-4	**15.2%** (0.0038) n = 75	**16.4%** (0.0012) n = 942	**-** - -	**16.4%** (0.0011) n = 1017
2001:1-2	**13.7%** (0.0026) n = 10	**16.3%** (0.0023) n = 529	**-** - -	**16.3%** (0.0022) n = 539

Standard errors in parentheses.

7

Windows

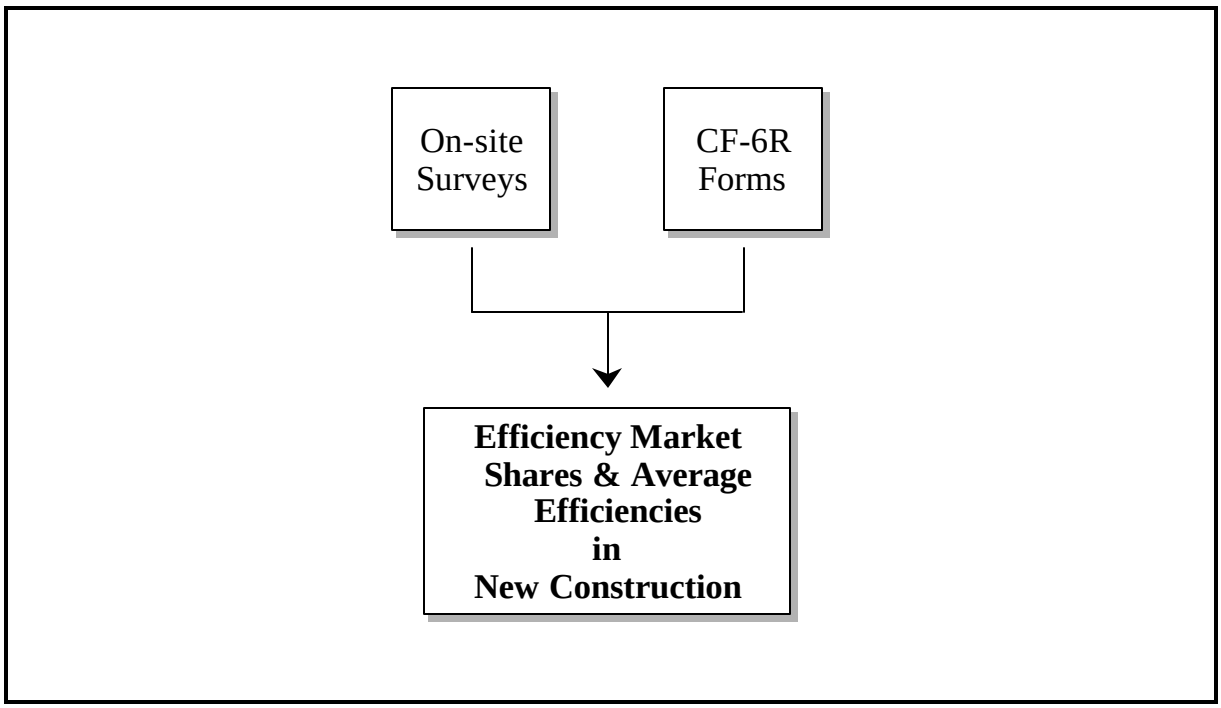
7.1 Overview

This section presents the efficiency market shares and average efficiencies of windows installed in California's residential new construction sector. Subsection 7.2 provides an overview of the data sources for the window analysis while Subsection 7.3 summarizes energy efficiency ratings for windows. Subsection 7.4 provides the estimates of the saturations of various window types in California's new construction sector and the estimates of average window efficiencies in California's new construction sector.

7.2 Data

Figure 7-1 provides an overview of the data sources for the window analysis. The on-site surveys provide information on the types of windows installed in new homes, which was used to estimate saturations of different window types. In addition, the data obtained from the building department installation forms (CF-6Rs) was used to estimate the average efficiencies of windows installed in residential new construction. Expansion weights were developed to expand the sample data to represent the California market. A detailed discussion of the data collection is provided in Section 2.2.

Figure 7-1: Overview of Data Sources for Window Analysis



7.3 Window Efficiency Ratings

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

As mentioned earlier, the installation forms (CF-6Rs) obtained from the building departments include the U-values of the windows installed. This data allowed for estimates of the average U-values to be calculated. However, since U-values could not be observed during the on-site visits, the data collected was used to complete an analysis of the types of windows installed in new construction. After reviewing every possible combination of window type, RER found that nine types of windows had a saturation of greater than 1%. These nine window types, listed below, are the focus of the analysis presented here.

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

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

7.4 Windows

On-Site Survey Results

Table 7-1 and Figure 7-2 present the distribution of the nine window types by six-month period for all newly constructed homes. Clear glass, double pane wood or vinyl framed air-filled units are by far the most predominant. The same distribution by single family and multifamily residence types is presented in Table 7-2, Figure 7-3 and Figure 7-4.

The distribution of window types by utility and residence type and window types by climate zone are presented in Table 7-3 and Table 7-4, respectively.

Table 7-1: Distribution of Window Types – On-Site Data

	Clear Glass Dual Pane Wood/Vinyl Frame Air Filled	Clear Glass Dual Pane Metal Frame Air Filled	Clear Glass Dual Pane Wood/Vinyl Frame Gas Filled	Clear Glass Single Pane Metal Frame Air Filled	Clear Glass Single Pane Wood/Vinyl Frame Air Filled	Low-e Glass Dual Pane Metal Frame Air Filled	Low-e Glass Dual Pane Wood/Vinyl Frame Air Filled	Low-e Glass Dual Pane Wood/Vinyl Frame Gas Filled	Reflective/ Tinted Glass Dual Pane Wood/Vinyl Frame Air Filled
1998: 3-4	85.0%	4.0%	1.1%	1.1%	0.7%	0.0%	4.5%	0.5%	3.1%
1999: 1-2	83.9%	2.4%	0.5%	0.8%	0.7%	0.2%	4.7%	0.6%	5.4%
1999: 3-4	74.8%	14.5%	0.0%	0.3%	0.8%	1.9%	6.1%	0.7%	0.5%
2000: 1-2	72.7%	15.4%	0.0%	0.0%	0.4%	2.9%	6.3%	1.0%	0.7%

Figure 7-2: Distribution of Window Types – On-Site

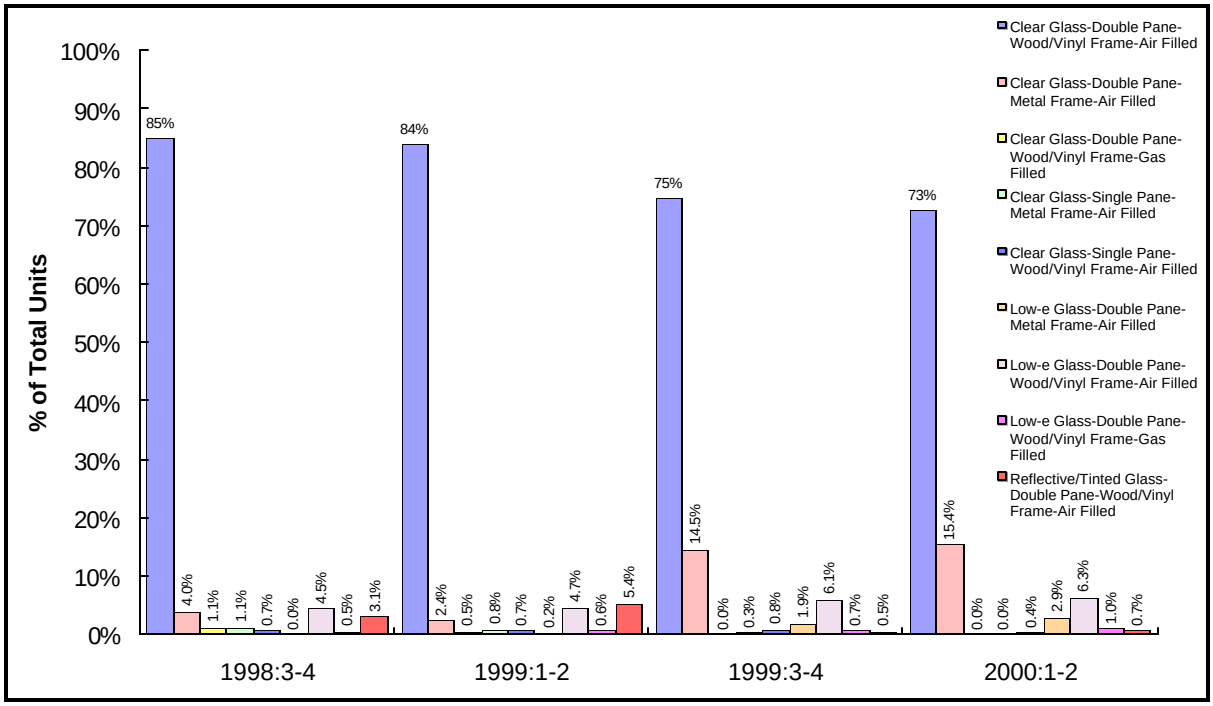


Table 7-2: Distribution of Window Types by Residence Type – On-Site Data

	Clear Glass Dual Pane Wood/Vinyl Frame Air Filled	Clear Glass Dual Pane Metal Frame Air Filled	Clear Glass Dual Pane Wood/Vinyl Frame Gas Filled	Clear Glass Single Pane Metal Frame Air Filled	Clear Glass Single Pane Wood/Vinyl Frame Air Filled	Low-e Glass Dual Pane Metal Frame Air Filled	Low-e Glass Dual Pane Wood/Vinyl Frame Air Filled	Low-e Glass Dual Pane Wood/Vinyl Frame Gas Filled	Reflective/ Tinted Glass Dual Pane Wood/Vinyl Frame Air Filled
Single Family									
1998: 3-4	86.4%	2.6%	1.4%	0.5%	0.4%	0.0%	4.3%	0.6%	3.7%
1999: 1-2	85.0%	1.5%	0.6%	0.0%	0.2%	0.0%	5.1%	0.4%	6.3%
1999: 3-4	75.1%	13.2%	0.0%	0.0%	0.7%	2.0%	7.0%	0.8%	0.6%
2000: 1-2	73.0%	14.7%	0.0%	0.0%	0.0%	3.6%	6.6%	1.3%	0.8%
Multifamily									
1998: 3-4	78.5%	10.3%	0.0%	3.9%	2.0%	0.0%	5.1%	0.0%	0.2%
1999: 1-2	79.1%	6.8%	0.0%	4.4%	2.6%	0.9%	2.8%	1.4%	1.4%
1999: 3-4	73.1%	20.6%	0.0%	1.8%	1.2%	1.6%	1.7%	0.0%	0.0%
2000: 1-2	71.8%	18.2%	0.0%	0.0%	1.9%	0.0%	5.1%	0.0%	0.4%

Figure 7-3: Distribution of Window Types – Single Family Homes – On-Site Data

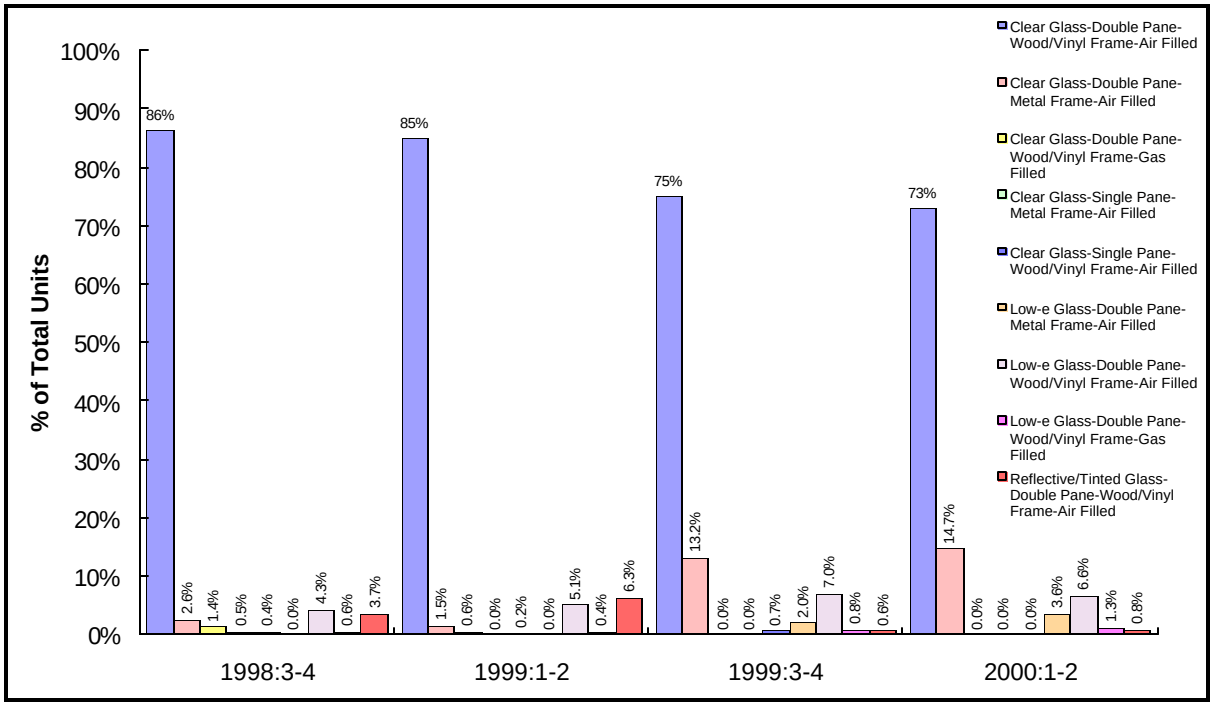


Figure 7-4: Distribution of Window Types – Multifamily Building – On-Site Data

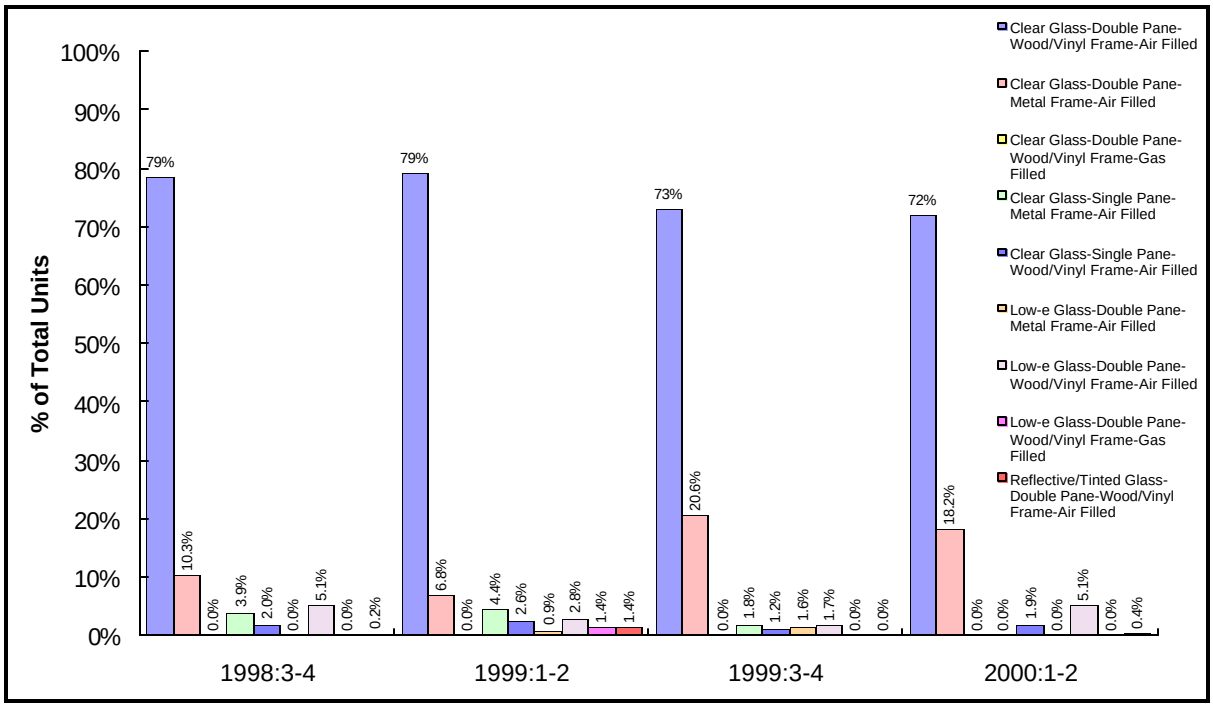


Table 7-3: Distribution of Window Type by Utility and Residence Type – On-Site Data

Residence Type & Utility Area		Clear Glass Dual Pane Wood/Vinyl Frame Air Filled	Clear Glass Dual Pane Metal Frame Air Filled	Clear Glass Dual Pane Wood/Vinyl Frame Gas Filled	Clear Glass Single Pane Metal Frame Air Filled	Clear Glass Single Pane Wood/Vinyl Frame Air Filled	Low-e Glass Dual Pane Metal Frame Air Filled	Low-e Glass Dual Pane Wood/Vinyl Frame Air Filled	Low-e Glass Dual Pane Wood/Vinyl Frame Gas Filled	Reflective/ Tinted Glass Dual Pane Wood/Vinyl Frame Air Filled
Single Family										
PG&E	1998:3-4	84.5%	2.6%	2.7%	0.8%	0.1%	0.0%	6.2%	1.1%	2.1%
	1999:1-2	82.0%	0.8%	0.7%	0.0%	0.2%	0.0%	8.3%	0.8%	5.6%
	1999:3-4	62.0%	19.2%	0.0%	0.0%	0.5%	3.4%	12.0%	1.3%	0.7%
	2000:1-2	60.7%	21.0%	0.0%	0.0%	0.0%	5.7%	10.0%	2.0%	0.4%
SCE	1998:3-4	87.5%	2.6%	0.0%	0.1%	1.0%	0.0%	3.0%	0.0%	5.7%
	1999:1-2	88.9%	1.7%	0.0%	0.0%	0.2%	0.0%	0.9%	0.0%	8.2%
	1999:3-4	93.4%	5.4%	0.0%	0.0%	1.2%	0.0%	0.0%	0.0%	0.0%
	2000:1-2	92.8%	4.6%	0.0%	0.0%	0.0%	0.0%	1.1%	0.0%	1.5%
SDG&E	1998:3-4	92.4%	2.4%	0.0%	0.8%	0.1%	0.0%	0.0%	0.0%	4.1%
	1999:1-2	90.2%	6.0%	3.1%	0.2%	0.4%	0.0%	0.0%	0.0%	0.1%
	1999:3-4	93.3%	2.7%	0.0%	0.0%	0.1%	0.0%	0.0%	0.8%	3.0%
	2000:1-2	98.9%	0.0%	0.0%	0.0%	0.4%	0.0%	0.0%	0.0%	0.2%
Multifamily										
PG&E	1998:3-4	76.2%	11.3%	0.0%	3.6%	1.3%	0.0%	7.6%	0.0%	0.0%
	1999:1-2	82.3%	2.2%	0.0%	2.2%	2.1%	1.3%	4.4%	2.2%	2.2%
	1999:3-4	60.5%	32.8%	0.0%	1.3%	0.1%	2.5%	2.8%	0.0%	0.0%
	2000:1-2	62.3%	26.4%	0.0%	0.0%	0.0%	0.0%	7.5%	0.0%	0.0%
SCE	1998:3-4	84.4%	8.6%	0.0%	4.3%	1.9%	0.0%	0.0%	0.0%	0.8%
	1999:1-2	73.6%	15.4%	0.0%	7.7%	3.3%	0.0%	0.0%	0.0%	0.0%
	1999:3-4	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	2000:1-2	99.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%
SDG&E	1998:3-4	79.2%	6.5%	0.0%	5.1%	9.3%	0.0%	0.0%	0.0%	0.0%
	1999:1-2	71.0%	11.2%	0.0%	13.3%	4.6%	0.0%	0.0%	0.0%	0.0%
	1999:3-4	88.9%	0.0%	0.0%	5.0%	5.8%	0.0%	0.0%	0.0%	0.0%
	2000:1-2	84.4%	0.0%	0.0%	0.0%	13.4%	0.0%	0.0%	0.0%	2.2%

Table 7-4: Distribution of Window Types by Climate Zone

CEC Climate Zone		Clear Glass Dual Pane Wood/Vinyl Frame Air Filled	Clear Glass Dual Pane Metal Frame Air Filled	Clear Glass Dual Pane Wood/Vinyl Frame Gas Filled	Clear Glass Single Pane Metal Frame Air Filled	Clear Glass Single Pane Wood/Vinyl Frame Air Filled	Low-e Glass Dual Pane Metal Frame Air Filled	Low-e Glass Dual Pane Wood/Vinyl Frame Air Filled	Low-e Glass Dual Pane Wood/Vinyl Frame Gas Filled	Reflective/ Tinted Glass Dual Pane Wood/Vinyl Frame Air Filled
CZ:1	1998:3-4	81.4%	5.6%	1.1%	1.1%	0.1%	0.0%	8.7%	1.1%	0.9%
	1999:1-2	81.2%	1.0%	1.2%	1.0%	0.6%	0.6%	6.5%	1.0%	4.4%
	1999:3-4	80.9%	11.5%	0.0%	0.0%	0.1%	0.0%	5.5%	1.4%	0.0%
	2000:1-2	83.9%	6.4%	0.0%	0.0%	0.0%	1.6%	7.8%	0.0%	0.4%
CZ:2	1998:3-4	86.9%	3.6%	0.0%	0.9%	0.5%	0.0%	1.6%	0.0%	6.4%
	1999:1-2	83.3%	5.4%	1.5%	1.1%	2.6%	0.0%	3.0%	0.0%	3.0%
	1999:3-4	96.7%	0.0%	0.0%	0.2%	1.5%	0.0%	0.0%	0.0%	1.5%
	2000:1-2	95.6%	0.0%	0.0%	0.0%	3.5%	0.0%	0.0%	0.0%	0.8%
CZ:3	1998:3-4	89.5%	3.6%	0.0%	0.9%	1.4%	0.0%	1.9%	0.0%	2.7%
	1999:1-2	87.3%	3.5%	0.0%	1.8%	0.2%	0.0%	0.0%	0.0%	7.2%
	1999:3-4	97.0%	0.8%	0.0%	0.6%	1.4%	0.0%	0.0%	0.0%	0.0%
	2000:1-2	96.4%	0.0%	0.0%	0.0%	0.0%	0.0%	1.5%	0.0%	2.1%
CZ:4	1998:3-4	84.6%	3.2%	2.9%	1.6%	0.6%	0.0%	3.9%	0.6%	2.5%
	1999:1-2	84.0%	1.2%	0.0%	0.0%	0.7%	0.0%	8.1%	1.1%	4.9%
	1999:3-4	47.3%	31.2%	0.0%	0.4%	0.6%	5.1%	12.9%	0.9%	0.9%
	2000:1-2	48.0%	31.9%	0.0%	0.0%	0.0%	6.0%	10.1%	2.4%	0.3%
CZ:5	1998:3-4	78.1%	1.8%	0.0%	0.0%	1.8%	0.0%	6.1%	0.0%	12.3%
	1999:1-2	82.0%	7.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	9.4%
	1999:3-4	98.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.3%	0.0%
	2000:1-2	92.2%	7.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

CF-6R Results

As mentioned earlier, U-values could not be collected during the on-site surveys. However, some of the CF-6Rs collected included the window installation form. This form has detailed information on the square footage and U-value of each window installed in a new home. Table 7-5 shows the average window U-value by utility and by quarter. Figure 7-5 presents the average U-value over the past two years (1999:3–2001:2). As shown, the statewide average U-values have fluctuated significantly by quarter.[1] Average U-values range from 0.48 in the third quarter of 1999 to 0.71 in the first quarter of 2001. Note that the sample size in a few quarters are small.

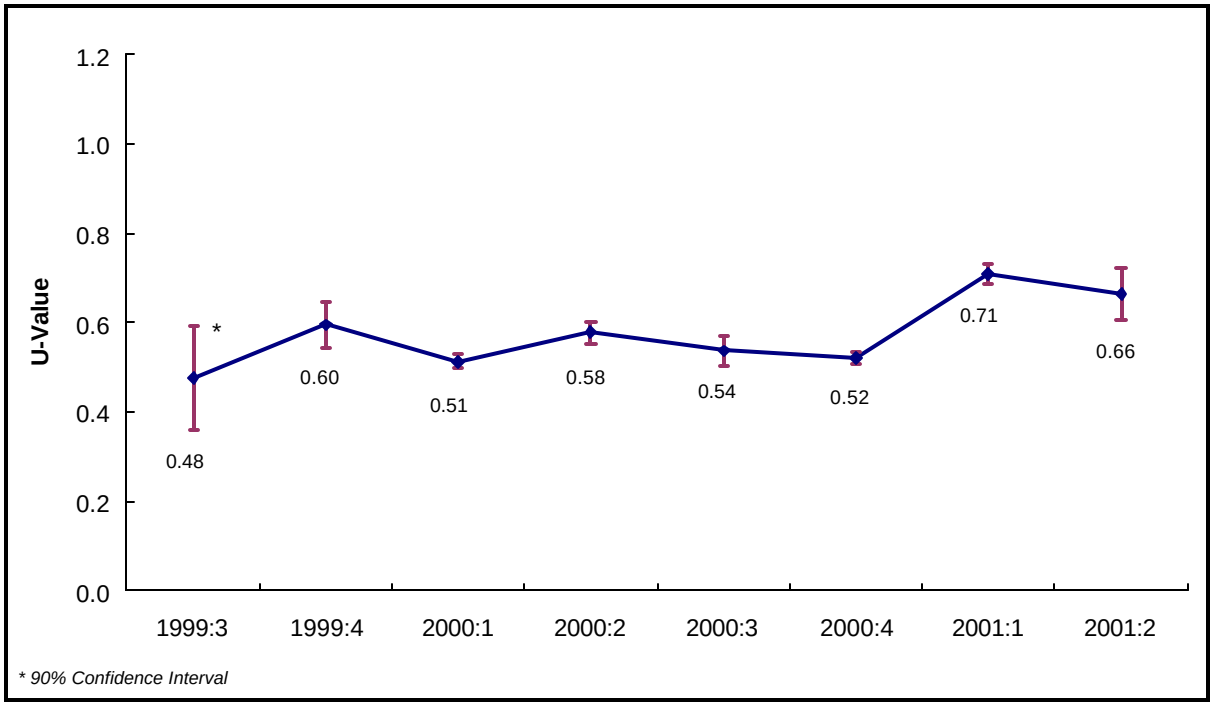
[1] A significance test at the 90% confidence level reveals that the estimates of the average U-value in the fourth quarter of 1999 is significantly different from the U-value in the first quarter of 2000. The difference between first quarter of 2000 and the second quarter of 2000 and the difference between fourth quarter of 2000 and the first quarter of 2001 are also significant at the 90% confidence level.

Table 7-5: Window Average U-Value – CF-6R Data

	PG&E	SCE	All
1999:3	**0.47** (0.1639) n = 2	**0.54** (0.0330) n = 4	**0.48** (0.0710) n = 6
1999:4	**0.60** (0.0424) n = 6	**0.54** (0.0358) n = 4	**0.60** (0.0312) n = 10
2000:1	**0.50** (0.0134) n = 50	**0.58** (0.0109) n = 63	**0.51** (0.0093) n = 113
2000:2	**0.74** (0.0450) n = 2	**0.54** (0.0123) n = 46	**0.58** (0.0156) n = 48
2000:3	**0.53** (0.0902) n = 4	**0.68** (0.0136) n = 57	**0.54** (0.0203) n = 61
2000:4	**-** (0.0000) n = 0	**0.52** (0.0072) n = 42	**0.52** (0.0072) n = 42
2001:1	**-** (0.0000) n = 0	**0.71** (0.0140) n = 27	**0.71** (0.0140) n = 27
2001:2	**-** (0.0000) n = 0	**0.66** (0.0346) n = 9	**0.66** (0.0346) n = 9

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

Figure 7-5: Window Average U-Value – CF-6R Data



8

Interior and Exterior Lighting

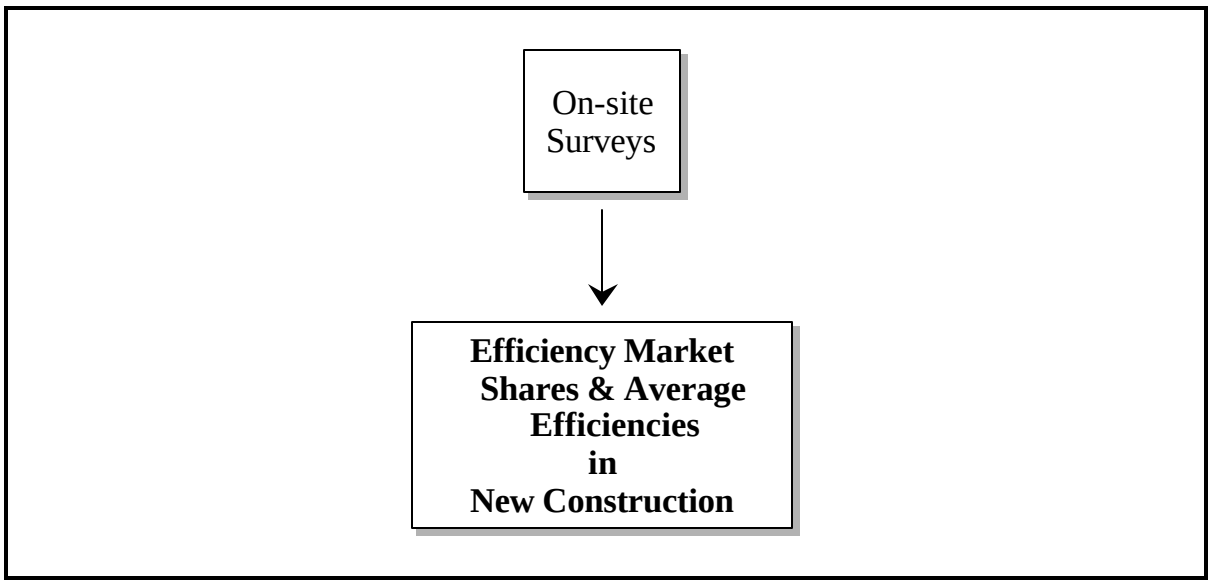
8.1 Overview

This section presents the efficiency market shares of high efficiency lighting in California's residential new construction sector. Subsection 8.2 includes a review of the data sources for the analysis and Subsection 8.3 and 8.4 present market share estimates of interior and exterior lighting bulbs and fixtures respectively. Subsection 8.5 presents the results of the connected load analysis while Subsection 8.6 provides the saturation of ceiling fans in new construction. Expansion weights were developed to expand the sample data to represent the California market. A detailed discussion of the data collection and analysis of lighting is provided in Section 2.2.

8.2 Data

Figure 8-1 provides an overview of the data sources for the lighting analysis. As shown, data from new construction on-site surveys was used to estimate the shares of high efficiency lighting installed in residential new construction. The on-site surveys collect detailed information on the type of fixture, the type of bulb, wattage, and location. The installation forms collected (CF-6Rs) do not include information on light fixtures.

Figure 8-1: Overview of Data Sources for Lighting Analysis



8.3 Interior Lighting

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

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

Interior Fixtures

Table 8-1 presents the average number of interior fixtures by residence type by six-month period. Figure 8-2 classifies fixtures by the type of bulb installed in the fixture. These include only hard-wired fixtures and distinguish between dedicated and non-dedicated CFL fixtures. As shown, an average of nearly 10% of the fixtures are fitted with CFL bulbs. The same distributions separated by single family and multifamily homes are shown in Figure 8-3. Comparing results by residence type indicates that on average, the shares of CFL bulbs in multifamily homes are greater than the shares of CFL bulbs in single family homes.

Table 8-2 through Table 8-5 present the number of interior fixtures installed by bulb type, residence type, and six-month period. Figure 8-4 presents the percent of fixtures installed by mount type. The same information by residence type is presented in Figure 8-5 and Figure 8-6.

Table 8-1: Average Number of Fixtures per Household – On-Site Data

	Multifamily	Single Family
1998:3-4	10.2	27.3
1999:1-2	11.8	26.4
1999:3-4	10.5	29.0
2000:1-2	11.7	29.9

Figure 8-2: Interior Fixtures by Installed Bulb Type – On-Site Data

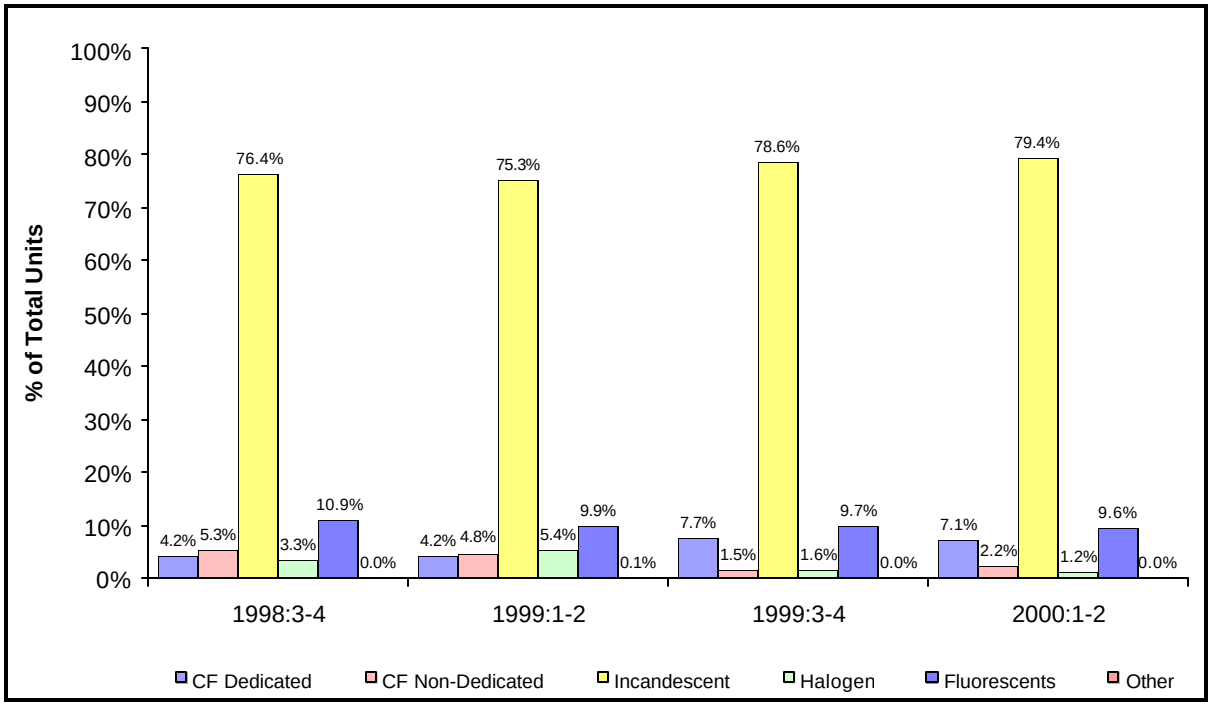


Figure 8-3: Interior Fixtures by Installed Bulb Type by Residence Type – On-Site Data

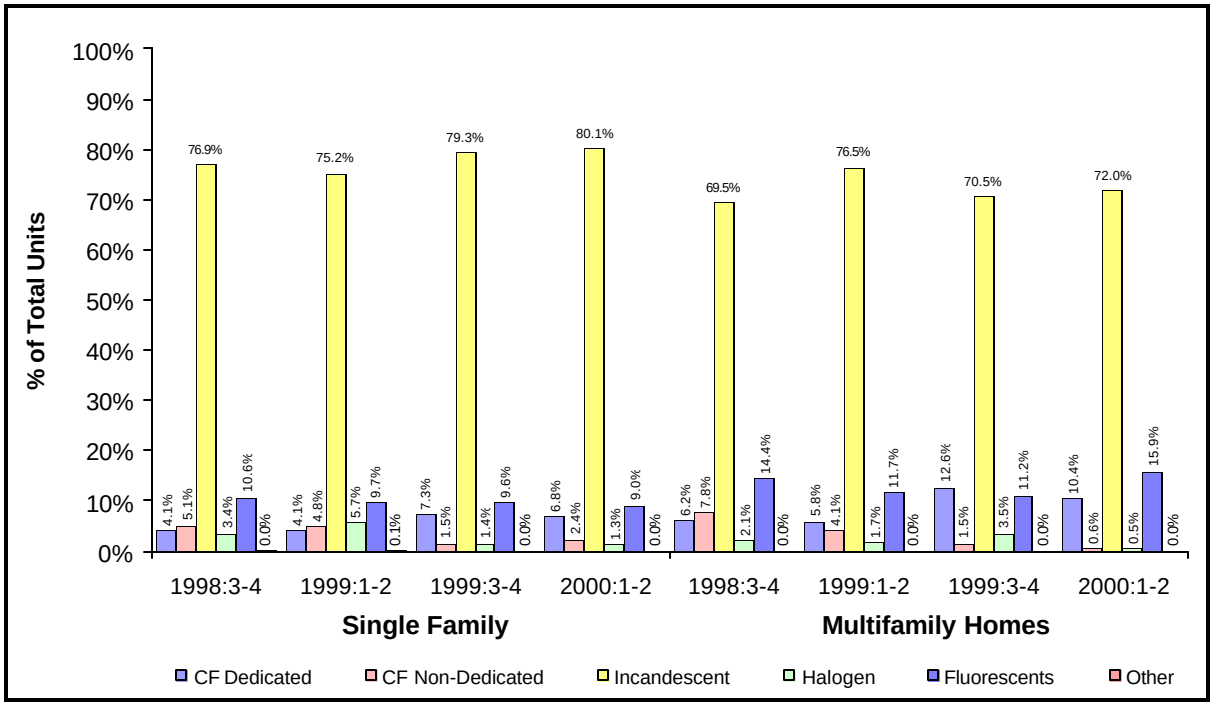


Table 8-2: Number of Interior Fixtures by Installed Bulb Type, Single Family – On-Site Data (1998:3-4 – 1999:1-2)

Location	CF Dedicated	CF Other	Incandescent	Halogen	Fluorescent	Other	Total
Kitchen	0.1	0.2	4.4	0.3	1.5	0.0	6.5
Family/Living	0.0	0.0	2.1	0.2	0.0	0.0	2.3
Bedrooms	0.0	0.1	3.1	0.2	0.0	0.0	3.4
Dining	0.0	0.0	1.0	0.1	0.0	0.0	1.1
Bath	1.0	2.0	3.8	0.1	0.2	0.0	7.1
Halls	0.0	0.1	4.9	0.4	0.0	0.0	5.3
Garage	0.0	0.0	0.6	0.0	0.8	0.0	1.4
Other	0.0	0.0	0.5	0.0	0.2	0.0	0.8
Total	**1.1**	**2.4**	**20.4**	**1.2**	**2.7**	**0.0**	**27.9**

Table 8-3: Number of Interior Fixtures by Installed Bulb Type, Single Family – On-Site Data (1999:3-4 – 2000:1-2)

Location	CF Dedicated	CF Other	Incandescent	Halogen	Fluorescent	Other	Total
Kitchen	0.2	0.4	4.7	0.1	1.6	0.0	7.1
Family/Living	0.0	0.0	2.4	0.1	0.0	0.0	2.6
Bedrooms	0.1	0.1	3.2	0.1	0.1	0.0	3.5
Dining	0.0	0.0	1.4	0.0	0.0	0.0	1.4
Bath	1.7	1.9	4.8	0.0	0.1	0.0	8.6
Halls	0.0	0.1	5.7	0.0	0.0	0.0	5.8
Garage	0.0	0.0	0.4	0.0	0.6	0.0	1.1
Other	0.0	0.0	0.2	0.0	0.0	0.0	0.3
Total	**2.1**	**2.6**	**23.4**	**0.4**	**2.7**	**0.0**	**30.4**

Table 8-4: Interior Fixtures by Installed Bulb Type by Room, Multifamily – On-Site Data (1998:3-4 – 1999:1-2)

Location	CF Dedicated	CF Other	Incandescent	Halogen	Fluorescent	Other	Total
Kitchen	0.1	0.1	1.4	0.0	1.0	0.0	2.6
Family/Living	0.0	0.1	1.0	0.1	0.0	0.0	1.1
Bedrooms	0.0	0.1	1.2	0.0	0.0	0.0	1.4
Dining	0.0	0.0	0.7	0.0	0.0	0.0	0.7
Bath	0.6	1.0	1.8	0.0	0.3	0.0	3.6
Halls	0.0	0.0	1.6	0.1	0.0	0.0	1.7
Garage	0.0	0.0	0.2	0.0	0.1	0.0	0.3
Other	0.0	0.0	0.1	0.0	0.0	0.0	0.1
Total	**0.7**	**1.3**	**8.1**	**0.2**	**1.4**	**0.0**	**11.6**

Table 8-5: Interior Fixtures by Installed Bulb Type by Room, Multifamily – On-Site Data (1999:3-4 – 2000:1-2)

Location	CF Dedicated	CF Other	Incandescent	Halogen	Fluorescent	Other	Total
Kitchen	0.1	0.1	1.3	0.1	1.0	0.0	2.6
Family/Living	0.0	0.0	0.5	0.0	0.0	0.0	0.6
Bedrooms	0.1	0.1	1.2	0.1	0.0	0.0	1.4
Dining	0.0	0.0	0.7	0.0	0.0	0.0	0.7
Bath	1.0	1.1	1.9	0.0	0.4	0.0	4.3
Halls	0.0	0.0	2.1	0.0	0.0	0.0	2.2
Garage	0.0	0.0	0.0	0.0	0.1	0.0	0.1
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	**1.3**	**1.4**	**7.9**	**0.2**	**1.5**	**0.0**	**12.0**

Figure 8-4: Interior Fixtures by Mount Type – On-Site Data

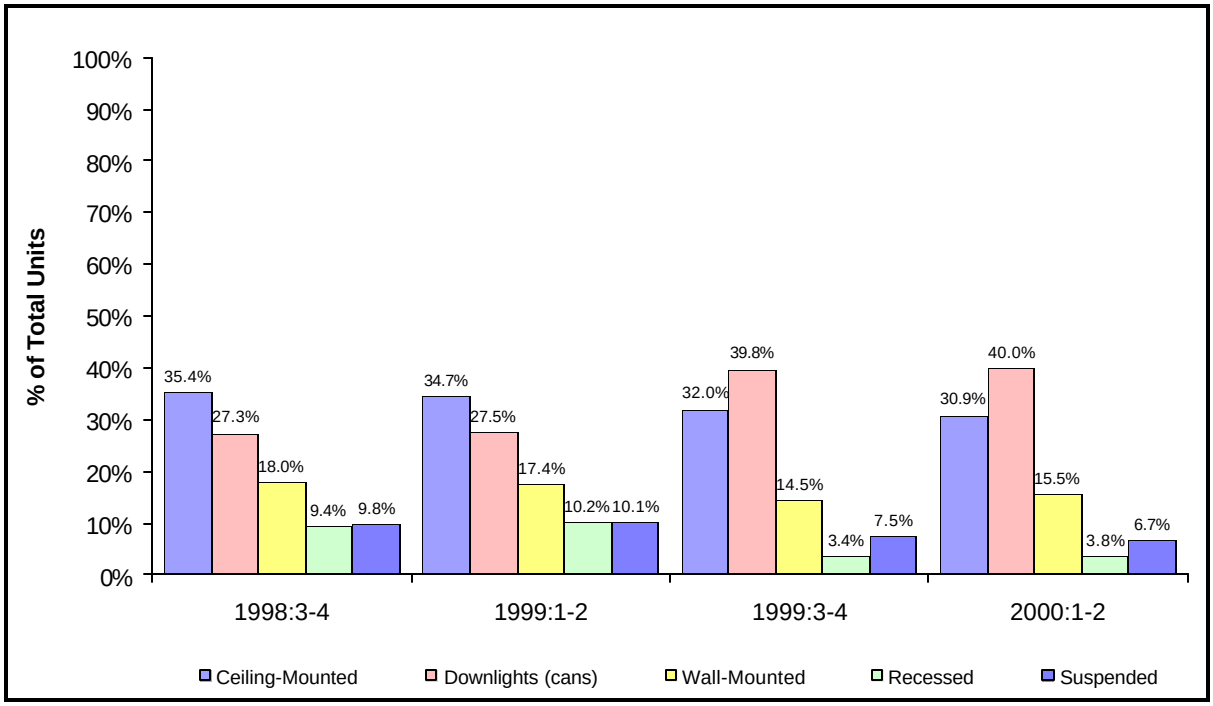


Figure 8-5: Interior Fixtures by Mount Type, Single Family – On-Site Data

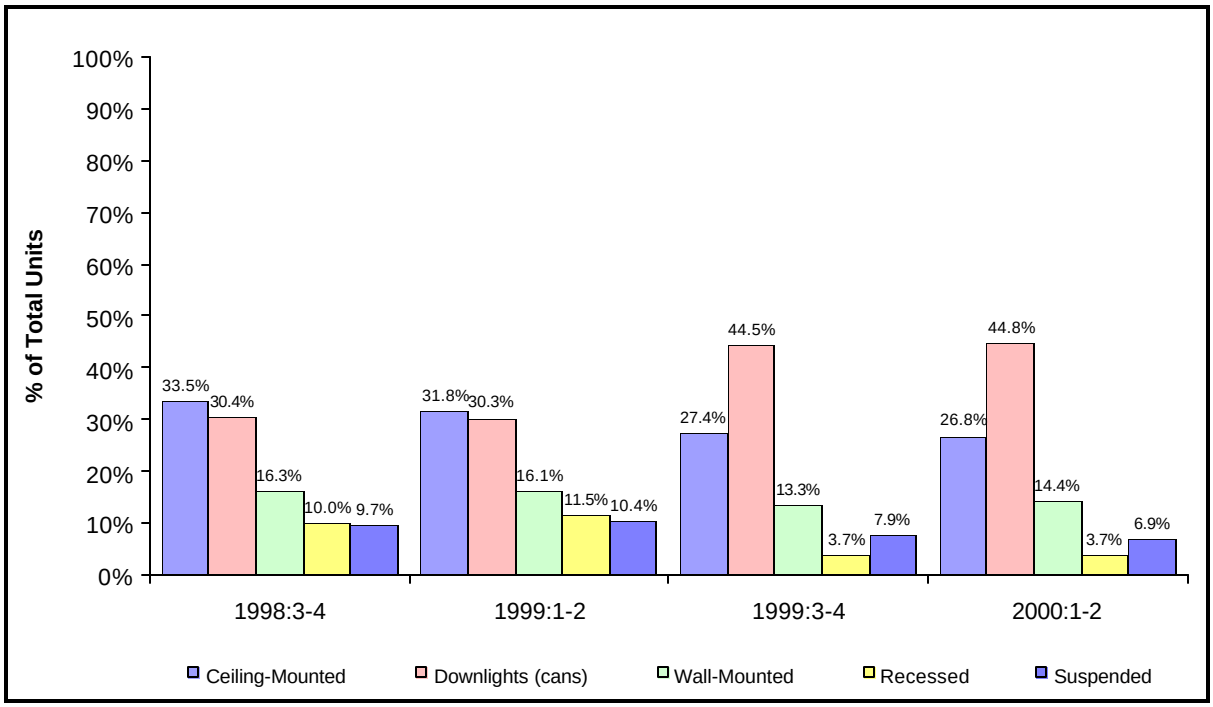
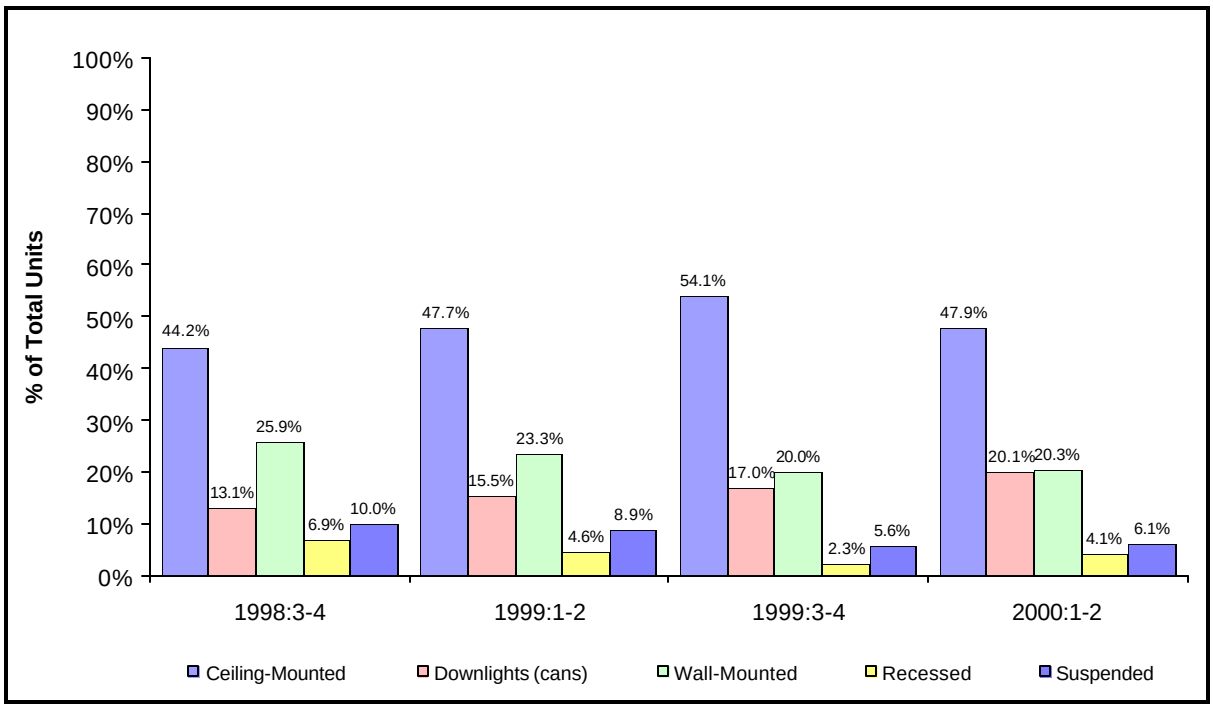


Figure 8-6: Interior Fixtures by Mount Type, Multifamily – On-Site Data



Interior Bulbs

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

The distribution of Type 2 bulbs is shown in Figure 8-9. The share of CF reflectors varies from 7.7% to 11.5% across periods. Figure 8-10 presents similar data for Type 2 bulbs by residence type. As depicted in these figures, multifamily homes have a larger share of CFL reflectors than single family residences.

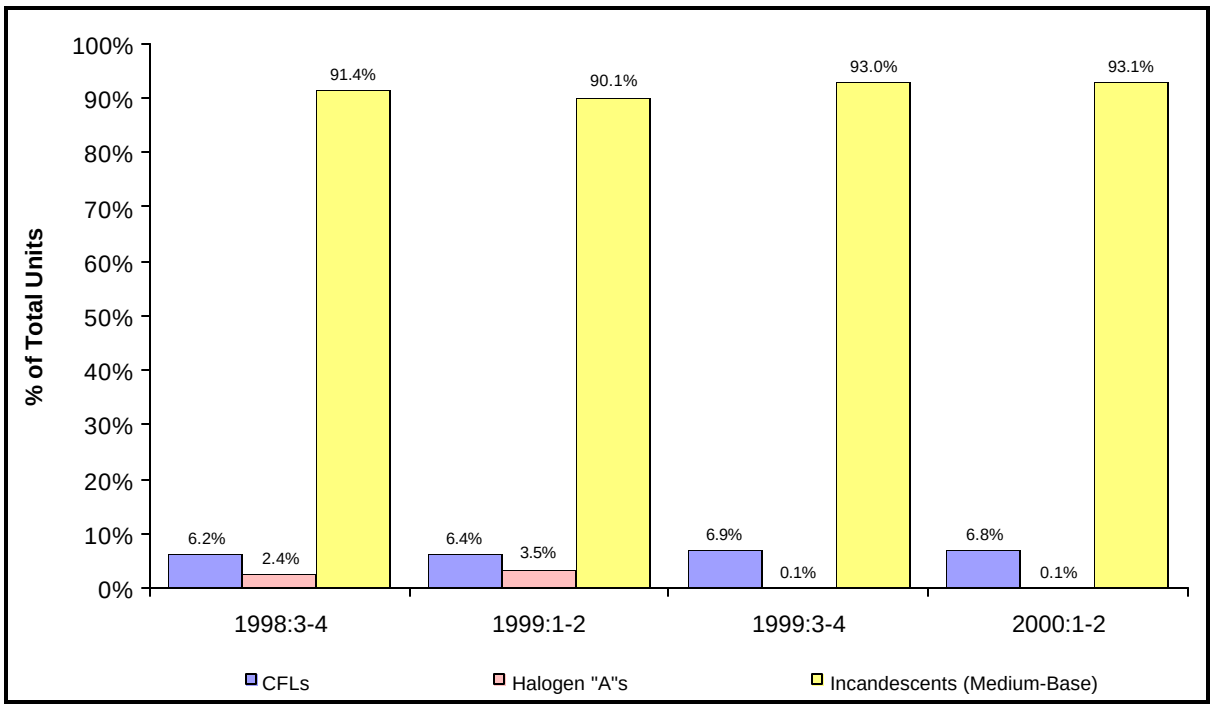
Table 8-7 and Table 8-8 present the average number of Type 1 bulbs by room type for single family and multifamily residences, respectively. Most Type 1 bulbs are found in bathroom areas. CFLs are predominately found in bathroom and kitchen applications. Table 8-9 and Table 8-10 present the average number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

Table 8-6: Average Number of Type 1 and Type 2 Bulbs per Household – On-Site Data

	Multifamily		Single Family	
	Type 1	Type 2	Type 1	Type 2
1998:3-4	16.5	1.9	34.8	5.7
1999:1-2	15.1	2.6	34.5	6.1
1999:3-4	12.9	2.9	26.9	13.0
2000:1-2	12.7	4.2	28.0	13.9

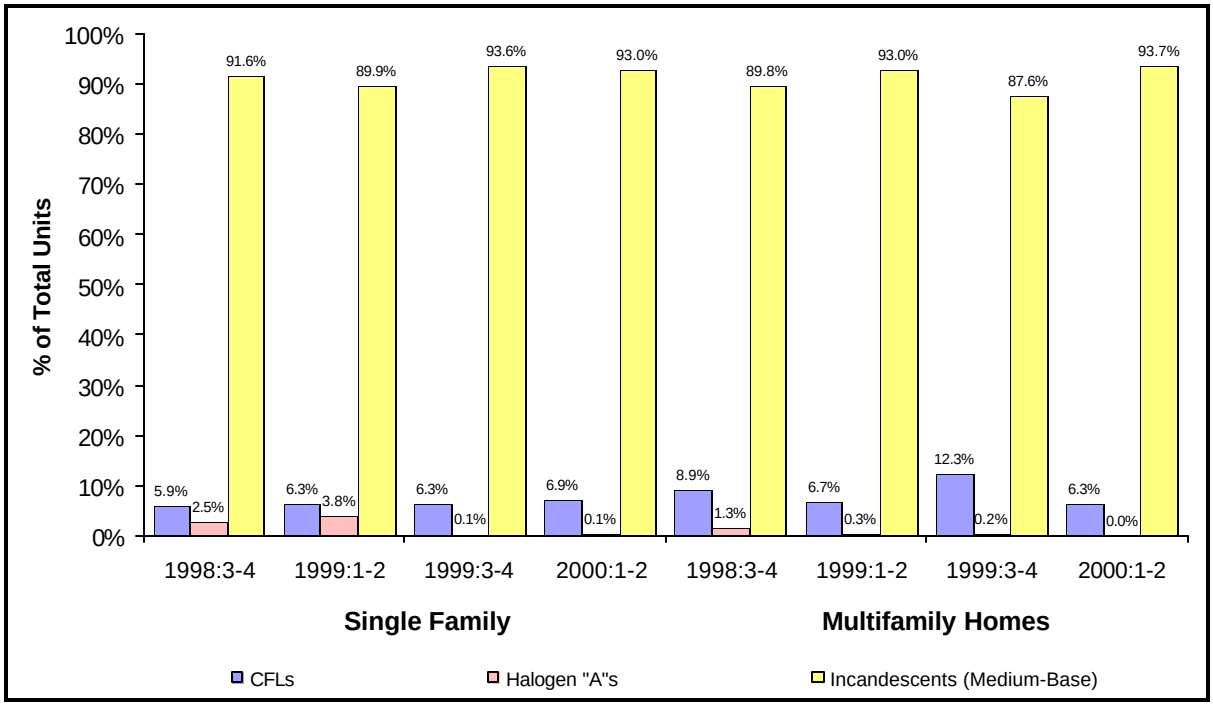
Type 1 bulbs are CFLs or are interchangeable with medium-based CFLs.
Type 2 bulbs are CF reflectors or are interchangeable with incandescent or halogen PAR/Reflector bulbs.

Figure 8-7: Distribution of Type 1 Bulbs – On-Site Data



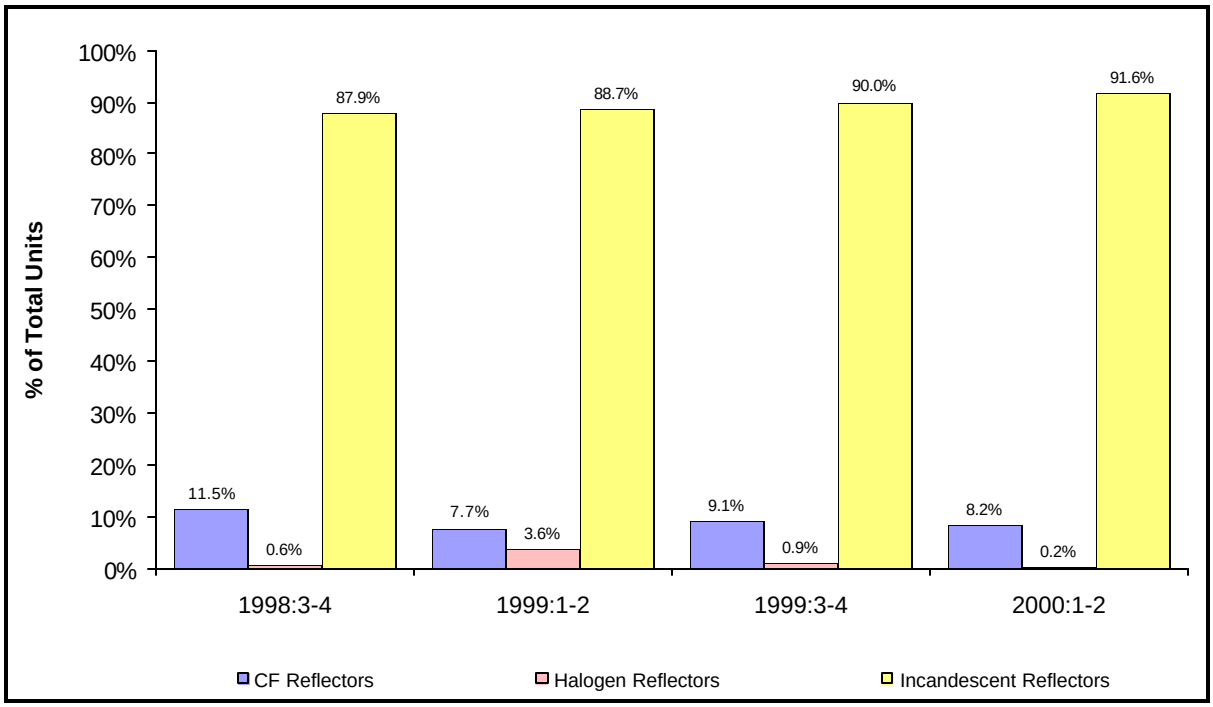
Type 1 bulbs are CFLs or are interchangeable with medium-based CFLs.

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



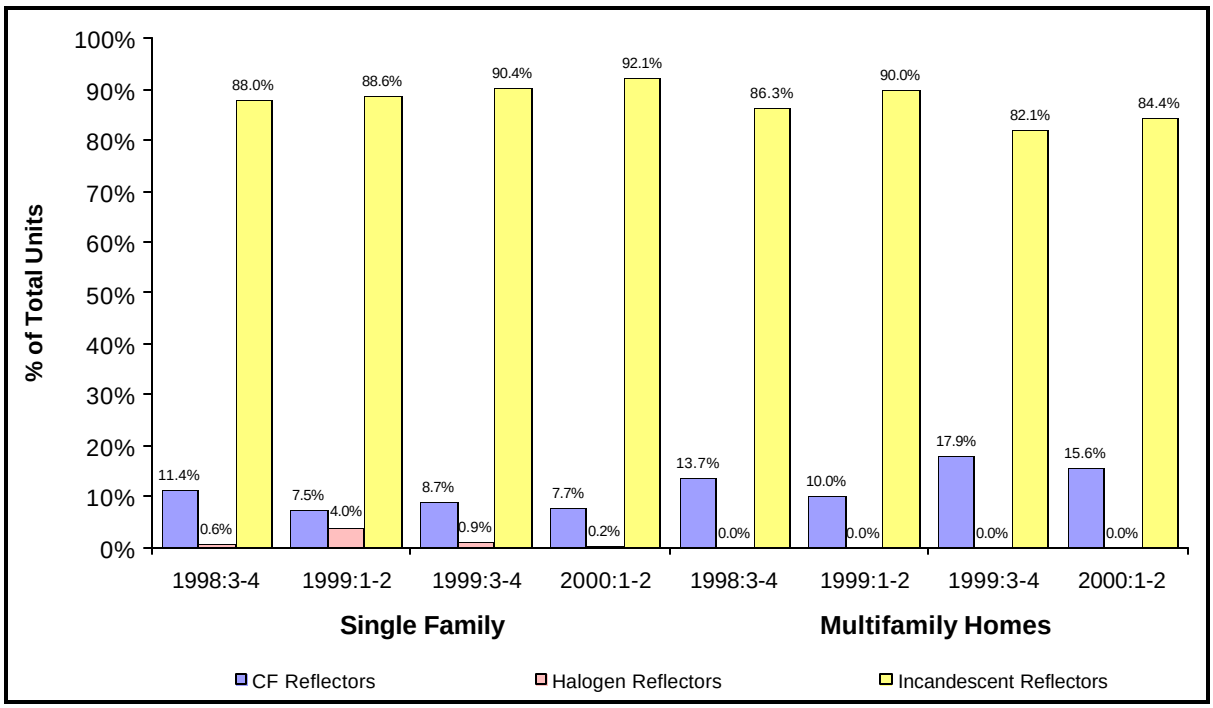
Type 1 bulbs are CFLs or are interchangeable with medium-based CFLs.

Figure 8-9: Distribution of Type 2 Bulbs – On-Site Data



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

Figure 8-10: Distribution of Type 2 Bulbs by Residence Type – On-Site Data



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

Table 8-7: Average Number of Type 1, Single Family – On-Site Data (1999:3-4 – 2000:1-2)

Location	CFLs	Halogen	Incandescent	Total
Kitchen	0.3	0.0	1.7	2.0
Family/Living	0.0	0.0	1.2	1.3
Bedrooms	0.1	0.0	2.8	2.9
Dining	0.0	0.0	1.5	1.6
Bath	1.2	0.0	14.7	16.0
Halls	0.1	0.0	2.4	2.4
Garage	0.0	0.0	0.4	0.5
Other	0.0	0.0	0.2	0.2
Total	**1.8**	**0.0**	**25.5**	**26.7**

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

Table 8-8: Average Number of Type 1 Bulbs, Multifamily – On-Site Data (1999:3-4 – 2000:1-2)

Location	CF Reflector	Halogen	Incandescent	Total
Kitchen	0.1	0.0	0.6	0.7
Family/Living	0.1	0.0	0.3	0.4
Bedrooms	0.1	0.0	1.3	1.4
Dining	0.0	0.0	0.8	0.8
Bath	0.8	0.0	7.0	7.8
Halls	0.0	0.0	1.3	1.3
Garage	0.0	0.0	0.0	0.0
Other	0.0	0.0	0.0	0.0
Total	**1.2**	**0.0**	**11.6**	**12.6**

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

Table 8-9: Average Number of Type 2, Single Family – On-Site Data (1999:3-4 – 2000:1-2)

Location	CFLs	Halogen	Incandescent	Total
Kitchen	0.2	0.0	3.2	3.4
Family/Living	0.0	0.0	1.6	1.6
Bedrooms	0.0	0.0	1.5	1.6
Dining	0.0	0.0	0.4	0.4
Bath	0.8	0.0	1.2	2.0
Halls	0.0	0.0	4.0	4.0
Garage	0.0	0.0	0.0	0.1
Other	0.0	0.0	0.1	0.1
Total	**1.1**	**0.1**	**12.2**	**13.2**

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

Table 8-10: Average Number of Type 2 Bulbs, Multifamily – On-Site Data (1999:3-4 – 2000:1-2)

Location	CF Reflector	Halogen	Incandescent	Total
Kitchen	0.0	0.0	0.8	0.8
Family/Living	0.0	0.0	0.2	0.2
Bedrooms	0.0	0.0	0.2	0.3
Dining	0.0	0.0	0.4	0.4
Bath	0.5	0.0	0.3	0.8
Halls	0.0	0.0	1.0	1.0
Garage	0.0	0.0	0.0	0.0
Other	0.0	0.0	0.0	0.0
Total	**0.6**	**0.0**	**3.0**	**3.5**

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

Torchieres and Floor/Table Lamps

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

Table 8-11 presents the saturation of torchieres (the percent of homes with at least one) and the average number of torchieres in homes that have at least one torchiere. The saturation and number per household for floor/table lamps is shown in Table 8-12.

Table 8-11: Saturations and Average Number of Torchieres per Household – On-Site Data

	Multifamily		Single Family	
	Saturation	Average Number/Home*	Saturation	Average Number/Home*
1998:3-4	35.3%	1.6	34.2%	1.7
1999:1-2	34.3%	1.3	36.6%	1.7
1999:3-4	32.6%	1.4	36.3%	1.9
2000:1-2	23.9%	1.6	27.4%	2.0

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

Table 8-12: Saturation and Average Number of Floor/Table Lamps per Household – On-Site Data

	Multifamily		Single Family	
	Saturation	Average Number/Home*	Saturation	Average Number/Home*
1998:3-4	83.3%	3.1	88.8%	5.4
1999:1-2	76.9%	3.1	89.3%	4.7
1999:3-4	81.2%	3.4	93.9%	6.0
2000:1-2	91.4%	3.7	91.6%	5.9

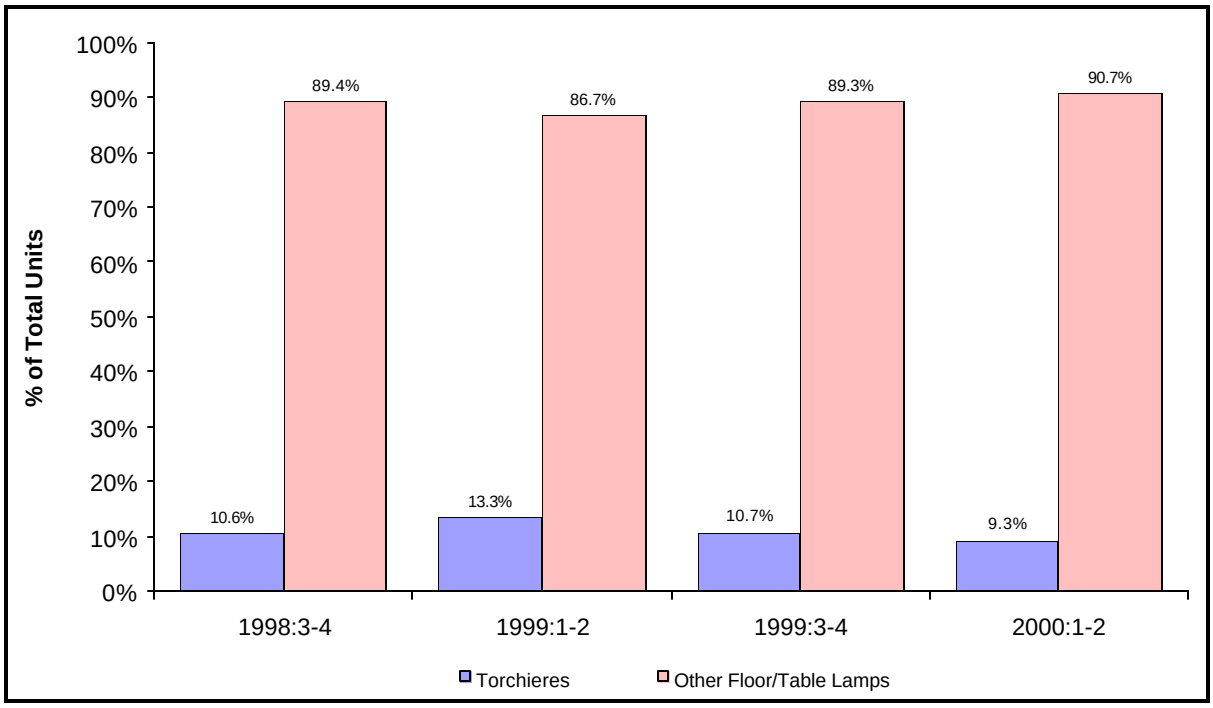
* Average number per home is average number per home with at least one floor/table lamp.

Figure 8-11 depicts the relative shares of torchieres and floor/table lamps by six-month period.[1] These data suggest that, from the perspective of all floor/table lamps and torchieres combined, torchieres represent from about 9% to 13% of all floor/table lamps.

[1] Note that we have included the time element of the analysis. However, it could be argued that torchieres and floor/table lamps could be purchased at any time since the construction of the home. As such, these

The distribution of torchieres by bulb type is shown in Figure 8-12. As shown, halogen-type torchieres constitute the vast majority of torchieres with a share of about 70% to 55% of the lamps. CFLs have a relatively small share ranging from under 2% to nearly 5%. Figure 8-13 presents the same data by residence type. The distribution of floor/table lamps by bulb type is illustrated in Figure 8-14. As shown, incandescent-type lamps have an overwhelming share at more than 92 % of all floor/table lamps.

Figure 8-11: Relative Shares of Torchieres and Floor/Table Lamps – On-Site Data



data are less useful as a tracking source, and instead provide a snapshot of torchiere and floor/table lamp stocks as of late 1999.

Figure 8-12: Distribution of Torchieres by Bulb Type – On-Site Data

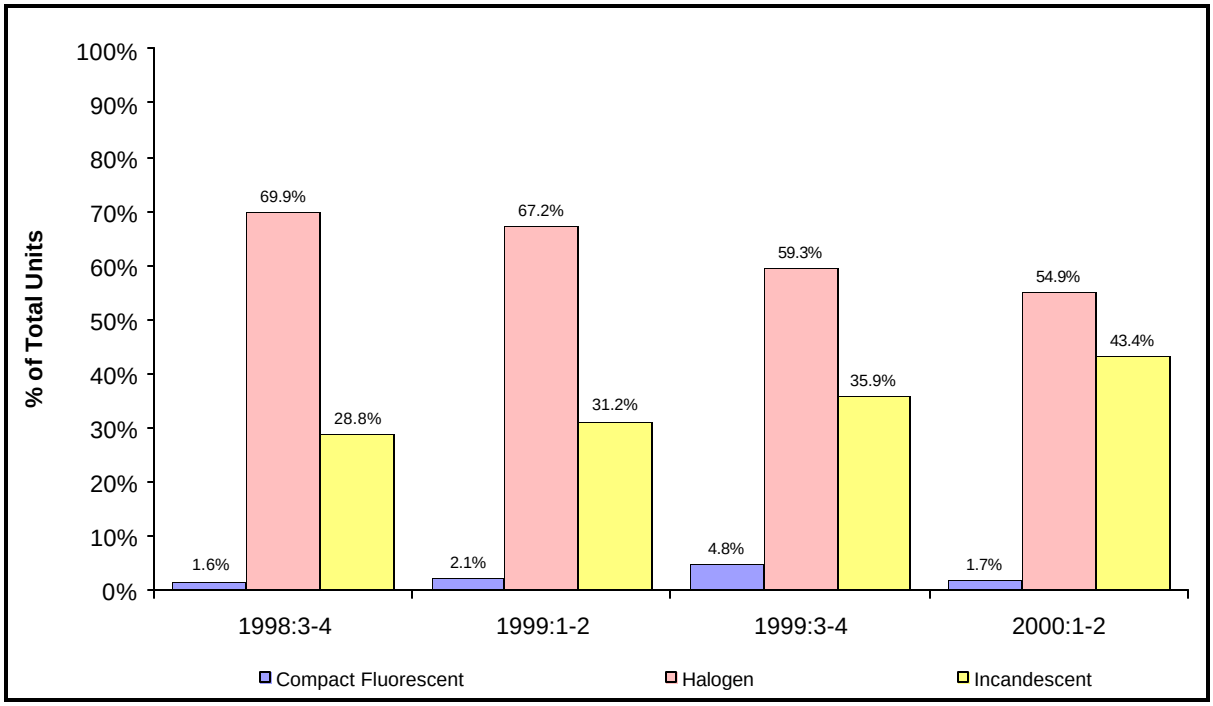


Figure 8-13: Distribution of Torchieres by Bulb Type and by Housing Type – On-Site Data

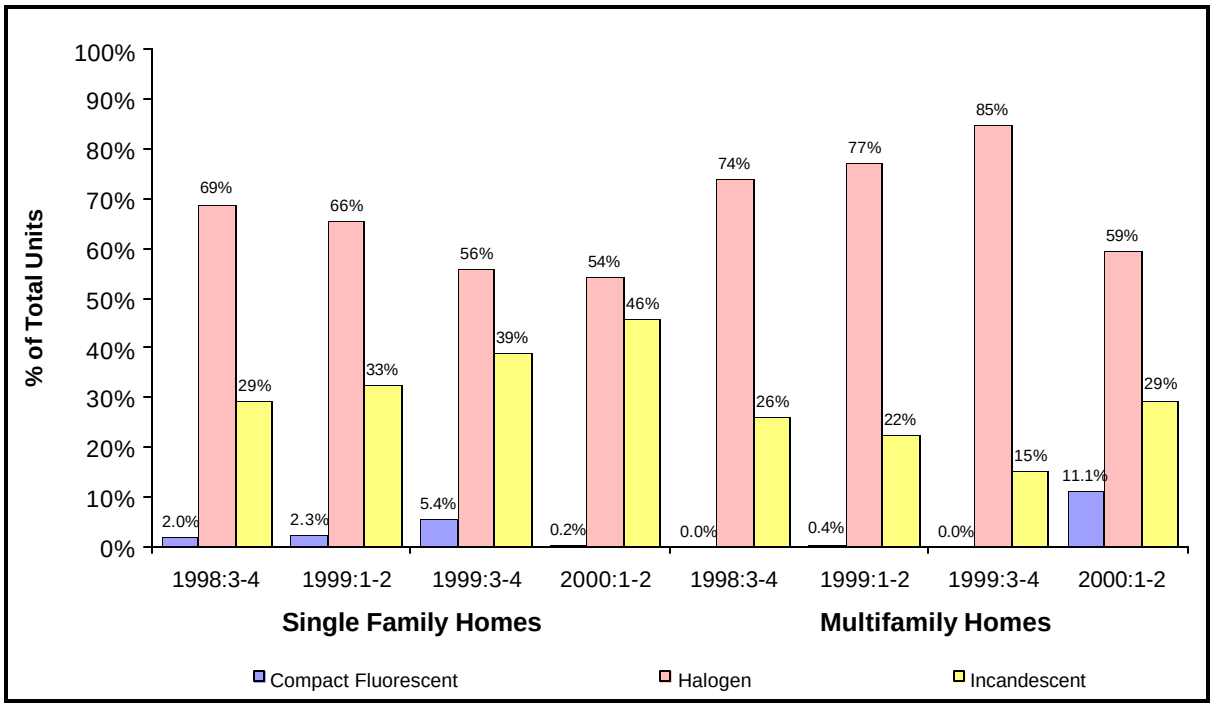
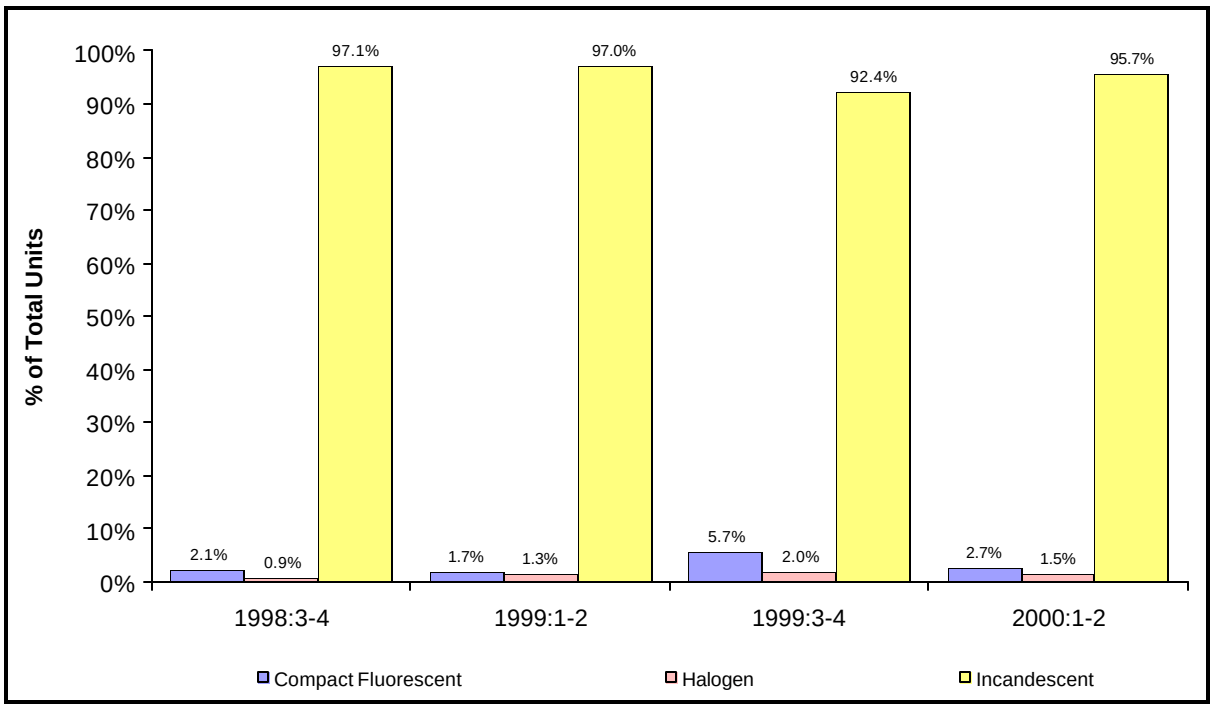


Figure 8-14: Distribution of Floor/Table Lamps by Bulb Type – On-Site Data



8.4 Exterior Lighting

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

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

Exterior Fixtures

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

Table 8-13 presents the average number of exterior fixtures per household. In the case of multifamily homes, this might be misleading as it pertains only to lighting controlled by an individual unit. That is, these averages do not include common area lighting.

Figure 8-15 presents the distribution of exterior fixtures by bulb type. As shown, the majority of exterior fixtures are incandescent, comprising over 90% of fixtures. The results by mount type are depicted in Figure 8-16. Figure 8-17 and Figure 8-18 present the same results for single family and multifamily residences, respectively. Figure 8-19 presents the distribution of exterior fixtures by control type. As expected, switches account for the majority of applications.

Table 8-13: Average Number of Exterior Fixtures per Household – On-Site Data

	Multifamily	Single Family
1998:3-4	1.8	4.8
1999:1-2	1.8	4.5
1999:3-4	1.7	5.3
2000:1-2	1.8	5.5

Figure 8-15: Distribution of Exterior Fixtures by Bulb Type – On-Site Data

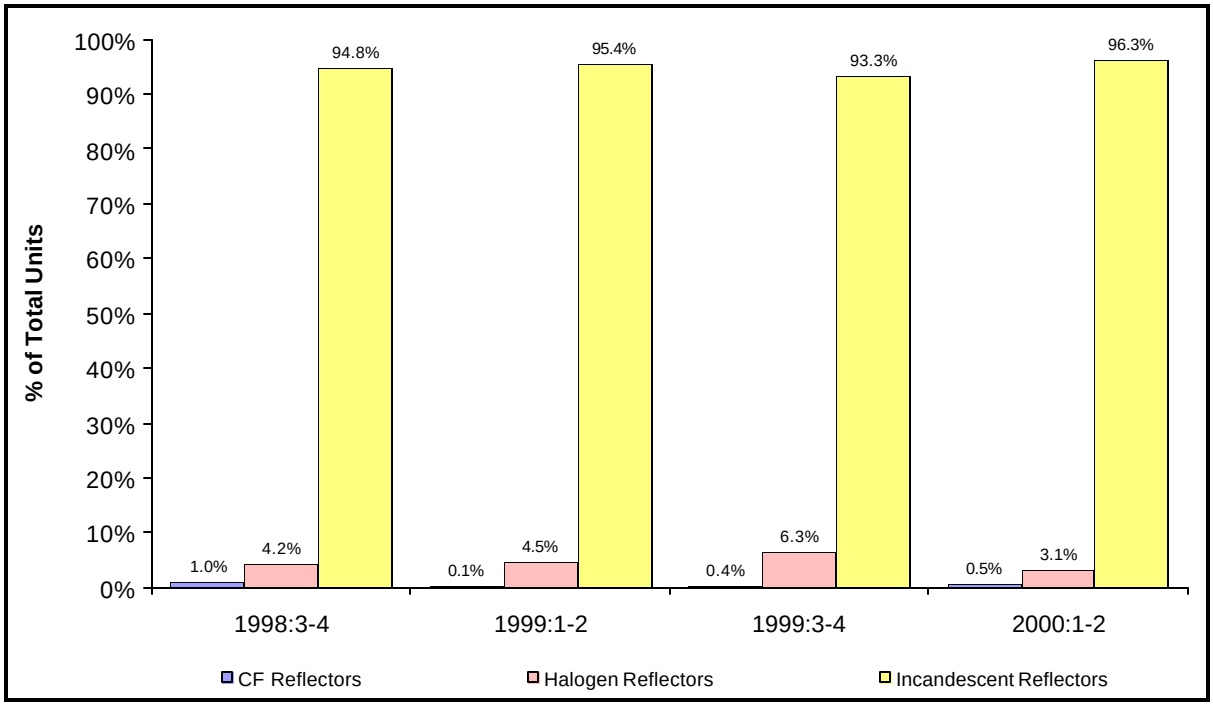


Figure 8-16: Distribution of Exterior Fixtures by Mounted Type – On-Site Data

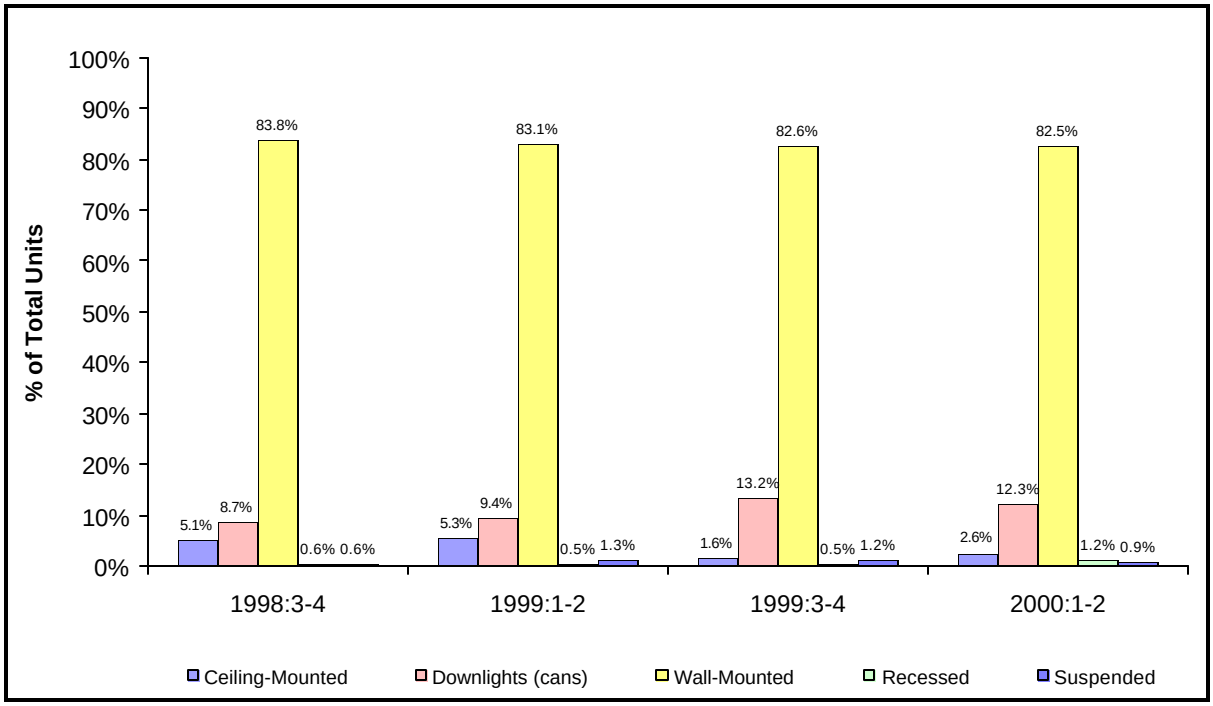


Figure 8-17: Exterior Fixtures by Mounted Type, Single Family – On-Site Data

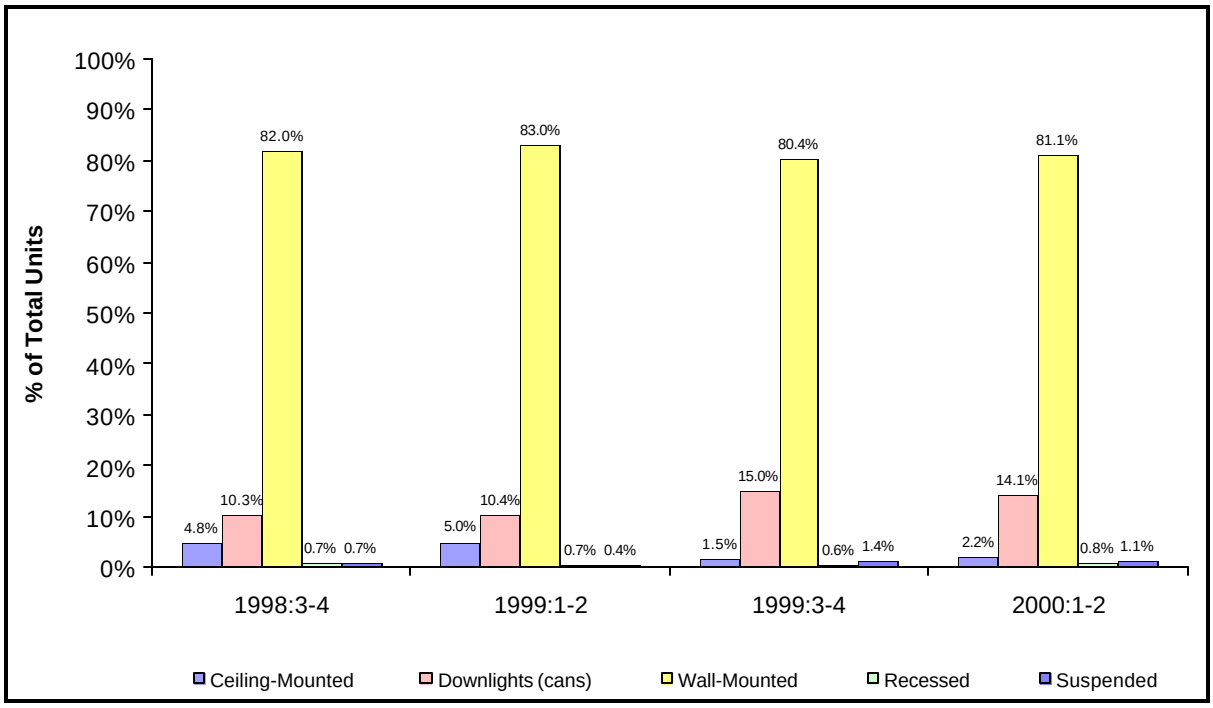


Figure 8-18: Exterior Fixtures by Mounted Type, Multifamily – On-Site Data

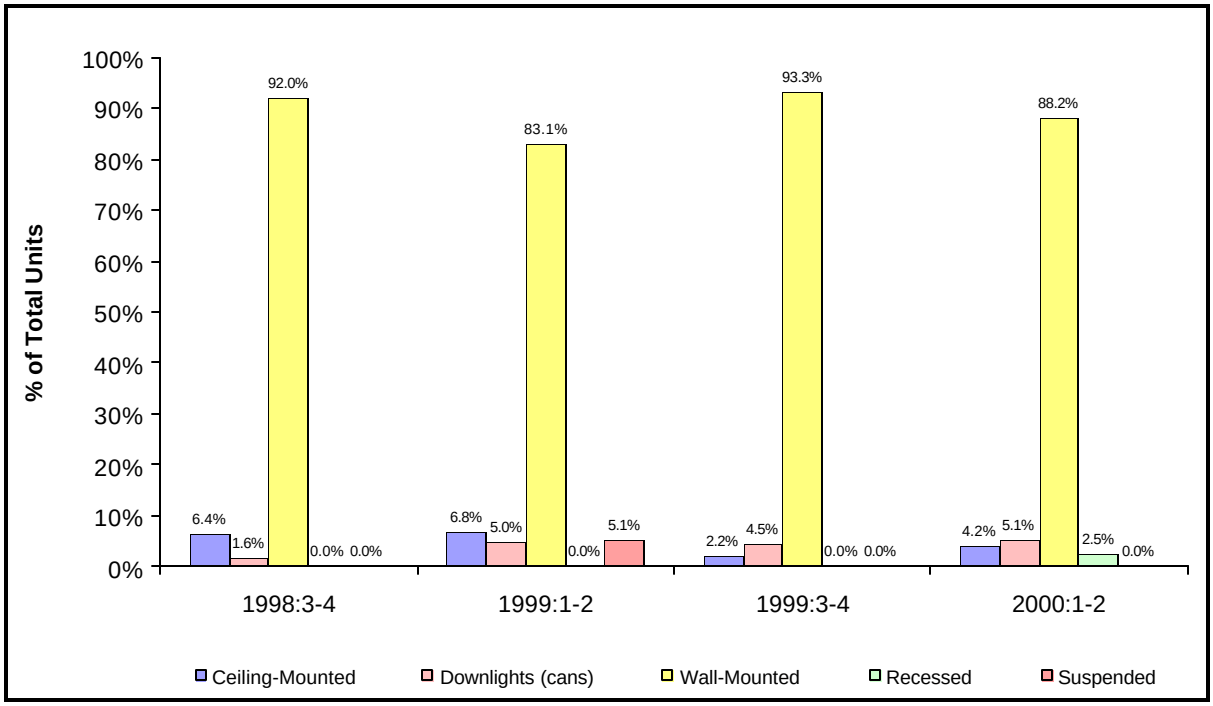
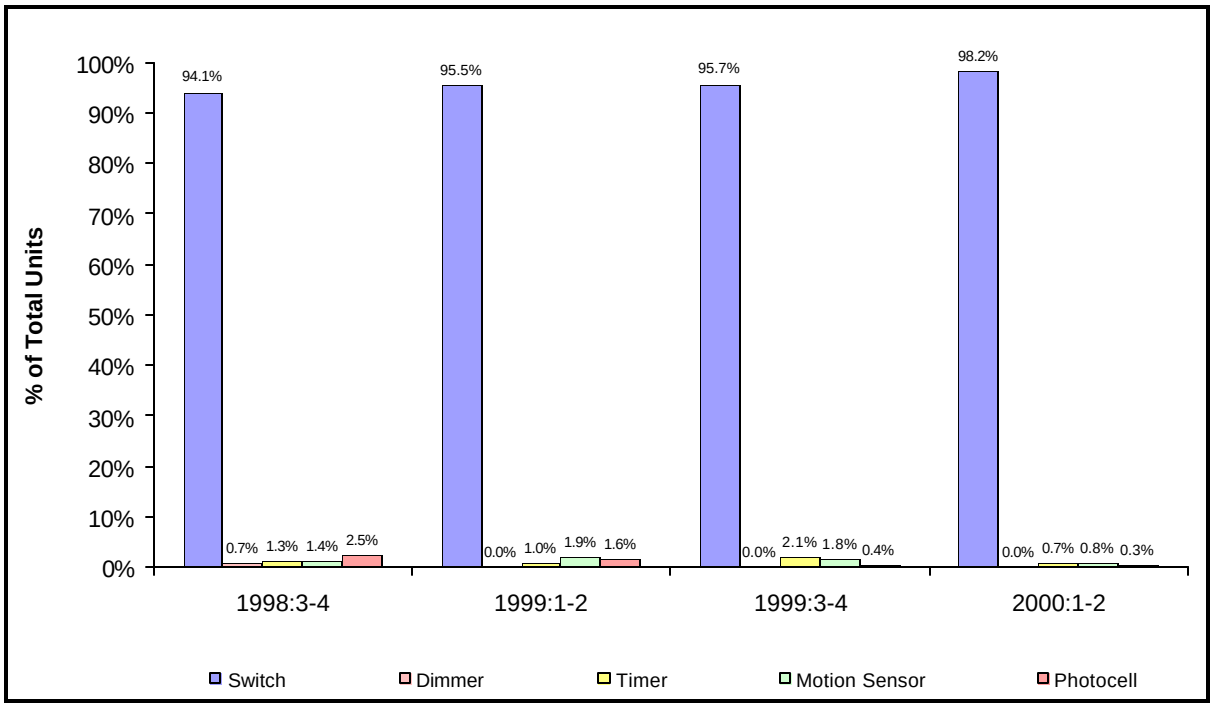


Figure 8-19: Distribution of Exterior Fixtures by Control Type – On-Site Data



Exterior Bulbs

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

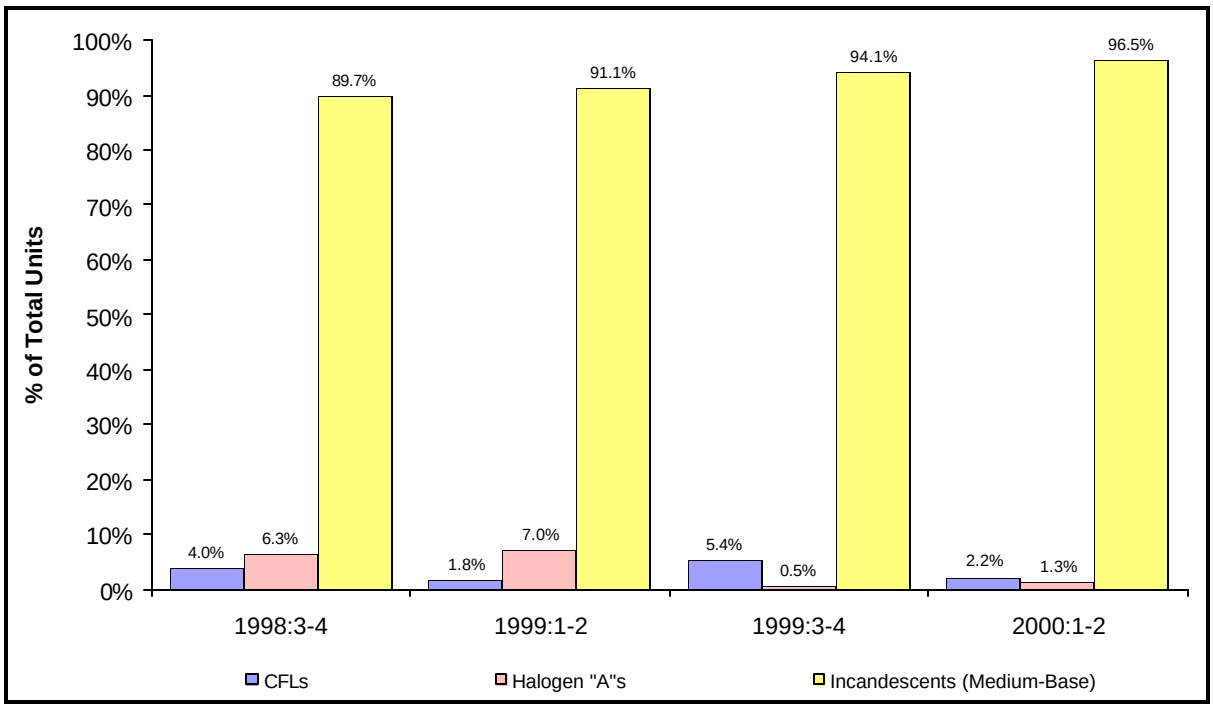
- ***Type 1:*** This includes the following interchangeable types of bulbs:
  - Incandescent (Medium Base),
  - CFLs, and
  - Halogen "A"s.
- ***Type 2:*** This includes the following interchangeable types of bulbs:
  - Incandescent PAR/Reflectors,
  - CF Reflectors, and
  - Halogen PAR/Reflectors.

Table 8-14 presents the average number of Type 1 and Type 2 bulbs per household by residence type. Figure 8-20 presents the distribution of Type 1 bulbs by six-month period. As expected, incandescent bulbs represent the majority of exterior of bulbs within each period. CFLs represent a share of roughly 2% to 5%. Figure 8-21 presents the distribution of Type 2 bulbs by six-month period. As shown, the share of CF reflectors never exceeds 1%.

Table 8-14: Average Number of Type 1 Exterior Bulbs per Household – On-Site Data

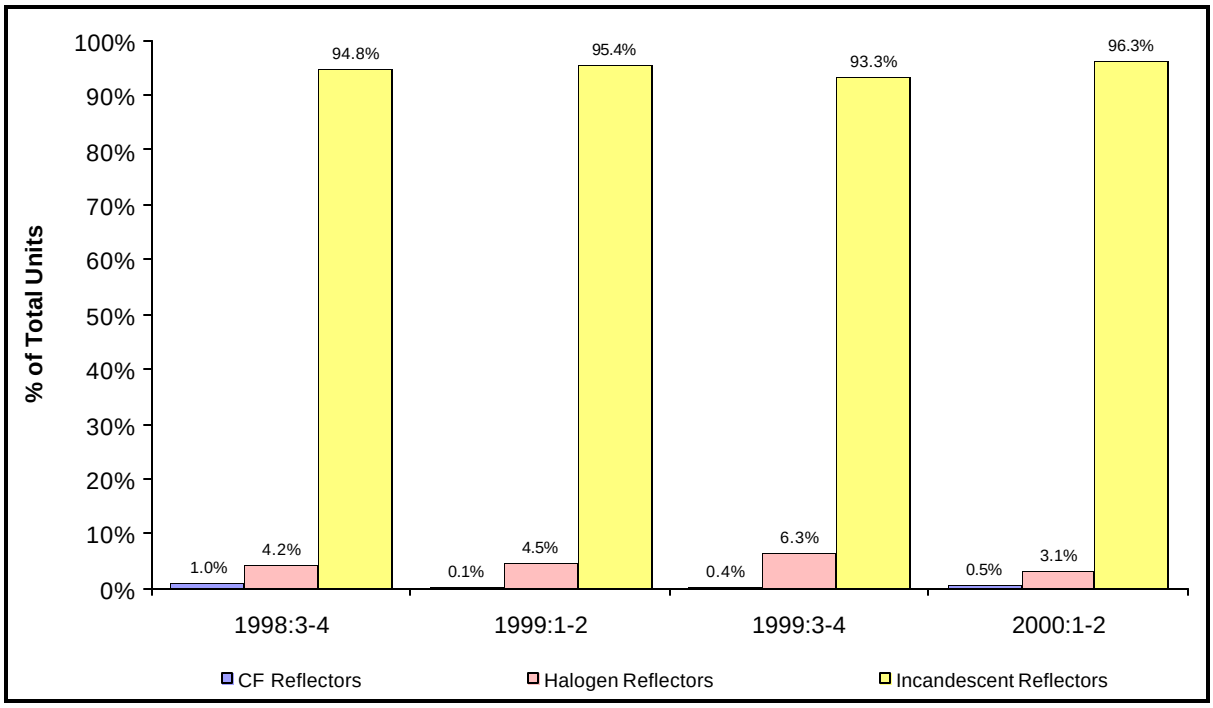
	Multifamily		Single Family	
	Type 1	**Type 2**	**Type 1**	**Type 2**
1998:3-4	1.8	0.0	4.0	0.3
1999:1-2	1.8	0.0	4.0	0.3
1999:3-4	1.4	0.2	3.6	1.2
2000:1-2	1.4	0.2	3.6	0.9

Figure 8-20: Distribution of Type 1 Exterior Bulbs – On-Site Data



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

Figure 8-21: Distribution of Type 2 Exterior Bulbs – On-Site Data



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

8.5 Lighting Connected Loads

The original scope of the RMST project did not include reviewing the issue of connected lighting load. However, some experts in the lighting industry have shown interest in this subject. Therefore, we present the following connected load analysis as an indication of baseline connected load in new construction.

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

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

Results. Table 8-14 presents the average interior and exterior connected load per household by residence type. Figure 8-22 and Figure 8-23 show the average distribution of the interior lighting connected load by room for single family and multifamily households, respectively.

Table 8-15: Average Total Connected Load (Watts) by Residence Type – On-Site Data

	Multifamily		Single Family	
	Interior	**Exterior**	**Interior**	**Exterior**
1998:3-4	1,395	108	2,928	332
1999:1-2	1,281	120	2,846	326
1999:3-4	1,288	97	3,304	361
2000:1-2	1,383	100	3,350	391

Figure 8-22: Distribution of Average Interior Connected Load, Single Family – On-Site Data (1999:3-4 – 2000:1-2)

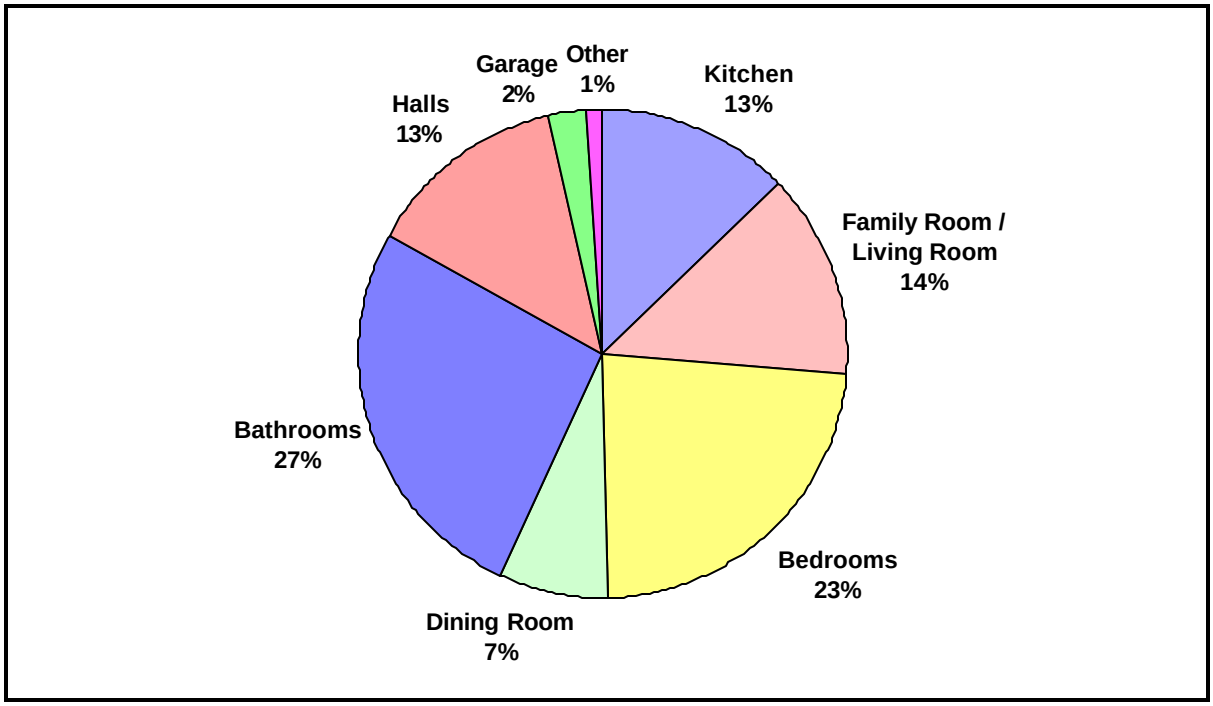
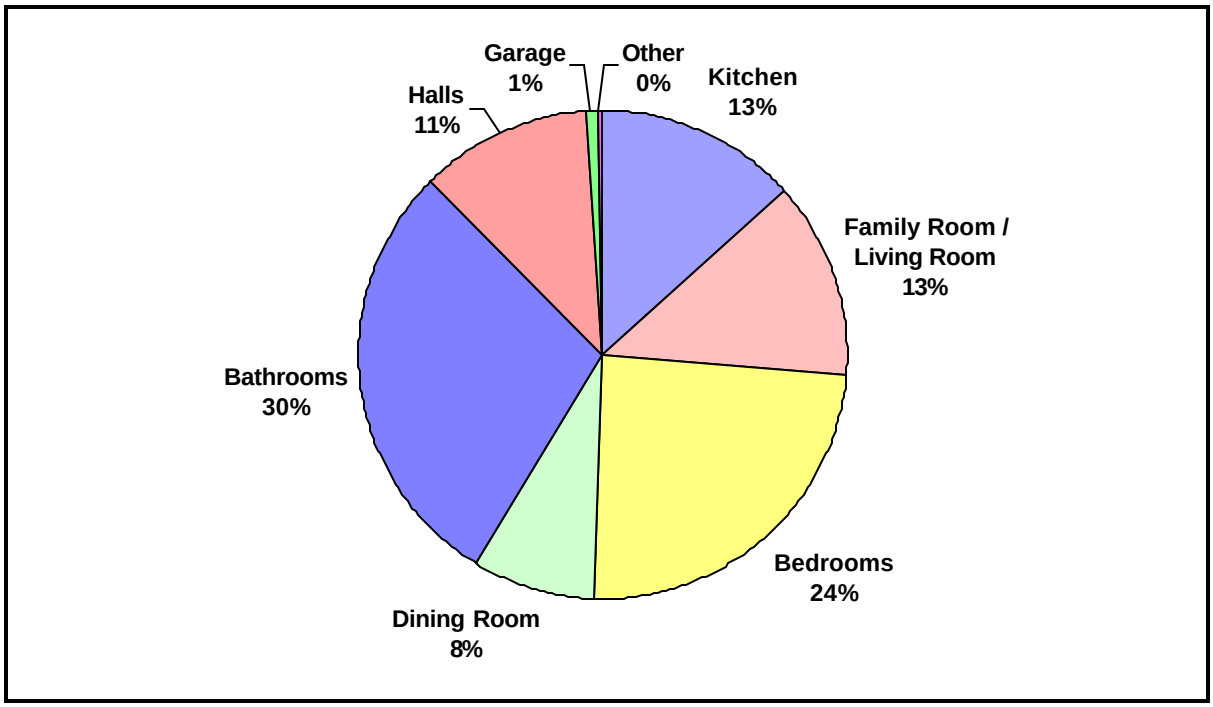


Figure 8-23: Distribution of Average Interior Connected Load, Multifamily – On-Site Data (1999:3-4 – 2000:1-2)



8.6 Ceiling Fans

As mentioned in Section 2.2, the survey form used for the second round of on-site visits was changed to include more detailed information on ceiling fans installed in new homes. Information was collected for fans with and without lights. Detailed information for those fans with lights included: location, number of lamps per fan, the wattage of each lamp, and the type of lamp. The only information collected for those fans without lights was the number of fans in the house. This section provides a brief overview of the saturation of ceiling fans in new homes and the types of bulbs used those ceiling fans with lights.

As shown in Table 8-16, nearly 71% of single family homes have at least one fan, while 58% have at least one fan that has light fixtures. Similarly, 28% of multifamily homes have at least one fan that has light fixtures. Table 8-17 shows the distribution of the average number of fans with lights per house by room as well as the average number of fans without lights per house. Note that the averages shown are the averages per home with at least one fan – by type. Table 8-18 presents the average number of fans by bulb type. As shown, nearly all of the fans installed use incandescent bulbs.

Table 8-16: Saturation of Homes with At Least One Ceiling Fan

	With Lights	W/Out Lights	Either
Multifamily	28.0%	12.1%	37.2%
Single Family	58.0%	18.1%	70.9%

Table 8-17: Average Number of Ceiling Fans by Building Type and Room (of those homes with at least one ceiling fan)

	Multifamily		Single Family	
Room	**With Lights**	**W/Out Lights**	**With Lights**	**W/Out Lights**
Family/Living Room	0.4	n/a	0.8	n/a
Bed Rooms	1.1	n/a	1.9	n/a
Dining Room	0.3	n/a	0.1	n/a
Kitchen	0.1	n/a	0.1	n/a
Other	0.0	n/a	0.1	n/a
Entire House	**1.9**	**1.4**	**3.0**	**2.8**

Table 8-18: Average Number of Ceiling Fans by Bulb Type and Building Type (of those homes with at least one ceiling fan)

Bulb Type	Multifamily	Single Family
Incandescents	1.88	2.93
Compact Fluorescents	0.00	0.01
Fluorescents	0.00	0.00
Halogens	0.00	0.01
Total	**1.88**	**2.96**

Appendix A

Acknowledgements

The development and success of the RMST project would not have been possible without the generous assistance of many professionals in the energy efficiency community as well as those in the private sector that have provided proprietary data for this effort.

To protect the confidentiality of those in the private sector that have provided data, RER cannot thank each company by name here. We can only hope that we have aptly expressed our appreciation and can provide them information equally as valuable as the data they have provided for the RMST project.

We would also like to thank a number of individuals, companies, and organizations for their guidance, input, and willingness to work with RER staff in developing the RMST project. As project managers, Rich Pulliam (SCE) and Rick Ridge (Ridge & Associates) provided unlimited guidance and support. RER was joined by three subcontractors whose hard work and diligence is greatly appreciated. Specifically, Volt VIEWtech conducted the residential new construction on-site surveys, Skumatz Economic Research Associates led the water heater distributor data collection effort, and Rick Winch's (Opinion Dynamics Corporation) invaluable insight and experience helped us develop the distributor data collection strategy.

In no specific order, we would also like to extend our sincere appreciation to D&R International, the Electric & Gas Industries Association, the California Residential Lighting and Appliance Program team (Richard Heath & Associates and Ecos Consulting), Linda Latham, Chris Calwell, Bill Daiber (SDG&E), Al Harwick (PG&E), Marian Brown (SCE), Mary O'Drain (PG&E), and Valerie Richardson (PG&E).

Appendix B

New Construction On-Site Survey

Site ID #

Residential New Construction
Market Share Tracking Project
On-Site Survey Form

Regional Economic Research, Inc. and Volt VIEWtech

Version: 11/17/1999

Contact Information:

Contact Name:			
Street Address:			
City:			
Zip Code:			
Phone Number:	**( )**		
County:		CEC Climate Zone #:	

Photo Information

Disposable Camera ID #		# of photos	

Survey Tracking Information:

	Date:	**Performed by, Initials**
Field Survey Performed:	__ / __ / __	__ __ __
Quality Control Check:	__ / __ / __	__ __ __
Data Entry Complete:	__ / __ / __	__ __ __
Duct Blaster test site?	☐	
Survey and Data Received by RER:	__ / __ / __	__ __ __

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Energy Utility Meters & Accounts

Is customer responsible for the utility bills? ☐ Yes ☐ No

If Yes, is the customer aware of electric industry deregulation and the option to switch providers? ☐ Yes ☐ No

-- If Yes, has the customer changed energy providers? ☐ Yes ☐ No

Item #	Service Type*	Utility	Meter Number (Enter –7 if can't read it)	Account Number
1	**E G O**	**SDG&E SCE SCG PG&E OT**		
2	**E G O**	**SDG&E SCE SCG PG&E OT**		
3	**E G O**	**SDG&E SCE SCG PG&E OT**		
4	**E G O**	**SDG&E SCE SCG PG&E OT**		
5	**E G O**	**SDG&E SCE SCG PG&E OT**		
6	**E G O**	**SDG&E SCE SCG PG&E OT**		

*Description for Other (**O**) Service Type: _____

Comments

General Site Information

Type of residence: (CHECK ONLY ONE. If **MF** indicated, complete pages 18 and 19)

- **SF** ☐ Detached, tract-built single family house
- **SF** ☐ Detached, custom-built single family house
- **MF** ☐ Attached home, Townhome/Condo
- **MF** ☐ Apartment in small complex (fewer than 5 units)
- **MF** ☐ Apartment in large complex (5+ units)
- **SF** ☐ Manufactured housing
- **SF** ☐ Mobile home/trailer
- **MF** ☐ Other, describe _____

Does the occupant own or rent this residence? ☐ Own ☐ Rent

If owned, is the occupant a first-time homebuyer? ☐ Yes ☐ No

How many stories tall is the residence (including basement)? ___ ☐ Split foyer ☐ Split level

What is the total conditioned floor area of the residence (other than garage, basement, and porch)? _____

How many bedrooms/bathrooms does the residence have? _____ / _____

Are any of the following areas used as conditioned living space? (ENTER FLOOR AREA FOR ALL THAT APPLY)

_____ Garage (ft^2) _____ Porch (ft^2

_____ Basement (ft^2) _____ Other (ft^2)

HOMEOWNERS ONLY: Any Title 24 documents present in homeowner's information packet? ☐ Yes ☐ No
(If so, note below what forms were found)

What was the purchase price of the home?

Actual price $_____

OR ☐ Declined to state

OR ☐ Under $100,000
☐ $100,000 - $200,000
☐ $200,000 - $300,000
☐ $300,000 - $400,000
☐ over $400,000

Builder/Development Information

Builder's Name:	
Development/Complex Name:	
Month/Year the home was occupied by current resident:	
Month/Year the home was built:	

FOR HOME OWNERS ONLY: Was the residence built under any of the following utility or federal residential energy-efficiency programs? (NOTE: Check customers document package for this information.)

- ☐ Don't know
- ☐ Energy Star Home (look for a bronze plaque mounted somewhere on the home)
- ☐ Pacific Gas & Electric (PG&E) Comfort Home
- ☐ Southern California Edison (SCE) ComfortWise Home
- ☐ Southern California Gas (SCG) Energy Advantage Home
- ☐ San Diego Gas & Electric (SDG&E) ComfortWise Home

FOR HOME OWNERS ONLY: Were any energy-saving options offered by the builder?

- ☐ No high-efficiency options offered
- ☐ High-efficiency cooling or heating equipment
- ☐ Advanced heating/cooling control/thermostat
- ☐ Improved performance windows
- ☐ Pre-wired Home Automation System
- ☐ Other _____
- ☐ Don't know

Household Characteristics

Please have the respondent answer the following questions:

Number of people who live in this home at least 9 months of the year in the following age groups:

under 2 years _____
2-5 _____
6-21 _____
22-39 _____
40-64 _____
65 and over _____

Indicate the household's current annual income before taxes?

- ☐ Under $20,000 per year
- ☐ $20,000 - 39,999
- ☐ $40,000 - 59,999
- ☐ $60,000 - 79,999
- ☐ $80,000 - 120,000
- ☐ Over $120,000
- ☐ Refused

NOTE: If any significant devices that affect energy use or conservation (i.e photovoltaic systems, backup generator systems for Y2K, electric automobiles, etc.) are observed during the survey, ask the occupant about them and record relevant notes on the comments page at the end of the survey form.

Indoor & Outdoor Lighting

Item #	1	2	3	4	5	6	7	8
Location: **X** = Outside Lighting **K** = Kitchen **L**=Living Room **D** = Dining Room **F** = Family Room **H** = Halls/Entry **B** = Bathroom **MB** = Master Bed. **OB** = Other Bedroom **G** = Garage **OT** = Other (describe)								
Control Type: **S** = Switch (on/off) **M** = Motion sensor **D** = Dimmer **P** = Photocell **T** = Timer **H** = Home Automation System **OT** = Other (describe) _____								
Fixture Type: **C** = Ceiling, surface-mounted **L** = Floor/table lamp **D** = Downlights (cans) **T** = Torchiere **W** = Wall –mounted **H** = Other hard-wired **R** = Recessed **P** = Other plug-in **S** = Suspended								
Total Number of Fixtures								
Number of lamps per fixture								
Watts per Lamp (enter 2 or 3-way as 50/100/150)								
Lamp Type & Lamp-Specific Details								
I = Incandescent Standard, medium base	I	I	I	I	I	I	I	I
IS = Incandescent Standard, small base	IS	IS	IS	IS	IS	IS	IS	IS
IP = Incandescent PAR	IP	IP	IP	IP	IP	IP	IP	IP
IR = Incandescent Reflector	IR	IR	IR	IR	IR	IR	IR	IR
For Incand. lamps: CFs Applicable (medium base)?	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
F = Fluorescent Tube	F	F	F	F	F	F	F	F
UT = Fluorescent U-tube	UT	UT	UT	UT	UT	UT	UT	UT
OF = Other Fluorescent (describe in comment block)	OF	OF	OF	OF	OF	OF	OF	OF
For Fluor. tubes: Length in ft. (e.g., 2 4 6 8)								
Diameter (e.g. T8 T10 T12)								
CFG = CF w/Globe-Shaped diffuser	CFG	CFG	CFG	CFG	CFG	CFG	CFG	CFG
CFC = CF, w/Capsule-Shaped diffuser	CFC	CFC	CFC	CFC	CFC	CFC	CFC	CFC
CFR = CF w/reflector	CFR	CFR	CFR	CFR	CFR	CFR	CFR	CFR
CF = Compact Fluorescent, Other	CF	CF	CF	CF	CF	CF	CF	CF
CIR = Circline	CIR	CIR	CIR	CIR	CIR	CIR	CIR	CIR
For CF and CIR,lamps, indicate base type: I=Integrated M=Modular D=Dedicated	I M D	I M D	I M D	I M D	I M D	I M D	I M D	I M D
HA= Halogen "A"	HA	HA	HA	HA	HA	HA	HA	HA
HT = Halogen Tubular	HT	HT	HT	HT	HT	HT	HT	HT
HL = Halogen low voltage	HL	HL	HL	HL	HL	HL	HL	HL
HP = Halogen reflector/PAR	HP	HP	HP	HP	HP	HP	HP	HP
MV = Mercury Vapor	MV	MV	MV	MV	MV	MV	MV	MV
MH = Metal Halide	MH	MH	MH	MH	MH	MH	MH	MH
HPS = High Pressure Sodium Vapor	HPS	HPS	HPS	HPS	HPS	HPS	HPS	HPS
LPS = Low Pressure Sodium Vapor	LPS	LPS	LPS	LPS	LPS	LPS	LPS	LPS
Field Notes: (Counts)								

Indoor & Outdoor Lighting

Item #	9	10	11	12	13	14	15	16
Location: **X** = Outside Lighting **K** = Kitchen **L**=Living Room **D** = Dining Room **F** = Family Room **H** = Halls/Entry **B** = Bathroom **MB** = Master Bed. **OB** = Other Bedroom **G** = Garage **OT** = Other (describe)								
Control Type: **S** = Switch (on/off) **M** = Motion sensor **D** = Dimmer **P** = Photocell **T** = Timer **H** = Home Automation System **OT** = Other (describe) _____								
Fixture Type: **C** = Ceiling, surface-mounted **L** = Floor/table lamp **D** = Downlights (cans) **T** = Torchiere **W** = Wall –mounted **H** = Other hard-wired **R** = Recessed **P** = Other plug-in **S** = Suspended								
Total Number of Fixtures								
Number of lamps per fixture								
Watts per Lamp (enter 2 or 3-way as 50/100/150)								
Lamp Type & Lamp-Specific Details								
I = Incandescent Standard, medium base	I	I	I	I	I	I	I	I
IS = Incandescent Standard, small base	IS	IS	IS	IS	IS	IS	IS	IS
IP = Incandescent PAR	IP	IP	IP	IP	IP	IP	IP	IP
IR = Incandescent Reflector	IR	IR	IR	IR	IR	IR	IR	IR
For Incand. lamps: CFs Applicable (medium base)?	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
F = Fluorescent Tube	F	F	F	F	F	F	F	F
UT = Fluorescent U-tube	UT	UT	UT	UT	UT	UT	UT	UT
OF = Other Fluorescent (describe in comment block)	OF	OF	OF	OF	OF	OF	OF	OF
For Fluor. tubes: Length in ft. (e.g., 2 4 6 8)								
Diameter (e.g. T8 T10 T12)								
CFG = CF w/Globe-Shaped diffuser	CFG	CFG	CFG	CFG	CFG	CFG	CFG	CFG
CFC = CF, w/Capsule-Shaped diffuser	CFC	CFC	CFC	CFC	CFC	CFC	CFC	CFC
CFR = CF w/reflector	CFR	CFR	CFR	CFR	CFR	CFR	CFR	CFR
CF = Compact Fluorescent, Other	CF	CF	CF	CF	CF	CF	CF	CF
CIR = Circline	CIR	CIR	CIR	CIR	CIR	CIR	CIR	CIR
For CF and CIR,lamps, indicate base type: I=Integrated M=Modular D=Dedicated	I M D	I M D	I M D	I M D	I M D	I M D	I M D	I M D
HA= Halogen "A"	HA	HA	HA	HA	HA	HA	HA	HA
HT = Halogen Tubular	HT	HT	HT	HT	HT	HT	HT	HT
HL = Halogen low voltage	HL	HL	HL	HL	HL	HL	HL	HL
HP = Halogen reflector/PAR	HP	HP	HP	HP	HP	HP	HP	HP
MV = Mercury Vapor	MV	MV	MV	MV	MV	MV	MV	MV
MH = Metal Halide	MH	MH	MH	MH	MH	MH	MH	MH
HPS = High Pressure Sodium Vapor	HPS	HPS	HPS	HPS	HPS	HPS	HPS	HPS
LPS = Low Pressure Sodium Vapor	LPS	LPS	LPS	LPS	LPS	LPS	LPS	LPS
Field Notes: (Counts)								

Indoor & Outdoor Lighting

Item #	__	__	__	__	__	__	__	__
Location: **X** = Outside Lighting **K** = Kitchen **L**=Living Room **D** = Dining Room **F** = Family Room **H** = Halls/Entry **B** = Bathroom **MB** = Master Bed. **OB** = Other Bedroom **G** = Garage **OT** = Other (describe)								
Control Type: **S** = Switch (on/off) **M** = Motion sensor **D** = Dimmer **P** = Photocell **T** = Timer **H** = Home Automation System **OT** = Other (describe) _____								
Fixture Type: **C** = Ceiling, surface-mounted **L** = Floor/table lamp **D** = Downlights (cans) **T** = Torchiere **W** = Wall –mounted **H** = Other hard-wired **R** = Recessed **P** = Other plug-in **S** = Suspended								
Total Number of Fixtures								
Number of lamps per fixture								
Watts per Lamp (enter 2 or 3-way as 50/100/150)								
Lamp Type & Lamp-Specific Details								
I = Incandescent Standard, medium base	I	I	I	I	I	I	I	I
IS = Incandescent Standard, small base	IS	IS	IS	IS	IS	IS	IS	IS
IP = Incandescent PAR	IP	IP	IP	IP	IP	IP	IP	IP
IR = Incandescent Reflector	IR	IR	IR	IR	IR	IR	IR	IR
For Incand. lamps: CFs Applicable (medium base)?	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
F = Fluorescent Tube	F	F	F	F	F	F	F	F
UT = Fluorescent U-tube	UT	UT	UT	UT	UT	UT	UT	UT
OF = Other Fluorescent (describe in comment block)	OF	OF	OF	OF	OF	OF	OF	OF
For Fluor. tubes: Length in ft. (e.g., 2 4 6 8)								
Diameter (e.g. T8 T10 T12)								
CFG = CF w/Globe-Shaped diffuser	CFG	CFG	CFG	CFG	CFG	CFG	CFG	CFG
CFC = CF, w/Capsule-Shaped diffuser	CFC	CFC	CFC	CFC	CFC	CFC	CFC	CFC
CFR = CF w/reflector	CFR	CFR	CFR	CFR	CFR	CFR	CFR	CFR
CF = Compact Fluorescent, Other	CF	CF	CF	CF	CF	CF	CF	CF
CIR = Circline	CIR	CIR	CIR	CIR	CIR	CIR	CIR	CIR
For CF and CIR,lamps, indicate base type: I=Integrated M=Modular D=Dedicated	I M D	I M D	I M D	I M D	I M D	I M D	I M D	I M D
HA= Halogen "A"	HA	HA	HA	HA	HA	HA	HA	HA
HT = Halogen Tubular	HT	HT	HT	HT	HT	HT	HT	HT
HL = Halogen low voltage	HL	HL	HL	HL	HL	HL	HL	HL
HP = Halogen reflector/PAR	HP	HP	HP	HP	HP	HP	HP	HP
MV = Mercury Vapor	MV	MV	MV	MV	MV	MV	MV	MV
MH = Metal Halide	MH	MH	MH	MH	MH	MH	MH	MH
HPS = High Pressure Sodium Vapor	HPS	HPS	HPS	HPS	HPS	HPS	HPS	HPS
LPS = Low Pressure Sodium Vapor	LPS	LPS	LPS	LPS	LPS	LPS	LPS	LPS
Field Notes: (Counts)								

Appliances & Other Equipment

***Refrigerators & Freezers** - Manufacturer/Model Data*

Item #1 -- Manufacturer	
-- Model Number	
Item #2 -- Manufacturer	
-- Model Number	
Item #3 -- Manufacturer	
-- Model Number	

***Refrigerators & Freezers** - Type/Configuration Data*

Item #	**1**	**2**	**3**
Equipment type: **R** = Refrigerator/Freezer **F** = Freezer **OT=** Other	**R F OT**	**R F OT**	**R F OT**
Defrost type: **F** = Frost-free **M** = Manual	**F M**	**F M**	**F M**
Configuration: ***Ref/Frz:*** **T**=Top mount **B**=Bottom mount **S**=Side-by-side **D**=1-door ***Freezer:*** **C** = Chest **U** = Upright **OT** = Other	**T B S D** **C U** **OT**	**T B S D** **C U** **OT**	**T B S D** **C U** **OT**
Space/Location: **C** = Conditioned **U** = Unconditioned	**C U**	**C U**	**C U**
Volume/size, ft^3			
Age in years (enter 1 if less than 1 year old)			
EF (Energy Factor, ft^3/kWh/day)			

Dishwasher

Manufacturer	**Model Number**

Clothes Washer

Axis Type	**Manufacturer**	**Model Number**	**Age**
Vert **H**oriz			

Clothes Dryer

Fuel Type	**Manufacturer**	**Model Number**	**Age**
E G P O			

Miscellaneous Equipment

Appliance	**Quantity**	**Fuel Type**
Oven		E G P O
Range		E G P O
Pool Heater		E G P O
Spa Heater		E G P O
Pool Pump		
Color Televisions		
Personal Computers		
Other _____		
Other _____		
Other _____		

Water Heating Equipment *(complete multiple sheets if multiple water heaters)*

Manufacturer	Model Number	EF (Energy Factor)

Equipment type: **S** = Standard Water Heater **I =** Instantaneous (Tankless) **HP** = Heat Pump Water Heater **B** = Boiler **C** = Central plant, shared service **OT** = Other	**S I HP B C OT**
Fuel Type: **E** = Electricity **G** = Natural Gas **P** = Propane (LPG) **S** = Solar w/back-up **F** = Fuel Oil **N**=Not Heated	**E G P S F N**
Solar Backup Type (if relevant): **E** = Electricity **G** = Natural Gas **P** = Propane (LPG) **OT**=Other _____	**E G P OT**
Heat trap? Y=yes, N=no	**Y N**
Low-flow fixtures (showerheads, faucets, etc.)? **Y**=yes, **N**=no	**Y N**
Input Capacity (Check units, either kBtuh or kW)	❑ kBtuh ❑ kW
Tank Capacity (Gallons)	
Does the hot water tank have an external insulation jacket? **Y**=yes, **N**=no	**Y N**
Are hot water pipes insulated? **Y**=yes, **N**=no	**Y N**
Hot water recirculation system present? **Y**=yes, **N**=no	**Y N**
Recirculation pump power (hp) (Enter zero for no pump.)	_____ hp
Hot water temperature (°F) If unknown: **H**=High **M**=Medium **L**=Low	**H M L**
Where is the water heater located? **C**=Conditioned or **U**=Unconditioned space	**C U**
Does the water heater serving this dwelling also serve others? Y=yes, N=no	**Y N**

Heating, Cooling, Fans, and Ducts

Heating and Cooling Systems

System ID	# ___	#___
System Information		
System Type: **C** = Central Unit **P** = Portable Unit **WW** = Window/Wall Unit **S** = Shared central system **EV** = Evaporative Cooler **OT** = Other* _____ **H** = Hydronic **BB** = Baseboard/Radiant Heater	C P WW S EV OT H BB	C P WW S EV OT H BB
% of Residence Served by this System		
Location: **G**=Garage **A**=Attic **S**=Cond. Space **M**= Mech. Room **OT**=Other _____	**G A S M OT**	**G A S M OT**
Heating Equipment		
Manufacturer		
Model Number (include dash numbers)		
Number of units:		
Equipment Type: **F** = Furnace **HP** = Heat Pump **RH** = Radiant Heater **ER** = Elec. Resist **HW** = Boiler **BB** = Baseboard Heater **N** = None **OT** = Other* **Fuel Type:** **E** = Electricity **G** = Natural Gas **P** = Propane (LPG) **F** = Fuel Oil **W** = Wood **OT** = Other* _____	**F** **HP** **RH** **ER** **HW** **BB** **N** **OT** **E** **G** **P** **F** **W** **OT**	**F** **HP** **RH** **ER** **HW** **BB** **N** **OT** **E** **G** **P** **F** **W** **OT**
Input Capacity (Check units, either kBtuh or kW)	_____ ❑ kBtuh ❑ kW	_____ ❑ kBtuh ❑ kW
Efficiency | Efficiency Units (A=AFUE H=HSPF E=EER C=COP)	| **A H E C**	| **A H E C**
***HP only**: -- Supplemental Heating Capacity (kW)*		
-- Soft start? (Y/N)	**Y N**	**Y N**
Cooling Equipment		
Manufacturer		
Model Number (include dash numbers)		
Number of Units:		
Type: **AC** = A/C (Std DX) **ID**= Indirect/Direct Evap **HP** = Heat Pump **N** = None **EV** = Direct Evap **OT** = Other _____	**AC HP EV ID N OT**	**AC HP EV ID N OT**
Output Capacity (kBtuh)		
Efficiency | Efficiency Units (S=SEER E=EER P=% Sat. Eff)	| **S E P**	| **S E P**
Condenser Type: **A**=Air **E**=Evap **G**=Ground W=Water	**A E G W**	**A E G W**

Heating and Cooling Systems (cont.)

System ID	# ___	#___
Fans/Ventilation (Ducted systems only)		
Indoor Fan, hp		
Supply Air Rate (CFM)		
Fan Type: **C**=Constant **T**=2-speed **V**=Variable	**C T V**	**C T V**
Special Features: **SV**= SmartVent ™ **WH***=Whole-house fan **OT***=Other	**SV WH OT**	**SV WH OT**
Thermostat/Controls		
Manufacturer		
Model Number		
Thermostat Type (only if applicable): **EM** = Electromechanical **D** = Digital **H** = Hybrid **HAS** = Home Automation System **OT** = Other _____	 **EM** **D** **H** **HAS** **OT**	 **EM** **D** **H** **HAS** **OT**

Duct Systems

☐ N/A

Does this residence have an accessible attic or ceiling crawl space? ☐ Yes ☐ No

Does this residence have an accessible floor crawl space? ☐ Yes ☐ No

	Supply	Return
Location of Ducts (indicate all that apply): **A**=Attic **CR**=Crawl Space **CS**=Cond. Space **W**=Wall Cavity **B**=Basement **OT**=Other*	**A CR CS W B OT**	**A CR CS W B OT**
Duct Types (indicate all that apply): **F**=Flexduct **M**=Metal **P**=Panned Joist **U**=Unfinished wall cavity **OT**=Other*	**F M P U OT**	**F M P U OT**
Duct Sealant Types (indicate all that apply): **M**=Mastic **BT**=Butyl Tape **MT**=Metal Tape **C**=Mech. clamps **OT**=Other*	**M BT MT C OT**	**M BT MT C OT**
--- Aerosol sealing used (check for certificate)**?**	**Y N**	**Y N**
Duct Insulation R-Value (–7 if insulation not labeled, 0 if not insulated)		

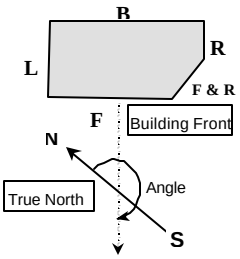
Duct Condition (note tape brand name if present)	
Plenum Condition	

* Describe Other types in comments block.

Additional Comments:

Building Orientation and Construction

Front Wall Orientation



Front orientation angle: (0-360°) _____

External Walls and Doors

Wall orientation (reference: facing the Front wall)	**Front**	**Left**	**Back**	**Right**
Shading: N= None L=Light M=Medium H=Heavy				
Gross Wall Area, ft^2 (*inc. windows, doors, etc.)*				
Demising Wall Area (wall between cond. and uncond. space), ft^2				
Wall Surface Type: S=Stucco W=Wood siding V=Vinyl siding M=Metal siding B=Brick/Block OT=Other*				
Exterior Wall Construction Type: WF24 = 2X4 Wood Framed; WF26 = 2X6 Wood Framed; MF24 = 2X4 Metal Framed; MF26 = 2X6 Metal Framed; WFOM = Wood Foam Panel; BLO = Concrete Block; BRI = Brick; OT = Other*				
Wall Insulation R-Value (from insulation certificate if available)				
Number of Wooden Doors				
Number of Insulated Metal Doors				
Number of Uninsulated Metal Doors				

Roof/Ceilings

Roof/Ceiling Type	FAT=Framed w/Attic-Crawl Space MET=Metal Decking ADB= Conditioned space above FNO=Framed w/o Attic-Crawl Space CON=Concrete Decking	
-- External Roof Surface	T=Tile (Clay, Concrete, etc.) C=Composition B=Built-up S= Shingle/Shake OT=Other*	
-- External Roof Color	W=White L=Light M=Medium D=Dark	
Radiant barrier?		**Y N**
Non-Vaulted Ceiling Height	Feet	
=> Vaulted Ceilings, Estimated % of Total Floor Area with Vaulted Ceilings?		%
Ceiling Insulation R-value	Indicate R-value OR	
	Indicate inches of insulation in roof cavity	

* Note "Other" construction types in comments block.

Building Orientation and Construction (cont.)

Floor

Number of floors	
Total conditioned floor area, ft^2	
Floor construction type	**S** =Slab **C** =Crawl **U** =Unheated Basement **O** =Open (Garage) **ADB** =Cond. space below
Insulation R-value	

Windows, Glass Doors, and Skylights

Item # (use multiple sheets if necessary)		1	2	3	4	5	6
Unit Type	**W** = Window **D** = Door **S** = Skylight						
Shading	**I** = Interior (blinds/drapes) **N** = None **E** = Exterior (overhangs/awnings) **B** = Both						
Style	**S**=Slider **F**=Fixed **A**=Art glass **D**=Double-hung **B**=Bay/Bow **C**=Casement **W**=Awning **OT**=Other						
Layers of glazing	**S**=Single **D**=Double **T**=Triple						
Muntins/grids?	**I**=Internal/between panes **E**=External **B**=Both						
Frame type	**M**=Metal **W**=Wood **V**=Vinyl **OT**=Other*						
Glass Type	**C**=Clear **T**=Tinted **R**=Reflective **L**=LowE						
-- Was this an after-market film/treatment?		**Y N**	**Y N**	**Y N**	**Y N**	**Y N**	**Y N**
Area per unit	Square feet						
Number of units installed:	=> **Front** wall (or **Roof** if skylight)						
	=> **Left** wall						
	=> **Back** wall						
	=> **Right** wall						
Fill Type	**N**=None **A**=Air **G**=Gas-filled						
Mfr. Or MFR. CODE	Enter **SB** if it looks like it was site-built						
SERIES	Enter window series/style						
SHGC	Solar Heat Gain Coefficient						
U-Value	Overall heat transfer coefficient						

* Describe Other frame type in comments block

Comments:

Building Orientation and Construction (cont.)

Windows, Glass Doors, and Skylights (cont.)

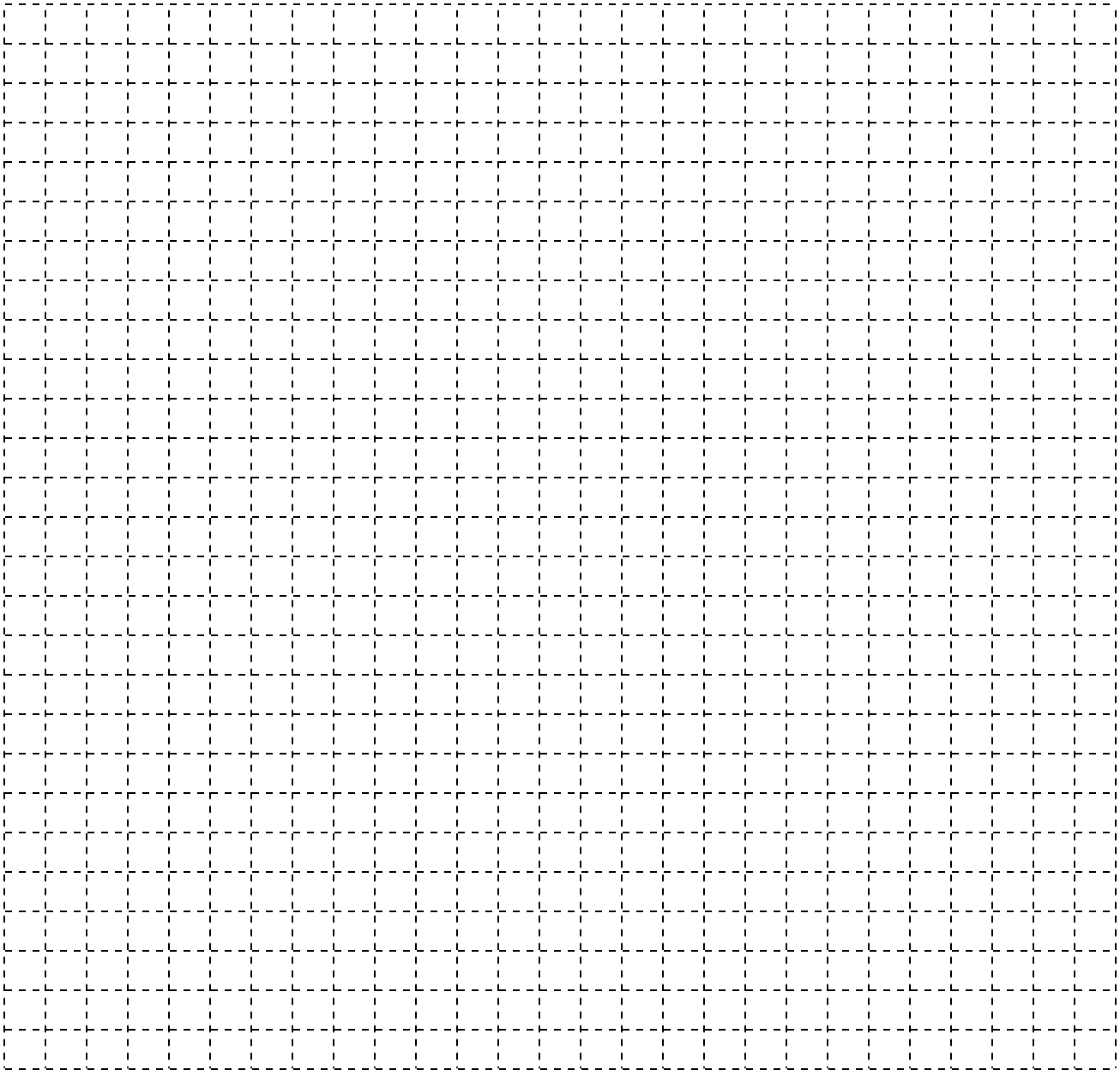
Item # (use multiple sheets if necessary)		__	__	__	__	__	__
Unit Type	**W** = Window **D** = Door **S** = Skylight						
Shading	**I** = Interior (blinds/drapes) **N** = None **E** = Exterior (overhangs/awnings) **B** = Both						
Style	**S**=Slider **F**=Fixed **A**=Art glass **D**=Double-hung **B**=Bay/Bow **C**=Casement **W**=Awning **OT**=Other						
Layers of glazing	**S**=Single **D**=Double **T**=Triple						
Muntins/grids?	**I**=Internal/between panes **E**=External **B**=Both						
Frame type	**M**=Metal **W**=Wood **V**=Vinyl **OT**=Other*						
Glass Type	**C**=Clear **T**=Tinted **R**=Reflective **L**=LowE						
-- Was this an after-market film/treatment?		**Y N**	**Y N**	**Y N**	**Y N**	**Y N**	**Y N**
Area per unit	Square feet						
Number of units installed:	=> **Front** wall (or **Roof** if skylight)						
	=> **Left** wall						
	=> **Back** wall						
	=> **Right** wall						
Fill Type	**N**=None **A**=Air **G**=Gas-filled						
Mfr. Or MFR. CODE	(Enter **SB** if it looks like it was site-built)						
SERIES	Enter window series/style						
SHGC	Solar Heat Gain Coefficient						
U-Value	Overall heat transfer coefficient						

* Describe Other frame type in comments block

Comments:

Site Sketch

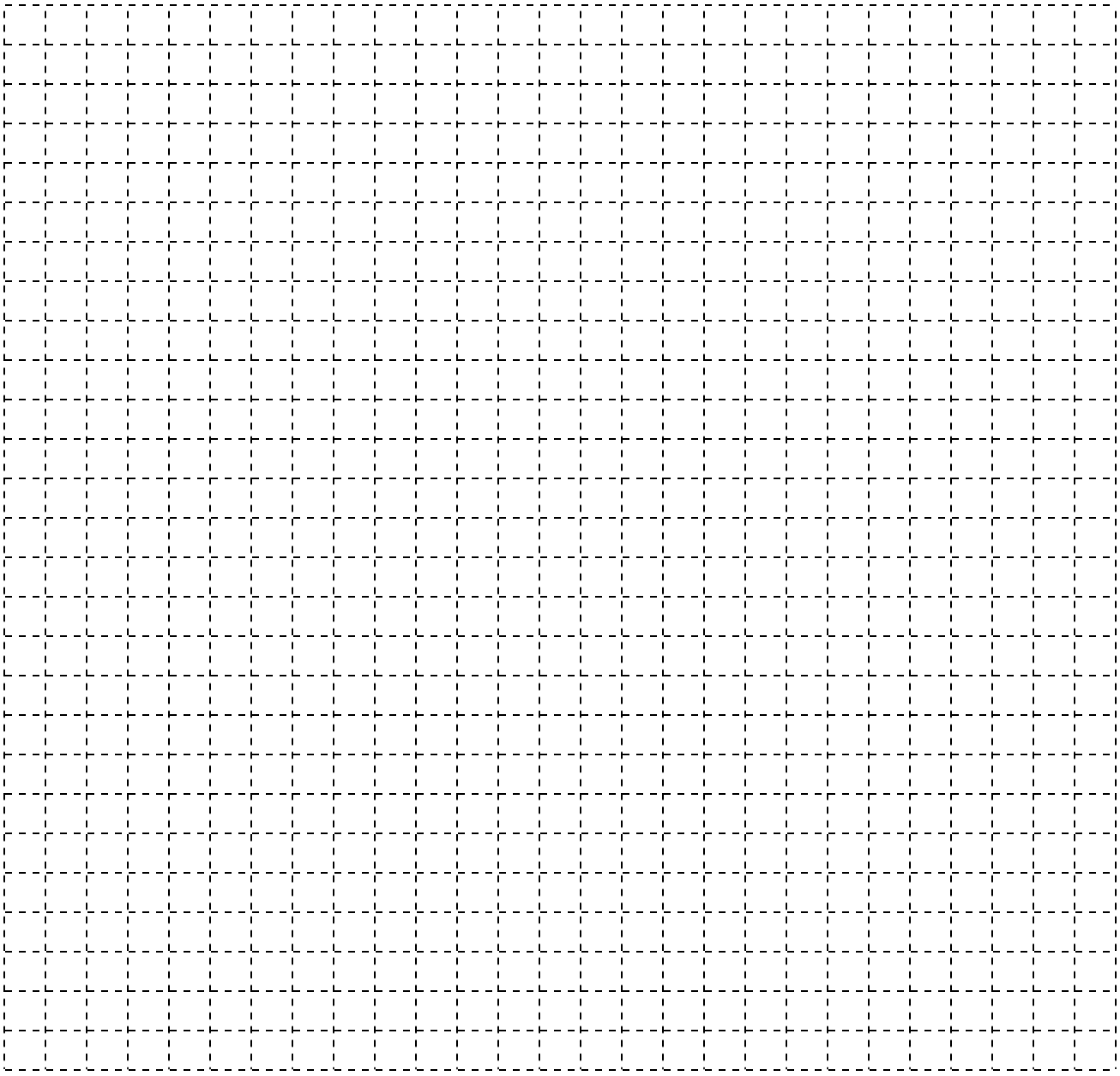
Sketch an outline (i.e. external walls) of the site. Include dimensions and note location of the garage. Draw an arrow to indicate North and show the Front Orientation angle. Note other external walls as Left, Right, and Back (see page 8). Indicate areas with vaulted ceilings. Indicate glazing locations. Show any trees or structures that provide significant shading. Use multiple sheets if needed and number accordingly.



Comments

Site Sketch, Additional Sheet

Sketch an outline (i.e. external walls) of the site. Include dimensions and note location of the garage. Draw an arrow to indicate North and show the Front Orientation angle. Note other external walls as Left, Right, and Back (see page 8). Indicate areas with vaulted ceilings. Indicate glazing locations. Show any trees or structures that provide significant shading. Use multiple sheets if needed and number accordingly.



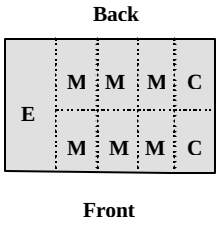
Comments

Multi-Family Building and Complex Information

Surveyed Residential Unit Characteristics

Residential unit configuration type	B=Back-to-back S=Straight-through H= Hallway (interior) P= Perimeter units (arranged around a central area) O=Other	**B S H P O**
Horizontal/Floorplan Location (figure below)	E=End Unit C=Corner unit M=Middle unit O=Other	**E C M O**
Vertical/Floor Location	Indicate floor/story number or **M** if Multi-floor unit	_____ or **M**
Are all residential units in this building the same size/ft^2?		**Y N**

Horizontal/Floorplan Location within Building



Building Characteristics

Number of floors	
Total number of residential units in this bldg?	
Approx. % of this building that is non-residence type space/activity (i.e. laundry facilities, rec. rooms, etc.)	
Approx **Front/Back** Length of building (Front same as for residential unit)	
Approx **Left/Right** Width of building	
Approx %Glass on => **Front** wall	
=> **Left** wall	
=> **Back** wall	
=> **Right** wall	

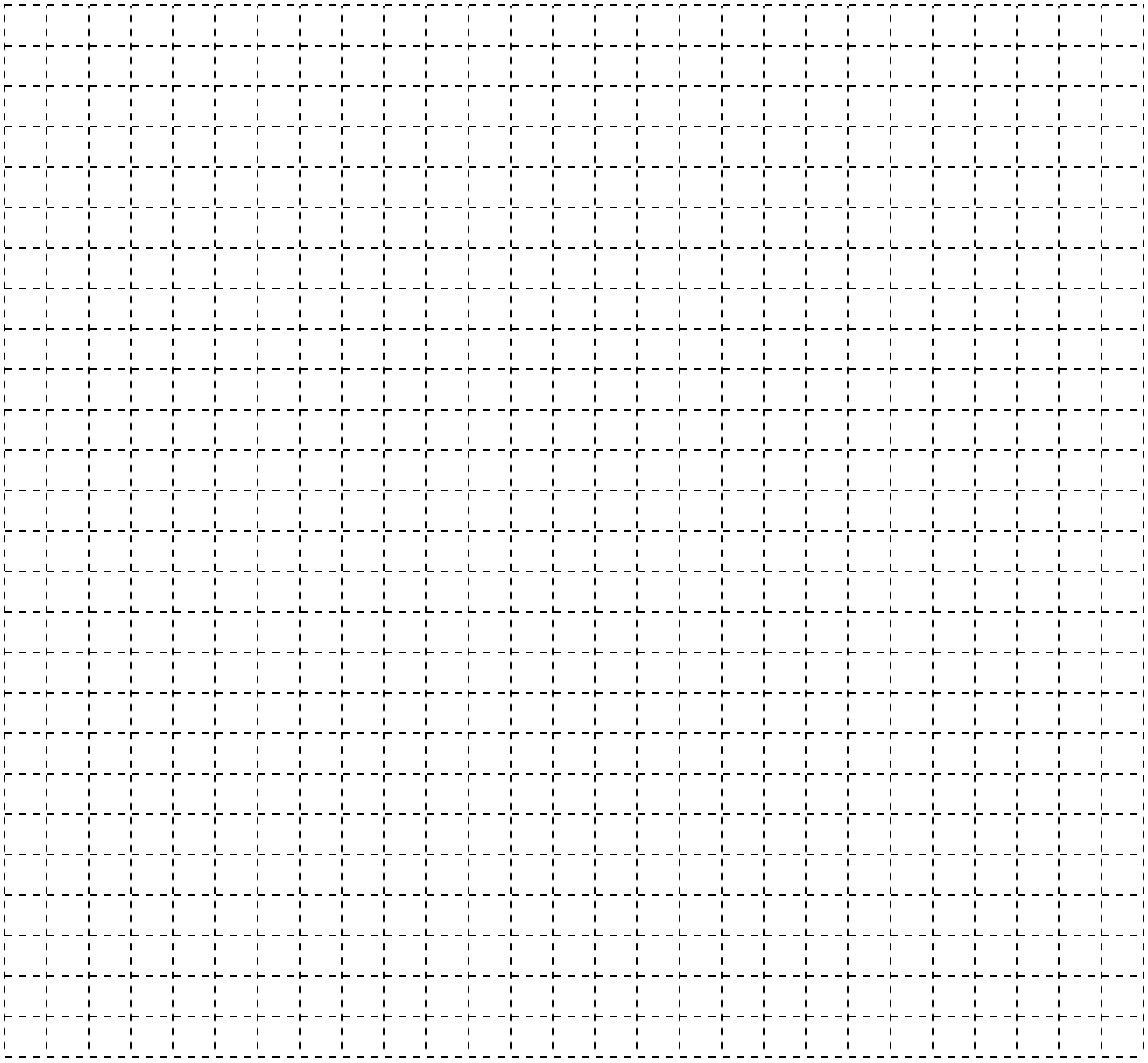
Housing Complex Characteristics

Total number of *residential units* in the complex?	
Total # of residential-unit *buildings* in the complex?	
-- # of buildings with this same floor plan?	
-- Typical orientation of other buildings	**S** = Same as surveyed bldg **V** = Varies

Comments:

Multi-Family Residence Building Sketch

Sketch an outline (i.e. external walls) of the building in which the surveyed residential unit was located. Indicate if there are areas other than residential units located within the building. Note overall dimensions and the *location of the surveyed unit within the building*. Draw an arrow to indicate North and show the Front Orientation angle. Note other external walls as Left, Right, and Back (see page 8). Indicate glazing locations. Show any trees or structures that provide significant shading. Use multiple sheets if needed and number accordingly.



Comments

Comments and Observations

Page #	Item	Comments

Appendix C

Duct Blaster Test Survey Form

Duct Blaster Data Collection Form

Site ID:	**Customer Name:**
Address:	**City:**
Date test performed:	**Test Performed by:**
Company Name:	**Duct Blaster Equipment/Model Type:**

HVAC System Type (check one):

- ❑ FAU with Platform Return or Return Air Chase
- ❑ FAU without Platform Return
- ❑ Attic FAU with Return Air Chase
- ❑ FAU with Sealed Blower compartment

TEST RESULTS	COMMENTS/DIAGRAM
Single point @ 25 Pascals: _____ Fan Pressure 1 2 3 Flow Ring (circle one) _____ Fan Flowrate (CFM)	

Appendix D

Building Department CF-6R Form

Available in hard copy only.