STATEWIDE RESIDENTIAL LIGHTING AND APPLIANCE SATURATION STUDY

FINAL REPORT
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Executive Summary

The CPUC is seeking to change conservation programs in California from resource acquisition programs into market transformation programs. To assess the success of these efforts and to guide public policy and program planning, this study was undertaken to collect baseline data on the saturation of lighting and major appliances in the residential sector.

RLW Analytics and ASW Engineering conducted this study for San Diego Gas and Electric Company, Sacramento Municipal Utility District and the CPUC. The study had three primary objectives:

Objective 1: Completion of 1,258 on-site surveys of single-family, multi-family and mobile homes throughout the service territories of PG&E, SCE, SDG&E and SMUD.

Objective 2: Development of a user-friendly database of residential lighting and appliance saturation by energy efficiency.

Objective 3: Determination of potential market barriers in the residential market to adopting energy efficient lighting systems.

Approach

The survey was implemented using palm-top mini-PC computers to gather the data directly in electronic format. This approach provided fast and cost effective on-site data collection. A total of 1,258 on-site surveys were completed between December 1999 and March 2000.

While on-site, the surveyors collected data on the major appliances and lighting systems in the home. The surveyors collected nameplate data for eight major appliances: Refrigerator-Freezers, Self-standing Freezers, Dishwashers, Clothes Washers, Clothes Dryers, Water Heaters, Heating Equipment, and Cooling Equipment. The auditors collected lamp and fixture data on each lighting fixture within the home, as well as the front porch fixture. The on-site surveyors also collected data on attic, floor and wall insulation R-values, wall construction, and window type.

In addition to the lighting and appliance survey, a seperate questionnaire was also designed to capture market barrier data on purchases of energy efficient residential lighting systems. The questions were designed to determine whether home owners were informed about energy efficient lighting technologies at the time of purchase, whether they did in fact purchase efficient lighting systems, and how they learned about energy efficient lighting.

As the data were collected, the auditors uploaded the site data from the palm-top computers to the RLW office, cleaned, and imported into an MS Access master database. Existing databases of appliance efficiency were acquired from the CEC, ARI, AHAM, etc. MS Access queries were designed and written to link the on-site data to the appliance efficiency databases based on model number. If linked, the corresponding efficiency was assigned to the matched appliance. Matching rates varied greatly by appliance type and age. Refrigerators had the highest match rates, while room air-conditioners and clothes dryers had the lowest. New appliances also generally had a higher matching rate.

The analysis for lighting and appliances is summarized in this report at the statewide level. Each site was given its appropriate sampling weight to project to the population or various subsections of the population. Analysis queries were written in MS Access and processed using RLW's Model Based Statistical Sampling (MBSS) software. The report contains numerous data queries, which for the most part are summarized by age bins, unit energy consumption (UEC) bins, efficiency, size bins and capacity bins. The utilities have been trained in how to further summarize the data using the MBSS software, such as by service territory, home type, home age, income level, etc.

Key Findings

Lighting

Overall, sampled residences contain approximately 20 fixtures and 35 lamps. For two story, single family homes, these figures are much higher -- 31 fixtures and 56 lamps. On statewide basis, the vast majority of installed lamps are incandescent at 81%. Less than 1% of all fixtures contain a compact fluorescent lamp.

Room by room analyses showing breakouts of lamp types and fixture types are included in the report. Highlights of technology specific queries that were performed include:

- Recessed cans - About one third of all homes have at least one recessed can, which represents approximately 12 % of all fixtures observed on-site. Newer and remodeled homes have a much greater saturation of recessed cans. Only 2% of the observed recessed cans contain a CFL.

- Ceiling Fans - Roughly half of the sampled homes contain a ceiling fan and 95% of the fans contain one or more lamps. Only 1% of the ceiling fans contain a CFL. Ten percent of homes have 4 or more ceiling fans, while on average ceiling fans contain approximately 3 lamps on average.

- Torchieres - About 25 % of homes have at least one torchiere. The distribution of lamps observed in the torchieres was : 26% incandescent, 71% halogen, and 1.5% CFL.

- Porch Lights - Roughly 80% of all porch lights are using incandescent lamps. Just over 6% of homes are using a CFL. Only 15 % of all porch lights are equipped with some form of control device such as a motion detector, photocell, timer, etc.

Refrigerators

Data was collected on both primary and secondary refrigerators, whether in use or not. Approximately 14 % of homes have a second refrigerator. The average age of the primary and secondary refrigerators is approximately 9 and 15 years old, respectively. The average life expectancy of refrigerators is 14 years[1]. Primary refrigerators are approximately 12% more efficient than secondary refrigerators, with average unit energy consumption (UEC) of 913 and 1,034 kWh/yr respectively.

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[1] All life expectancy estimates for the appliances were obtained from *Appliance Magazine*.

Over 50% of primary refrigerators and over 75 % of secondary refrigerators are at least 50% *less* efficient (i.e. use 50% more energy) than the DOE 2001 energy standards. Finally, while 13.4% of primary refrigerators meet 1993 Energy Star qualifications, only 2% of secondary refrigerators meet the same standard.

Self Standing Freezers

Over 16% of homes have at least one self-standing freezer. Upright-type freezers comprise almost 71% of all freezers, with the remainder being chest freezers. The average annual energy usage is 765 kWh/yr for upright freezers and 406 kWh/yr for chest freezers.

Upright freezers are larger, older and use more energy than chest freezers. The average size is 16.6 cubic feet for upright freezers and 13.4 cubic feet for chest freezers. The average age is 14.5 years for upright freezers and 11.5 years for chest freezers.

Cooling Systems

Approximately half of all homes have at least one air conditioner. In these homes approximately 78% of the air conditioning systems are central. The remaining 22% of air conditioners are space systems. Space systems are defined as systems that condition only the room or area where the system is located (i.e., window wall air conditioner). Split system air conditioning (AC) units are most common (54%) followed by packaged system AC units (16%) and window wall AC units (16%).

Of the 78% of air conditioners that are central systems, 75% are split-system, 23% are packaged, and 2% are evaporative systems. Of the 22% of air conditioners that are space systems, 79% are window wall units, while evaporative systems comprise the remaining 21%.

The average age of both package and split air conditioner systems is 12 years. The average life expectancy of central air conditioning systems is 13 years. About 72% of all systems were manufactured in 1985 or later. The average SEER for central split systems is 9.73, which is 2.3% below the 1992 federal minimum standard of 10.0 and 19% below the minimum Energy Star standard of 12.0.

Packaged air conditioning systems tend to be older than central and split system air conditioning systems with an average of age of 15 years. Approximately 67% of these units were manufactured in 1985 or later. Packaged systems have an average SEER of 9.84, which is 1.4% greater than the 1992 federal minimum standard of 9.70 and 18% below the minimum Energy Star standard of 12.0.

Heat Pumps

Nearly five percent of homes have a heat pump. The majority of primary heat pumps are central split systems, totaling over 48% of the units. The other types of heat pumps are central packaged air-to-air and space window/wall, totaling 37% and 15% respectively. The average age of the matched packaged heat pumps is 16 years, while the average age of the matched split system heat pumps is 12 years.

Central split systems are more efficient than central packaged systems. The average SEER for central split systems is 9.87, while the average SEER for

central packaged systems is 8.23. This compares to the minimum federal energy standard of 10.0 and 9.7 for split and packaged systems respectively. Minimum Energy Star Qualifications are 12.0 SEER for both system types.

Heating Systems

The dominant heating fuel type is natural gas with a saturation of 88%. Seven percent of homes use electricity as the primary heating source. Four percent report heat pumps as their primary heating system. The most popular heating system is the forced air furnace accounting for 66% of all primary heating systems. The average age of these forced air furnaces is 17 years. Most, 94%, are fueled by natural gas.

The average efficiency of forced air natural gas furnaces is 78.2 Annual Fuel Utilization Efficiency (AFUE). The majority of these furnaces, (60%) meet or exceed the 1992 federal minimum efficiency standard of 78 AFUE. Only four percent of forced air furnaces meet or exceed the minimum qualifying Energy Star standard of 90 AFUE.

The second most popular heating system is the wall heater, comprising almost 20% of all primary heating systems. These are an estimated 30 years old on average, much older than the forced air furnaces. Their average energy consumption is 68.3 AFUE.

Clothes Washing and Drying Appliances

Roughly three quarters of homes in the sample have a clothes dryer. Of this number, 41% are electric and 59% are gas. As one might expect, customers living in a single family home have a much higher likelihood of having a clothes dryer than customers living in apartments. Approximately seventy percent of all dryers are less than 10 years old, with another 20% between 11-15 years old.

The average age of washing machines is approximately seven years. The average estimated life expectancy is 12 years. The average statewide energy factor[2] for clothes washers is 1.26, in contrast with the current federal standard of 1.18.

All matched top loading washing machines surveyed exceed current federal standards, but are under the Energy Star minimum qualifying energy factor of 2.5. A total of eighteen horizontal-axis washing machines were found during the study, or just under two percent of all washing machines surveyed.

Dishwashers

Over seventy percent of all homes have a dishwasher. The highest saturation of dishwashers is in single-family unattached two story residences, with 91% of these homes having one. About half of all apartments have a dishwasher. On average, dishwashers are nine years old. The average estimated life expectancy is 10 years. Just over 40% are manufactured in 1995 or later. Eighty-two percent of all dishwashers matched have an energy factor[3] between 0.460 and 0.519, with

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[2] The definition for washing machine energy factor can be found in the section titled Washing Machines.

[3] The definition for dishwasher energy factor can be found in the section titled Dishwashers.

an overall average energy factor of 0.48. This compares to the federal standard of 0.46, and Energy Star level of 0.52.

Hot Water Heaters

Less than ten percent of all water heaters surveyed are electric, the majority are gas fired. The average size of electric and gas water heaters is slightly over 40 gallons. 40-gallon gas water heaters are the most common. However there is a time trend to larger units.

The average water heater efficiency is equal to that of the federal energy standard, 0.57 in units of Energy Factor[4]. Electric units are, on the whole, slightly less efficient than the federal standards of 0.90.

Window and Wall Constructions

The overwhelming majority of window frame type used in the homes is metal, constituting more than three-quarters of the homes, with the remainder consisting of wood and vinyl windows. Over half the homes have metal framed, single paned windows. The second most common frame and pane types are metal framed, double paned windows, totaling almost 24% of the homes. One percent of homes have triple pane metal windows.

The large majority of homes are constructed using 2 x 4 framing material, totaling over 83% of all homes. The second most common wall construction type is 2 x 6 framing, totaling 8.5% of all homes.

Insulation

Almost 60% of all homes are "slab on grade". If "Slab on grade" homes have floor insulation it is not observable because the insulation is laid under a concrete foundation. Seven percent of homes have at least some floor insulation, while 34% have no insulation. The average R-Value for attic insulation is 19.7. Over 25% of all homes have no exterior wall insulation.

Limitations

The leading contributor to bias in this study is the model-number matching of appliances. Newer appliances were easier to match than older units. This introduces an unintentional bias in the efficiency results towards newer and generally more efficient appliances. It may be possible to reduce some of this bias using either analytical techniques or working to get a more representative number of model number matches by date of manufacture. We recommend that a follow-up study be undertaken to carry out this work.

Several databases were used in this study to match appliance model numbers. These databases are highly limited for the majority of the appliances surveyed for this study. The most problematic limitation is that of the ages of appliances in databases. Older appliances were much more difficult to find matches for than were the newer appliances. Each of the appliance sections below includes a summary table of the number of units matched by date of manufacture. These

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[4] The definition for hot water heater energy factor can be found in the section titled Hot Water Heaters.

tables should be referenced to understand the potential age bias when conducting efficiency analysis.

For the most part, all of the data the study hoped to collect through the on-site surveys was easily collectable. However, in situations where heating and cooling systems were on the roof of the customer's residence we were not able to collect model number data. This is fairly common in the Central Valley and particularly in SMUD service territory. These units are commonly package air conditioners and heat pumps and evaporative cooling systems. Water heater blankets are fairly common and in many circumstances covered the nameplate data. Blankets were not completely removed to collect this information, only slightly moved if easily replaceable.

Introduction

This is the final report for the California Statewide Residential Lighting and Appliance Saturation Study. RLW Analytics Inc. and ASW Engineering conducted the study on behalf of the California Board for Energy Efficiency (CBEE). San Diego Gas and Electric Company managed the study. The steering committee consisted of one member from the National Resource Defense Council (NRDC) and one member from the CBEE. A member from each of the investor owned utilities (PG&E, SCE, SCG, SDG&E), SMUD, the steering committee, RLW Analytics and ASW Engineering comprised the study team.

Background and Goals of the Project

The CPUC is seeking to change conservation programs in California from resource acquisition programs into market transformation programs. To assess the success of these efforts, and specifically to guide public policy and program planning, it is important to characterize the current residential market. To characterize the current residential market, lighting and appliance baseline data is required. Through on-site surveys of California residences, a database of lighting and appliance data was constructed to provide the utilities with baseline information to aid in program design The four investor owned utilities, in addition to SMUD, participated in the study. This report summarizes the on-site survey data that was collected over a four-month period.

There were three primary objectives this study needed to achieve:

Objective 1: Completion of 1,258 on-site surveys of single-family, multi-family and mobile homes throughout the service territories of PG&E, SCE, SDG&E and SMUD.

Objective 2: Development of a user-friendly database of residential lighting and appliance saturation by energy efficiency.

Objective 3: Determine the potential market barriers in the residential market to adopting energy efficient lighting systems.

Approach

RLW and ASW Engineering combined together to form a team that offered considerable coverage of the state of California. RLW is located in the northern California, while ASW is located in southern California. Together, the team was able to cost effectively conduct 1,258 on-site surveys spanning December 1999-March 2000. In the early stages of the study survey instruments were developed by RLW under guidance from the study team. With the integrity of all survey questions intact, the finalized survey was redesigned for a palm-top computer software program (FieldWorker Pro™). Combined with easy to use mini-PC computers, the software was programmed to allow for fast and easy on-site data collection.[5]

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[5] Hewlett Packard (HP) Jornada 680 palm-top computers were used.

While on-site, the surveyors collected data on the major appliances and lighting systems in the home. The surveyors collected nameplate data for the following appliances:

- Refrigerator-Freezer
- Self-standing Freezers
- Dishwashers
- Clothes Washers
- Clothes Dryers
- Water Heaters
- Heating Equipment
- Cooling Equipment

Each lighting fixture and lamp type was surveyed within the home, in addition to the front porch fixture and lamp type. In addition to the lighting and appliance survey data, the on-site surveyors also collected data on attic, floor and wall insulation R-values, wall construction (i.e. 2x4, 2x6, masonry) types, and window type and number of panes.

As the data was collected the auditors uploaded the site data from the palm-top computers to the RLW office. The data was cleaned for any data inconsistencies and imported into the MS Access master database. Using existing databases of appliance efficiencies tabulated by manufacturer and model numbers (i.e. CEC appliance databases, ARI, AHAM, etc.), MS Access queries were designed and written to link on-site data to the efficiency databases based on model number. If linked, the corresponding efficiency was assigned to the matched appliance.

Matching rates varied greatly by appliance type. For example, refrigerators had the highest match rates, while room air-conditioners and clothes dryers had the lowest. One of the key tasks of this project was the search for efficiency databases to link on-site data to. At least one database for each appliance was found with the exception of clothes dryers. Therefor, there are no efficiency results or match rates for clothes dryers in this report. Table 1 shows the final match rates, numbers of each appliance surveyed, number of model numbers found, and percentages of the values for each appliance surveyed.

	All Utilities	Total Number In Database (A)	Model Numbers Found (B)	Model Numbers Matched (C)	% Model Numbers Matched (C/B)	% Model Numbers Not Found (B/A)	% of Total Matched (C/A)
Appliance	**Refrigerators**	1444	1260	865	69%	13%	60%
	Cooling Overall	733	460	300	65%	37%	41%
	Cooling Evap	49	13	0	0%	73%	0%
	Cooling Packaged	117	48	26	54%	59%	22%
	Cooling Split Sys	400	328	268	82%	18%	67%
	Cooling Win Wall	167	71	6	8%	57%	4%
	Furnace	1275	791	339	43%	38%	27%
	Heat Pumps	83	60	30	50%	28%	36%
	Freezers	214	165	51	31%	23%	24%
	Dishwashers	871	849	286	34%	3%	33%
	Washing Machines	965	865	156	18%	10%	16%
	Hot Water Heaters	1074	822	439	53%	23%	41%

Table 1: Model Number Match Rates by Appliance

It was anticipated in the design stages of the project that the match rates would be better than what is shown in Table 1. RLW encountered several problems when matching model numbers using MS Access standard query language (SQL). One of the most troubling problems was that of wildcards (*, /, #, etc.) found in the model numbers. The wildcards added to the complexity of the query designs and decreased matching rates. The "layered" queries searched several databases for matching model numbers. Once the automated process was complete, a manual process of looking up the unmatched appliances was undertaken. There was approximately equal success between the manual and automated process.

Efficiency databases were exhausted using the above protocols for matching appliances. RLW is confident that the great majority of model numbers found on-site were found if they appeared in any of the efficiency databases. The problem with the low matching rates lies in the efficiency databases themselves. Simply put, much of the equipment found in the state of California is not documented in publicly or privately available efficiency databases. Furthermore, the private data (refrigerator-freezer) that was purchased from AHAM was not in the best condition, and somewhat partial in content. Due to cost considerations, the AHAM room air-conditioner database was not purchases for this project. It is our belief that if the AHAM room air-conditioner data had been available the match rates for these units would be much better than the present 8%. This is the only database to our knowledge that could increase any of the match rates presented above in Table 1.

Midway through the project, the study team discussed ways to "slice and dice" the lighting and appliance data for analysis purposes. Those discussions formed the basis for this report and the queries to be delivered with the final analysis database. Once all of the analysis queries were written, each site was given its appropriate weight and the queries were run. Each query was then processed through RLW's Model Based Statistical Sampling (MBSS) software which projected the results to the population.

The analysis for lighting and appliances is summarized in this report on the statewide level, each member of the study team received the analysis database

and software for conducting their own analysis (e.g. by utility, home type, income level, etc.) on the data.

In addition to the lighting and appliance survey, a survey questionnaire was also designed to capture market barrier data on purchases of energy efficient residential lighting systems. To qualify for this "additional" survey, the homeowner must have remodeled their hard-wired lighting systems within the last three years. Data was collected on up to two rooms that were recently remodeled, with those two rooms being the most frequently used.[6] The questions were designed to determine whether home owners were informed about energy efficient lighting technologies at the time of purchase, whether they did in fact purchase efficient lighting systems, and how they learned about energy efficient lighting. This data is summarized in the Market Barriers to Energy Efficient Lighting Chapter.

Future Study Recommendations

The following section summarizes some of the lessons learned by the RLW team and suggests alternative approaches for conducting future studies similar to this one.

First and foremost, RLW does not recommend beginning a study that requires on-site customer visitation during the Christmas and New Year holiday season. On-site surveys for this project began in early December. Appointments during this time were extremely difficult to schedule and difficult for customers to keep. Considerable budget was used on recruiting and missed appointments during this period of the study. Moreover, recruiting refusal rates were much higher during this time of the on-site surveys than it was during the remaining months.

Others who plan to do similar work should not under estimate an automated model number matching process. RLW wrote more complex queries than was expected to automate the model number matching process. Additional time should be budgeted to hand match model numbers that were not successfully matched using the automated process. Furthermore, the best source of heating and cooling equipment efficiencies used by RLW (Carrier Bluebook) is not in a database format. Therefore databases should be combined with as much manufacturer data as possible to get the most comprehensive data as possible.

To have unbiased efficiency information, reviewers should look to contractors that propose to match proportionally the age of units by the number of units in the population by age. For example, in Table 2, 13% of hot water heaters manufactured between 1985 and 1989 were matched, yet 21% of the population's hot water heaters are of this age. An even distribution of percent matched and age distribution of all water heaters would remove bias of efficiency related to age. Only in 1990-1994 do we have a good correlation between the two (28% and 29%). Bidders who propose to proportionally match units by age distribution will remove much of the bias introduced when using only existing databases to match appliances. Contractors will certainly need to work with manufacturers to acquire this more representative data.

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[6] This is true only in cases where there were more than two rooms that qualified for the market barrier survey.

Age	Number of Units Matched	Percent of Units Matched	Age Distribution of all Water Heaters (n = 754)
1995 -2000	183	56%	38%
1990 -1994	91	28%	29%
1985 -1989	41	13%	21%
1980 -1984	9	3%	7%
1979 or older	3	1%	5%
Total	**327**	100%	100%

Table 2: Manufactured Date of Matched Hot Water Heaters

RLW's use of the palm-top computer worked well for all intensive purposes. Using electronic mail, auditors were sent daily appointments and could easily communicate day-to-day events. Furthermore, the palm-top provided easy Internet access for direction finding and other research needs. RLW invested in a relatively new software, *FieldWorker Pro*, as the application to run under Windows CE. This software (including Window CE) like many new software products has bugs. RLW spent some amount of hours working through these bugs. We would recommend using the palm-tops again, but would allocate more time to debugging, data cleaning and uploading. It should be said that the amount of resources saved (i.e., paper, copying, phone calls, faxes) as a result of the palm-tops is extraordinary.

Sample Design

Sampling Plan

Table 3 below documents our sample design. The table shows the residential rate classes served by SCE, SDG&E, PG&E, and SMUD together with the number of accounts in each class (population size).

For SCE, SDG&E, and PG&E, we calculated the percentage of the grand total in each class. Then we calculated the sample size basically by multiplying the desired sample of 1,000 homes by the proportion in each class. In practice several of the classes were so small that the preceding methodology led to less than a single home. So we added the constraint that the sample should be at least 1 from each rate class and adjusted the results proportionately so that the total sample would still be 1,000 for the three utilities. Furthermore, the sampling plan and sample weights allows for each of the utilities to conduct statistically representative analyses for the population of customers at the utility level.

For SMUD, the sample sizes were selected so that the expected relative precision associated with the SMUD sample would be 7%. In other words, the SMUD sample sizes were selected so that the error associated with estimates for the SMUD population alone would be 7% of the estimate.

Utility	Stratum	Stratum Definition	Population Size	Sample Size
SCE	D-APS	Domestic Automatic Powershift	117,621	13
SCE	D-CARE	California Alternate Rates for Energy	489,762	56
SCE	D-CARE-APS	California Alternate Rates for Energy with Domestic Automatic Powershift	8,150	1
SCE	DE	Domestic Service to Utility Employees	11,309	1
SCE	DE-APS	Domestic Service to Utility Employees with Domestic Automatic Powershift	2,437	1
SCE	DOMESTIC	Domestic Service	3,044,603	345
SCE	D-S	Domestic Seasonal	8,577	1
SCE	TOU-D-1	Time-Of-Use Domestic (Usage = 400 - 600 kWh/month)	490	1
SCE	TOU-D-2	Time-Of-Use Domestic (Usage = 600 - 700 kWh/month)	4,057	1
SCE	**SUB TOTAL**		**3,687,006**	**420**
SDG&E	DR	Residential	935,250	106
SDG&E	DRLI	Residential Low Income	113,081	13
SDG&E	DRTOU	Residential Time-of-Use Service	4,081	1
SDG&E	**SUB TOTAL**		**1,052,412**	**120**
PG&E	E1	Residential Services	3,625,084	411
PG&E	E1L	Residential CARE Program Service	230,285	26
PG&E	E7	Residential Time-of-Use Service	106,057	12
PG&E	E7L	Residential CARE Program Time-of-Use Service	1,390	1
PG&E	E8	Residential Seasonal Service Option	81,338	9
PG&E	E8L	Residential Seasonal CARE Program Service Option	3,205	1
PG&E	**SUB TOTAL**		**4,047,359**	**460**
SMUD	MULTI EAPR ELE	Multi-Family Low Income Electric Heat	4,796	20
SMUD	MULTI EAPR GAS	Multi-Family Low Income Gas Heat	5,038	40
SMUD	MULTI STD ELE	Multi-Family Standard Rate Electric Heat	45,659	20
SMUD	MULTI STD GAS	Multi-Family Standard Rate Gas Heat	44,255	40
SMUD	SINGLE EAPR ELE	Single-Family Low Income Electric Heat	2,688	20
SMUD	SINGLE EAPR GAS	Single-Family Low Income Gas Heat	9,781	40
SMUD	SINGLE STD ELE	Single-Family Standard Rate Electric Heat	57,941	20
SMUD	SINGLE STD GAS	Single-Family Standard Rate Gas Heat	245,983	60
SMUD	**SUB TOTAL**		**416,141**	**260**
TOTAL	**TOTAL**		**9,202,918**	**1,260**

Table 3: Sample Size by Utility

Final Sample

Table 4 shows the final sample along with the weight associated with each stratum. For most strata, the final sample size is identical to the original sample design. Note that the weights for SMUD strata tend to be quite a bit smaller than the weights for the other three utilities. This reflects the fact that the SMUD population was more heavily sampled than the other three utilities.

Utility	Stratum	Stratum Definition	Population Size	Sample Size	Weight
SCE	D-APS	Domestic Automatic Powershift	117,621	18	6,535
SCE	D-CARE	California Alternate Rates for Energy	489,762	54	9,070
SCE	D-CARE-APS	California Alternate Rates for Energy with Domestic Automatic Powershift	8,150	2	4,075
SCE	DE	Domestic Service to Utility Employees	11,309	1	11,309
SCE	DE-APS	Domestic Service to Utility Employees with Domestic Automatic Powershift	2,437	1	2,437
SCE	DOMESTIC	Domestic Service	3,044,603	339	8,981
SCE	D-S	Domestic Seasonal	8,577	2	4,289
SCE	TOU-D-1	Time-Of-Use Domestic (Usage = 400 - 600 kWh/month)	490	1	490
SCE	TOU-D-2	Time-Of-Use Domestic (Usage = 600 - 700 kWh/month)	4,057	2	2,029
SCE	**SUB TOTAL**		**3,687,006**	**420**	
SDG&E	DR	Residential	935,250	106	8,823
SDG&E	DRLI	Residential Low Income	113,081	13	8,699
SDG&E	DRTOU	Residential Time-of-Use Service	4,081	1	4,081
SDG&E	**SUB TOTAL**		**1,052,412**	**120**	
PG&E	E1	Residential Services	3,625,084	409	8,863
PG&E	E1L	Residential CARE Program Service	230,285	26	8,838
PG&E	E7	Residential Time-of-Use Service	106,057	12	7,394
PG&E	E7L	Residential CARE Program Time-of-Use Service	1,390	1	8,857
PG&E	E8	Residential Seasonal Service Option	81,338	11	1,390
PG&E	E8L	Residential Seasonal CARE Program Service Option	3,205	1	3,205
PG&E	**SUB TOTAL**		**4,047,359**	**460**	
SMUD	MULTI EAPR ELE	Multi-Family Low Income Electric Heat	4,796	20	240
SMUD	MULTI EAPR GAS	Multi-Family Low Income Gas Heat	5,038	39	129
SMUD	MULTI STD ELE	Multi-Family Standard Rate Electric Heat	45,659	20	2,283
SMUD	MULTI STD GAS	Multi-Family Standard Rate Gas Heat	44,255	40	1,106
SMUD	SINGLE EAPR ELE	Single-Family Low Income Electric Heat	2,688	20	134
SMUD	SINGLE EAPR GAS	Single-Family Low Income Gas Heat	9,781	40	245
SMUD	SINGLE STD ELE	Single-Family Standard Rate Electric Heat	57,941	20	2,897
SMUD	SINGLE STD GAS	Single-Family Standard Rate Gas Heat	245,983	59	4,169
SMUD	**SUB TOTAL**		**416,141**	**258**	
TOTAL	**TOTAL**		**9,202,918**	**1,258**	

Table 4: Final Sample

Figure 1 through Figure 5 detail the site locations of the four utility's final samples as well as the statewide sample. Each diamond represents a zip code where a house or houses were surveyed.
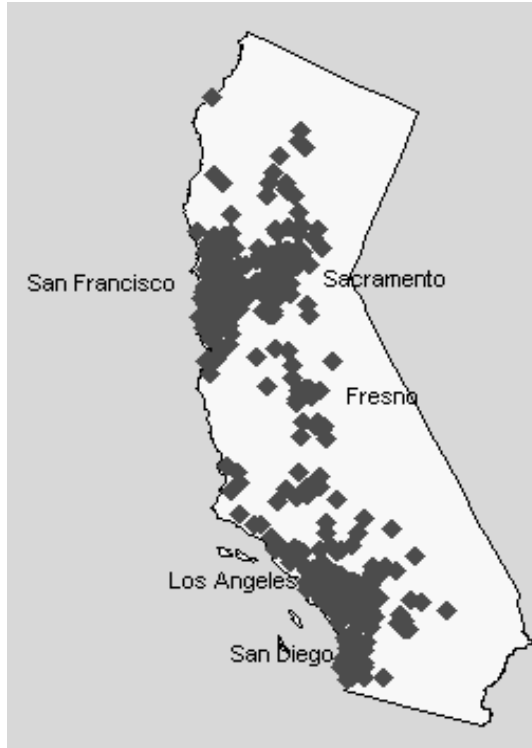
Figure 1: Statewide Final Sample Location

Figure 2: PG&E Final Sample Location
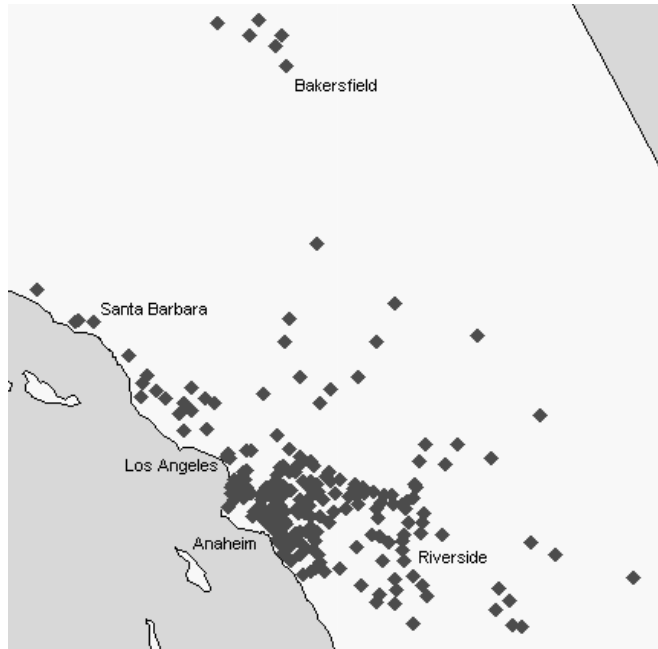
Figure 3: SCE Final Sample Location

Figure 4: SDG&E Final Sample Location
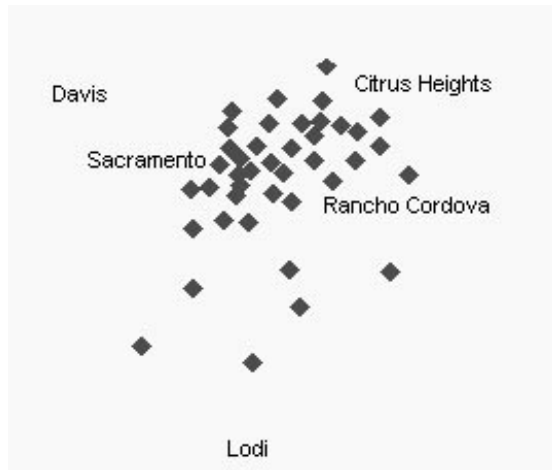
Figure 5: SMUD Final Sample Location

Data Collection

Overview

The data collection component of the study was highly resource intensive, taking the better part of four months to complete. The data collection began during the month of December 1999 and ended at the end of March 2000. Due to the holiday season, very few on-sites were completed during December and early January due to low customer willingness to participate.

ASW Engineering completed the on-site surveys in the territories of San Diego Gas and Electric, Southern California Edison, Southern California Gas, and the southern most regions of PG&E service territory. RLW Analytics field staff surveyed sites in PG&E and SMUD territory. A total of 21 surveyors were used to complete the 1,258 on-site surveys.

Each auditor participated in a one-day training session. The training was focused on demographic, lighting and appliance, and market barrier data to be collected while in the field. Additionally, the auditors were trained to use the palm-top computers, including data entry using FieldWorker Pro, data uploading and downloading and Internet access. Two training sessions were held, one in Tustin for the ASW auditors, the other in Sonoma for the RLW auditors.

Twenty-five on-sites were piloted during the initial stages of data collection. After the twenty-five pilot sites were completed the survey instrument was reviewed for completeness and modified to reflect unanticipated field observations. The final survey instrument was then modified in the FieldWorker Pro software for each of the palm-top computers for use in the remaining on-sites.

Recruiting

RLW and ASW recruited customers based on their geographic location. In general, RLW recruited in the northern part of California, and ASW the southern region. A twenty-five-dollar incentive was offered to customers that agreed to participate in the study. The recruiters scheduled appointments between the hours of 9AM and 8PM. The recruiting manager dispatched the information electronically to the field surveyors at the end of each day. In all, 1,258 sites were recruited to participate in the study, Table 5 shows the number of sites recruited and surveyed per utility service territory.

Service Territory	Number of Sites Recruited
PG&E	460
SCE/SCG	420
SDG&E	120
SMUD	258

Table 5: Number of Sites Recruited by Service Territory

Generally, the recruiters made up to seven attempts to recruit the customer's participation. If unsuccessful after the seventh call the customer was replaced

with a back-up customer. Table 6 summarizes the disposition codes and final outcome for customers that the recruiters attempted to contact during the study. PG&E had the highest refusal rate of the utilities. During recruiting we found a higher refusal rate among customers living in the south bay (San Jose metropolitan area) than we did in other parts of the PG&E service area. This is the biggest contributor to the high refusal rate among PG&E customers.

RLW and ASW took a slightly different approach to leaving messages; on the third message RLW recruiters would explain the reason for the call and leave a number that they could call to either refuse or accept participation in the study. This approach was not used for SCE or SDG&E customers by the ASW recruiters. The difference in approach explains whey the PG&E and SMUD refusal rates are higher than SCE and SDG&E, and also why the final outcomes for "left message" are higher for SCE and SDG&E.

	PG&E		SCE		SDG&E		SMUD		Statewide	
	Count	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**
Appointment Completed	460	19%	420	15%	120	21%	258	22%	1,258	18%
Appointment Scheduled but Not Completed	41	2%	49	2%	13	2%	21	2%	124	2%
Left Message	203	8%	403	14%	75	13%	73	6%	754	11%
Call Back Later	58	2%	146	5%	18	3%	47	4%	268	4%
Busy	5	0.2%	39	1%	3	0.5%	12	1%	59	0.8%
No Answer	104	4%	204	7%	23	4%	57	5%	389	6%
Refused	1,054	44%	672	24%	116	20%	332	29%	2,174	31%
Wrong or No Number	386	16%	774	27%	184	32%	319	28%	1,663	24%
Communication Barrier	75	3%	81	3%	14	2%	38	3%	208	3%
Vacant Address	6	0.3%	59	2%	6	1%	0	0%	71	1%

Table 6: Recruiting Final Outcome by Service Territory

SMUD has the highest conversion rate, at 22%. This is most likely explained by the fact that half of their customers were sampled from their low-income rate class, where a twenty-five-dollar incentive is more attractive. SCE had the lowest conversion rate of 15%, a result of a large majority of wrong numbers, refusals and un-returned phone calls.

On-Site Survey Data

The study team developed a list of data and data attributes to be collected during the on-site surveys. A palm top computer was given to each surveyor loaded with fieldworker software. The software consisted of a series of screens to be filled during the course of the site visit.

The following data were collected at all sites by the field surveyors. For further detail refer to the on-site survey instrument in the appendix,

Demographics

A list of demographic data was developed by the study team to be collected by the field surveyors. The following demographic data was collected:

♦ Type of residence

♦ Number of residents by age

♦ Primary language of residents

♦ Total annual income for the home

♦ Year residence was built

♦ Total heated floor space of the home

♦ Has the home been remodeled in last 10 years, if so what was the nature of the remodel (i.e. appliances, hard-wired lights, cosmetic, which rooms)

♦ Are there plans to remodel in the future

♦ Whether the residence is rented or owner occupied

♦ If rented, the party responsible for the utility bills, (owner or renter)

♦ If rented, the owner of the refrigerator, washing machine, dryer and air conditioner

The remainder of this section contains tables that summarize the demographic characteristics of the sample. These results have not been weighted to reflect the population.

Table 7 shows the percentage of homes by type of residence. Over 43% of all the residences are single family, unattached, 1-story dwellings. The second most commonly visited type of residence was 1-2 story apartments, totaling 22.3% of the sample.

Type of Residence	% of Homes
Apt(1 or 2 stories)	22.3%
Apt(3 or more stories)	4.1%
Duplex-Triplex-or Quadplex	6.5%
Mobile Home-Double Wide	1.7%
Mobile Home-Single Wide	0.5%
Modular/prefabricated	0.6%
Single Family-Unattached- >2 stories	1.1%
Single Family-Unattached-1 story	43.4%
Single Family-Unattached-2 story	16.7%
Townhouse or Rowhouse	2.8%
Other-Triple Wide	0.2%
Other-Flat Over Commercial Prop.	0.1%
Other-Granny Unit	0.1%

Table 7: Percentage of Homes by Type of Residence

Table 8 shows the percentage of homes by number of people occupying the home. The largest percentage of homes, or 32.0% of homes, have 2 occupants. However, it was also common to visit homes with 1, 3, or 4 occupants. The average number of people per home is 2.8 people.

Total Number of People	% of Homes
1	19.7%
2	32.0%
3	18.0%
4	17.5%
5	6.4%
6	3.7%
7	1.3%
8	0.6%
9	0.2%
10	0.3%
Vacant	0.4%

Table 8: Percentage of Homes by Number of People[7]

Table 9 shows the percentage of homes by number of adults occupying the home. Not surprisingly, over half of homes, or 56.0%, have 2 adults present.   The average number of adults per home is 1.9.

Total Number of Adults	% of Homes
1	27.6%
2	56.0%
3	10.9%
4	3.3%
5	1.2%
6	0.3%
7	0.1%
Vacant	0.7%

Table 9: Percentage of Homes by Number of Adults

Table 10 shows the percentage of homes by primary language. Not surprisingly, english was the primary language spoken at over 89% of the homes. Spanish was the second most common language, with over 5% of all respondents speaking Spanish as their primary language.

[7] A few homes were found to be vacant after the surveyor went to the site.

Primary Language	% of Homes
Chinese	1.3%
English	89.7%
French	0.2%
Indian	0.2%
Japanese	0.3%
Korean	0.2%
Other	1.7%
Russian	0.2%
Spanish	5.1%
Tagalog	0.8%
Vietnamese	0.2%

Table 10: Percentage of Homes by Primary Language

Table 11 shows the percentage of homes by total household income. Interestingly, over 21% of the residents have an annual income under $25,000. The largest percentage or residents have an annual income between $25,000 and $50,000, totaling almost 25% of the sample.

Total Household Income	% of Homes
< $25000	21.8%
$25001 - $50000	24.6%
$50001 - $75000	15.6%
$75001 - $100000	10.9%
> $100000	8.9%
Don't Know	6.2%
Vacant	0.4%
Refused	11.7%

Table 11: Percentage of Homes by Total Household Income

Table 12 shows the percentage of homes by age of home. The age of homes was evenly distributed among the age ranges, with homes built in the 1970s and 1980s being slightly more common in the sample.

Age Range	% of Homes
1950 - 1954	5.1%
1955 - 1959	5.2%
1960 - 1964	7.6%
1965 - 1969	7.0%
1970 - 1974	9.7%
1975 - 1979	8.7%
1980 - 1984	5.9%
1985 - 1989	10.5%
1990 - 1994	7.0%
1995 - 2000	5.8%
Don't Know	16.9%
Older Than 1950	10.5%

Table 12: Percentage of Homes by Age Range of Home

Table 13 shows the percentage of homes by the total heated floorspace of the homes. Almost 60% of the homes surveyed were between 600 to 1,599 sqft.

Total Heated Floorspace	% of Homes
Fewer than 600 square feet	4.8%
600 to 999 square feet	23.1%
1000 to 1599 square feet	36.7%
1600 to 1999 square feet	16.4%
2000 to 2399 square feet	7.9%
2400 to 2999 square feet	6.5%
3000 or more square feet	2.9%
Don't Know	1.7%

Table 13: Percentage of Homes by Total Heated Floorspace

Table 14 shows the percentage of homes by whether the home was remodeled in the last 10 years. The overwhelming majority of residences have not been remodeled, totaling 68.9% of the homes.

Remodeled in Last 10 Years	% of Homes
No	68.9%
Yes	24.2%
Don't Know	6.9%

Table 14: Percentage of Homes that were Remodeled in Last 10 Years

Table 15 shows the percentage of homes by type of remodel among those homes that were remodeled in the last 10 years. Almost 30% of homes were remodeled cosmetically, while 24% were completely remodeled. In the table below, "Cosmetic" stands for "Cosmetic/Other" types of remodels, and "Lighting" stands for "Lighting (hard wired fixtures only)".

Type of Remodel	% of Homes that were Remodeled
All	24.0%
Cosmetic Only	29.9%
Kitchen Appliances Only	8.2%
Lighting Only	5.9%
Cosmetic and Lighting Only	12.5%
Cosmetic and Kitchen Appliances Only	11.8%
Lighting and Kitchen Appliances Only	6.9%
Don't Know	0.7%

Table 15: Percentage of Homes that were Remodeled by Type of Remodel

Table 16 shows the percentage of residents that plan to remodel in the next 2 years. Interestingly, almost three-quarters of the residents replied that they have no plans to remodel.

Plan to Remodel in Next 2 Years	% of Homes
No	74.9%
Yes	14.1%
Don't Know	11.0%

Table 16: Percentage of Residents that Plan to Remodel in Next 2 Years

Table 17 shows the percentage of homes by type of ownership. Over 60% of homes were occupied by owners. Renters constituted 39% of the sample, while those who occupied residences without paying rent constituted 0.3% of the sample.

Rent or Own	% of Homes
Occupied without payment of rent	0.3%
Own/Buying	60.7%
Rent	39.0%

Table 17: Percentage of Homes by Ownership Type

All renters and all other non-owners of the residences that were surveyed were asked who owned the air conditioner, refrigerator, washing machine, and dryer in the residence if the appliance was present.

Table 18 shows the owners of the four aforementioned appliances among all residences with the appliances that were occupied by non-owners. Not surprisingly, the largest percentage of washing machines were located in common areas. Interestingly, among those washing machines that were located in the actual residence, occupant-owned washing machines were more common than landlord-owned.

	Landlord		Occupant		In Common Area		
	Percentage	**Error Bound**	**Percentage**	**Error Bound**	**Percentage**	**Error Bound**	**Sample Size**
Air Conditioner	91.0%	3.5%	7.8%	3.3%	1.2%	1.3%	317
Refrigerator	57.1%	4.3%	42.9%	4.3%	-	-	494
Washing Machine	16.3%	3.3%	38.6%	4.4%	45.1%	4.5%	442
Dryer	17.3%	3.5%	35.9%	4.4%	46.8%	4.6%	426

Table 18: Owner of Appliances Among All Non-Owners of Residences

Table 19 shows the percentage of homes that are occupied by non-owners that have gas or electric by who pays for each fuel type. Among all non-owners with electricity, 96.8% responded that they pay for the electricity, and only 2.9% stated that their landlord paid for their electricity. Among all non-owners with gas, only 87.9% pay for their own gas bill, while 11.4% of landlords pay for the gas bill.

	Landlord		Occupant		Don't Know		
	Percentage	**Error Bound**	**Percentage**	**Error Bound**	**Percentage**	**Error Bound**	**Sample Size**
Electricity Costs	2.9%	1.5%	96.8%	1.5%	0.3%	0.5%	494
Gas Costs	11.4%	2.8%	87.9%	2.9%	0.6%	0.7%	456

Table 19: Who Pays for Electric and Gas Among All Non-Owners of Residences

Appliances

Data was collected for heating systems cooling systems, washing machines, clothes dryers, dishwashers, refrigerator/freezers, self-standing freezers and water heaters. No data was collected on stoves or small appliances.

♦ The residents were asked for the age of each appliance. If the resident did not know the age of the appliance, the surveyor would estimate the age or the appliance whenever possible.

♦ The classification of each appliance by type of was observed from visual inspections of the appliances and recorded. Appliance types that were noted include; standard or horizontal axis washers, and side by side, freezer on bottom, freezer on top or other refrigerator freezers, among others.

♦ Fuel types, such as electricity, natural gas or propane for heating systems, washing machines and water heaters were noted from visual inspection.

♦ The manufacturer, model number and size were taken from nameplate data when observable. If possible, sizes of some appliance were estimated in the case of missing, or unreadable data tags.

♦ Residents were asked to estimate the percentage of time in use for refrigerators and freezers to establish seasonal usage.

♦ Various features relating to energy efficiency were noted such as the existence of a through the door water dispenser for refrigerator freezers or insulation levels for water heaters.

Lighting

Every lighting fixture in each residence was inventoried by fixture type, number of lamps and by lamp type. Special emphasis was placed on front porch and kitchen lighting. Fixture wattages were noted for the "kitchen light used most often". Kitchen light switches were also inventoried and noted for dimming capabilities and control over kitchen "downlights". Front porch lighting control schemes such as manual, timer, light sensor or motion sensor were also collected.

Insulation

The insulation levels of the floor, walls and attic were obtained by visual inspection if possible. Efforts were made to estimate the insulation levels through discussions with the residents and based on educated judgment (i.e. wall construction 2x4, 2x6, home age, etc.) when no visual observations were possible.

Windows

The surveyor recorded the predominant window frame construction, wood, metal or vinyl, found in the home was noted, as was the number of panes found of the predominant window type.

Supplemental Market Barrier Survey

A supplemental market barrier survey was given to all residents who remodeled the hard-wired lighting within the past three years. The surveyors completed 36 surveys concerning the selection of the lighting installed during the recent remodel. Details and results of this survey are discussed in the section titled Market Barriers to Energy Efficient Lighting. A copy of the survey instrument is included in the appendix.

Database

Overview

The data collected during the 1258 on-site visits are contained in two final databases. One database contains all appliance and envelope information, and the other contains all the lighting information. These two databases to be delivered will be in MS Access format. In addition to the auditor information collected on site, the appliance database contains all information linked from the efficiency databases that pertains to the models in the sample, and contains the efficiency categories that were created in order to analyze the data.

The data on each appliance in the appliance database are located in a separate table. Queries have been set up that allow the user to analyze some key questions for each appliance. The same is true of the lighting database. All of the summary tables in this report have been obtained from queries conduted on the project database.

The following is a list of the steps that were taken to ready the databases for delivery:

- ➢ Consolidation of Auditor Information
- ➢ Cleaning of Auditor Information
- ➢ Merge of Weights
- ➢ Acquisition of Efficiency Databases to Link with Auditor Data
- ➢ Creation of Efficiency Categories
- ➢ Creation of Analysis Queries
- ➢ Development of Database Summarization Tool

This section contains a description of the databases and the steps taken to prepare the databases for analysis and delivery, however for a complete description of each table and query see the appendix to this report.

Consolidation of Auditor Information

During the site visit, the auditors entered all information directly into a palmtop computer as the survey was completed. The data that resulted from this form of data collection was in the form of multiple records for each site in one spreadsheet, regardless of the appliance.

Each auditor sent their site information in electronic text format to the offices of RLW where it was integrated into a central database using a VB program specifically designed to manipulate the data in the spreadsheet into the individual appliance tables. This was essential in order to enable the analysts to compare the saturation of different appliances in different markets.

Merge of Weights

Once the sites were merged and cleaned in the central database, the sample design case weights for the analysis were merged into the database in the 'General Information' table. Each site in a given stratum was given a corresponding case weight that we define to be the number of sites in the population that the site is thought to represent. These weights were used to expand the sample to the population. See the sample design section of this report for an explanation on how the weights were calculated. Once the weights were merged, all the lighting data were pasted into a separate database so the databases were more manageable.

Data Sources

Several data sources were used in conjunction with the on-site data. RLW invested more time than anticipated manually linking sites as a result of model number wild cards and irregular alphanumeric characters such as dashes, hyphens, slashes, stars, and other text. These characters made automated matching difficult and resulted in a more rigorous model number matching effort. Furthermore, the best source of information we found for heating and cooling efficiencies was Carriers Electronic Blue Book of Heating and Cooling Equipment. We had great success matching model numbers using this software, however it required looking up each model number in a slow and tedious process that was not anticipated to be necessary early on. Other heating and cooling databases used to match were CEC and ARI databases. The difficulty in automated matching of model numbers should not be underestimated by anyone wishing to conduct this type of study in the future.

Matching model numbers for refrigerator-freezers was a more successful process. The CEC database of refrigerators was used in combination with the Association of Home Appliance Manufacturers (AHAM) historical database of refrigerator-freezers. Between these databases we were able to match nearly 70% of the model numbers found for refrigerators. All other appliances were matched using the appropriate CEC efficiency database attained over the internet.

Merging of Saturation and Efficiency Information

The auditors were able to observe make and model number on-site, but in most cases, not energy efficiency. The RLW team used all available resources to match the model numbers collected on-site with a reliable source of efficiency ratings and/or Unit Energy Consumption (UEC).Other sources included the aforementioned CEC databases, ARI databases (for HVAC), AHAM databases, manufacturer-supplied information and other relevant sources of efficiency information.

We matched the on-site information by model number with standard efficiency ratings for each end-use. For example, in the case of residential cooling, the energy efficiency rating is provided in SEER, or Seasonal Energy Efficiency Ratio units. End-uses that do not have an associated standard efficiency rating (e.g., refrigerators) are characterized in terms of annual unit energy consumption or UEC.

Creation of Efficiency Categories

Efficiency categories were developed for each appliance type depending on the distribution of the efficiencies. Size and age categories were also created for each appliance. The size ranges were determined by the distribution of the sizes of each appliance. The age ranges for each appliance were broken into 5 or 6 year increments, starting with 1995-2000, then 1990-1994, and so on until the last category of 1974 and older. The efficiency, size and age categories were linked to the auditor information using logic statements built into the analysis queries. These categories are not difficult to adjust if the user finds it necessary to do so.

Creation of Analysis Queries

Analysis queries for each appliance were created in MS Access in order to answer some key questions on market saturation. These queries were designed to analyze each appliance by age, type, size, and any other energy consumption or efficiency variable. Analysis queries were also established for the lighting database. These analysis queries were designed specifically for the Model Bases Statistical Sampling (MBSS) program to analyze the data using ratio estimation techniques. More information on the format of each query is provided in the appendix.

Development of Database Summarization Tool

The final big challenge to the success of this project was to make the database user-friendly. To meet this challenge, we provided a variant of the analysis software developed for a CEC Nonresidential New Construction Database project and used extensively in the CBEE Nonresidential New Construction Baseline study. In these prior studies we faced the challenge of providing analysis software that would implement stratified ratio estimation using an Access database of complex building characteristics. We created a Visual Basic application of MBSS that would select one or more queries in the database, carry out the statistical calculations of stratified ratio estimation, and create tables in the database with the results desired. The application tailored for this project has the ability to:

➢ Calculate ratio estimates, (e.g., of the saturation level of a set of appliances), classified by any available categorical variable such as age of home, residence type, or utility service territory.

➢ Calculate the underlying sample sizes

➢ Calculate the appropriate model-based error bounds

➢ Calculate proportions (i.e., proportion of all cooling units that are space vs. central)

This software can be used to create one-way, two-way or multi-way tables categorizing the market share of specified appliances and measures by any specified dimensions. The resulting tables can be easily exported to Excel and displayed graphically. This software was used to create the graphs shown in the writing sample given in the Appendix. The software provided is fully

documented in the Appendix, and a help file is available within the software if the user encounters any problems.

The following is a list of some examples of the types of weighted statistics that can be obtained from the database:

- ➢ Average Efficiency of primary HVAC and other equipment

- ➢ Percentage of Homes with two or three refrigerators

- ➢ Average Energy Usage or Wattage of Equipment

This type of information can be developed for all sites, or for various classifications of residences. Using the standard queries that we provide in the database, the sites can be classified by any combination of the following variables:

- ➢ Level of Efficiency (by End Use)

- ➢ Utility Service Territory

- ➢ Type of Residence

- ➢ Size of Household (Total People or Total Adults)

- ➢ Square Footage

- ➢ Household Income

- ➢ Primary Language

- ➢ Age of Home

- ➢ Rent or Own

- ➢ Remodeled in Last 10 years

- ➢ Stratum

Very few of the results provided in this report are grouped by the aforementioned demographic data. The intent of the study was to collect the data, build a database of information, and provide the utilities with a tool by which they could analyze the data. Given this, only top-level analysis was conducted for reporting purposes. However, where the data was thought to differ drastically by the demographics of the household, the data was grouped by the appropriate characteristic.

Data Analysis

Lighting

This section of this chapter presents findings from the lighting analysis. A total of 1255 residences are included in the lighting analysis; lighting data is missing for three sites because of a palmtop computer malfunction. Data regarding the number of fixtures and lamps per home, average number of lamps per fixture, percentage of homes having a certain fixture or lamp type[8], and the prevalence of compact fluorescent lamps is presented. A more specific overview is provided for recessed cans, torchieres, and ceiling fans. For each room type, the percentage of homes with a certain fixture type and lamp type is presented. For porch lights, the percentage of homes with a given lamp type and control type is provided.

In order to determine the saturation levels of ceiling fans with and without lamps, data was collected and analyzed for all ceiling fans, including ceiling fans that are not designed to contain lamps. For kitchen lighting, data was collected and analyzed for the kitchen light that is used most often as well as all kitchen lighting. A more in-depth analysis is provided for the kitchen light that is used most often since it is believed that this is the light in the home that is operating for the most number of hours per day.

Throughout the lighting analysis, the room type "other" is given as a category of room. The Other room type is includes attics, bars, basements, exercise rooms, game/play rooms, music rooms, sewing rooms, as well as pool houses.

Lighting Overview

Table 20 presents the average number of fixtures and lamps per home by type of residence. Overall, homes have approximately 20 fixtures and 34 lamps on average. As might be expected, apartments and duplexes/triplexes/quadplexes have significantly fewer fixtures and lamps on average than do single family, unattached residences. Interestingly, two story homes have a slightly higher number of lamps than do homes with more than two stories, even though they have slightly more fixtures than two story homes. However, the sample size for homes greater than two stories is too low to draw any solid conclusions.

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[8] For a complete list and definition for lamp and fixture types refer to the Appendix.

	Fixtures		Lamps		
Type of Residence	**Average #**	**Error Bound**	**Average #**	**Error Bound**	**Sample Size**
Overall	19.72	0.69	33.82	1.16	1255
Apt(1 or 2 stories)	11.43	0.70	18.89	1.38	281
Apt(3 or more stories)	10.49	1.14	16.37	2.00	51
Duplex-Triplex-or Quadplex	10.92	0.82	16.19	1.64	82
Mobile Home-Double Wide	18.21	2.66	29.28	5.66	21
Mobile Home-Single Wide	12.81	3.13	19.14	6.64	6
Modular/prefabricated	20.16	1.47	37.42	5.26	7
Other	20.64	5.25	36.80	8.60	4
Single Family-Unattached- >2 stories	32.67	6.49	51.51	12.81	14
Single Family-Unattached-1 story	20.37	0.98	35.23	1.53	544
Single Family-Unattached-2 story	31.10	1.90	55.03	3.09	210
Townhouse or Rowhouse	18.36	1.74	30.83	3.11	35

Table 20: Average Number of Fixtures/Lamps by Type of Residence

Table 21 displays the average number of fixtures per home by fixture type. The most common fixture types are ceiling mount and table lamp, with homes having an average of 5.6 ceiling mount and 3.7 table lamp fixtures. Also, homes have, on average, 2.4 recessed cans and 2.3 wall mount fixtures. Table 21 also tells us that each home has just over one ceiling fan.

Fixture Type	**Average # of Fixtures (n = 1255)**	**Error Bound**
All Fixture Types	**19.72**	**0.69**
Architecturally Integrated	0.31	0.08
Ceiling Fan	1.11	0.08
Chandelier / Hanging	1.30	0.08
Ceiling Mount	5.57	0.20
Floor Lamp	0.83	0.06
Garage Door Opener	0.15	0.02
Other	0.06	0.02
Recessed Can	2.37	0.36
Recessed Lighting - Other	1.02	0.12
Table Lamp	3.69	0.15
Torchiere	0.36	0.04
Track Lighting	0.38	0.07
Under Counter	0.24	0.04
Wall Mount	2.33	0.11

Table 21: Average Number of Fixtures by Fixture Type

Table 22 presents the percentage of all fixtures that are a certain type. Nearly 30% of all fixtures are ceiling mounts, while almost 20% are table lamps. Over 10% of all fixtures are recessed cans or wall mounts.

Fixture Type	% of Total Fixtures (n = 1255 Homes)	Error Bound
All Fixture Types	**100.0%**	
Architecturally Integrated	1.6%	0.4%
Ceiling Fan	5.6%	0.4%
Chandelier / Hanging	6.6%	0.4%
Ceiling Mount	28.2%	1.0%
Floor Lamp	4.2%	0.3%
Garage Door Opener	0.8%	0.1%
Other	0.3%	0.1%
Recessed Can	12.0%	1.5%
Recessed Lighting - Other	5.2%	0.6%
Table Lamp	18.7%	0.7%
Torchiere	1.8%	0.2%
Track Lighting	1.9%	0.4%
Under Counter	1.2%	0.2%
Wall Mount	11.8%	0.5%

Table 22: Percentage Fixture Types

Table 23 displays the percentage of homes having each fixture type. Over 85% of all homes are equipped with a ceiling mount, a table lamp, or a wall mount. About half of homes have a ceiling fan or floor lamp, while about three-fifths of homes have a chandelier / hanging fixture. About a third of homes have recessed cans or other recessed lighting present.

Fixture Type	% of Homes (n = 1255)	Error Bound
Architecturally Integrated	11.4%	1.6%
Ceiling Fan	49.4%	2.5%
Chandelier / Hanging	59.8%	2.5%
Ceiling Mount	97.1%	0.8%
Floor Lamp	48.2%	2.5%
Garage Door Opener	14.3%	1.7%
Other	2.9%	0.8%
Recessed Can	32.8%	2.4%
Recessed Lighting - Other	31.9%	2.3%
Table Lamp	86.8%	1.7%
Torchiere	21.7%	2.1%
Track Lighting	12.3%	1.6%
Under Counter	12.2%	1.6%
Wall Mount	85.2%	1.8%

Table 23: Percentage of Homes with Fixture Types

Table 24 shows the distribution of the number of fixtures per home. About two-fifths of homes have a total of eleven to twenty fixtures. Approximately 6% of homes have more than 40 fixtures present.

Number of Fixtures	% of Homes (n = 1255)	Error Bound
1 - 10	22.7%	2.1%
11 - 20	42.7%	2.5%
21 - 30	19.9%	2.0%
31 - 40	8.6%	1.4%
41 - 50	3.0%	0.8%
>50	3.1%	0.9%

Table 24: Distribution of Number of Fixtures per Home

Table 25 presents the distribution of the number of fixtures per home by residence type. As might be expected, apartments, mobile homes, and duplexes/triplexes/quadplexes have significantly fewer fixtures on average than do single family, unattached residences.

Type of Residence	1 - 10 Fixtures		11 - 20 Fixtures		21 - 30 Fixtures		31 - 40 Fixtures		41 - 50 Fixtures		>50 Fixtures		Sample Size
	% of Homes	Error Bound	% of Homes	Error Bound	% of Homes	Error Bound	% of Homes	Error Bound	% of Homes	Error Bound	% of Homes	Error Bound	
Overall	22.7%	2.1%	42.7%	2.5%	19.9%	2.0%	8.6%	1.4%	3.0%	0.8%	3.1%	0.9%	1255
Apt(1 or 2 stories)	56.1%	5.7%	37.6%	5.6%	5.2%	2.5%	0.7%	0.9%	-	-	0.5%	0.8%	281
Apt(3 or more stories)	60.4%	12.0%	37.3%	11.9%	2.3%	3.7%	-	-	-	-	-	-	51
Duplex-Triplex-or Quadplex	52.6%	10.5%	45.4%	10.5%	2.0%	2.8%	-	-	-	-	-	-	82
Mobile Home-Double Wide	12.8%	13.7%	50.6%	20.4%	30.3%	18.7%	6.3%	10.1%	-	-	-	-	21
Mobile Home-Single Wide	19.4%	28.6%	80.6%	28.6%	-	-	-	-	-	-	-	-	6
Modular/prefabricated	-	-	64.2%	37.0%	35.4%	37.0%	0.4%	0.7%	-	-	-	-	7
Other	12.6%	18.2%	50.3%	51.9%	37.1%	49.5%	-	-	-	-	-	-	4
Single Family-Unattached- >2 stories	-	-	22.3%	18.6%	25.6%	19.0%	14.9%	15.9%	22.3%	18.6%	14.8%	15.9%	14
Single Family-Unattached-1 story	12.2%	2.5%	51.8%	3.7%	21.8%	3.0%	8.9%	2.1%	3.4%	1.3%	1.8%	0.9%	544
Single Family-Unattached-2 story	2.4%	1.7%	22.6%	4.9%	36.1%	5.7%	22.0%	4.9%	6.2%	2.8%	10.7%	3.6%	210
Townhouse or Rowhouse	3.7%	5.6%	57.7%	15.1%	38.6%	14.9%	-	-	-	-	-	-	35

Table 25: Distribution of Number of Fixtures per Home by Residence Type

Table 26 displays the percentage of fixtures containing a compact fluorescent lamp by fixture type. Overall, nearly 1% of fixtures contain a compact fluorescent lamp. Torchieres are most likely to contain a compact fluorescent lamp, with about 1.5% of all torchieres having such a lamp. Approximately 1% of ceiling mounts, floor lamps, and table lamps have a compact fluorescent lamp installed.

Fixture Type	% Fixtures With CFL	Error Bound	Sample Size (# Homes)
Overall	0.8%	0.1%	1255
Architecturally Integrated	0.6%	0.7%	132
Ceiling Fan	0.7%	0.4%	644
Chandelier / Hanging	0.4%	0.3%	728
Ceiling Mount	1.0%	0.2%	1211
Floor Lamp	1.0%	0.5%	586
Recessed Can	0.4%	0.2%	380
Recessed Lighting - Other	1.1%	0.6%	398
Table Lamp	1.2%	0.3%	1085
Torchiere	1.5%	1.0%	298
Track Lighting	0.3%	0.4%	146
Wall Mount	0.6%	0.2%	1083

Table 26: Fixtures Containing Compact Fluorescent Lamps

Table 27 shows the average number of lamps per fixture by fixture type. Chandeliers/Hanging fixtures tend to contain more lamps (3.44 lamps) than any other fixture type. Ceiling fans contain 2.72 lamps on average. Recessed cans and torchieres contain the fewest number of lamps, with each of these fixtures containing approximately one lamp on average.

| Fixture Type | Lamps per Fixture | | |
	Average	Error Bound	Sample Size (# Homes)
Architecturally Integrated	1.62	0.15	132
Ceiling Fan	2.72	0.10	644
Chandelier / Hanging	3.44	0.14	728
Ceiling Mount	1.56	0.03	1211
Floor Lamp	1.34	0.06	586
Garage Door Opener	1.29	0.12	174
Other	1.72	0.31	41
Recessed Can	1.00	0.00	380
Recessed Lighting - Other	1.73	0.09	398
Table Lamp	1.07	0.01	1085
Torchiere	1.01	0.01	298
Track Lighting	2.31	0.29	146
Under Counter	1.22	0.09	149
Wall Mount	2.63	0.11	1083

Table 27: Average Number of Lamps per Fixture

Table 28 presents the average number of lamps per home by lamp type. Fluorescent T12, standard incandescent, and incandescent decorative lamps are the most prevalent throughout California, with the average home having 4.5, 16, and 5 lamps, respectively.

Lamp Type	Average # of Lamps (n = 1255)	Error Bound
All Lamp Types	**33.82**	**1.16**
Compact Flourescent Unknown	0.03	0.01
Compact Flourescent Globe	0.02	0.01
Compact Flourescent Integral	0.15	0.04
Compact Flourescent Modular	0.07	0.02
Compact Flourescent Other	0.04	0.03
Compact Flourescent Reflector	0.02	0.02
Compact Flourescent Square	0.001	0.002
Compact Fluorescent Total	**0.32**	
Fluorescent T12	4.49	0.29
Fluorescent T8	0.23	0.07
Fluorescent Circline	0.13	0.03
Fluorescent Other	0.11	0.05
Fluorescent Tube Unknown	0.24	0.05
Fluorescent Total	**5.20**	
Halogen Other	0.18	0.05
Halogen Parabolic Reflector	0.34	0.13
Halogen Tubular	0.40	0.04
Halogen Unknown	0.01	0.01
Halogen Total	**0.93**	
Incandescent Standard	15.96	0.49
Incandescent Decorative	4.91	0.36
Incandescent Globe	3.82	0.35
Incandescent Other	0.24	0.09
Incandescent Reflector	2.34	0.34
Incandescent Unknown	0.05	0.02
Incandescent Total	**27.33**	
Unknown	0.03	0.02

Table 28: Average Number of Lamps by Lamp Type

Table 29 shows the percentage of all lamps that are a certain type. Almost half of all lamps are standard incandescent lamps. Over 10% of lamps are fluorescent T12, incandescent decorative, or incandescent globe lamps. Incandescent reflector lamps account for about 7% of all lamps.

Lamp Type	% of Total Lamps (n = 1255 Homes)	Error Bound
Compact Fluorescent Unknown	0.08%	0.04%
Compact Fluorescent Globe	0.05%	0.03%
Compact Fluorescent Integral	0.44%	0.1%
Compact Fluorescent Modular	0.21%	0.07%
Compact Fluorescent Other	0.12%	0.1%
Compact Fluorescent Reflector	0.05%	0.06%
Compact Fluorescent Square	0.003%	0.005%
Compact Fluorescent Total	**0.95%**	
Fluorescent T12	13.3%	0.7%
Fluorescent T8	0.7%	0.2%
Fluorescent Circline	0.4%	0.1%
Fluorescent Other	0.3%	0.2%
Fluorescent Tube Unknown	0.7%	0.2%
Fluorescent Total	**15.4%**	
Halogen Other	0.5%	0.1%
Halogen Parabolic Reflector	1.0%	0.4%
Halogen Tubular	1.2%	0.1%
Halogen Unknown	0.03%	0.02%
Halogen Total	**2.8%**	
Incandescent Standard	47.2%	1.3%
Incandescent Decorative	14.5%	0.9%
Incandescent Globe	11.3%	0.9%
Incandescent Other	0.7%	0.3%
Incandescent Reflector	6.9%	0.9%
Incandescent Unknown	0.2%	0.1%
Incandescent Total	**80.8%**	

Table 29: Percentage Lamp Types

Table 30 shows the percentage of homes where a particular lamp type is present. Virtually all homes are equipped with at least one standard incandescent lamp, while nearly two-thirds have at least one fluorescent T12 lamp. Over 40% of homes have at least one decorative incandescent or incandescent globe. Incandescent reflector lamps are present in approximately one-third of homes. About 25% of homes have at least one halogen tube present.

Lamp Type	% of Homes (n = 1255)	Error Bound
Compact Flourescent Unknown	1.6%	0.6%
Compact Flourescent Globe	0.9%	0.5%
Compact Flourescent Integral	6.1%	1.2%
Compact Flourescent Modular	3.6%	0.9%
Compact Flourescent Other	1.2%	0.6%
Compact Flourescent Reflector	0.3%	0.3%
Compact Flourescent Square	0.1%	0.2%
Compact Fluorescent Total	**12.4%**	**1.6%**
Fluorescent T12	64.9%	2.4%
Fluorescent T8	4.7%	1.1%
Fluorescent Circline	7.2%	1.3%
Fluorescent Other	2.7%	0.8%
Fluorescent Tube Unknown	7.4%	1.3%
Fluorescent (Non-T8) Total	**70.4%**	**2.3%**
Halogen Other	7.3%	1.3%
Halogen Parabolic Reflector	4.3%	1.0%
Halogen Tubular	24.1%	2.2%
Halogen Unknown	0.8%	0.4%
Halogen Total	**32.2%**	**2.4%**
Incandescent Standard	99.8%	0.2%
Incandescent Decorative	51.6%	2.5%
Incandescent Globe	41.3%	2.5%
Incandescent Other	6.8%	1.3%
Incandescent Reflector	31.2%	2.3%
Incandescent Unknown	2.1%	0.7%
Incandescent Total	**99.9%**	**0.2%**

Table 30: Percentages of Homes with Lamp Types

Table 31 displays the distribution of the number of lamps per home. Nearly 30% of homes have more than 40 lamps. This finding combined with findings about the number of fixtures per home suggests that most homes are equipped with fixtures containing more than one lamp.

Number of Lamps	% of Homes (n = 1255)	Error Bound
1 - 10	8.6%	1.4%
11 - 20	23.7%	2.1%
21 - 30	23.2%	2.1%
31 - 40	15.9%	1.8%
41 - 50	11.1%	1.6%
>50	17.5%	1.9%

Table 31: Distribution of Number of Lamps per Home

Table 32 presents the distribution of the number of lamps per home by residence type. As might be expected, apartments, mobile homes, and duplexes/triplexes/quadplexes have significantly fewer fixtures and lamps on average than do single family, unattached residences. Also, single family,

unattached residences that are two or more stories contain significantly more lamps than single family, unattached residences that are one story.

Type of Residence	1 - 10 Lamps		11 - 20 Lamps		21 - 30 Lamps		31 - 40 Lamps		41 - 50 Lamps		>50 Lamps		
	% of Homes	Error Bound	% of Homes	Error Bound	% of Homes	Error Bound	% of Homes	Error Bound	% of Homes	Error Bound	% of Homes	Error Bound	Sample Size
Overall	8.6%	1.4%	23.7%	2.1%	23.2%	2.1%	15.9%	1.8%	11.1%	1.6%	17.5%	1.9%	1255
Apt(1 or 2 stories)	21.5%	4.7%	46.7%	5.7%	18.9%	4.5%	7.2%	3.0%	3.1%	2.0%	2.7%	1.9%	281
Apt(3 or more stories)	29.9%	11.3%	41.9%	12.2%	23.0%	10.4%	2.9%	3.8%	2.3%	3.7%	-	-	51
Duplex-Triplex-or Quadplex	24.3%	9.2%	50.7%	10.5%	20.3%	8.5%	3.9%	3.7%	-	-	0.8%	1.3%	82
Mobile Home-Double Wide	-	-	19.2%	16.2%	44.1%	20.2%	23.9%	17.2%	6.5%	10.3%	6.3%	10.1%	21
Mobile Home-Single Wide	19.4%	28.6%	39.0%	35.2%	21.8%	28.8%	19.8%	29.1%	-	-	-	-	6
Modular/prefabricated	-	-	-	-	38.4%	37.8%	26.2%	36.1%	35.0%	36.8%	0.4%	0.7%	7
Other	-	-	12.6%	18.2%	-	-	50.3%	51.9%	37.1%	49.5%	-	-	4
Single Family-Unattached- >2 stories	-	-	7.5%	11.8%	22.2%	18.6%	10.9%	12.8%	14.8%	15.8%	44.7%	22.1%	14
Single Family-Unattached-1 story	3.4%	1.4%	17.6%	2.8%	29.6%	3.4%	19.5%	2.9%	13.2%	2.5%	16.6%	2.7%	544
Single Family-Unattached-2 story	1.1%	1.2%	5.0%	2.5%	9.5%	3.5%	18.1%	4.6%	20.6%	4.8%	45.7%	5.9%	210
Townhouse or Rowhouse	-	-	17.9%	11.7%	32.8%	14.3%	38.7%	14.8%	3.5%	5.7%	7.1%	7.9%	35

Table 32: Distribution of Number of Lamps per Home by Residence Type

Specific Fixture Overviews

This section presents results regarding kitchen light switches as well as more in-depth overviews for recessed cans, ceiling fans, and torchieres. These fixture types were selected for more in-depth analysis because efficient lighting technologies are currently being developed for these fixture types. For each of these fixture types, the distribution of the number of fixtures as well as the percentage of homes containing these fixtures is presented.

Kitchen Light Switches

Kitchens lighting is controlled by 1.35 switches on average. About 6% of kitchen light switches are dimmable. Table 33 displays the distribution of the number of downlights controlled per switch. Nearly 80% of all switches control no downlights. The majority of switches controlling downlights control between 1 – 4 downlights. Twenty-three percent of switches controlling downlights are dimmable.

# Downlights per Switch	% of Switches (n = 1104 Homes)
0	79.9%
1 - 4	16.6%
5 - 7	3.0%
8 - 10	0.4%

Table 33: Number of Downlights per Kitchen Switch

Recessed Cans

About one-third of homes have at least one recessed can. Recessed cans account for approximately 12% of all fixtures, and on average, homes contain 2.37 recessed cans. About 0.4% of all recessed cans contain a compact fluorescent lamp.

Table 34 presents the distribution of the number of recessed cans per home. Approximately two-thirds of homes have no recessed cans present. Among homes with recessed cans, about half have a total of 1 – 4 cans, and another twenty percent have more than ten cans.[9]

Number of Recessed Cans	% of Homes (n = 1255)	Error Bound
0	67%	2%
1 - 4	18%	2%
5 - 7	5%	1%
8 - 10	3%	1%
11 - 20	5%	1%
>20	2%	1%

Table 34: Number of Recessed Cans per Home

Table 35 shows the percentage of homes with recessed cans by room type. Nearly one-fifth of homes have recessed cans in the kitchen or halls, and one-tenth of homes have cans present in the bathroom or living room.

Room	% of Homes	Error Bound	Sample Size
Bathroom	11%	2%	1231
Bedroom	6%	1%	1219
Breakfast Nook	5%	2%	392
Closets	4%	2%	348
Dining Room	3%	1%	751
Garage	1%	1%	580
Halls	18%	2%	1020
Kitchen	18%	2%	1255
Laundry Room	8%	2%	426
Living Room	9%	1%	1180
Office	7%	3%	291
Other	8%	7%	48

Table 35: Percentage of Homes with Recessed Cans by Room Type

Table 36 displays the percentage of homes with recessed cans by age of the home. Homes built in 1990 or later are more likely to contain recessed cans than are homes built prior to 1990. About 60% of homes built in 1990 or later have recessed cans, while approximately one-third of homes built earlier have cans.

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[9] (% Homes With 1 – 4 Cans Among Homes with Cans) $= \dfrac{\text{\% Homes With 1 - 4 Cans}}{\text{\% Homes With Cans}} = \dfrac{.18}{1-.67} = 0.54$

(% Homes With >10 Cans Among Homes with Cans) $= \dfrac{\text{\% Homes With >10 Cans}}{\text{\% Homes With Cans}} = \dfrac{.05+.02}{1-.67} = 0.21$

Age of Home	% of Homes	Error Bound	Sample Size
1949 and Older	26%	7%	131
1950 - 1954	27%	10%	63
1955 - 1959	41%	11%	66
1960 - 1964	33%	8%	96
1965 - 1969	31%	8%	88
1970 - 1974	35%	8%	122
1975 - 1979	25%	7%	110
1980 - 1984	17%	8%	74
1985 - 1989	41%	8%	131
1990 - 1994	60%	9%	88
1995 - 2000	57%	10%	73
Don't Know	16%	5%	213

Table 36: Percentage of Homes with Recessed Cans by Age of Home

Table 37 shows the percentage of homes containing recessed cans by age of the home as well as remodeling status. In general, older homes that have been remodeled in the last ten years are more likely to have recessed cans present than homes of the same age that have not been remodeled.

	Remodeled in Last 10 Years			Not Remodeled in Last 10 Years		
Age of Home	% of Homes	Error Bound	Sample Size	% of Homes	Error Bound	Sample Size
1949 and Older	35%	11%	49	21%	8%	77
1950 - 1954	28%	17%	19	29%	12%	42
1955 - 1959	62%	16%	29	28%	13%	35
1960 - 1964	42%	15%	33	30%	10%	60
1965 - 1969	37%	15%	31	28%	10%	55
1970 - 1974	46%	15%	37	31%	9%	78
1975 - 1979	45%	16%	30	18%	8%	73
1980 - 1984	22%	16%	25	16%	9%	46
1985 - 1989	44%	20%	18	42%	8%	105
1990 - 1994	67%	32%	6	59%	10%	76
1995 - 2000	80%	29%	5	57%	11%	66
Don't Know	18%	18%	22	16%	6%	151

Table 37: Percentage of Homes with Recessed Cans by Age of Home and Remodeling Status

Table 38 presents the average number of recessed cans per home by age of home. Homes built in 1990 or later contain significantly more recessed cans on average than do homes built prior to 1990, suggesting a trend in residential new construction towards an increased number of recessed cans.

Age of Home	# of Recessed Cans	Error Bound	Sample Size
1949 and Older	1.50	0.72	131
1950 - 1954	1.66	1.31	63
1955 - 1959	2.43	1.00	66
1960 - 1964	2.31	0.89	96
1965 - 1969	2.33	0.94	88
1970 - 1974	3.13	2.42	122
1975 - 1979	1.76	0.74	110
1980 - 1984	0.37	0.23	74
1985 - 1989	2.78	0.99	131
1990 - 1994	5.27	1.70	88
1995 - 2000	6.45	1.84	73
Don't Know	0.39	0.18	213

Table 38: Number of Recessed Cans per Home by Age of Home

Table 39 shows the number of recessed cans per home by age of home as well as remodeling status. In general, older homes that have been remodeled in the last ten years have significantly more recessed cans present than homes of the same age that have not been remodeled. This finding further supports the previous result about a trend in new construction towards an increased number of recessed cans.

Age of Home	Remodeled in Last 10 Years			Not Remodeled in Last 10 Years		
	# of Recessed Cans	Error Bound	Sample Size	# of Recessed Cans	Error Bound	Sample Size
1949 and Older	2.56	1.35	49	0.83	0.80	77
1950 - 1954	4.28	4.05	19	0.52	0.29	42
1955 - 1959	4.18	2.02	29	1.30	0.84	35
1960 - 1964	3.36	1.80	33	1.89	1.02	60
1965 - 1969	4.13	2.21	31	1.33	0.68	55
1970 - 1974	4.09	2.33	37	2.95	3.54	78
1975 - 1979	3.08	1.73	30	1.17	0.76	73
1980 - 1984	0.75	0.70	25	0.22	0.13	46
1985 - 1989	4.02	2.10	18	2.73	1.17	105
1990 - 1994	3.00	1.82	6	5.68	1.96	76
1995 - 2000	8.83	5.63	5	6.47	1.98	66
Don't Know	1.36	1.62	22	0.26	0.12	151

Table 39: Number of Recessed Cans per Home by Age of Home and Remodeling Status

Ceiling Fans

About half of homes have at least one ceiling fan. Ceiling fans account for approximately 6% of all fixtures, and on average, homes contain 1.11 ceiling fans. About 0.7% of all ceiling fans contain a compact fluorescent lamp.

Table 40 displays the distribution of the number of ceiling fans per home. About half of homes do not have any ceiling fans, and about one-quarter of homes have only one ceiling fan. Ten percent of homes have four or more ceiling fans.

Number of Ceiling Fans	% of Homes (n = 1255)	Error Bound
0	51%	3%
1	23%	2%
2	9%	1%
3	7%	1%
4	5%	1%
>4	5%	1%

Table 40: Number of Ceiling Fans per Home

Table 41 presents the percentage of homes with ceiling fans by room type. About 25% of homes have a ceiling fan in the bedroom, breakfast nook, or dining room. About one-fifth of homes have a ceiling fan in the living room or in a home office.

Room	% of Homes	Error Bound	Sample Size
Bathroom	-	-	1231
Bedroom	25.8%	2.2%	1219
Breakfast Nook	29.4%	4.1%	392
Closets	-	-	348
Dining Room	24.7%	2.8%	751
Garage	1.0%	0.7%	580
Halls	2.1%	0.8%	1020
Kitchen	5.9%	1.2%	1255
Laundry Room	4.1%	1.6%	426
Living Room	19.8%	2.1%	1180
Office	17.0%	3.8%	291
Other	10.8%	7.5%	48

Table 41: Percentage of Homes with Ceiling Fans by Room Type

Table 42 shows the distribution of the number of lamps per ceiling fan. Nearly 95% of ceiling fans are equipped with lights. About 30% of ceiling fans contain one lamp, and about 40% of ceiling fans contain four or more lamps.

Number of Lamps	% of Fans (n = 644 Homes)	Error Bound
0	5.4%	1.6%
1	28.9%	2.9%
2	2.3%	0.8%
3	22.7%	2.7%
4	32.8%	2.9%
5+	7.8%	1.8%

Table 42 : Distribution of Number of Lamps per Ceiling Fan

Table 43 displays the percentage of ceiling fans equipped with each lamp type. Over three-fourths of ceiling fans have standard incandescent lamps installed, and another 17% of ceiling fans are equipped with incandescent decorative bulbs. Compact fluorescent lamps were present in only 1.1% of fans equipped with lamps.

Lamp Type	% of Ceiling Fans (n = 620 Homes)	Error Bound
Compact Flourescent Unknown	0.3%	0.3%
Compact Flourescent Integral	0.6%	0.5%
Compact Flourescent Other	0.3%	0.5%
Compact Fluorescent Total	**1.1%**	
Flourescent Circline	0.2%	0.2%
Fluorescent Total	**0.2%**	
Halogen Other	0.1%	0.2%
Halogen Total	**0.1%**	
Incandescent Standard	77.3%	2.9%
Incandescent Decorative	16.9%	2.7%
Incandescent Globe	2.4%	1.0%
Incandescent Other	0.1%	0.2%
Incandescent Reflector	1.1%	0.6%
Incandescent Unknown	0.2%	0.3%
Incandescent Total	**98.1%**	
Unknown	0.5%	0.4%

Table 43: Ceiling Fan Lamp Types Among Ceiling Fans With Lamps

Torchieres

About 20% of homes have at least one torchiere. Torchieres account for approximately 1.8% of all fixtures, with an average of 0.36 torchieres per home. About 1.5% of all torchieres contain a compact fluorescent lamp.

Table 44 shows the distribution of the number of torchieres per home. One-fifth of homes have a torchiere. Nearly two-thirds of homes with a torchiere have only one torchiere.[10]

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[10] (% Homes With Only 1 Torchiere Among Homes with Torchiere) =

Number of Torchieres	% of Homes (n = 1255)	Error Bound
0	79%	2%
1	13%	2%
2	5%	1%
3	2%	1%
4	1%	0.4%
>4	0.3%	0.3%

Table 44: Number of Torchieres per Home

Table 45 displays the percentage of homes with at least one torchiere by room type. Nearly 20% of homes have a torchiere in the living room. About 10% of homes have a torchiere present in the bedroom or the other room type. No homes have a torchiere in the garage, kitchen, or laundry room. Auditors categorized room type "other" when no other room description matched (i.e., game/play room).

Room	% of Homes	Error Bound	Sample Size
Bathroom	0.1%	0.2%	1231
Bedroom	10%	2%	1219
Breakfast Nook	1%	1%	392
Closets	0.01%	0.02%	348
Dining Room	2%	1%	751
Garage	-	-	580
Halls	0.2%	0.3%	1020
Kitchen	-	-	1255
Laundry Room	-	-	426
Living Room	17%	2%	1180
Office	5%	2%	291
Other	9%	7%	48

Table 45: Percentage of Homes with Torchieres by Room Type

Table 46 displays the percentage of torchieres equipped with each lamp type. About 70% of torchieres have halogen tube lamps installed, and another 23% of torchieres are equipped with standard incandescent bulbs.

$$\frac{\% \text{ Homes With 1 Torchiere}}{\% \text{ Homes With Torchiere}} = \frac{.13}{1 - .79} = 0.62$$

Lamp Type	% of Torchieres (n = 298 Homes)	Error Bound
Compact Fluorescent Unknown	0.5%	0.5%
Compact Fluorescent Integral	0.5%	0.6%
Compact Fluorescent Other	0.5%	0.6%
Compact Fluorescent Total	**1.5%**	
Fluorescent Circline	0.6%	0.6%
Fluorescent Total	**0.6%**	
Halogen Other	2.4%	1.8%
Halogen Tubular	69.0%	6.3%
Halogen Total	**71.4%**	
Incandescent Standard	23.4%	5.2%
Incandescent Decorative	2.7%	3.9%
Incandescent Reflector	0.3%	0.5%
Incandescent Total	**26.4%**	

Table 46: Torchiere Lamp Types

Room Lighting Analysis

This section contains lighting results by room type. For each room type, the percentage of homes with a given fixture type and lamp type are shown. A more comprehensive analysis is provided for the kitchen light that is used most often.

Kitchen

All Kitchen Lights

Table 47 presents the percentage of homes with a given fixture type and lamp type in the kitchen along with the error bounds associated with these estimates. The most predominant fixture and lamp type combinations are ceiling mounts with fluorescent lamps other than T8s, ceiling mounts with incandescent lamps, other recessed lighting fluorescent lamps other than T8s, as well as recessed cans with incandescent lamps.

Fixture Type	Lamp Type												
	Overall		Compact Fluorescent		Fluorescent T8		Fluorescent - Other Tube		Halogen		Incandescent	
(n = 1255)	% of Homes	Error Bound	% of Homes	Error Bound	% of Homes	Error Bound	% of Homes	Error Bound	% of Homes	Error Bound	% of Homes	Error Bound
Overall			1.7%	0.6%	3.7%	0.9%	55.8%	2.5%	1.9%	0.7%	63.9%	2.4%
Architecturally Integrated	5.9%	1.2%	0.1%	0.2%	0.3%	0.3%	4.7%	1.1%	-	-	1.2%	0.5%
Ceiling Fan	5.9%	1.2%	0.1%	0.2%	-	-	-	-	-	-	5.4%	1.1%
Chandelier / Hanging	5.9%	1.2%	-	-	-	-	0.6%	0.4%	-	-	5.3%	1.1%
Ceiling Mount	65.5%	2.4%	1.0%	0.5%	2.1%	0.7%	30.3%	2.3%		-	36.1%	2.4%
Floor Lamp	0.3%	0.3%	-	-	-	-	0.1%	0.2%	-	-	0.2%	0.2%
Other	1.1%	0.5%	-	-	0.1%	0.2%	0.2%	0.2%	0.1%	0.2%	0.7%	0.4%
Recessed Can	18.1%	1.9%	0.4%	0.3%	-	-	0.2%	0.2%	1.0%	0.5%	17.0%	1.9%
Recessed Lighting - Other	22.3%	2.1%	0.1%	0.2%	0.9%	0.5%	18.2%	1.9%	0.1%	0.2%	3.4%	0.9%
Table Lamp	1.3%	0.6%	0.01%	0.01%	-	-	0.1%	0.2%	-	-	1.2%	0.5%
Track Lighting	2.2%	0.7%	-	-	-	-	-	-	0.4%	0.3%	1.8%	0.7%
Under Counter	10.3%	1.5%	-	-	0.5%	0.3%	5.3%	1.1%	0.5%	0.4%	4.2%	1.0%
Wall Mount	3.1%	0.9%	0.1%	0.2%	0.1%	0.2%	0.8%	0.4%	-	-	2.1%	0.7%

Table 47: Percentage of Homes with Fixture Type and Lamp Type in Kitchen

Kitchen Light Used Most Often

Table 48 presents the percentage of homes using a certain fixture type and lamp type as the kitchen light used most often as well as the error bounds associated with these estimates. Similar to all kitchen lighting, the most predominant fixture and lamp type combinations are ceiling mounts with fluorescent lamps other than T8s, ceiling mounts with incandescent lamps, other recessed lighting with fluorescent lamps other than T8s, as well as recessed cans with incandescent lamps. It is equally as common to find an incandescent lamp in a ceiling mounted fixture as it is a fluorescent lamp. Recessed cans are the third most common fixture, with incandescent also the most common lamp type.

Fixture Type	Lamp Type												
	Overall		Compact Fluorescent		Fluorescent T8		Fluorescent - Other Tube		Halogen		Incandescent	
(n = 1255)	% of Homes	Error Bound	% of Homes	Error Bound	% of Homes	Error Bound	% of Homes	Error Bound	% of Homes	Error Bound	% of Homes	Error Bound
Overall			1.1%	0.5%	3.2%	0.9%	49.9%	2.5%	1.1%	0.5%	42.9%	2.5%
Architecturally Integrated	4.0%	1.0%	0.1%	0.2%	0.2%	0.2%	3.5%	0.9%	-	-	0.2%	0.2%
Ceiling Fan	2.6%	0.8%	0.1%	0.2%	-	-	-	-	-	-	2.5%	0.8%
Chandelier / Hanging	3.0%	0.9%	-	-	-	-	0.5%	0.4%	-	-	2.5%	0.8%
Ceiling Mount	59.5%	2.5%	0.8%	0.5%	1.9%	0.7%	28.6%	2.3%		-	28.7%	2.3%
Floor Lamp	0.2%	0.2%	-	-	-	-	-	-	-	-	0.2%	0.2%
Other	0.5%	0.3%	-	-	-	-	0.1%	0.2%	-	-	0.4%	0.3%
Recessed Can	9.4%	1.5%	-	-	-	-	0.2%	0.2%	0.6%	0.4%	8.6%	1.4%
Recessed Lighting - Other	18.2%	1.9%	0.1%	0.2%	0.9%	0.5%	16.1%	1.8%	0.1%	0.2%	1.1%	0.5%
Table Lamp	0.5%	0.3%	0.01%	0.01%	-	-	-	-	-	-	0.5%	0.3%
Track Lighting	1.4%	0.6%	-	-	-	-	-	-	0.3%	0.3%	1.1%	0.5%
Under Counter	1.6%	0.6%	-	-	0.1%	0.2%	1.0%	0.5%	0.1%	0.2%	0.4%	0.3%
Wall Mount	1.1%	0.5%	-	-	-	-	0.4%	0.3%	-	-	0.7%	0.4%

Table 48: Percentage of Homes with Fixture Type and Lamp Type as Kitchen Light Used Most Often

Table 49 displays the average number of lamps and average watts per fixture by fixture type for the kitchen light used most often. Most fixture types contain 1 – 2 lamps per fixture on average. Architecturally integrated fixtures, ceiling fans, and chandelier/hanging fixtures contain an average of 2.3 lamps per fixture. For most fixtures, the average wattage is close to 100 watts. Under Counter fixtures have the lowest average watts per fixture (43 watts). Not surprisingly, the average watts per fixture tends to increase as the average number of lamps per fixture increases.

	Lamps per Fixture			Watts per Fixture		
Fixture Type	Average	Error Bound	Sample Size (# Homes)	Average	Error Bound	Sample Size (# Homes)
Architecturally Integrated	2.27	0.46	45	108	21.70	44
Ceiling Fan	2.36	0.51	34	165	40.79	30
Chandelier / Hanging	2.32	0.50	33	154	34.76	31
Ceiling Mount	1.91	0.07	762	105	3.54	658
Floor Lamp	1.51	0.58	2	120	-	2
Other	1.72	0.34	10	92	8.06	10
Recessed Can	1.00	-	104	81	6.62	101
Recessed Lighting - Other	1.86	0.11	233	116	10.00	224
Table Lamp	1.00	-	7	92	22.30	7
Track Lighting	2.00	0.65	15	137	54.47	13
Under Counter	1.39	0.43	18	43	13.52	13
Wall Mount	1.46	0.27	13	89	27.37	12

Table 49: Average Number of Lamps and Watts per Fixture

Bedrooms

Table 50 presents the percentage of homes with a given fixture type and lamp type in the bedroom, as well as the error bounds associated with these estimates. The most predominant fixture and lamp type combinations are ceiling fans, ceiling mounts, wall mounts, floor lamps, and table lamps with incandescent lamps, as well as torchieres with halogen tube lamps.

Fixture Type	Overall		Compact Fluorescent		Fluorescent - Other Tube		Halogen		Incandescent	
(n = 1219)	% of Homes	Error Bound	% of Homes	Error Bound	% of Homes	Error Bound	% of Homes	Error Bound	% of Homes	Error Bound
Overall			3.2%	0.9%	7.2%	1.3%	15.5%	1.8%	98.0%	0.7%
Architecturally Integrated	0.8%	0.5%	-	-	0.2%	0.2%	0.1%	0.2%	0.6%	0.4%
Ceiling Fan	25.8%	2.2%	0.4%	0.3%	-	-	-	-	24.7%	2.2%
Chandelier / Hanging	7.0%	1.3%	0.2%	0.2%	0.1%	0.2%	0.4%	0.3%	6.2%	1.2%
Ceiling Mount	44.7%	2.5%	0.5%	0.4%	2.9%	0.8%	0.4%	0.3%	42.6%	2.5%
Floor Lamp	18.7%	2.0%	0.3%	0.3%	0.3%	0.3%	4.7%	1.1%	14.5%	1.8%
Other	0.9%	0.5%	-	-	-	-	0.05%	0.08%	0.8%	0.5%
Recessed Can	5.8%	1.2%	0.05%	0.08%	-	-	0.4%	0.3%	5.5%	1.2%
Recessed Lighting - Other	1.6%	0.6%	0.1%	0.2%	0.3%	0.3%	0.1%	0.1%	1.1%	0.5%
Table Lamp	74.3%	2.2%	1.7%	0.7%	1.5%	0.6%	2.7%	0.8%	73.3%	2.3%
Torchiere	10.2%	1.5%	0.1%	0.2%	0.1%	0.2%	7.7%	1.4%	2.7%	0.8%
Track Lighting	3.3%	0.9%	-	-	-	-	0.4%	0.3%	2.9%	0.8%
Under Counter	0.9%	0.5%	-	-	0.6%	0.4%	0.1%	0.2%	0.1%	0.2%
Wall Mount	17.5%	1.9%	0.3%	0.3%	1.2%	0.5%	0.2%	0.2%	16.0%	1.9%

The Lamp Type spans all the sub-columns above.

Table 50: Percentage of Homes with Fixture Type and Lamp Type in Bedroom

Living Room

Table 51 presents the percentage of homes with a given fixture type and lamp type in the living room, along with the error bounds associated with these estimates. The most commonly found fixture and lamp type combinations are ceiling fans, ceiling mounts, chandeliers, recessed cans, floor lamps, and table lamps with incandescent lamps, as well as torchieres with halogen lamps.

Fixture Type	Overall		Compact Fluorescent		Fluorescent - Other Tube		Halogen		Incandescent	
(n = 1180)	% of Homes	Error Bound	% of Homes	Error Bound	% of Homes	Error Bound	% of Homes	Error Bound	% of Homes	Error Bound
Overall			3.8%	1.0%	4.5%	1.1%	21.8%	2.1%	93.0%	1.3%
Architecturally Integrated	2.9%	0.9%	-	-	0.8%	0.4%	0.3%	0.3%	2.1%	0.7%
Ceiling Fan	19.8%	2.1%	0.2%	0.2%	-	-	-	-	17.4%	2.0%
Chandelier / Hanging	15.3%	1.9%	0.2%	0.2%	0.3%	0.3%	-	-	15.0%	1.9%
Ceiling Mount	10.5%	1.6%	0.2%	0.2%	1.2%	0.6%	0.3%	0.3%	8.9%	1.5%
Floor Lamp	36.2%	2.5%	0.3%	0.3%	0.2%	0.2%	6.2%	1.3%	30.7%	2.4%
Other	0.2%	0.2%	-	-	-	-	-	-	0.2%	0.2%
Recessed Can	8.9%	1.5%	0.2%	0.2%	-	-	0.5%	0.4%	8.7%	1.5%
Recessed Lighting - Other	2.1%	0.7%	-	-	0.7%	0.4%	0.2%	0.2%	1.3%	0.6%
Table Lamp	67.8%	2.4%	2.8%	0.9%	1.0%	0.5%	1.4%	0.6%	65.2%	2.5%
Torchiere	16.8%	1.9%	0.4%	0.3%	0.1%	0.2%	12.6%	1.7%	4.3%	1.0%
Track Lighting	4.7%	1.1%	-	-	-	-	1.3%	0.6%	3.7%	1.0%
Under Counter	0.2%	0.2%	-	-	0.2%	0.2%	-	-	-	-
Wall Mount	6.4%	1.3%	0.003%	0.005%	0.2%	0.2%	0.5%	0.4%	5.7%	1.2%

The Lamp Type spans all the sub-columns above.

Table 51: Percentage of Homes with Fixture Type and Lamp Type in Living Room

Bathrooms

Table 52 presents the percentage of homes with a given fixture type and lamp type in bathrooms and the error bounds associated with these estimates. The most commonly found fixture and lamp type combinations are ceiling mounts, wall

mounts, and recessed cans with incandescent lamps, as well as ceiling mounts with fluorescent tube lamps other than T8s. Note that the bathroom sample size is only 1231 because these bathrooms were inaccessible at the time of the on-site visit and the resident was unable to accurately recall the bathroom lighting.

Fixture Type	Lamp Type												
	Overall		Compact Fluorescent		Fluorescent T8		Fluorescent - Other Tube		Halogen		Incandescent	
(n = 1231)	% of Homes	Error Bound	% of Homes	Error Bound	% of Homes	Error Bound	% of Homes	Error Bound	% of Homes	Error Bound	% of Homes	Error Bound
Overall			3.9%	1.0%	0.5%	0.4%	14.9%	1.8%	1.5%	0.6%	94.7%	1.1%
Architecturally Integrated	2.0%	0.7%	-	-	-	-	1.5%	0.6%	-	-	0.5%	0.4%
Chandelier / Hanging	5.3%	1.1%	-	-	-	-	-	-	-	-	5.3%	1.1%
Ceiling Mount	47.8%	2.5%	2.3%	0.8%	-	-	7.8%	1.4%	0.2%	0.2%	40.0%	2.5%
Floor Lamp	0.1%	0.2%	-	-	-	-	-	-	-	-	0.1%	0.2%
Other	0.1%	0.2%	-	-	-	-	-	-	-	-	0.1%	0.2%
Recessed Can	11.0%	1.6%	0.4%	0.3%	-	-	-	-	0.5%	0.3%	10.6%	1.5%
Recessed Lighting - Other	8.2%	1.4%	0.6%	0.4%	0.1%	0.2%	2.2%	0.7%	-	-	5.4%	1.1%
Table Lamp	2.2%	0.8%	0.1%	0.2%	-	-	-	-	-	-	2.1%	0.7%
Torchiere	0.1%	0.2%	-	-	-	-	-	-	0.1%	0.2%	-	-
Track Lighting	1.9%	0.7%	0.1%	0.2%	-	-	-	-	0.1%	0.2%	1.7%	0.7%
Wall Mount	77.9%	2.1%	0.5%	0.4%	0.4%	0.3%	3.8%	1.0%	0.8%	0.5%	74.0%	2.2%

Table 52: Percentage of Homes with Fixture Type and Lamp Type in Bathroom

Halls

Table 53 presents the percentage of homes with a given fixture type and lamp type in hallways and the error bounds associated with these estimates. The most commonly found fixture and lamp type combinations are ceiling mounts, wall mounts, recessed cans, and chandelier/hanging fixtures with incandescent lamps.

Fixture Type	Lamp Type												
	Overall		Compact Fluorescent		Fluorescent T8		Fluorescent - Other Tube		Halogen		Incandescent	
(n = 1020)	% of Homes	Error Bound	% of Homes	Error Bound	% of Homes	Error Bound	% of Homes	Error Bound	% of Homes	Error Bound	% of Homes	Error Bound
Overall			1.4%	0.7%	0.2%	0.2%	2.1%	0.8%	1.4%	0.7%	97.9%	0.8%
Architecturally Integrated	0.6%	0.4%	0.1%	0.2%	-	-	0.3%	0.3%	-	-	0.1%	0.2%
Ceiling Fan	2.1%	0.8%	-	-	-	-	-	-	-	-	1.8%	0.7%
Chandelier / Hanging	16.2%	2.1%	0.04%	0.06%	-	-	-	-	0.1%	0.2%	16.1%	2.0%
Ceiling Mount	70.7%	2.5%	0.8%	0.5%	0.1%	0.2%	1.6%	0.7%	0.4%	0.3%	68.5%	2.6%
Floor Lamp	0.7%	0.5%	0.1%	0.2%	-	-	-	-	0.1%	0.2%	0.5%	0.4%
Other	0.1%	0.2%	-	-	-	-	-	-	-	-	0.1%	0.2%
Recessed Can	17.6%	2.1%	0.2%	0.3%	-	-	-	-	0.4%	0.3%	17.3%	2.1%
Recessed Lighting - Other	5.8%	1.3%	0.1%	0.1%	-	-	0.1%	0.2%	-	-	5.6%	1.3%
Table Lamp	2.2%	0.8%	0.1%	0.2%	-	-	-	-	-	-	2.1%	0.8%
Torchiere	0.2%	0.3%	-	-	-	-	-	-	0.2%	0.3%	-	-
Track Lighting	1.3%	0.6%	-	-	-	-	-	-	0.2%	0.3%	1.1%	0.6%
Under Counter	0.3%	0.3%	-	-	0.1%	0.1%	0.1%	0.2%	-	-	0.1%	0.2%
Wall Mount	14.8%	2.0%	0.03%	0.05%	-	-	0.003%	0.01%	-	-	14.8%	2.0%

Table 53: Percentage of Homes with Fixture Type and Lamp Type in Bathroom

Dining Room

Table 54 presents the percentage of homes with a given fixture type and lamp type in dining rooms as well as the error bounds associated with these estimates. The most commonly found fixture and lamp type combinations are ceiling fans, ceiling mounts, chandelier/hanging fixtures and table lamps with incandescent bulbs.

Fixture Type	Lamp Type									
	Overall		Compact Fluorescent		Fluorescent - Other Tube		Halogen		Incandescent	
(n = 751)	% of Homes	Error Bound	% of Homes	Error Bound	% of Homes	Error Bound	% of Homes	Error Bound	% of Homes	Error Bound
Overall			0.8%	0.6%	2.1%	0.9%	3.4%	1.2%	95.8%	1.3%
Architecturally Integrated	1.7%	0.8%	-	-	0.3%	0.4%	0.2%	0.3%	1.2%	0.7%
Ceiling Fan	24.7%	2.8%	0.3%	0.4%	-	-	0.2%	0.3%	24.0%	2.7%
Chandelier / Hanging	58.8%	3.2%	0.2%	0.3%	-	-	1.0%	0.6%	57.8%	3.2%
Ceiling Mount	13.2%	2.2%	0.3%	0.4%	1.1%	0.7%	-	-	11.7%	2.1%
Floor Lamp	1.7%	0.8%	-	-	-	-	0.2%	0.3%	1.6%	0.8%
Other	0.3%	0.4%	-	-	-	-	-	-	0.3%	0.4%
Recessed Can	3.2%	1.1%	-	-	-	-	0.5%	0.4%	2.7%	1.0%
Recessed Lighting - Other	1.0%	0.6%	-	-	0.3%	0.4%	0.2%	0.3%	0.6%	0.5%
Table Lamp	7.4%	1.7%	-	-	0.002%	0.004%	-	-	7.4%	1.7%
Torchiere	2.0%	0.9%	-	-	0.0%	0.0%	1.2%	0.7%	0.9%	0.6%
Track Lighting	1.4%	0.8%	-	-	-	-	0.3%	0.3%	1.1%	0.7%
Under Counter	-	-	-	-	-	-	-	-	-	-
Wall Mount	2.6%	1.0%	-	-	0.2%	0.3%	-	-	2.4%	1.0%

Table 54: Percentage of Homes with Fixture Type and Lamp Type in Dining Room

Breakfast Nook

Table 55 presents the percentage of homes with a given fixture type and lamp type in breakfast nooks along with the error bounds associated with these estimates. Similar to dining rooms, the most commonly found fixture and lamp type combinations are ceiling fans, ceiling mounts, and chandeliers with incandescent bulbs.

Fixture Type	Lamp Type											
	Overall		Compact Fluorescent		Fluorescent T8		Fluorescent - Other Tube		Halogen		Incandescent	
(n = 392)	% of Homes	Error Bound	% of Homes	Error Bound	% of Homes	Error Bound	% of Homes	Error Bound	% of Homes	Error Bound	% of Homes	Error Bound
Overall			0.9%	0.9%	0.3%	0.5%	3.7%	1.7%	1.9%	1.2%	94.7%	2.0%
Architecturally Integrated	0.3%	0.5%	-	-	-	-	0.3%	0.5%	-	-	-	-
Ceiling Fan	29.4%	4.1%	0.3%	0.5%	-	-	-	-	0.3%	0.5%	28.4%	4.0%
Chandelier / Hanging	48.6%	4.5%	0.3%	0.5%	-	-	0.6%	0.7%	0.6%	0.7%	47.1%	4.5%
Ceiling Mount	16.1%	3.3%	-	-	0.3%	0.5%	1.2%	1.0%	-	-	14.6%	3.2%
Floor Lamp	1.6%	1.1%	-	-	-	-	-	-	0.3%	0.5%	1.3%	1.0%
Other	-	-	-	-	-	-	-	-	-	-	-	-
Recessed Can	5.4%	2.1%	-	-	-	-	-	-	0.3%	0.5%	5.1%	2.0%
Recessed Lighting - Other	0.7%	0.7%	-	-	-	-	0.6%	0.7%	-	-	0.1%	0.2%
Table Lamp	2.4%	1.4%	0.3%	0.5%	-	-	-	-	-	-	2.4%	1.4%
Torchiere	1.2%	1.0%	-	-	-	-	-	-	0.6%	0.7%	0.6%	0.7%
Track Lighting	1.0%	0.9%	-	-	-	-	-	-	-	-	1.0%	0.9%
Under Counter	0.6%	0.7%	-	-	0.3%	0.5%	0.3%	0.5%	-	-	-	-
Wall Mount	0.6%	0.7%	-	-	-	-	0.3%	0.5%	-	-	0.3%	0.5%

Table 55: Percentage of Homes with Fixture Type and Lamp Type in Breakfast Nook

Home Office

Table 56 presents the percentage of homes with a given fixture type and lamp type in home offices and the error bounds associated with these estimates. The most commonly found fixture and lamp type combinations are ceiling fans, ceiling mounts, floor lamps, table lamps, and wall mounts with incandescent bulbs. A table lamp with an incandescent lamp is the most common fixture lamp combination, with nearly 50% of home offices having this combination.

Fixture Type	Lamp Type											
	Overall		Compact Fluorescent		Fluorescent T8		Fluorescent - Other Tube		Halogen		Incandescent	
(n = 291)	% of Homes	Error Bound	% of Homes	Error Bound	% of Homes	Error Bound	% of Homes	Error Bound	% of Homes	Error Bound	% of Homes	Error Bound
Overall			3.0%	1.7%	0.8%	0.9%	13.0%	3.4%	13.1%	3.4%	90.1%	3.1%
Architecturally Integrated	1.6%	1.3%	-	-	0.4%	0.7%	0.8%	0.9%	-	-	0.4%	0.7%
Ceiling Fan	17.0%	3.8%	0.4%	0.7%	-	-	-	-	-	-	16.2%	3.7%
Chandelier / Hanging	8.6%	2.8%	-	-	-	-	-	-	-	-	8.6%	2.8%
Ceiling Mount	36.2%	4.9%	0.7%	0.8%	-	-	7.8%	2.7%	0.8%	0.9%	28.1%	4.6%
Floor Lamp	22.9%	4.3%	0.5%	0.7%	-	-	-	-	4.2%	2.1%	18.6%	4.0%
Garage Door Opener	-	-	-	-	-	-	-	-	-	-	-	-
Other	0.8%	0.9%	-	-	-	-	0.4%	0.7%	-	-	0.4%	0.7%
Recessed Can	7.0%	2.6%	-	-	-	-	-	-	1.2%	1.1%	5.8%	2.3%
Recessed Lighting - Other	3.1%	1.7%	-	-	-	-	1.5%	1.1%	0.7%	0.9%	1.2%	1.1%
Table Lamp	49.9%	5.1%	1.2%	1.1%	-	-	1.5%	1.2%	3.1%	1.8%	47.1%	5.1%
Torchiere	5.0%	2.2%	0.4%	0.7%	-	-	-	-	4.6%	2.1%	-	-
Track Lighting	5.5%	2.3%	-	-	-	-	-	-	0.3%	0.5%	5.2%	2.3%
Under Counter	1.8%	1.3%	-	-	0.4%	0.7%	1.0%	1.0%	-	-	0.4%	0.7%
Wall Mount	10.2%	3.0%	0.4%	0.7%	-	-	0.7%	0.9%	-	-	9.1%	2.9%

Table 56: Percentage of Homes with Fixture Type and Lamp Type in Home Office

Laundry Room

Table 57 presents the percentage of homes with a given fixture type and lamp type in laundry rooms along with the error bounds associated with these estimates. The most predominant fixture and lamp type combinations are ceiling mounts with fluorescent tube lamps other than T8s, ceiling mounts with incandescent lamps, as well as recessed cans with incandescent lamps.

Fixture Type	Overall		Compact Fluorescent		Fluorescent T8		Fluorescent - Other Tube		Halogen		Incandescent	
(n = 426)	% of Homes	Error Bound	% of Homes	Error Bound	% of Homes	Error Bound	% of Homes	Error Bound	% of Homes	Error Bound	% of Homes	Error Bound
Overall			1.0%	0.8%	0.7%	0.7%	21.3%	3.5%	0.3%	0.5%	80.0%	3.4%
Ceiling Fan	4.1%	1.6%	-	-	-	-	-	-	-	-	1.1%	0.9%
Chandelier / Hanging	0.9%	0.8%		-	-	-	0.3%	0.5%	0.3%	0.5%	0.3%	0.5%
Ceiling Mount	79.5%	3.4%	0.3%	0.5%	0.7%	0.7%	16.3%	3.2%	-	-	62.9%	4.1%
Floor Lamp	0.6%	0.7%	-	-	-	-	-	-	-	-	0.6%	0.7%
Garage Door Opener	0.3%	0.5%	-	-	-	-	-	-	-	-	0.3%	0.5%
Recessed Can	8.4%	2.3%	0.4%	0.5%	-	-	-	-	-	-	7.9%	2.3%
Recessed Lighting - Other	5.4%	1.9%		-	-	-	2.8%	1.3%	-	-	2.7%	1.4%
Table Lamp	2.9%	1.5%	-	-	-	-	-	-	-	-	2.9%	1.5%
Track Lighting	0.3%	0.5%	-	-	-	-	-	-	-	-	0.3%	0.5%
Under Counter	0.8%	0.7%	-	-	-	-	0.8%	0.7%	-	-	-	-
Wall Mount	8.0%	-	0.3%	-	-	-	1.1%	-	-	-	6.6%	-

Table 57: Percentage of Homes with Fixture Type and Lamp Type in Laundry Room

Closets

Table 58 presents the percentage of homes with a given fixture type and lamp type in closets and the error bounds associated with these estimates. The most commonly found fixture and lamp type combinations are ceiling mounts and wall mounts with incandescent bulbs.

Fixture Type	Overall		Compact Fluorescent		Fluorescent - Other Tube		Halogen		Incandescent	
(n = 348)	% of Homes	Error Bound	% of Homes	Error Bound	% of Homes	Error Bound	% of Homes	Error Bound	% of Homes	Error Bound
Overall			2.7%	1.5%	8.1%	2.6%	0.3%	0.6%	93.1%	2.4%
Chandelier / Hanging	1.3%	1.0%	-	-	0.3%	0.6%	-	-	0.9%	0.9%
Ceiling Mount	84.7%	3.4%	2.1%	1.3%	5.4%	2.1%	-	-	78.1%	3.9%
Recessed Can	4.3%	1.9%	-	-	-	-	0.3%	0.6%	3.9%	1.8%
Recessed Lighting - Other	3.6%	1.7%	0.3%	0.5%	1.4%	1.1%	-	-	2.0%	1.3%
Table Lamp	0.01%	0.02%	-	-	-	-	-	-	0.01%	0.02%
Torchiere	0.01%	0.02%	-	-	-	-	0.01%	0.02%	-	-
Track Lighting	0.2%	0.3%	-	-	-	-	-	-	0.2%	0.3%
Wall Mount	13.0%	3.2%	0.3%	0.6%	1.4%	1.1%	-	-	12.0%	3.1%

Table 58: Percentage of Homes with Fixture Type and Lamp Type in Closets

Garage

Table 59 presents the percentage of homes with a given fixture type and lamp type in garages along with the error bounds associated with these estimates. The most predominant fixture and lamp type combinations are ceiling mounts and

chandeliers (hanging lamps) with fluorescent lamps other than T8s as well as ceiling mounts, wall mounts, and garage door openers with incandescent lamps.

Fixture Type	Overall		Compact Fluorescent		Fluorescent T8		Fluorescent - Other Tube		Halogen		Incandescent	
(n = 581)	% of Homes	Error Bound	% of Homes	Error Bound	% of Homes	Error Bound	% of Homes	Error Bound	% of Homes	Error Bound	% of Homes	Error Bound
Overall			1.3%	0.8%	1.2%	0.8%	56.3%	3.6%	0.2%	0.3%	71.9%	3.2%
Ceiling Fan	1.0%	0.7%	-	-	-	-	-	-	-	-	0.9%	0.7%
Chandelier / Hanging	14.9%	2.5%	-	-	0.6%	0.6%	14.1%	2.5%	-	-	0.6%	0.5%
Ceiling Mount	64.3%	3.4%	0.8%	0.6%	0.6%	0.6%	32.8%	3.4%	-	-	35.6%	3.4%
Floor Lamp	0.8%	0.6%	-	-	-	-	-	-	-	-	0.8%	0.6%
Garage Door Opener	28.5%	3.2%	-	-	-	-	-	-	-	-	28.5%	3.2%
Other	0.6%	0.6%	-	-	-	-	0.4%	0.5%	-	-	0.2%	0.3%
Recessed Can	0.8%	0.6%	-	-	-	-	-	-	-	-	0.8%	0.6%
Recessed Lighting - Other	8.7%	2.0%	-	-	-	-	8.6%	2.0%	-	-	0.2%	0.3%
Table Lamp	1.6%	0.9%	-	-	-	-	0.2%	0.3%	-	-	1.6%	0.9%
Track Lighting	1.2%	0.8%	-	-	-	-	-	-	-	-	1.2%	0.8%
Under Counter	0.7%	0.6%	-	-	-	-	0.3%	0.4%	-	-	0.4%	0.5%
Wall Mount	26.9%	3.1%	0.6%	0.6%	-	-	1.6%	0.9%	0.2%	0.3%	24.5%	3.0%

Table 59: Percentage of Homes with Fixture Type and Lamp Type in Garage

All Other Rooms

Table 60 presents the percentage of homes with a given fixture type and lamp type in all rooms other than the types previously mentioned as well as the error bounds associated with these estimates. The Other room type is includes attics, bars, basements, exercise rooms, game/play rooms, music rooms, sewing rooms, as well as pool houses. The most predominant fixture and lamp type combinations are ceiling mounts with fluorescent lamps other than T8s as well as ceiling mounts, wall mounts, floor lamps, and table lamps with incandescent lamps. Error bounds are high because of the low number of 'other' rooms surveyed (n = 48).

Fixture Type	Lamp Type							
	Overall		Fluorescent - Other Tube		Halogen		Incandescent	
(n = 48)	% of Homes	Error Bound	% of Homes	Error Bound	% of Homes	Error Bound	% of Homes	Error Bound
Overall			23.3%	10.3%	9.0%	7.0%	91.4%	6.8%
Architecturally Integrated	4.5%	5.1%	2.2%	3.7%	2.2%	3.6%	2.2%	3.6%
Ceiling Fan	10.8%	7.5%	-	-	-	-	9.0%	7.0%
Chandelier / Hanging	2.1%	2.4%	1.0%	1.7%	-	-	1.0%	1.7%
Ceiling Mount	50.0%	12.1%	8.9%	7.0%	-	-	47.7%	12.1%
Floor Lamp	7.8%	6.4%	-	-	-	-	7.8%	6.4%
Garage Door Opener	1.9%	3.0%	-	-	-	-	1.9%	3.0%
Other	2.2%	3.6%	-	-	-	-	2.2%	3.6%
Recessed Can	8.4%	6.6%	-	-	0.0%	0.1%	8.4%	6.6%
Recessed Lighting - Other	5.5%	5.3%	4.5%	5.1%	-	-	1.0%	1.7%
Table Lamp	21.2%	9.9%	4.5%	5.1%	-	-	21.2%	9.9%
Torchiere	8.9%	7.0%	-	-	6.7%	6.2%	2.2%	3.6%
Track Lighting	4.5%	5.1%	-	-	-	-	4.5%	5.1%
Under Counter	4.4%	5.0%	4.4%	5.0%	-	-	-	-
Wall Mount	17.8%	9.4%	-	-	2.2%	3.6%	15.6%	8.9%

Table 60: Percentage of Homes with Fixture Type and Lamp Type in Other Room Type

Porch Lighting

Table 61 shows the percentage of homes with a porch light by type of residence. Overall, about 93% of homes have a porch light. As might be expected, apartments are significantly less likely to have a porch light than are single family residences.

Type of Residence	% of Homes	Error Bound	Sample Size
Overall	93%	1%	1258
Apt(1 or 2 stories)	78%	5%	281
Apt(3 or more stories)	47%	12%	51
Duplex-Triplex-or Quadplex	95%	5%	82
Mobile Home-Double Wide	100%	-	22
Mobile Home-Single Wide	81%	29%	6
Modular/prefabricated	100%	-	7
Other	100%	-	4
Single Family-Unattached- >2 stories	100%	-	14
Single Family-Unattached-1 story	100%	0.3%	546
Single Family-Unattached-2 story	100%	-	210
Townhouse or Rowhouse	96%	6%	35

Table 61: Percentage of Homes with a Porch Light

Table 62 presents the percentage of homes utilizing each lamp type for the porch light. Approximately 75% of all homes are using a standard incandescent lamp for the porch light. Just over 6% of homes are using a compact fluorescent lamp.

Lamp Type	% of Homes (n = 1177)	Error Bound
Compact Fluorescent Unknown	0.5%	0.3%
Compact Fluorescent Globe	0.5%	0.4%
Compact Fluorescent Integral	2.6%	0.8%
Compact Fluorescent Modular	2.3%	0.8%
Compact Fluorescent Square	0.2%	0.2%
Compact Fluorescent Total	**6.0%**	
Fluorescent T12	0.1%	0.2%
Fluorescent Circline	0.3%	0.3%
Fluorescent Other	0.6%	0.4%
Fluorescent Tube Unknown	0.3%	0.3%
Fluorescent Total	**1.4%**	
Halogen Other	0.002%	0.002%
Halogen Parabolic Reflector	0.5%	0.4%
Halogen Tubular	0.3%	0.3%
Halogen Total	**0.8%**	
Incandescent Standard	74.4%	2.3%
Incandescent Decorative	9.7%	1.5%
Incandescent Globe	1.3%	0.6%
Incandescent Other	0.8%	0.5%
Incandescent Reflector	3.6%	1.0%
Incandescent Unknown	0.1%	0.2%
Incandescent Total	**90.0%**	
Other	0.5%	0.4%
Not Observable	1.3%	0.6%

Table 62:Percentage of Homes Having Lamp Type as Porch Light

Table 63 shows the percentage of homes have a given lamp type and lamp control type among homes with a porch light. About two-thirds of homes with a porch light are using a standard incandescent lamp controlled manually.

Lamp Type	% of Homes with a Porch Light (n = 1177)						
		Controlled By					
	Total	Manual	Motion Detector	Motion Detector with Photocell	Other	Photocell	Timer
Compact Fluorescent Unknown	0.5%	0.03%	-	-	-	-	0.4%
Compact Fluorescent Globe	0.5%	0.4%	-	-	-	-	0.1%
Compact Fluorescent Integral	2.6%	1.6%	0.1%	-	0.1%	0.1%	0.6%
Compact Fluorescent Modular	2.3%	1.0%	-	0.002%	0.1%	0.4%	0.7%
Compact Fluorescent Square	0.2%	0.1%	-	0.1%	-	-	-
Compact Fluorescent Total	**6.0%**	**3.2%**	**0.1%**	**0.1%**	**0.2%**	**0.5%**	**1.8%**
Fluorescent T12	0.1%	-	-	-	0.1%	-	-
Fluorescent Circline	0.3%	0.1%	-	-	0.1%	-	0.1%
Fluorescent Other	0.6%	0.4%	0.1%	-	-	-	0.1%
Fluorescent Tube Unknown	0.3%	-	-	-	-	0.1%	0.2%
Fluorescent Total	**1.4%**	**0.5%**	**0.1%**	**-**	**0.2%**	**0.1%**	**0.4%**
Halogen Other	0.002%	0.002%	-	-	-	-	-
Halogen Parabolic Reflector	0.5%	0.1%	0.3%	0.1%	-	-	-
Halogen Tubular	0.3%	-	0.2%	0.1%	-	-	-
Halogen Total	**0.8%**	**0.1%**	**0.5%**	**0.2%**	**-**	**-**	**-**
Incandescent Standard	74.4%	65.5%	2.6%	0.9%	0.002%	2.1%	3.4%
Incandescent Decorative	9.7%	8.4%	0.5%	0.2%	-	0.4%	0.2%
Incandescent Globe	1.3%	1.2%	-	-	-	0.1%	0.003%
Incandescent Other	0.8%	0.5%	0.2%	0.1%	-	-	-
Incandescent Reflector	3.6%	2.2%	1.0%	0.4%	-	-	-
Incandescent Unknown	0.1%	0.002%	-	-	-	-	0.1%
Incandescent Total	**90.0%**	**77.8%**	**4.3%**	**1.6%**	**0.002%**	**2.6%**	**3.7%**
Other	0.5%	0.1%	-	-	-	0.4%	-
Not Observable	1.3%	0.4%	-	-	0.2%	0.03%	0.6%

Table 63: Percentage of Homes Having Lamp Type and Control Type

Lamp Type	% of Homes with a Porch Light (n = 1177)						
		Controlled By					
	Total	Manual	Motion Detector	Motion Detector with Photocell	Other	Photocell	Timer
Compact Flourescent Unknown	0.3%	0.06%	-	-	-	-	0.3%
Compact Flourescent Globe	0.4%	0.3%	-	-	-	-	0.2%
Compact Flourescent Integral	0.8%	0.7%	0.2%	-	0.2%	0.2%	0.4%
Compact Flourescent Modular	0.8%	0.5%	-	0.002%	0.2%	0.3%	0.4%
Compact Flourescent Square	0.2%	0.2%	-	0.2%	-	-	-
Compact Fluorescent Total							
Flourescent T12	0.2%	-	-	-	0.2%	-	-
Flourescent Circline	0.3%	0.2%	-	-	0.2%	-	0.2%
Flourescent Other	0.4%	0.3%	0.2%	-	-	-	0.2%
Flourescent Tube Unknown	0.3%	-	-	-	-	0.2%	0.2%
Fluorescent Total							
Halogen Other	0.0%	0.002%	-	-	-	-	-
Halogen Parabolic Reflector	0.4%	0.2%	0.3%	0.2%	-	-	-
Halogen Tubular	0.3%	-	0.2%	0.2%	-	-	-
Halogen Total							
Incandescent Standard	2.3%	2.5%	0.8%	0.5%	0.002%	0.7%	0.9%
Incandescent Decorative	1.5%	1.4%	0.4%	0.2%	-	0.3%	0.2%
Incandescent Globe	0.6%	0.6%	-	-	-	0.2%	0.005%
Incandescent Other	0.5%	0.4%	0.2%	0.2%	-		
Incandescent Reflector	1.0%	0.8%	0.5%	0.3%	-	-	-
Incandescent Unknown	0.2%	0.002%	-	-	-	-	0.2%
Incandescent Total							
Other	0.4%	0.1%	-	-	-	0.3%	-
Not Observable	0.6%	0.4%	-	-	0.2%	0.04%	0.4%

Table 64: Error Bounds for Percentage of Homes Having Lamp Type and Control Type

Appliances

Refrigerator Freezers

The following section describes the refrigerator/freezers found at the surveyed households. All 1258 homes surveyed for this study have at least one refrigerator, 14.4% of all homes have a second, and only 0.7% of all homes have a third refrigerator. For this analysis any refrigerator with a capacity under 8 cubic feet is considered a "half-size' refrigerator, while any refrigerator with a capacity of 8 cubic feet and above is referred to as "full-size". The following table summarizes second and third refrigerators by the residence types where they were found. Not surprisingly, it is more common to find second and third refrigerators in single family dwellings than apartments.

| Type of Residence | Second Refrigerator | | | | Third Refrigerator | | | | |
| | Full or Half | | Full Only | | Full or Half | | Full Only | | |
	%	Error Bound	%	Error Bound	%	Error Bound	%	Error Bound	Sample Size
Overall	14.4%	1.8%	12.7%	1.7%	0.7%	0.4%	0.2%	0.2%	1,258
Apt(1 or 2 stories)	1.0%	1.2%	1.0%	1.2%	-	-	-	-	281
Apt(3 or more stories)	2.3%	3.7%	-	-	-	-	-	-	51
Duplex-Triplex-or Quadplex	3.6%	3.9%	1.8%	2.8%	-	-	-	-	82
Mobile Home-Double Wide	24.9%	17.6%	18.7%	15.9%	-	-	-	-	22
Mobile Home-Single Wide	24.6%	29.1%	-	-	-	-	-	-	6
Modular/prefabricated	26.2%	36.1%	26.2%	36.1%	-	-	-	-	7
Other	-	-	-	-	-	-	-	-	4
Single Family-Unattached- >2 stories	22.3%	18.6%	22.3%	18.6%	-	-	-	-	14
Single Family-Unattached-1 story	17.6%	2.8%	16.1%	2.7%	0.6%	0.6%	0.4%	0.5%	546
Single Family-Unattached-2 story	24.6%	5.0%	22.0%	4.8%	2.4%	1.8%	0.2%	0.4%	210
Townhouse or Rowhouse	13.2%	10.2%	9.6%	8.8%	-	-	-	-	35

Table 65: Percentage of Homes with Second or Third Refrigerator by Type of Residence

Due to the small number of homes with third refrigerators, the following summary information is only based upon the primary and secondary refrigerators. This refrigerator/freezer section of the report first summarizes the analysis conducted on the primary refrigerators, and then summarizes the secondary refrigerators.

The primary and secondary refrigerators are summarized by type, size, age, energy consumption, Energy Star qualifications, and UEC relative to standards. Because the amount of data for each of the aforementioned characteristics differs, the number of sites in each of the analyses will differ. The data used in the refrigerator analyses are described below.

♦ Type-The type of each refrigerator was obtained from the site visit.

♦ Size-The size of the refrigerators, in cubic feet, was first obtained from the efficiency databases (CEC and AHAM) if the model number successfully matched a model in the database. In the event that the models were not matched, the data on the size collected on-site were used.

♦ Age-The age of the freezer was also obtained from the efficiency databases if a match was made, otherwise the age from the on site visit was used in the analysis.

♦ Usage (UEC)-The usage data was obtained exclusively from the efficiency databases.

♦ Energy Star Qualification-The unit was marked as energy star qualified if its UEC was calculated as 20% above standard for 1993 standards, and 10% above standard for 2001 standards[11].

Primary Refrigerators

All homes that were visited over the course of this study have a primary refrigerator. The classification of the refrigerators is by size, configuration and existence of a through the door ice dispenser. Full size refrigerators are categorized as either single or double door. The double door refrigerators are further classified by freezer position: either bottom mounted, top mount, or side by side. In the case of the side by side and top mount, a further division is the existence of a through the door ice dispenser. The following figure shows the percentage breakdown of primary refrigerators by type. The majority of the primary refrigerators found are the top-mounted freezer type, accounting for almost 60% of all the primary refrigerators. Side by Side type refrigerators account for over 34% of the primary refrigerators.

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[11] Top Mounted under 12.5 cu.ft., and Bottom Mounted and Side-by-Side under 18.5 cu.ft., and all single door refrigerators were excluded from the energy star qualified analysis due to the fact that those types and sizes would not qualify for Energy Star status according to the program guidelines.
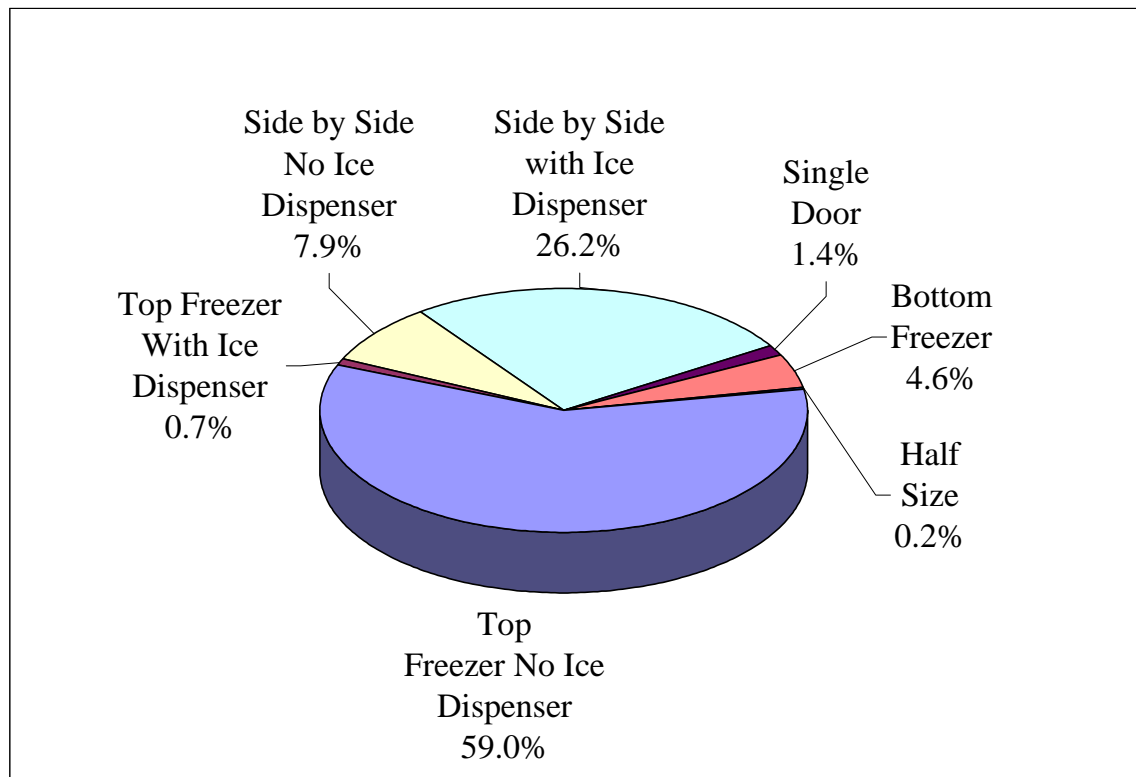
Figure 6: Percentage of Homes with Primary Refrigerator/Freezer by Type

The following abbreviations (common for refrigerators) are used throughout this section to describe the various types of refrigerator and defrost types as found:

- ♦ **BF** = Bottom Mounted Freezer (All Automatic)

- ♦ **SD** = Single Door (All Manual Defrost)

- ♦ **SI** = Side by Side with Ice Dispenser (All Automatic)

- ♦ **SS** = Side by Side without Ice Dispenser (All Automatic)

- ♦ **TF** = Top Mounted Freezer without Ice Dispenser (Partial and Automatic Defrost)

- ♦ **TI** = Top Mounted Freezer with Ice Dispenser (All Automatic)

Size

The sizes of refrigerators were obtained from manufacturer data if the unit is matched, else from survey data if not matched. The following summary of the sizes of the refrigerators summarizes both the matched and unmatched units, or the manufacturer reported and surveyor estimated sizes. The manufacturer reported average overall size is not significantly different from the estimated overall sizes.

The sample size that is used in the following table that summarizes the average size of the refrigerators is 1120. This is the number of full size refrigerators, 8 cubic feet or greater, for which we obtained size data from the efficiency databases.

Refrigerator Type	Average Est Size	Error Bound	Sample Size
All Types	19.9	0.2	1120
BF	21.5	1.5	44
SD	12.7	1.0	15
SI	23.9	0.2	273
SS	21.8	0.6	73
TF	17.9	0.2	704
TI	21.6	0.9	11

Table 66: Average Estimated Size by Refrigerator Type

The following table shows the distribution of the sizes of the refrigerators. The largest percentage of the refrigerators, or 21.8%, are within the size range between 20.5 to 22.49 cubic feet.

	Refrigerator Type													
	All Types (n=1120)		BF (n=44)		SD (n=15)		SI (n=273)		SS (n=73)		TF (n=704)		TI (n=11)	
Size Range (CuFt)	%	Error Bound	%	Error Bound	%	Error Bound	%	Error Bound	%	Error Bound	%	Error Bound	%	Error Bound
8 to 12.5	1.3%	0.6%	-	-	48.1%	23.0%	0.0%	0.0%	-	-	1.1%	0.7%	-	-
12.5 to 14.49	9.8%	1.6%	-	-	32.2%	21.5%	0.4%	0.7%	-	-	15.6%	2.5%	0.4%	0.6%
14.5 to 16.49	9.7%	1.6%	-	-	15.9%	16.9%	0.4%	0.7%	1.2%	2.0%	15.7%	2.5%	-	-
16.5 to 18.49	18.4%	2.1%	4.9%	5.6%	3.7%	6.2%	0.3%	0.5%	-	-	30.4%	3.2%	0.4%	0.7%
18.5 to 20.49	14.9%	1.9%	46.7%	12.7%	-	-	5.4%	2.3%	37.7%	9.6%	14.5%	2.4%	13.9%	21.1%
20.5 to 22.49	21.8%	2.2%	42.8%	12.6%	-	-	22.3%	4.3%	37.8%	9.6%	17.9%	2.6%	71.5%	27.1%
22.5 to 24.49	7.6%	1.4%	-	-	-	-	19.9%	4.1%	11.9%	6.5%	2.3%	1.0%	-	-
24.5 to 26.49	12.5%	1.8%	3.1%	5.0%	-	-	38.2%	5.0%	7.7%	5.1%	2.4%	1.1%	13.9%	21.1%
> 26.49	4.0%	1.0%	2.4%	4.0%	-	-	13.1%	3.5%	3.7%	3.6%	0.2%	0.3%	-	-

Table 67: Percentage of All Refrigerators by Type within Size Ranges-Estimated Sizes

Age

There is some inherent bias in the distribution of the manufactured date data. The bias is a result of higher matching rates for newer refrigerators, resulting in more data for newer refrigerators than older refrigerators. In an attempt to overcome this bias, the ages of the non matched and matched refrigerators are also presented in this section to show the difference between the full set of refrigerators with estimated ages and the matched set of refrigerators with manufacturer reported ages.

During the on-site visit residents were asked for the approximate age of their refrigerators. If the resident was unable to provide an age, surveyors estimated the age of the refrigerators whenever possible. These estimated ages were used for refrigerators when no age data from manufacturers was available for the following estimated age analysis.

The bias in this data results from a customer or auditor reported age, which will inherently have some amount of incorrect information. However, it is our judgement that the latter of the two, the estimated ages, will be more accurate because there is much less bias towards newer refrigerators and the total number of respondents is higher (687 vs. 1137). However, in order to give the reader an

idea of the ages of the matched refrigerators that are used in the UEC, Energy Star, and Standards Comparison analyses, the average manufacturer reported ages are presented in this section also.

The following table summarizes the data that resulted from the matches of the refrigerator/freezer model numbers collected from on-sites with manufacturer data to obtain an approximate manufacture date. The ages of 687 primary refrigerator/freezers were obtained in this manner. Based on this sample, the overall average age of these refrigerators is 8.5 years with an error bound of 0.4 years. The average life expectancy for refrigerators is 14 years. The manufacture date range of 1990 through 1994 accounts for 33.7% of all primary refrigerators.

Ref Type	Size Range (CuFt)	Avg Mfr. Age	Avg Mfr. Age EB	Manufacture Date Ranges					Sample Size
				1995-2000	1990-1994	1985-1989	1980-1984	1975-1979	
All Types	Overall	8.5	0.4	31.5%	33.7%	21.6%	10.3%	2.9%	687
	8 to 12.5	16.2	4.4	-	19.8%	-	60.4%	19.8%	6
	12.5 to 14.49	9.2	1.2	27.6%	37.1%	22.7%	8.4%	4.2%	103
	14.5 to 16.49	10.0	1.3	22.3%	36.3%	21.0%	15.9%	4.4%	87
	16.5 to 18.49	7.6	0.8	32.3%	40.0%	20.9%	4.8%	2.0%	131
	18.5 to 20.49	10.9	1.1	18.1%	26.4%	33.1%	17.0%	5.4%	101
	20.5 to 22.49	6.7	0.8	43.7%	34.3%	13.1%	7.2%	1.7%	134
	22.5 to 24.49	10.6	1.3	18.2%	27.3%	31.2%	23.3%	-	46
	24.5 to 26.49	6.3	1.1	48.8%	29.9%	17.5%	1.9%	1.9%	57
	> 26.49	6.6	1.5	39.9%	35.8%	24.3%	-	-	22
	Size Unknown								0
BF	Overall	7.0	1.6	40.9%	25.2%	30.4%	3.5%	-	30
	16.5 to 18.49								0
	18.5 to 20.49	10.5	1.9	13.8%	20.9%	58.5%	6.8%	-	16
	20.5 to 22.49	3.3	1.2	70.2%	29.8%	-	-	-	14
	24.5 to 26.49								0
	> 26.49								0
	Size Unknown								0
SD	Overall	18.0	2.7	-	-	19.9%	59.8%	20.2%	7
	8 to 12.5	19.3	3.8	-	-	-	66.9%	33.1%	3
	12.5 to 14.49	16.1	2.3	-	-	49.3%	49.4%	1.3%	4
	14.5 to 16.49								0
	16.5 to 18.49								0
	Size Unknown								0
SI	Overall	7.8	0.8	33.7%	35.6%	21.2%	7.8%	1.7%	139
	8 to 12.5								0
	12.5 to 14.49								0
	14.5 to 16.49								0
	16.5 to 18.49								0
	18.5 to 20.49	10.5	4.2	21.8%	46.6%	15.9%	-	15.8%	10
	20.5 to 22.49	7.0	1.3	30.1%	50.4%	14.2%	5.2%	0.1%	32
	22.5 to 24.49	10.3	1.5	18.8%	31.3%	27.3%	22.7%	-	34
	24.5 to 26.49	6.5	1.4	48.6%	26.0%	20.2%	2.6%	2.6%	42
	> 26.49	6.7	1.5	38.3%	36.7%	24.9%	-	-	21
	Size Unknown								0
SS	Overall	11.0	2.0	30.1%	25.9%	8.6%	25.8%	9.5%	39
	14.5 to 16.49								0
	18.5 to 20.49	14.7	2.9	13.1%	19.7%	6.5%	45.5%	15.1%	19
	20.5 to 22.49	8.9	3.3	36.4%	36.3%	18.3%	-	9.0%	11
	22.5 to 24.49	10.5	4.8	24.8%	24.9%	-	50.4%	-	4
	24.5 to 26.49	3.8	2.5	74.6%	25.4%	-	-	-	4
	> 26.49	1.0	-	100.0%	-	-	-	-	1
	Size Unknown								0
TF	Overall	8.4	0.5	30.3%	35.6%	22.5%	9.0%	2.7%	463
	8 to 12.5	11.6	6.4	-	49.3%	-	50.7%	-	3
	12.5 to 14.49	8.9	1.2	28.6%	38.4%	21.8%	7.0%	4.3%	99
	14.5 to 16.49	10.0	1.3	22.3%	36.3%	21.0%	15.9%	4.4%	87
	16.5 to 18.49	7.6	0.8	32.3%	40.0%	20.9%	4.8%	2.0%	130
	18.5 to 20.49	9.8	1.4	20.7%	27.7%	36.5%	12.9%	2.3%	56
	20.5 to 22.49	6.6	1.2	46.2%	30.4%	13.4%	8.4%	1.7%	70
	22.5 to 24.49	11.7	2.4	12.4%	12.6%	62.5%	12.4%	-	8
	24.5 to 26.49	7.0	2.0	32.6%	51.4%	16.0%	-	-	10
	> 26.49								0
	Size Unknown								0
TI	Overall	8.9	4.3	45.6%	-	21.8%	32.6%	-	9
	12.5 to 14.49								0
	16.5 to 18.49	15.0	-	-	-	100.0%	-	-	1
	18.5 to 20.49								0
	20.5 to 22.49	10.2	4.6	35.3%	-	25.6%	39.0%	-	7
	24.5 to 26.49	2.0	-	100.0%	-	-	-	-	1

Table 68: Average Age and Percentage of Refrigerator Manufacturer Reported Ages within Size Ranges

The sample size of 1137 primary refrigerator ages represents all full size primary refrigerator ages obtained in this study. The average manufacturer and surveyor reported age and error bound along with the distribution of manufacturing date range by type and size range are presented in the following table. The average age of the refrigerators is 9.1 years with an error bound of 0.4 years.

Ref Type	Size Range (CuFt)	Manufacture Date and Estimated Mfr Date Ranges								Sample Size
		Average Est Age	Avg Est Age EB	1995-2000	1990-1994	1985-1989	1980-1984	1975-1979	1974 and Older	
All Types	Overall	9.1	0.4	34.2%	30.2%	20.8%	10.0%	3.1%	1.6%	1137
	8 to 12.5	18.1	6.7	20.0%	9.9%	10.0%	30.1%	10.0%	19.9%	13
	12.5 to 14.49	9.5	1.1	27.0%	36.0%	24.1%	6.2%	6.8%	-	134
	14.5 to 16.49	9.8	1.0	24.6%	34.9%	21.6%	15.3%	3.5%		112
	16.5 to 18.49	9.3	0.9	29.3%	33.3%	22.2%	10.1%	3.2%	1.9%	190
	18.5 to 20.49	10.2	0.9	25.8%	25.3%	31.5%	13.3%	3.3%	0.8%	158
	20.5 to 22.49	7.7	0.7	43.4%	29.7%	15.1%	8.8%	2.5%	0.5%	215
	22.5 to 24.49	10.9	1.2	18.1%	31.8%	30.5%	16.6%	-	3.0%	69
	24.5 to 26.49	6.0	0.9	58.2%	24.5%	11.0%	2.7%	2.5%	1.1%	119
	> 26.49	7.0	1.9	49.9%	31.6%	15.8%	-	-	2.7%	40
	Size Unknown	11.6	1.7	25.9%	31.4%	19.2%	13.5%	4.2%	5.8%	87
BF	Overall	11.1	2.4	31.3%	24.9%	22.8%	7.5%	2.2%	11.4%	50
	16.5 to 18.49	12.5	14.5	50.0%	-	-	-	50.0%	-	2
	18.5 to 20.49	12.1	2.3	10.5%	23.7%	50.0%	10.5%	-	5.2%	21
	20.5 to 22.49	5.3	1.8	54.3%	34.3%	5.7%	5.7%	-	-	19
	24.5 to 26.49	30.0	-	-	-	-	-	-	100.0%	1
	> 26.49	40.0	-	-	-	-	-	-	100.0%	1
	Size Unknown	16.5	10.5	36.6%	18.3%	-	8.6%	-	36.6%	6
SD	Overall	24.0	5.2	-	-	25.5%	22.2%	29.4%	22.9%	17
	8 to 12.5	25.0	8.1	-	-	16.7%	33.4%	16.5%	33.3%	6
	12.5 to 14.49	20.5	3.8	-	-	25.0%	25.0%	50.0%	-	6
	14.5 to 16.49	13.0	-	-	-	100.0%	-	-	-	1
	16.5 to 18.49	11.0	-	-	-	100.0%	-	-	-	1
	Size Unknown	36.1	15.3	-	-	-	-	47.4%	52.6%	3
SI	Overall	6.9	0.6	47.9%	29.9%	14.2%	5.6%	1.6%	0.8%	280
	8 to 12.5	24.0	-	-	-	-	-	100.0%	-	1
	12.5 to 14.49	10.0	-	-	100.0%	-	-	-	-	1
	14.5 to 16.49									0
	16.5 to 18.49	8.0	-	-	100.0%	-	-	-	-	1
	18.5 to 20.49	7.6	2.8	47.4%	29.9%	15.0%	-	7.6%	-	17
	20.5 to 22.49	7.3	1.3	41.1%	37.1%	13.3%	4.7%	2.0%	1.9%	58
	22.5 to 24.49	10.1	1.3	21.4%	36.4%	24.5%	15.5%	-	2.2%	49
	24.5 to 26.49	5.5	0.9	61.5%	21.3%	11.8%	3.3%	2.2%	-	98
	> 26.49	5.9	1.1	52.2%	32.8%	14.9%	-	-	-	35
	Size Unknown	5.5	2.0	67.5%	23.1%	-	9.4%	-	-	20
SS	Overall	11.7	1.3	21.7%	25.6%	27.2%	17.3%	6.8%	1.4%	81
	14.5 to 16.49	10.0	0.0	-	100.0%	-	-	-	-	1
	18.5 to 20.49	13.7	2.1	12.9%	21.5%	25.8%	29.9%	9.9%	-	27
	20.5 to 22.49	9.9	2.0	29.9%	29.8%	29.8%	6.2%	4.2%	-	24
	22.5 to 24.49	14.2	5.0	14.1%	14.2%	28.7%	28.7%	-	14.3%	7
	24.5 to 26.49	6.5	4.4	66.4%	19.5%	-	-	14.1%	-	6
	> 26.49	9.1	4.9	19.5%	40.3%	40.3%	-	-	-	3
	Size Unknown	12.9	2.7	8.9%	26.5%	35.3%	20.5%	8.8%	-	13
TF	Overall	9.2	0.4	30.4%	32.5%	22.8%	10.8%	2.8%	0.7%	698
	8 to 12.5	7.8	4.5	50.0%	24.7%	-	25.3%	-	-	6
	12.5 to 14.49	8.9	1.0	28.7%	37.1%	24.4%	5.3%	4.6%	-	126
	14.5 to 16.49	9.8	1.1	25.2%	34.6%	20.8%	15.7%	3.6%	-	110
	16.5 to 18.49	9.3	0.9	29.2%	33.5%	22.4%	10.3%	2.7%	2.0%	185
	18.5 to 20.49	9.2	1.1	28.8%	26.4%	32.0%	11.5%	1.3%	-	92
	20.5 to 22.49	7.6	1.0	46.4%	26.4%	13.7%	10.6%	2.9%	-	107
	22.5 to 24.49	12.2	1.8	8.0%	24.2%	54.0%	13.9%	-	-	13
	24.5 to 26.49	7.0	1.7	32.8%	55.1%	12.1%	-	-	-	13
	> 26.49	5.0	-	100.0%	-	-	-	-	-	1
	Size Unknown	11.7	1.7	13.6%	40.1%	26.4%	14.5%	2.7%	2.7%	45
TI	Overall	8.2	3.8	53.4%	-	18.7%	27.9%	-	-	11
	12.5 to 14.49	4.0	-	100.0%	-	-	-	-	-	1
	16.5 to 18.49	15.0	-	-	-	100.0%	-	-	-	1
	18.5 to 20.49	4.0	-	100.0%	-	-	-	-	-	1
	20.5 to 22.49	10.2	4.6	35.3%	-	25.6%	39.0%	-	-	7
	24.5 to 26.49	2.0	-	100.0%	-	-	-	-	-	1

Table 69: Average Age and Percentage of Refrigerator Manufacturer Reported Ages and On Site Estimated Ages within Size Ranges

Energy Consumption

The average annual unit energy consumption (UEC) for refrigerator/freezers were obtained from the model number matches to manufacturer data. A sample of 797 UECs were obtained for the analysis below. Table 70 shows the average UEC by type of refrigerator and defrost type. The refrigerators are grouped by defrost type since the federal standards are also broken out by defrost type.

The average overall UEC for all types of refrigerators is 913.3 with an error bound of 19.8. The manual, single door refrigerators on average have the lowest UEC at 537.1, followed by top mounted refrigerators without an ice dispenser that have an average UEC of 808.7. The tables in the next section of the report that summarize the UECs relative to standards help to put these numbers into perspective.

Defrost Type	Ref Type	Size Range (CuFt)	Average UEC	Avg UEC EB	Sample Size
All Types		Overall	913.3	19.8	797
		8 to 12.5	588.9	80.9	9
		12.5 to 14.49	735.1	47.6	117
		14.5 to 16.49	838.2	55.7	93
		16.5 to 18.49	771.5	28.2	140
		18.5 to 20.49	1,002.5	58.3	114
		20.5 to 22.49	886.6	36.5	156
		22.5 to 24.49	1,274.5	74.1	48
		24.5 to 26.49	1,011.0	49.5	90
		> 26.49	1,119.4	96.6	30
Manual	SD	Overall	537.1	20.3	7
		8 to 12.5	519.6	21.6	3
		12.5 to 14.49	562.9	0.7	4
Partial	TF	Overall	845.6	66.8	10
		12.5 to 14.49	849.7	89.4	7
		14.5 to 16.49	770.2	-	1
		8 to 12.5	900.0	0.0	2
Automatic	BF	Overall	851.8	90.2	30
		18.5 to 20.49	1,024.1	121.3	16
		20.5 to 22.49	666.0	70.6	14
	SI	Overall	1,096.8	40.0	187
		18.5 to 20.49	1,116.5	154.2	11
		20.5 to 22.49	971.6	69.4	38
		22.5 to 24.49	1,315.9	93.2	36
		24.5 to 26.49	1,033.9	59.1	73
		> 26.49	1,122.5	98.2	29
	SS	Overall	1,242.7	100.4	41
		18.5 to 20.49	1,390.1	164.5	20
		20.5 to 22.49	1,151.0	168.6	12
		22.5 to 24.49	1,203.2	139.4	4
		24.5 to 26.49	991.7	113.4	4
		> 26.49	949.0	-	1
	TF	Overall	808.7	18.8	511
		12.5 to 14.49	732.0	51.6	105
		14.5 to 16.49	839.4	56.5	92
		16.5 to 18.49	771.4	28.2	139
		18.5 to 20.49	861.3	50.2	66
		20.5 to 22.49	825.9	35.8	85
		22.5 to 24.49	1,134.6	106.0	8
		24.5 to 26.49	901.0	70.2	12
		8 to 12.5	552.4	21.0	4
	TI	Overall	1,047.6	204.4	11
		12.5 to 14.49	498.0	-	1
		16.5 to 18.49	1,219.8	-	1
		18.5 to 20.49	714.0	-	1
		20.5 to 22.49	1,157.3	242.1	7
		24.5 to 26.49	825.0	-	1

Table 70: Average UEC by Type of Refrigerator

The bin distribution of unit energy consumption of all successfully matched full size primary refrigerators is shown below grouped by size and type. Among all types of refrigerators, the largest percentage, or 26.4%, are in the range between 600 to 749.9 kWh/year.

Defrost Type	Ref Type	Size Range (CuFt)	Unit Energy Consumption Ranges (kWh/Year)											
			450 to 599.9	600 to 749.9	750 to 899.9	900 to 1049.9	1050 to 1199.9	1200 to 1349.9	1350 to 1499.9	1500 to 1649.9	1650 to 1799.9	1800 to 1949.9	1950 to 2099.9	2400 to 2549.9
All Types		Overall	11.2%	26.4%	21.2%	15.6%	10.5%	5.5%	3.3%	3.0%	2.8%	0.2%	0.0%	0.3%
		8 to 12.5	85.5%	-	-	14.5%	-	-	-	-	-	-	-	-
		12.5 to 14.49	35.1%	29.8%	14.8%	9.9%	6.7%	-	1.6%	2.2%	-	-	-	-
		14.5 to 16.49	11.9%	38.9%	19.5%	9.6%	6.4%	9.7%	-	-	4.0%	-	-	-
		16.5 to 18.49	13.3%	40.1%	31.7%	9.9%	3.1%	0.0%	-	-	1.8%	-	0.1%	-
		18.5 to 20.49	5.5%	25.6%	12.0%	16.0%	21.7%	4.4%	5.5%	6.5%	1.1%	0.5%	-	1.1%
		20.5 to 22.49	10.2%	31.6%	21.0%	15.5%	12.3%	1.8%	2.9%	2.5%	1.4%	0.7%	0.0%	-
		22.5 to 24.49	-	-	13.1%	17.4%	15.3%	17.4%	16.8%	-	20.1%	-	-	-
		24.5 to 26.49	-	11.0%	28.1%	35.8%	5.2%	11.3%	3.7%	3.7%	-	-	-	1.2%
		> 26.49	-	7.4%	26.3%	1.9%	24.5%	18.5%	-	17.6%	3.8%	-	-	-
Manual	SD	Overall	100.0%	-	-	-	-	-	-	-	-	-	-	-
		8 to 12.5	100.0%	-	-	-	-	-	-	-	-	-	-	-
		12.5 to 14.49	100.0%	-	-	-	-	-	-	-	-	-	-	-
Partial	TF	Overall	-	25.4%	29.6%	45.0%	-	-	-	-	-	-	-	-
		12.5 to 14.49	-	36.3%	21.1%	42.5%	-	-	-	-	-	-	-	-
		14.5 to 16.49	-	-	100.0%	-	-	-	-	-	-	-	-	-
		8 to 12.5	-	-	-	100.0%	-	-	-	-	-	-	-	-
Automatic	BF	Overall	32.1%	21.5%	5.2%	-	30.4%	3.7%	7.1%	-	-	-	-	-
		18.5 to 20.49	13.8%	13.9%	-	-	51.6%	7.0%	13.7%	-	-	-	-	-
		20.5 to 22.49	52.0%	29.7%	10.9%	-	7.5%	-	-	-	-	-	-	-
	SI	Overall	0.6%	6.8%	28.2%	19.7%	11.8%	11.8%	8.2%	6.2%	6.2%	-	0.0%	0.6%
		18.5 to 20.49	-	6.3%	25.9%	-	40.6%	13.4%	-	13.9%	-	-	-	-
		20.5 to 22.49	3.0%	8.5%	45.2%	12.0%	13.5%	4.5%	9.0%	4.4%	-	-	0.1%	-
		22.5 to 24.49	-	-	14.8%	17.7%	8.9%	8.8%	22.8%	-	27.2%	-	-	-
		24.5 to 26.49	-	9.2%	27.5%	34.7%	3.8%	14.1%	4.6%	4.6%	-	-	-	1.5%
		> 26.49	-	7.5%	26.8%	0.1%	24.9%	18.9%	-	18.0%	3.8%	-	-	-
	SS	Overall	-	5.4%	19.1%	9.5%	24.4%	8.2%	8.1%	15.9%	2.7%	4.0%	-	2.7%
		18.5 to 20.49	-	6.1%	6.3%	6.3%	18.3%	6.2%	18.3%	29.7%	-	2.9%	-	6.1%
		20.5 to 22.49	-	8.2%	33.5%	-	33.3%	-	-	8.4%	8.3%	8.4%	-	-
		22.5 to 24.49	-	-	-	24.8%	24.9%	50.4%	-	-	-	-	-	-
		24.5 to 26.49	-	-	49.5%	25.1%	25.4%	-	-	-	-	-	-	-
		> 26.49	-	-	-	100.0%	-	-	-	-	-	-	-	-
	TF	Overall	14.6%	37.8%	19.5%	15.2%	7.6%	2.9%	0.3%	0.4%	1.7%	-	0.0%	-
		12.5 to 14.49	35.6%	30.3%	14.8%	7.6%	7.5%	-	1.7%	2.5%	-	-	-	-
		14.5 to 16.49	12.1%	39.5%	18.2%	9.7%	6.5%	9.8%	-	-	4.1%	-	-	-
		16.5 to 18.49	13.3%	40.1%	31.7%	9.9%	3.1%	-	-	-	1.8%	-	0.1%	-
		18.5 to 20.49	5.8%	36.5%	15.5%	26.3%	11.9%	1.9%	-	-	2.0%	-	-	-
		20.5 to 22.49	8.2%	47.1%	10.3%	22.2%	9.6%	1.4%	-	-	1.4%	-	-	-
		22.5 to 24.49	-	-	12.4%	12.6%	37.6%	37.4%	-	-	-	-	-	-
		24.5 to 26.49	-	26.7%	17.9%	48.9%	6.6%	-	-	-	-	-	-	-
		8 to 12.5	100.0%	-	-	-	-	-	-	-	-	-	-	-
	TI	Overall	0.4%	27.7%	25.3%	13.9%	4.5%	0.4%	13.9%	14.1%	-	-	-	-
		12.5 to 14.49	100.0%	-	-	-	-	-	-	-	-	-	-	-
		16.5 to 18.49	-	-	-	-	-	100.0%	-	-	-	-	-	-
		18.5 to 20.49	-	100.0%	-	-	-	-	-	-	-	-	-	-
		20.5 to 22.49	-	19.4%	16.0%	19.4%	6.3%	-	19.4%	19.7%	-	-	-	-
		24.5 to 26.49	-	-	100.0%	-	-	-	-	-	-	-	-	-

Table 71: Percentage of Primary Refrigerators by UEC Ranges and Type within Size Ranges

Additionally, the above groupings of full size primary refrigerators are compared with the 2001 Federal Appliance Standards for annual energy consumption.

Percentage Above/Below 2001 Federal Appliance Standards

The average percentage above or below the 2001 standards for each unit is calculated as follows:

$$\% \text{ Relative to Std} = \frac{2001 \text{ Standard (KWh/Yr)} - UEC \text{ (KWh/Yr)}}{2001 \text{ Standard (KWh/Yr)}}$$

For example, suppose the annual energy consumption for a refrigerator is 550 KWh/Yr. The 2001 standard consumption for this unit is 500 kWh/Yr. The percentage better or worse than 2001 standards is calculated as follows:

$$\frac{500 - 550}{500} \quad = \quad \frac{-50}{500} \quad = \quad -10\%$$

Thus, the annual energy consumption for this unit is 10% worse than 2001 standards.

Table 72 shows the average percentage below standards by type of refrigerator and defrost type. The average percentage below standards for all types of refrigerators is 64.8%. Again we find that single door, manual defrost refrigerators are the closest to standards among all refrigerators at 48.6% below standards. However, no conclusions will be drawn since the sample size is only seven.

Defrost Type	Ref Type	Size Range (CuFt)	Average UEC relative to 2001 Std	Error Bound	Sample Size
All Types		Overall	-64.8%	3.2%	797
		8 to 12.5	-58.0%	22.6%	9
		12.5 to 14.49	-69.1%	11.1%	117
		14.5 to 16.49	-86.1%	12.3%	93
		16.5 to 18.49	-60.7%	5.9%	140
		18.5 to 20.49	-84.1%	9.4%	114
		20.5 to 22.49	-54.1%	6.0%	156
		22.5 to 24.49	-90.7%	11.0%	48
		24.5 to 26.49	-45.0%	7.0%	90
		> 26.49	-51.7%	13.1%	30
Manual	SD	Overall	-48.6%	5.2%	7
		12.5 to 14.49	-47.4%	0.1%	4
		8 to 12.5	-49.6%	8.9%	3
Partial	TF	Overall	-117.5%	18.4%	10
		8 to 12.5	-145.9%	0.0%	2
		12.5 to 14.49	-117.0%	22.8%	7
		14.5 to 16.49	-93.0%	0.0%	1
Automatic	BF	Overall	-49.0%	16.0%	30
		18.5 to 20.49	-80.5%	21.5%	16
		20.5 to 22.49	-15.5%	12.1%	14
	SI	Overall	-55.3%	5.7%	187
		18.5 to 20.49	-72.9%	24.4%	11
		20.5 to 22.49	-45.2%	10.4%	38
		22.5 to 24.49	-88.2%	13.4%	36
		24.5 to 26.49	-43.2%	8.2%	73
		> 26.49	-52.0%	13.4%	29
	SS	Overall	-95.3%	16.1%	41
		18.5 to 20.49	-122.3%	26.2%	20
		20.5 to 22.49	-80.9%	26.6%	12
		22.5 to 24.49	-84.7%	20.9%	4
		24.5 to 26.49	-50.1%	17.3%	4
		> 26.49	-36.7%	0.0%	1
	TF	Overall	-67.6%	3.8%	511
		8 to 12.5	-38.0%	2.2%	4
		12.5 to 14.49	-66.3%	11.7%	105
		14.5 to 16.49	-86.0%	12.5%	92
		16.5 to 18.49	-60.7%	5.9%	139
		18.5 to 20.49	-73.5%	10.0%	66
		20.5 to 22.49	-58.9%	6.8%	85
		22.5 to 24.49	-108.2%	20.3%	8
		24.5 to 26.49	-58.8%	12.5%	12
	TI	Overall	-69.4%	33.0%	11
		12.5 to 14.49	5.5%	0.0%	1
		16.5 to 18.49	-111.4%	0.0%	1
		18.5 to 20.49	-20.0%	0.0%	1
		20.5 to 22.49	-87.9%	38.6%	7
		24.5 to 26.49	-25.6%	0.0%	1

Table 72: Percentage Above/Below 2001 Federal Appliance Standards By Type of Refrigerator

The distribution of the percentages better or worse than 2001 standards for all refrigerators that were successfully matched by size range and type are presented in the table below.

As can be seen in the table only 1.3% of all refrigerators are better than 2001 energy standards for annual energy consumption. A closer inspection shows that all of the refrigerator exceeding the 2001 standard are of the side by side type

with through the door ice dispenser (SI). Over 50% of all refrigerators have an estimated UEC of 0.01% to 49.9% worse than 2001 Federal appliance standards for annual energy consumption.

Defrost Type	Ref Type	Size Range (CuFt)	Percentage Comparison to 2001 Federal Appliance Standards										Sample Size
			Better	Worse									
			25% to 10%	-.01% to -24.9%	-25% to -49.9%	-50% to -74.9%	-75% to -99.9%	-100% to -124.9%	-125% to -149.9%	-150% to -174.9%	-175% to -199.9%	<-199.9%	
All Types		Overall	1.3%	17.6%	32.5%	10.4%	17.6%	9.6%	3.5%	4.7%	1.0%	1.8%	797
		8 to 12.5	-	-	71.4%	14.1%	-	-	14.5%	-	-	-	9
		12.5 to 14.49	-	26.1%	26.1%	10.0%	16.8%	7.4%	1.5%	8.2%	-	3.8%	117
		14.5 to 16.49	-	7.1%	31.1%	17.7%	11.4%	12.2%	0.4%	8.0%	8.1%	4.0%	93
		16.5 to 18.49	-	13.3%	36.4%	16.1%	24.1%	7.7%	0.4%	-	-	1.9%	140
		18.5 to 20.49	-	13.8%	21.6%	4.0%	24.0%	15.0%	11.1%	7.6%	0.5%	2.2%	114
		20.5 to 22.49	0.7%	23.7%	40.1%	6.6%	14.6%	7.3%	3.3%	2.2%	0.8%	0.7%	156
		22.5 to 24.49	-	6.5%	21.7%	6.5%	19.6%	19.0%	6.5%	20.1%	-	-	48
		24.5 to 26.49	6.1%	23.2%	37.6%	14.7%	13.4%	2.5%	1.2%	-	-	1.2%	90
		> 26.49	7.4%	26.3%	26.4%	3.7%	14.8%	17.6%	3.8%	-	-	-	30
Manual	SD	Overall	-	-	80.3%	19.7%	-	-	-	-	-	-	7
		8 to 12.5	-	-	66.9%	33.1%	-	-	-	-	-	-	3
		12.5 to 14.49	-	-	100.0%	-	-	-	-	-	-	-	4
Partial	TF	Overall	-	-	-	-	55.0%	-	30.2%	14.8%	-	-	10
		8 to 12.5	-	-	-	-	-	-	100.0%	-	-	-	2
		12.5 to 14.49	-	-	-	-	57.5%	-	21.4%	21.1%	-	-	7
		14.5 to 16.49	-	-	-	-	100.0%	-	-	-	-	-	1
Automatic	BF	Overall	-	53.7%	5.2%	-	14.4%	19.6%	3.5%	3.6%	-	-	30
		18.5 to 20.49	-	27.7%	-	-	27.8%	30.8%	6.8%	6.8%	-	-	16
		20.5 to 22.49	-	81.7%	10.9%	-	-	7.5%	-	-	-	-	14
	SI	Overall	4.8%	24.1%	30.3%	10.5%	13.3%	8.1%	2.1%	6.2%	0.0%	0.6%	187
		18.5 to 20.49	-	19.6%	12.6%	-	53.9%	-	0.2%	13.7%	-	-	11
		20.5 to 22.49	3.0%	32.0%	33.7%	13.5%	4.5%	9.0%	4.4%	-	0.1%	-	38
		22.5 to 24.49	-	8.9%	23.6%	8.9%	20.6%	11.0%	-	27.2%	-	-	36
		24.5 to 26.49	7.7%	27.5%	36.3%	13.7%	8.7%	3.1%	1.5%	-	-	1.5%	73
		> 26.49	7.5%	26.8%	25.0%	3.8%	15.1%	18.0%	3.8%	-	-	-	29
	SS	Overall	-	8.2%	23.0%	2.8%	24.4%	8.2%	8.1%	18.6%	4.0%	2.7%	41
		18.5 to 20.49	-	12.3%	6.1%	0.2%	18.3%	6.2%	18.3%	29.7%	2.9%	6.1%	20
		20.5 to 22.49	-	8.2%	33.5%	-	33.3%	-	-	16.6%	8.4%	-	12
		22.5 to 24.49	-	-	24.8%	-	24.9%	50.4%	-	-	-	-	4
		24.5 to 26.49	-	-	49.5%	25.1%	25.4%	-	-	-	-	-	4
		> 26.49	-	-	100.0%	-	-	-	-	-	-	-	1
	TF	Overall	-	13.3%	36.6%	11.8%	18.9%	10.1%	3.1%	2.5%	1.3%	2.4%	511
		8 to 12.5	-	-	100.0%	-	-	-	-	-	-	-	4
		12.5 to 14.49	-	29.2%	25.6%	11.2%	14.1%	8.3%	-	7.5%	-	4.2%	105
		14.5 to 16.49	-	7.2%	31.6%	18.0%	10.0%	12.4%	0.4%	8.1%	8.2%	4.1%	92
		16.5 to 18.49	-	13.3%	36.4%	16.1%	24.2%	7.7%	0.4%	-	-	1.9%	139
		18.5 to 20.49	-	7.8%	34.5%	7.1%	20.9%	15.8%	11.9%	-	-	2.0%	66
		20.5 to 22.49	-	12.2%	51.3%	4.8%	19.4%	8.2%	2.7%	-	-	1.4%	85
		22.5 to 24.49	-	-	12.4%	-	12.6%	37.6%	37.4%	-	-	-	8
		24.5 to 26.49	-	8.9%	35.7%	17.8%	37.6%	-	-	-	-	-	12
	TI	Overall	-	27.7%	25.3%	13.9%	4.5%	0.4%	13.9%	14.1%	-	-	11
		12.5 to 14.49	-	-	-	-	-	-	-	-	-	-	1
		16.5 to 18.49	-	-	-	-	-	100.0%	-	-	-	-	1
		18.5 to 20.49	-	100.0%	-	-	-	-	-	-	-	-	1
		20.5 to 22.49	-	19.4%	16.0%	19.4%	6.3%	-	19.4%	19.7%	-	-	7
		24.5 to 26.49	-	-	100.0%	-	-	-	-	-	-	-	1

Table 73: Percentage of Refrigerators with a UEC Better or Worse than 2001 Standards by Percentage Bins and Type within Size Ranges

Energy Star Qualified

To qualify for 1993 Energy Star standards, the annual energy consumption of a refrigerator must be at least 20% less than 1993 Federal Appliance Standards for annual energy consumption. To qualify for 2001 Energy Star standards, the annual energy consumption of a refrigerator must be at least 10% less than 2001 Federal Appliance Standards for annual energy consumption. The following analysis is based on a sample of 784 primary refrigerators for which we have obtained UEC data.

The distribution of Primary Refrigerator Freezers that meet Energy Star qualifications grouped by size and type is shown below. These data are not shown by defrost type since the refrigerator data only contained automatic models that met the size requirements of the program. As can be seen in the table the percentage of all refrigerators that meet 1993 Energy Star qualifications is 13.4 % with a 2.2% error bound. The percentage of all refrigerators that meet 2001 Energy Star qualifications is 1.3 % with a 0.7% error bound.

Defrost Type	Ref Type	Size Range (CuFt)	1993 Energy		2001 Energy		Sample Size
			Percentage	Error Bound	Percentage	Error Bound	
All Types		Overall	13.4%	2.2%	1.3%	0.7%	784
		12.5 to 14.49	15.2%	7.2%	-	-	113
		14.5 to 16.49	4.2%	3.9%	-	-	93
		16.5 to 18.49	6.7%	3.8%	-	-	140
		18.5 to 20.49	8.3%	4.7%	-	-	114
		20.5 to 22.49	17.4%	5.3%	0.7%	1.2%	156
		22.5 to 24.49	6.5%	6.0%	-	-	48
		24.5 to 26.49	25.1%	7.8%	6.1%	4.4%	90
		> 26.49	31.0%	14.4%	7.4%	8.3%	30
Automatic	BF	Overall	53.7%	15.4%	-	-	30
		18.5 to 20.49	27.7%	19.3%	-	-	16
		20.5 to 22.49	81.7%	16.6%	-	-	14
		> 26.49	31.5%	14.6%	7.5%	8.4%	29
	SI	Overall	22.3%	5.2%	4.8%	2.7%	187
		18.5 to 20.49	6.3%	10.3%	-	-	11
		20.5 to 22.49	17.5%	10.7%	3.0%	4.8%	38
		22.5 to 24.49	8.9%	8.0%	-	-	36
		24.5 to 26.49	29.9%	9.2%	7.7%	5.4%	73
	TF	Overall	8.2%	2.3%	-	-	507
		12.5 to 14.49	16.3%	7.7%	-	-	105
		14.5 to 16.49	4.3%	3.9%	-	-	92
		16.5 to 18.49	6.7%	3.8%	-	-	139
		18.5 to 20.49	5.8%	5.4%	-	-	66
		20.5 to 22.49	9.6%	5.6%	-	-	85
		22.5 to 24.49	-	-	-	-	8
		24.5 to 26.49	8.9%	13.9%	-	-	12
	TI	Overall	0.4%	0.6%	-	-	11
		12.5 to 14.49	100.0%	-	-	-	1
		16.5 to 18.49	-	-	-	-	1
		18.5 to 20.49	-	-	-	-	1
		20.5 to 22.49	-	-	-	-	7
		24.5 to 26.49	-	-	-	-	1

Table 74: Percentage of Energy Star Qualified Primary Refrigerators by Type and Size Range

Secondary Refrigerators

Of the 14.4% of homes with second refrigerator/freezers, 11% have half-size models with capacities fewer than 8 cubic feet. No further analysis is carried out on half size refrigerators. The majority of homes with at least two refrigerators have top mount freezers (TF) as their secondary refrigerator type. A complete breakdown of secondary refrigerator/freezer by type is shown below.
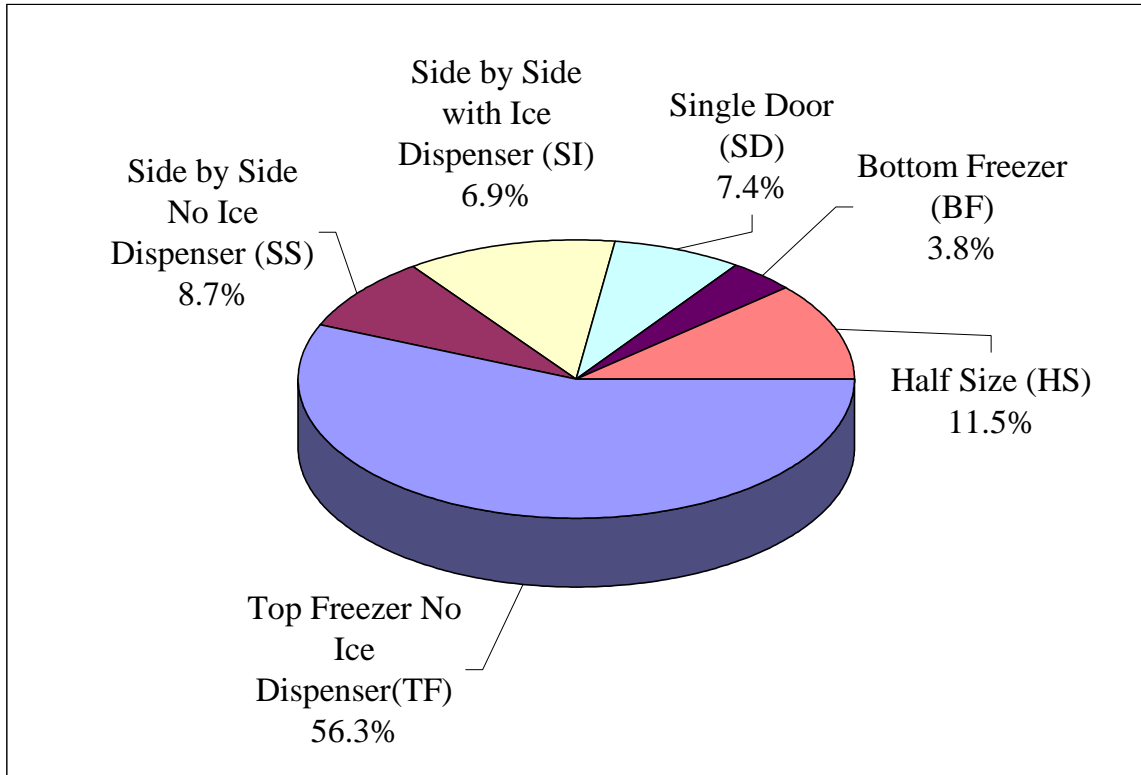
Figure 7: Secondary Refrigerators by Type

Size

The sample size that is used in the following analysis of the secondary refrigerators by size of the unit is 131. This is the number of full size refrigerators, 8 cubic feet or greater, for which we obtained size data. Size data was obtained from the manufacturer data and the surveyor estimate.

Table 75 shows the average estimated size of the refrigerators by type. The average of all types of refrigerators is 18.5 cuft with an error bound of 0.6 cuft. The side by side with ice dispensers are 23.8 cuft on average, the largest of all the types.

Refrigerator Type	Avg Est Size (CuFt)	Error Bound	Sample Size
Overall	18.5	0.6	131
BF	21.3	2.5	3
SD	13.9	2.6	8
SI	23.8	0.6	21
SS	20.6	0.9	11
TF	17.3	0.5	88

Table 75: Average Estimated Size of Secondary Refrigerators by Type

The following table shows the distribution of the sizes of the refrigerators. The largest percentage of the secondary refrigerators surveyed (29.2%) fall in the size range of 16.5 to 18.49 cubic feet

Size Range (CuFt)	All Types (n=131)		Bottom Freezer (BF) (n=3)		Single Door (SD) (n=8)		Side by Side with Ice Maker (SI)		Side by Side No Ice Maker(SS)		Top Freezer (TF) (n=88)	
	%	Error Bound	%	Error Bound	%	Error Bound	%	Error Bound	%	Error Bound	%	Error Bound
8 to 12.5	7.3%	4.1%	-	-	50.1%	29.1%	-	-	-	-	5.7%	4.5%
12.5 to 14.49	9.5%	4.6%	-	-	12.5%	19.3%	-	-	-	-	13.4%	6.6%
14.5 to 16.49	5.5%	3.3%	-	-	-	-	-	-	-	-	8.5%	5.1%
16.5 to 18.49	29.2%	7.0%	-	-	12.5%	19.3%	-	-	9.5%	14.8%	42.7%	9.4%
18.5 to 20.49	21.3%	6.3%	66.6%	44.8%	24.9%	25.1%	5.7%	9.0%	47.8%	25.1%	19.0%	7.5%
20.5 to 22.49	12.2%	4.9%	-	-	-	-	16.5%	13.4%	28.7%	22.9%	10.5%	5.7%
22.5 to 24.49	7.0%	3.9%	-	-	-	-	34.0%	18.3%	14.1%	16.3%	0.2%	0.4%
24.5 to 26.49	8.0%	4.2%	33.4%	44.8%	-	-	43.8%	19.0%	-	-	-	-
> 26.49	-	-	-	-	-	-	-	-	-	-	-	-

Table 76: Estimated Size Distribution of Secondary Freezers by Type

Age

Similar to the primary refrigerator, this analysis attempts to match the refrigerator/freezer model numbers collected from on-sites with manufacturer data to obtain an approximate manufacture date. The ages of 63 secondary refrigerator/freezers were obtained in this manner. Based on this sample, the overall average age of secondary refrigerators is 12.8 years with an error bound of 1.3 years. This is considerably older than the average age of primary refrigerators, which is 8.5 years. The manufacture date range of 1980 through 1984 have the largest percentage, accounting for 31.8% of all secondary refrigerators.

Ref Type	Size Range (CuFt)	Avg Mfr Rpt Age	Avg Mfr Age EB	Manufacturer Reported Age Ranges					Sample Size
				1995-2000	1990-1994	1985-1989	1980-1984	1975-1979	
All Types	Overall	12.8	1.3	9.3%	24.4%	28.5%	31.8%	6.0%	63
	8 to 12.5	2.0	-	100.0%	-	-	-	-	1
	12.5 to 14.49	12.8	4.3	18.2%	8.6%	18.4%	54.8%	-	6
	14.5 to 16.49	12.5	2.4	-	47.1%	19.4%	33.6%	-	8
	16.5 to 18.49	11.8	1.8	9.9%	24.0%	36.6%	29.5%	-	22
	18.5 to 20.49	15.7	4.7	15.6%	0.5%	18.6%	46.4%	18.9%	7
	20.5 to 22.49	12.2	2.1	-	36.6%	48.3%	14.7%	0.4%	11
	22.5 to 24.49	17.4	6.3	-	-	51.0%	-	49.0%	3
	24.5 to 26.49	14.6	4.3	-	39.8%	-	40.1%	20.1%	5
SD	12.5 to 14.49	17.0	-	-	-	-	100.0%	-	1
SI	Overall	14.2	3.2	-	33.1%	22.4%	22.3%	22.1%	10
	20.5 to 22.49	10.0	3.5	-	50.0%	50.0%	-	-	2
	22.5 to 24.49	17.4	6.3	-	-	51.0%	-	49.0%	3
	24.5 to 26.49	14.6	4.3	-	39.8%	-	40.1%	20.1%	5
SS	Overall	19.0	4.3	-	-	33.2%	33.1%	33.7%	3
	18.5 to 20.49	21.5	4.1	-	-	-	49.6%	50.4%	2
	20.5 to 22.49	14.0	-	-	-	100.0%	-	-	1
TF	Overall	11.8	1.3	12.5%	24.9%	30.3%	32.1%	0.1%	49
	8 to 12.5	2.0	-	100.0%	-	-	-	-	1
	12.5 to 14.49	11.9	5.0	22.3%	10.5%	22.6%	44.6%	-	5
	14.5 to 16.49	12.5	2.4	-	47.1%	19.4%	33.6%	-	8
	16.5 to 18.49	11.8	1.8	9.9%	24.0%	36.6%	29.5%	-	22
	18.5 to 20.49	12.1	5.0	24.9%	0.8%	29.8%	44.5%	-	5
	20.5 to 22.49	12.8	2.8	-	39.1%	34.3%	25.9%	0.7%	8

Table 77: Average Age and Percentage of Refrigerator Manufacturer Reported Ages within Size Ranges

During the on-site visit residents were asked for the approximate age of their refrigerators. If the resident was unable to provide an age, surveyors estimated the age of the refrigerators whenever possible. These estimated ages were used for refrigerators when no age data from manufacturers was available for the following analysis. The sample size of 142 secondary refrigerator ages represents all full size secondary refrigerator age data obtained in this study. The average age and error bound along with the distribution of manufacturing date range by type and size range are presented in the following table. The average age of the refrigerators is 15.5 years with an error bound of 1.2 years.

Similar to the primary refrigerator age estimates, both of the secondary refrigerator manufactured and estimated ages have some bias. These biases are explained in the primary refrigerator section. It is likely that less bias exists in the estimated age analysis, though we thought it important to report both.

Ref Type	Size Range (CuFt)	Avg Mfr Rpt Age	Avg Mfr Age EB	Manufacturer Reported Age Ranges						Sample Size
				1995-2000	1990-1994	1985-1989	1980-1984	1975-1979	1974 and Older	
All Types	Overall	15.5	1.2	8.2%	23.8%	22.5%	27.6%	7.3%	10.7%	142
	8 to 12.5	20.4	7.9	12.4%	25.1%	12.5%	-	12.5%	37.5%	8
	12.5 to 14.49	11.9	3.8	19.1%	23.7%	19.2%	28.6%	9.5%	-	11
	14.5 to 16.49	12.5	2.4	-	46.9%	19.3%	33.9%	-	-	9
	16.5 to 18.49	12.9	1.6	11.8%	19.2%	34.1%	31.5%	3.3%	-	35
	18.5 to 20.49	15.3	2.4	8.5%	19.1%	18.6%	39.7%	9.4%	4.6%	24
	20.5 to 22.49	14.6	3.3	3.6%	41.0%	24.9%	15.1%	0.2%	15.1%	19
	22.5 to 24.49	18.2	4.1	-	26.0%	13.5%	28.3%	13.0%	19.2%	10
	24.5 to 26.49	14.2	3.8	11.5%	34.3%	-	23.0%	31.2%	-	9
	Size Unknown	22.5	4.0	-	6.8%	29.1%	27.2%	-	36.9%	17
BF	Overall	21.4	4.3	-	-	19.9%	40.0%	20.0%	20.0%	5
	18.5 to 20.49	16.5	1.7	-	-	49.9%	50.1%	-	-	2
	24.5 to 26.49	22.0	-	-	-	-	-	100.0%	-	1
	Size Unknown	26.0	7.0	-	-	-	49.9%	-	50.1%	2
SD	Overall	21.3	4.5	-	19.0%	9.5%	28.8%	9.6%	33.1%	11
	8 to 12.5	23.0	7.8	-	25.0%	-	-	25.0%	50.0%	4
	12.5 to 14.49	17.0	-	-	-	-	100.0%	-	-	1
	16.5 to 18.49	19.0	-	-	-	-	100.0%	-	-	1
	18.5 to 20.49	14.0	7.0	-	49.6%	-	50.4%	-	-	2
	Size Unknown	27.2	10.4	-	-	40.5%	-	-	59.5%	3
SI	Overall	13.7	2.3	5.7%	39.1%	11.4%	28.4%	15.4%	-	20
	18.5 to 20.49	20.0	-	-	-	-	100.0%	-	-	1
	20.5 to 22.49	9.7	2.4	-	66.0%	34.0%	-	-	-	4
	22.5 to 24.49	15.3	3.3	-	33.1%	17.1%	33.3%	16.5%	-	7
	24.5 to 26.49	13.2	3.9	13.0%	38.7%	-	25.9%	22.4%	-	8
SS	Overall	19.1	4.0	8.6%	8.7%	17.4%	26.2%	17.5%	21.6%	12
	16.5 to 18.49	3.0	-	100.0%	-	-	-	-	-	1
	18.5 to 20.49	19.8	3.8	-	-	20.1%	39.8%	40.1%	-	5
	20.5 to 22.49	17.7	8.5	-	33.5%	33.0%	-	-	33.5%	3
	22.5 to 24.49	30.0	-	-	-	-	-	-	100.0%	2
	Size Unknown	20.0	-	-	-	-	100.0%	-	-	1
TF	Overall	14.2	1.5	10.4%	24.7%	27.8%	26.6%	2.7%	7.9%	94
	8 to 12.5	17.7	13.3	24.8%	25.2%	25.2%	-	-	24.8%	4
	12.5 to 14.49	11.4	4.0	21.1%	26.2%	21.3%	21.0%	10.5%	-	10
	14.5 to 16.49	12.5	2.4	-	46.9%	19.3%	33.9%	-	-	9
	16.5 to 18.49	13.0	1.6	9.1%	20.5%	36.6%	30.2%	3.6%	-	33
	18.5 to 20.49	13.0	3.5	16.0%	27.1%	17.5%	30.7%	-	8.7%	14
	20.5 to 22.49	15.2	4.2	6.5%	34.2%	18.0%	27.3%	0.4%	13.6%	12
	22.5 to 24.49	18.0	-	-	-	-	100.0%	-	-	1
	Size Unknown	20.8	5.4	-	10.7%	35.5%	21.6%	-	32.2%	11

**Table 78: Average Age and Percentage of Secondary Refrigerator
Manufacturer Reported Ages and On Site Estimated Ages by Size Range
and Type**

Energy Consumption

The average annual unit energy consumption (UEC) data for refrigerator/freezers is obtained from the model number matches to manufacturer data. A sample of 68 UECs were obtained for the analysis below. The bin distribution and the average of annual energy consumption based upon the sample of all successfully matched full size secondary refrigerators is shown below grouped by size and type.

The average overall UEC is 1034 kWh/year with an error bound of 89.2 kWh/year. The largest percentage of refrigerators (19.6%) is within the range between 900 to 1049.9 kWh/year.

Defrost Type	Ref Type	Size Range (CuFt)	Average UEC	Average UEC EB	Unit Energy Consumption Ranges												Sample Size
					450-599.9	600-749.9	750-899.9	900-1049.9	1050-1199.9	1200-1349.9	1350-1499.9	1500-1649.9	1650-1799.9	1950-2099.9	2100-2249.9	2400-2549.9	
All Types		Overall	1,034.2	89.2	9.8%	17.3%	14.2%	19.6%	17.4%	6.4%	2.4%	3.7%	3.7%	1.8%	1.8%	1.8%	68
		8 to 12.5	523.0	-	100.0%	-	-	-	-	-	-	-	-	-	-	-	1
		12.5 to 14.49	805.0	147.4	30.9%	22.8%		30.9%	15.4%		-	-	-	-	-	-	7
		14.5 to 16.49	926.8	130.8	-	30.2%	16.9%	19.4%	16.9%	16.7%		-	-	-	-	-	8
		16.5 to 18.49	899.1	59.9	7.1%	17.4%	25.1%	21.4%	29.0%		-	-	-	-	-	-	23
		18.5 to 20.49	1,070.0	298.2	12.0%	34.2%	12.0%	-	12.2%	5.6%	-	11.9%	-	-	12.1%	-	10
		20.5 to 22.49	1,132.3	181.9	-	0.2%	14.9%	36.2%	14.7%	14.5%	4.7%	0.4%	14.5%	-	-	-	11
		22.5 to 24.49	1,701.2	366.8	-	-	-	-	-	1.4%	49.6%	-	-	49.0%	-	-	3
		24.5 to 26.49	1,603.3	348.9	-	-	-	19.8%	-	20.1%	-	20.1%	20.1%	-	-	20.1%	5
Manual	SD	Overall	615.2	61.0	50.4%	49.6%	-	-	-	-	-	-	-	-	-	-	2
		12.5 to 14.49	563.2	-	100.0%	-	-	-	-	-	-	-	-	-	-	-	1
		18.5 to 20.49	668.0	-	-	100.0%	-	-	-	-	-	-	-	-	-	-	1
Automatic	SI	Overall	1,552.9	257.2	-	-	11.0%	11.0%	-	11.4%	11.1%	11.1%	22.1%	11.0%	-	11.1%	10
		20.5 to 22.49	1,273.9	551.4	-	-	50.0%	-	-	-	-	-	50.0%	-	-	-	2
		22.5 to 24.49	1,701.2	366.8	-	-	-	-	-	1.4%	49.6%	-	-	49.0%	-	-	3
		24.5 to 26.49	1,603.3	348.9	-	-	-	19.8%	-	20.1%	-	20.1%	20.1%	-	-	20.1%	5
	SS	Overall	1,675.1	381.8	-	-	-	-	-	33.2%	-	33.1%	-	-	33.7%	-	3
		18.5 to 20.49	1,904.1	335.5	-	-	-	-	-	-	-	49.6%	-	-	50.4%	-	2
		20.5 to 22.49	1,214.8	-	-	-	-	-	-	100.0%	-	-	-	-	-	-	1
	TF	Overall	891.8	49.5	10.7%	20.8%	16.7%	23.9%	23.4%	3.6%	0.8%	0.1%	-	-	-	-	53
		8 to 12.5	523.0	-	100.0%	-	-	-	-	-	-	-	-	-	-	-	1
		12.5 to 14.49	849.5	154.8	18.2%	27.0%	-	36.6%	18.2%		-	-	-	-	-	-	6
		14.5 to 16.49	926.8	130.8	-	30.2%	16.9%	19.4%	16.9%	16.7%	-	-	-	-	-	-	8
		16.5 to 18.49	899.1	59.9	7.1%	17.4%	25.1%	21.4%	29.0%	-	-	-	-	-	-	-	23
		18.5 to 20.49	832.0	153.5	18.7%	34.8%	18.7%	-	19.1%	8.8%	-	-	-	-	-	-	7
		20.5 to 22.49	1,038.8	86.8	-	0.4%	0.7%	63.9%	25.9%	-	8.4%	0.7%	-	-	-	-	8

Table 79: Percentage of Refrigerators by UEC Ranges and Type within Size Ranges

Percentage Above/Below 2001 Federal Appliance Standards

Additionally, the above groupings of full size secondary refrigerators are compared with the 2001 Federal Appliance Standards for annual energy consumption, calculated the same as described in the primary refrigerator section.

Table 80 shows that on average, the secondary refrigerators are 100.1% worse than standard. This is significantly worse than the primary refrigerators that are 64.8% worse than standard.

Defrost Type	Ref Type	Size Range (CuFt)	% Worse than 2001 Standards	Error Bound	Sample Size
All Types		Overall	-100.1%	12.6%	68
		8 to 12.5	-35.1%	0.0%	1
		12.5 to 14.49	-89.1%	31.8%	7
		14.5 to 16.49	-106.0%	28.1%	8
		16.5 to 18.49	-88.3%	12.6%	23
		18.5 to 20.49	-105.7%	45.7%	10
		20.5 to 22.49	-94.8%	28.0%	11
		22.5 to 24.49	-143.7%	52.5%	3
		24.5 to 26.49	-122.1%	47.7%	5
Manual	SD	Overall	-52.5%	5.7%	2
		12.5 to 14.49	-47.4%	0.0%	1
		18.5 to 20.49	-57.2%	0.0%	1
Automatic	SI	Overall	-120.3%	35.3%	10
		20.5 to 22.49	-90.5%	80.5%	2
		22.5 to 24.49	-143.7%	52.5%	3
		24.5 to 26.49	-122.1%	47.7%	5
	SS	Overall	-167.0%	63.1%	3
		18.5 to 20.49	-205.4%	55.2%	2
		20.5 to 22.49	-91.3%	0.0%	1
	TF	Overall	-88.8%	10.2%	53
		8 to 12.5	-35.1%	0.0%	1
		12.5 to 14.49	-95.9%	34.8%	6
		14.5 to 16.49	-106.0%	28.1%	8
		16.5 to 18.49	-88.3%	12.6%	23
		18.5 to 20.49	-66.6%	30.6%	7
		20.5 to 22.49	-98.7%	16.0%	8

Table 80: Percentage Below 2001 Federal Appliance Standards By Type of Refrigerator

The distribution of the percentages below the 2001 standards for all full size secondary refrigerators that were successfully matched by size range and type is presented in the table below. There were no secondary refrigerators that met 2001 federal appliance standards.

Over 23% of all refrigerators have an estimated UEC of 0.01% to 49.9% worse than 2001 Federal Appliance standards for annual energy consumption. Over 24% of all refrigerators have an estimated UEC between 75% to 99.9% worse than standard.

Defrost Type	Ref Type	Size Range (CuFt)	Percentage Worse than 2001 Standards									Sample Size
			-.01% to -24.9%	-25% to -49.9%	-50% to -74.9%	-75% to -99.9%	-100% to -124.9%	-125% to -149.9%	-150% to -174.9%	-175% to -199.9%	<-199.9%	
All Types		Overall	6.1%	17.4%	12.3%	24.5%	9.8%	14.6%	9.1%	2.4%	3.7%	68
		8 to 12.5	-	100.0%	-	-	-	-	-	-	-	1
		12.5 to 14.49	-	46.5%	7.2%	-	30.9%	-	15.4%	-	-	7
		14.5 to 16.49	-	5.4%	24.7%	30.8%	5.4%	-	33.6%	-	-	8
		16.5 to 18.49	7.1%	12.2%	14.5%	32.0%	10.7%	23.6%	-	-	-	23
		18.5 to 20.49	12.0%	22.3%	11.9%	12.0%	-	17.9%	11.9%	-	12.1%	10
		20.5 to 22.49	14.5%	0.2%	0.4%	50.6%	14.7%	-	14.5%	4.7%	0.4%	11
		22.5 to 24.49	-	-	-	51.0%	-	-	-	49.0%	-	3
		24.5 to 26.49	-	19.8%	20.1%	-	-	40.1%	-	-	20.1%	5
Manual	**SD**	Overall	-	50.4%	49.6%	-	-	-	-	-	-	2
		12.5 to 14.49	-	100.0%	-	-	-	-	-	-	-	1
		18.5 to 20.49	-	-	100.0%	-	-	-	-	-	-	1
Automatic	**SI**	Overall	11.0%	11.0%	11.1%	11.4%	-	22.3%	11.0%	11.0%	11.1%	10
		20.5 to 22.49	50.0%	-	-	-	-	-	50.0%	-	-	2
		22.5 to 24.49	-	-	-	51.0%	-	-	-	49.0%	-	3
		24.5 to 26.49	-	19.8%	20.1%	-	-	40.1%	-	-	20.1%	5
	SS	Overall	-	-	-	33.2%	-	-	33.1%	-	33.7%	3
		18.5 to 20.49	-	-	-	-	-	-	49.6%	-	50.4%	2
		20.5 to 22.49	-	-	-	100.0%	-	-	-	-	-	1
	TF	Overall	5.7%	18.5%	11.6%	28.0%	13.2%	14.7%	7.4%	0.8%	0.1%	53
		8 to 12.5	-	100.0%	-	-	-	-	-	-	-	1
		12.5 to 14.49	-	36.6%	8.6%	-	36.6%	-	18.2%	-	-	6
		14.5 to 16.49	-	5.4%	24.7%	30.8%	5.4%	-	33.6%	-	-	8
		16.5 to 18.49	7.1%	12.2%	14.5%	32.0%	10.7%	23.6%	-	-	-	23
		18.5 to 20.49	18.7%	34.8%	-	18.7%	-	27.9%	-	-	-	7
		20.5 to 22.49	-	0.4%	0.7%	63.9%	25.9%	-	-	8.4%	0.7%	8

Table 81: Percentage range of Secondary Refrigerators with a UEC Worse than 2001 Standards by Percentage Bins and Type within Size Ranges

Energy Star Qualified

To qualify for 1993 Energy Star standards, the annual energy unit consumption of a refrigerator must be at least 20% less than 1993 Federal Appliance Standards for annual energy consumption. To qualify for 2001 Energy Star standards, the annual energy consumption of a refrigerator must be at least 10% less than 2001 Federal Appliance Standards for annual energy consumption. The following analysis is based on a sample of 65 secondary refrigerators for which we have obtained UEC data.

The distribution of secondary refrigerator/freezers that meet Energy Star qualifications grouped by size and type is shown below. As can be seen in the table the percentage of all full size secondary refrigerators that meet 1993 Energy Star qualifications is 2.0% with a 3.1% error bound. No full size secondary refrigerators meet 2001 Federal Appliance standard, therefore none qualify for 2001 Energy Star status.

Ref Type	Size Range (CuFt)	1993 Energy Star Qualified		
		Percentage	Error Bound	Sample Size
All Types	Overall	2.0%	3.1%	65
	12.5 to 14.49	-	-	6
	14.5 to 16.49	-	-	8
	16.5 to 18.49	0.1%	0.1%	23
	18.5 to 20.49	13.6%	20.7%	9
	20.5 to 22.49	-	-	11
	22.5 to 24.49	-	-	3
	24.5 to 26.49	-	-	5
TF	All TF	2.6%	4.1%	52
	12.5 to 14.49	-	-	6
	14.5 to 16.49	-	-	8
	16.5 to 18.49	0.1%	0.1%	23
	18.5 to 20.49	18.7%	27.5%	7
	20.5 to 22.49	-	-	8
SI	All SI	-	-	10
SS	All SS	-	-	3

**Table 82: Percentage of 1993 Energy Star Qualified Secondary Refrigerators by Type and Size Range**

Self-standing Freezers

The following section describes the self-standing freezers. Over 16% of all homes have one self-standing freezer and less than 1% of all homes have a second self-standing freezer. Due to the small number of homes with secondary freezers, the following summary information is only based upon the primary freezers.

This section summarizes the freezers by type, size, age, and usage. The type of the freezers was obtained from the site visit. The size of the freezers was first obtained from the efficiency databases (CEC and AHAM) if the model number successfully matched a model in the database. For the models that were not matched, the information on the size collected on site by the auditor was used. The age of the freezer was also obtained from the efficiency databases if a match was made, otherwise the age from the on site visit was used in the age analysis. The usage data was obtained exclusively from the efficiency databases. Due to the fact that some ages and sizes were not obtained during the on site visit, the number of sites in each of the following analyses will differ.

During the site visit residents were asked to estimate the percentage of the year the freezer is operated to determine seasonal usage. The average percentage of time that the self-standing freezers were reported to be in use is 97%. This high percentage reflects that the majority of freezers are operated year round.

The following figure shows the percentage breakdown of primary freezers by freezer type. The majority of the primary freezers found were the upright type, totaling almost 71% of all the primary freezers. Chest type freezers accounted for over 29% of the primary freezers.
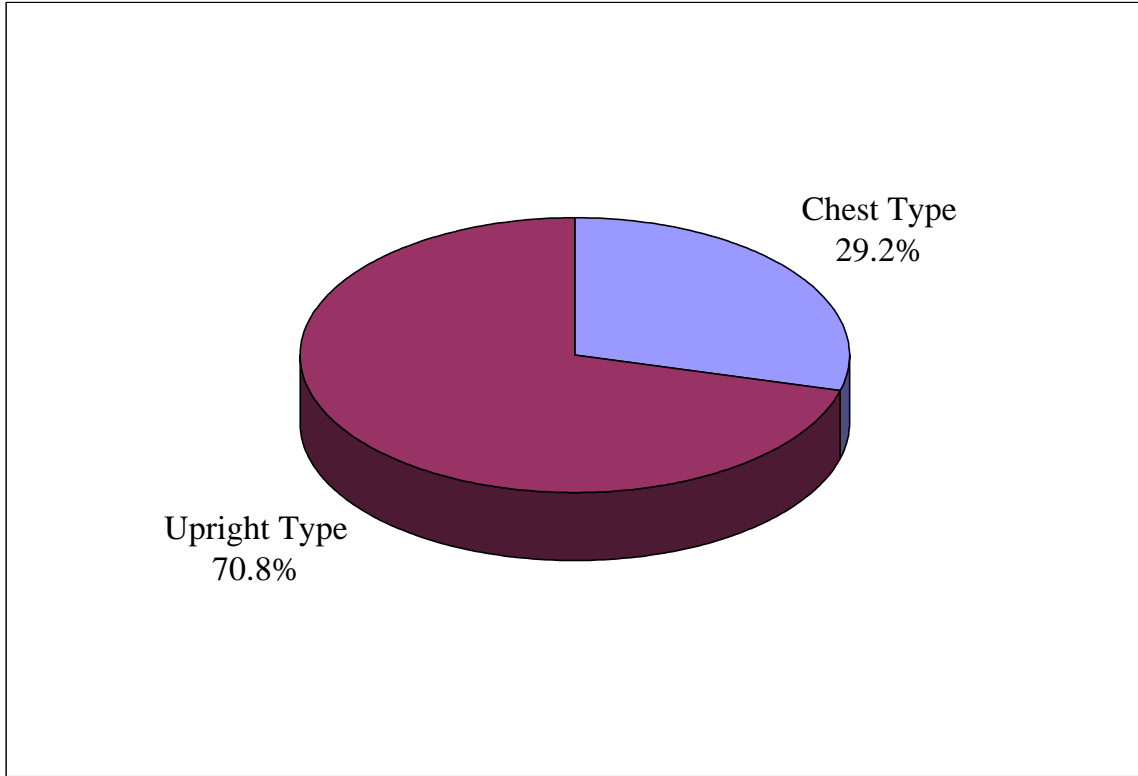
Figure 8: Percentage of Freezer Types Among All Primary Freezers

Size

Table 83 shows the average size of the chest and upright freezers. The average size of both types of freezers combined is also shown. The error bound and sample size for the freezers used in each analysis are also presented in the following table. The average size of chest units is found to be approximately 3.3 cu.ft. smaller than the average of the upright units. The number in the sample of chest units is less than half that of upright units.

	Average Size (CuFt)	Error Bound	Sample Size
Chest and Upright	15.65	0.75	159
Chest	13.38	1.63	48
Upright	16.62	0.76	111

Table 83: Average Size of Primary Freezers by Type

Table 84 shows the distribution of the size of the primary freezers by type of freezer. The largest percentage of chest freezers are in the size range between 5 and 7.9 cu.ft., totaling over 27% of the chest freezers. The largest percentage of upright freezers are in the size range between 14 and 16.9 cu.ft., containing over one-third of all the upright freezers.

Size Range (CuFt)	Chest and Upright (n=159)		Chest (n=48)		Upright (n=111)	
	Percentage	Error Bound	Percentage	Error Bound	Percentage	Error Bound
5-7.9	9.8%	4.1%	27.8%	11.4%	2.1%	2.5%
8-10.9	13.6%	4.8%	20.1%	10.4%	10.9%	5.2%
11-13.9	6.7%	3.5%	5.0%	5.6%	7.5%	4.3%
14-16.9	28.8%	6.3%	17.5%	9.8%	33.6%	7.8%
17-19.9	15.8%	5.0%	7.0%	6.1%	19.6%	6.5%
20-22.9	17.1%	5.3%	10.1%	7.8%	20.1%	6.7%
23-25.9	5.5%	3.2%	10.0%	7.8%	3.5%	3.0%
26-28.9	1.1%	1.4%	2.5%	4.0%	0.5%	0.8%
29-31.9	1.5%	1.7%	-		2.1%	2.5%

Table 84: Distribution of Size of Primary Freezers and Type

Annual Energy Consumption

Table 86 shows the average annual usage of the primary freezers by type. The average annual usage of upright freezers is significantly higher than that of chest freezers. This result is not a surprise due to the fact that upright freezers were found to be larger and older than chest freezers on average.

The sample sizes for the analyses by UEC are smaller than those for the size analyses due to the fact that we were only able to match small percentage of the units with the efficiency databases that were used to obtain the UEC.

Table 85 shows the distribution of UEC data by freezer type. The majority of self standing freezers of both types use less than 625 kWh per year.

Annual Usage Range (Kwh/Yr)	Chest and Upright (n=49)		Chest (n=11)		Upright (n=38)	
	Percentage	Error Bound	Percentage	Error Bound	Percentage	Error Bound
225 to 424.9	28.9%	11.5%	71.1%	24.3%	17.7%	10.8%
425 to 624.9	28.9%	11.4%	17.1%	19.1%	32.0%	13.2%
625 to 824.9	11.0%	7.8%	11.8%	18.1%	10.8%	8.7%
825 to 1024.9	12.5%	8.5%	-	-	15.7%	10.5%
1025 to 1224.9	14.3%	8.7%	-	-	18.1%	10.7%
1225 to 1424.9	2.0%	3.3%	-	-	2.6%	4.2%
2025 to 2224.9	2.5%	4.0%	-	-	3.1%	5.0%

Table 85: Distribution of Annual Usage of Primary Freezers by Type

Federal efficiency standards for residential freezers were increased in 1993. The standard is a maximum UEC equation as a function of capacity and type. The standards are to be further tightened in 2001. Since the minimum standard UEC is a function of capacity, the 1993 and 2001 standards presented for comparison are based upon the capacities of the sample. The average UECs for both chest and upright freezers are above the federal maximum, and therefore on average are *less* efficient than current standards.

Type	Sample Size	Manufacturer Data		1993 Standard		2001 Standard	
		UEC (kWh/yr)	Error Bound	UEC (kWh/yr)	Error Bound	UEC (kWh/yr)	Error Bound
All Types	49	690	92	533	44	457	35
Upright	38	765	104	581	43	495	34
Chest	11	406	93	348	68	313	61

Table 86: Unit Energy Consumption of Primary Freezers by Type

Federal efficiency standards for residential freezers were increased in 1993. The standard is a maximum UEC equation as a function of capacity. The comparison shown in Table 88 compares the UEC from the efficiency databases to the calculated current federal maximum UEC for each model. The 6.1% of freezers that are over 100% worse than 1993 standard consume more than twice the electricity than the maximum allowed for a freezer manufactured today . 47.6% of freezers meet the 1993 minimum standards, however no freezers in the sample exceed the 2001 minimum standards

Comparison to 1993 Standards	(n=49)	
	Percentage	Error Bound
10 to 15% better	9.2%	7.3%
0 to 10% better	38.4%	12.3%
0 to 10% worse	7.4%	6.7%
10 to 25% worse	4.9%	5.6%
25 to 50% worse	16.0%	9.3%
50 to 100% worse	18.1%	9.6%
Over 100% worse	6.1%	5.8%

Table 87: Comparison of Primary Freezers to Federal Standards

Age

Table 88 shows the average manufacture date of the primary freezers by type. The average age of chest type freezers is on average lower than that of upright freezers.

Freezer Type	Estimated			Mfr. Reported		
	Average Age (Years)	Error Bound	Sample Size	Average Age (Years)	Error Bound	Sample Size
Chest and Upright	13.6	1.2	169.0	10.14	1.93	44.0
Chest	11.5	2.1	46.0	9.02	2.60	10.0
Upright	14.5	1.4	123.0	10.44	2.34	34.0

Table 88: Average Manufacture Date of Primary Freezers by Type

Table 89 shows the distribution of the age of the primary freezers within 5 year age ranges. The largest percentage of all the primary freezers were in the age range from 1990 to 1994.

Manufacture Date (Years)	Estimated						Mfr. Reported					
	Chest and Upright (n=169)		Chest (n=46)		Upright (n=123)		Chest and Upright (n=44)		Chest (n=10)		Upright (n=34)	
	%	Error Bound	%	Error Bound	%	Error Bound	%	Error Bound	%	Error Bound	%	Error Bound
1995-2000	18.1%	5.1%	21.4%	10.5%	16.8%	5.8%	24.0%	11.5%	13.7%	20.6%	26.8%	13.4%
1990-1994	27.7%	6.0%	35.9%	12.4%	24.6%	6.8%	38.7%	13.1%	57.9%	29.1%	33.6%	14.3%
1985-1989	19.0%	5.3%	17.4%	9.8%	19.6%	6.2%	9.9%	7.9%	13.3%	20.4%	8.9%	8.4%
1980-1984	17.5%	5.1%	15.3%	9.3%	18.4%	6.1%	15.4%	9.6%	15.0%	20.5%	15.5%	10.9%
1975-1979	6.6%	3.2%	-	-	9.1%	4.4%	12.0%	8.6%	-	-	15.2%	10.6%
1974 and Older	11.1%	4.2%	10.0%	7.8%	11.5%	4.9%	-	-	-	-	-	-

Table 89: Distribution of Manufacture Date of Primary Freezers by Type
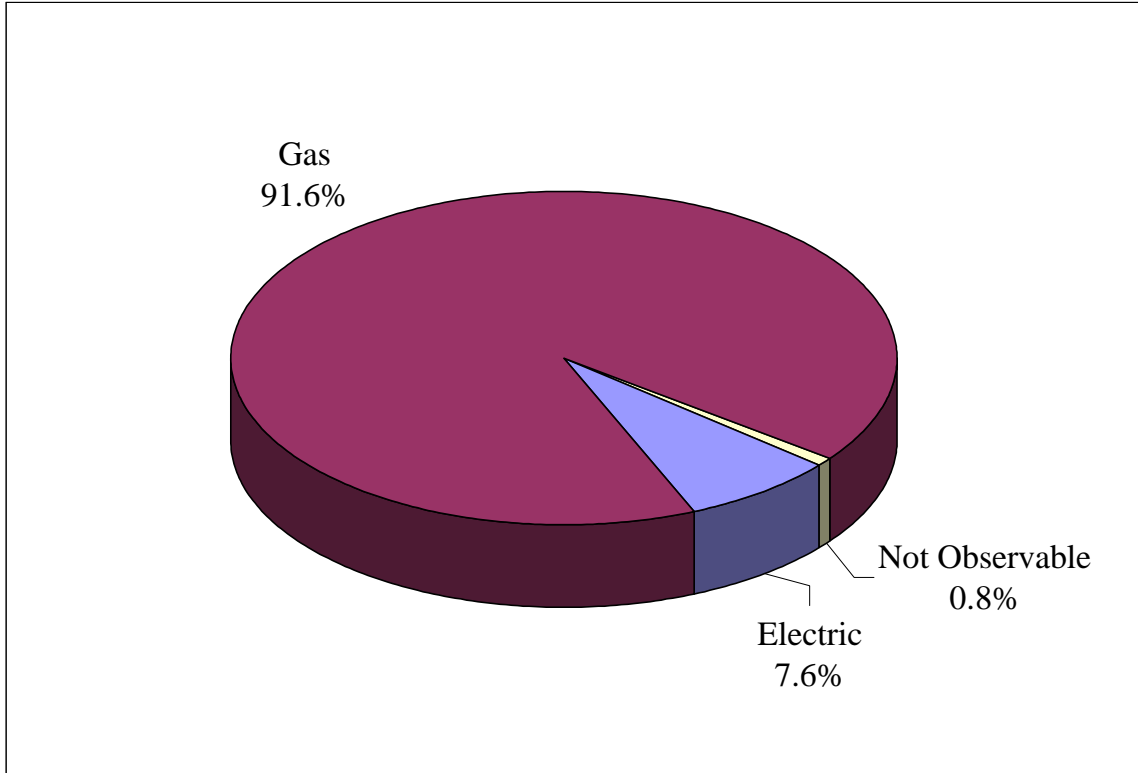
Hot Water Heaters

The following section summarizes the data on the water heaters that were collected during the on-site visit. Only one site that we visited has an instantaneous water heater. The unit is a 1 gallon, electric heat pump model with an energy factor of 1.9. No further reference to this unit will be made. The remaining summary refers to storage water heaters only.

The majority of water heaters in California are gas fired 40 gallon storage units. . Energy factor for water heaters is a measure of efficiency expressed as a percentage. It is defined as the heater supplied energy content of the delivered hot water divided by the energy consumed by the water heater. The average energy factor for the popular 40 gallon gas fired heater is 0.57, which equals the National Appliance Energy Conservation Act Standards (NAECA), implemented in 1990. The average energy factor for electric models of the same size heater is slightly below standard.

Energy Factor Comparison			
Size	Fuel Type	Standard EF	Average EF
40 Gallon	Electric	0.90	0.89
40 Gallon	Gas	0.57	0.57

Fuel Type

Figure 9 shows the break down of water heaters by fuel type. A large majority of water heaters are gas, either natural gas or propane, totaling over 90% of all water heaters found. Less than 10% of the water heaters are electric.

Figure 9: Water Heaters by Fuel Type

Table 90 shows the average size of the water heaters, overall and for each of the fuel types. The average size of the unit was obtained from two sources, the first being from the manufacturer if the model number matched a model in the efficiency databases, the second being from the site visit if the model was not matched. The auditor attempted to obtain the capacity of the water heater from the nameplate information, if no nameplate capacity data were available, the surveyor made an estimate wherever possible.

Fuel Type	Average Size (Gallons)	Error Bound	Sample Size
All Types	41.7	0.5	919
Electric	42.2	2.1	88
Gas	41.6	0.6	829

Table 90: Average Size of Water Heaters by Fuel Type

Table 91 shows the percentage of water heaters in each size range within each fuel type. The sample sizes used to calculate the percentages in each fuel type are also presented in the table below. Notice that the distribution of water heater capacities is similar for electric and gas units. The majority of water heaters are in the size range from 40 to 44 gallons, the followed by the 50 to 54 gallon range and then 30 to 34 gallon range.

| | Fuel Type | | | | | |
| | All Types (n=919) | | Electric (n=88) | | Gas (n=829) | |
Size (Gallons)	Percentage	Error Bound	Percentage	Error Bound	Percentage	Error Bound
20 to 24	0.7%	0.5%	3.5%	4.0%	0.4%	0.4%
30 to 34	15.6%	2.1%	15.7%	7.6%	15.6%	2.2%
35 to 39	0.4%	0.4%	-	-	0.4%	0.4%
40 to 44	56.9%	2.8%	46.4%	10.3%	57.8%	3.0%
50 to 54	23.7%	2.4%	30.5%	9.5%	23.2%	2.5%
55 to 59	0.2%	0.2%	-	-	0.2%	0.2%
60 to 64	0.4%	0.4%	0.0%	0.0%	0.3%	0.3%
65 to 69	0.3%	0.2%	2.2%	2.9%	0.1%	0.1%
75 to 79	1.2%	0.6%	-	-	1.3%	0.7%
80 to 84	0.2%	0.2%	1.8%	2.9%	0.1%	0.1%
>85	0.5%	0.4%	-	-	0.5%	0.4%

Table 91: Percentage of Water Heaters by Size Range and Fuel Type

Table 92 shows the percentage of total water heaters by fuel type within the size ranges. These percentages were calculated as a proportion relative to the entire set of water heaters, regardless of fuel type. This summary tables better displays the actual percentage of the population water heaters in each size range. The previous table shows that the 40 to 44 gallon size range accounts for 46.4% of all electric water heaters and Table 92 shows that the same size electric heaters constitute only 3.0% of the entire population. This emphasizes the market dominance of the 40-gallon gas fired water heater that accounts for 48.0% of water heaters.

| (n=919) | Electric | | Gas | |
Size (Gallons)	Percentage	Error Bound	Percentage	Error Bound
20 to 24	0.2%	0.3%	0.4%	0.3%
30 to 34	1.0%	0.5%	13.0%	1.8%
35 to 39	-	-	0.4%	0.3%
40 to 44	3.0%	0.9%	48.0%	2.7%
50 to 54	2.0%	0.7%	19.3%	2.1%
55 to 59	-	-	0.2%	0.2%
60 to 64	0.0%	0.0%	0.2%	0.3%
65 to 69	0.1%	0.2%	0.1%	0.1%
75 to 79	-	-	1.1%	0.6%
80 to 84	0.1%	0.2%	0.1%	0.1%
>85	-	-	0.4%	0.4%

Table 92: Percentage of Water Heaters within each Size Range Among all Water Heaters

Age

Table 93 shows the average age of water heaters by fuel type in each of the size ranges. The ages of the water heaters were obtained during the site visit only.

No age information was available in the efficiency databases. The average age of all water heaters for which an age obtained is 8.8 years old. The ages of the electric and gas water heaters are not significantly different.

Size (Gallons)	Fuel Type								
	All Types			Electric			Gas		
	Average Age	Error Bound	Sample Size	Avgerage Age	Error Bound	Sample Size	Avgerage Age	Error Bound	Sample Size
All Sizes	8.8	0.4	754	9.4	1.9	60	8.8	0.5	692
20 to 24	14.8	3.3	5	15.4	5.2	2	14.4	4.3	3
30 to 34	10.4	1.4	102	10.3	5.6	7	10.4	1.5	95
35 to 39	2.4	0.6	4	-	-	-	2.4	0.6	4
40 to 44	8.8	0.6	410	8.9	2.8	27	8.8	0.6	383
50 to 54	7.6	0.9	173	10.0	4.1	16	7.4	0.8	157
55 to 59	22.8	3.5	2	-	-	-	22.8	3.5	2
60 to 64	13.5	1.7	2	-	-	-	12.0	0.0	1
65 to 69	12.1	5.8	3	12.0	0.0	1	3.0	0.0	1
75 to 79	7.7	3.8	7	-	-	-	7.7	3.8	7
80 to 84	7.0	1.5	2	6.0	0.0	1	9.0	0.0	1
>85	8.5	7.6	2	-	-	-	8.5	7.6	2
Size Unknown	9.6	1.9	42	6.0	3.2	5	10.0	2.1	37

Table 93: Average Age of Water Heaters by Fuel Type within Size Ranges

Table 94 shows the percentage of water heaters within each fuel type and size range that fall into each of the purchase date ranges. The first row of data, representing all water heaters, shows the largest percentage were purchased in the last 6 years, totaling over 38% of all the units. The largest percentage of both fuel type water heaters in the size range from 50 to 54 gallons falls into the purchase date range between 1995-2000, totaling over 43% of all units that size.

All size/fuel categories with a sample of 95 and above show a similar distribution of age ranges. The largest percentage is found in the most recent age range and the percentage decreases with each successive older age range ending with a few per cent in the 1974 and older category.

Fuel Type	Size Range (Gallons)	Purchase Date (Years)						Sample Size
		2000-1995	1994-1990	1989-1985	1984-1980	1979-1975	1974 and Older	
All Types	All Sizes	38.1%	29.5%	21.0%	6.4%	2.2%	2.7%	754
	20 to 24	-	19.8%	40.3%	39.9%	-	-	5
	30 to 34	32.3%	24.2%	26.9%	9.7%	1.2%	5.8%	102
	35 to 39	100.0%	-	-	-	-	-	4
	40 to 44	37.9%	30.8%	19.6%	7.4%	2.1%	2.2%	410
	50 to 54	43.3%	31.5%	18.1%	2.8%	2.5%	1.9%	173
	55 to 59	-	-	-	32.0%	68.0%	-	2
	60 to 64	-	-	100.0%	-	-	-	2
	65 to 69	26.8%	-	55.1%	-	-	18.1%	3
	75 to 79	43.9%	26.8%	14.7%	14.7%	-	-	7
	80 to 84	-	100.0%	-	-	-	-	2
	>100	50.2%	-	49.8%	-	-	-	2
	Size Unknown	35.5%	27.2%	28.5%	-	3.4%	5.4%	42
Electric	All Sizes	41.6%	19.7%	18.9%	7.1%	8.5%	4.2%	1
	20 to 24	-	-	50.6%	49.4%	-	-	2
	30 to 34	33.8%	33.0%	16.6%	-	-	16.6%	7
	40 to 44	49.4%	11.4%	20.2%	5.2%	13.8%	-	27
	50 to 54	44.3%	15.6%	14.4%	10.3%	7.8%	7.7%	16
	60 to 64							0
	65 to 69	-	-	100.0%	-	-	-	1
	80 to 84	-	100.0%	-	-	-	-	2
	Size Unknown	47.0%	47.0%	-	-	6.0%	-	5
Gas	All Sizes	37.9%	30.3%	21.1%	6.4%	1.8%	2.6%	692
	20 to 24	-	33.0%	33.5%	33.5%	-	-	3
	30 to 34	32.2%	23.5%	27.7%	10.4%	1.2%	5.0%	95
	35 to 39	100.0%	-	-	-	-	-	4
	40 to 44	37.2%	32.0%	19.6%	7.5%	1.5%	2.3%	383
	50 to 54	43.2%	32.9%	18.4%	2.1%	2.0%	1.4%	157
	55 to 59	-	-	-	32.0%	68.0%	-	2
	60 to 64	-	-	100.0%	-	-	-	1
	65 to 69	100.0%	-	-	-	-	-	1
	75 to 79	43.9%	26.8%	14.7%	14.7%	-	-	7
	80 to 84	-	100.0%	-	-	-	-	0
	Gallons >100	50.2%	-	49.8%	-	-	-	2
	Size Unknown	34.0%	24.6%	32.2%	-	3.1%	6.1%	37

Table 94: Percentage of Water Heaters in Purchase Date Ranges by Fuel Type

Energy Factor

Energy factor for water heaters is as the heater supplied energy content of the hot water usage divided by the energy consumption of the water heater. Table 95 shows the average energy factor by fuel type within each size range. The energy factor was obtained from the efficiency databases, thus only the models that matched were included in the following summary table. The average energy factor from matched gas units is 0.57 while the average energy factor for all electric units is 0.89.

Size (Gallons)	Fuel Type			
	Electric		Gas	
	Average En Factor	Sample Size	Average En Factor	Sample Size
Overall	0.89	37	0.57	393
30 to 34	0.90	5	0.57	66
35 to 39	-	-	0.60	4
40 to 44	0.89	15	0.57	235
50 to 54	0.88	16	0.57	85
65 to 69	-	-	0.53	1
75 to 79	-	-	0.50	2
Size Unknown	0.88	1	-	-

Table 95: Average Energy Factor by Fuel Type in Size Ranges

Table 96 shows water heaters within each fuel type and size range that fall into each of the energy factor ranges. The highest percentage of gas water heaters, regardless of size, is in the energy factor range from 0.56 to 0.579. The majority of electric water heaters are somewhat evenly distributed in the four ranges from 0.87-0.909.

Fuel Type	Size Range (Gallons)	Energy Factor								Sample Size
		0.86 to 0.869	0.87 to 0.879	0.88 to 0.889	0.89 to 0.899	0.90 to 0.909	0.91 to 0.919	0.92 to 0.929	0.93 to 0.939	
Electric	All Sizes	0.1%	25.4%	21.4%	22.2%	24.5%	-	-	6.3%	37
	30 to 34	-	-	-	24.3%	75.7%	-	-	-	5
	40 to 44	-	-	36.3%	27.4%	36.2%	-	-	-	15
	50 to 54	0.2%	55.4%	13.7%	17.0%	-	-	-	13.8%	16
	Size Unknown	-	-	100.0%	-	-	-	-	-	1
Gas	Size Range (Gallons)	<0.48	0.49 to 0.519	0.52 to 0.539	0.54 to 0.559	0.56 to 0.579	0.58 to 0.599	0.60 to 0.619	0.62 to 0.639	Sample Size
	All Sizes	-	0.3%	1.0%	23.3%	45.3%	7.1%	11.0%	12.1%	392
	30 to 34	-	-	-	-	78.6%	19.6%	1.8%	-	66
	35 to 39	-	-	-	-	30.2%	-	69.8%	-	4
	40 to 44	-	-	-	19.9%	47.8%	6.5%	8.3%	17.5%	234
	50 to 54	-	-	2.7%	52.2%	15.3%	-	23.2%	6.7%	85
	65 to 69	-	-	100.0%	-	-	-	-	-	1
	75 to 79	-	54.8%	45.2%	-	-	-	-	-	2

Table 96: Percentage of Water Heaters in Energy Factor Ranges by Fuel Type and Size

The grayed cells of the above table represent energy factors below 1990 minimum standards for a given water heater size and fuel type. The minimum standards are a function of heater storage capacity. Note that all gas-fired units are above minimum standards. However the electric hot water heaters have a majority *below* 1990 minimum standards in all size categories with available energy factor data. All of the 30 to 34 gallon, 63.7 percent of 40 to 44 gallon and 55.6 percent of 50 to 54 gallon electric water heaters are below 1990 standards.

Table 97 shows the percentage of all water heaters for which the tank was observable that were wrapped and unwrapped with insulation. Over three-quarters of the water heaters were unwrapped.

Fuel Type	Size Range (Gallons)	Tank Wrapped		Tank Not Wrapped		Sample Size
		Percentage	Error Bound	Percentage	Error Bound	
All Types	Overall	24.2%	2.4%	75.8%	2.4%	1003
	20 to 24	38.9%	35.2%	61.1%	35.2%	6
	30 to 34	18.9%	5.7%	81.1%	5.7%	148
	35 to 39	-	-	100.0%	-	4
	40 to 44	20.1%	3.1%	79.9%	3.1%	509
	50 to 54	20.5%	4.8%	79.5%	4.8%	207
	55 to 59	-	-	100.0%	-	2
	60 to 64	66.3%	44.5%	33.7%	44.5%	4
	65 to 69	39.3%	42.8%	60.7%	42.8%	4
	75 to 79	10.2%	15.9%	89.8%	15.9%	10
	80 to 84	-	-	100.0%	-	2
	>100	-	-	100.0%	-	4
	Size Unobs	66.0%	8.7%	34.0%	8.7%	103

Table 97: Percentage of Water Heaters that were Wrapped and Unwrapped

Clothes Washers

The following section describes the clothes washer data. The model numbers collected on the washers were linked with the CEC database in order to obtain the energy factor. There was no manufacture date data, thus all the age data presented in this section are customer reported dates from the on site survey.

Approximately 79.6% of all homes have a washing machine. All modular homes in our sample were found to have a washer, thus the weighted percentage of modular homes with washers is also 100%. A large majority of single family homes have a washer in the house, with two story houses having the highest percentage. The percentage of apartments with washers is significantly lower than that of single family homes because it is common to have a central laundry facility in apartment complexes.

Type of Residence	Percentage	Error Bound	Sample Size
All Types	79.6%	2.0%	1258
Apt(1 or 2 stories)	31.8%	5.3%	281
Apt(3 or more stories)	30.0%	11.3%	51
Duplex-Triplex-or Quadplex	62.2%	10.2%	82
Mobile Home-Double Wide	93.9%	9.8%	22
Mobile Home-Single Wide	80.6%	28.6%	6
Modular/prefabricated	100.0%	0.0%	7
Other	87.4%	18.2%	4
Single Family-Unattached- >2 stories	92.5%	11.8%	14
Single Family-Unattached-1 story	96.4%	1.4%	546
Single Family-Unattached-2 story	98.4%	1.5%	210
Townhouse or Rowhouse	96.5%	5.7%	35

Table 98: Percentage of Homes with Clothes Washers by Type of Residence

Table 99 shows the distribution of the 965 clothes washers found on site, presented by type of washer and type of residence. Only 2% of all washers found were horizontal axis washing machines. The largest percentage of homes with horizontal axis washers occurred in single family two story houses and townhouses/rowhouses. Approximately 3.6% of all homes of that type with washers have horizontal axis washers. Interestingly, the third largest percentage of households with horizontal axis washers occurred in 1 to 2 story apartments, totaling 3.2% of all washers found at that type of residence.

Type of Residence	Horizontal		Standard		Both
	Percentage	Error Bound	Percentage	Error Bound	Sample Size
All Types	2.0%	0.8%	98.0%	0.8%	965
Apt(1 or 2 stories)	3.2%	3.7%	96.8%	3.7%	83
Apt(3 or more stories)	-	-	100.0%	0.0%	14
Duplex-Triplex-or Quadplex	2.8%	4.6%	97.2%	4.6%	53
Mobile Home-Double Wide	-	-	100.0%	0.0%	21
Mobile Home-Single Wide	-	-	100.0%	0.0%	5
Modular/prefabricated	-	-	100.0%	0.0%	7
Other	-	-	100.0%	0.0%	2
Single Family-Unattached- >2 stories	-	-	100.0%	0.0%	13
Single Family-Unattached-1 story	1.3%	0.9%	98.7%	0.9%	527
Single Family-Unattached-2 story	3.6%	2.2%	96.4%	2.2%	206
Townhouse or Rowhouse	3.6%	5.9%	96.4%	5.9%	34

Table 99: Distribution of Clothes Washers by Type of Washer and by Type of Residence

The average age of the washing machines for which an age was obtainable during the on site visit is 7.4 years with an error bound of 0.4 years. The average estimated life expectancy of clothes washers is 12 years. The sample size of washers with ages was 823. Again, the age data reported is number of years old the customer reported for the washing machine. The washing machine was excluded from this part of the analysis if the customer was not aware of how old the machine was.

Manufacture Date (Years)	Percentage (n=823)	Error Bound
1995-2000	44.8%	3.0%
1990-1994	29.9%	2.7%
1985-1989	18.2%	2.3%
1980-1984	4.5%	1.3%
1975-1979	1.5%	0.7%
1974 and Older	1.1%	0.6%

Table 100: Distribution of Manufacture Date of Clothes Washers

Energy factor for clothes washers is defined in cubic feet per kWh per cycle. The current federal efficiency standards for standard top-loading clothes washers, effective 1994, set a minimum energy factor of 1.18. The minimum energy star qualifying energy factor 2.5 for all clothes washers. The average energy factor of the clothes washers, based upon the sample of clothes washers that were successfully linked with the efficiency database, is 1.26 with an error bound of 0.1. The sample size used to calculate the average energy factor is 155.

	1994 EF Minimum Standard	Energy Star Qualifying EF	Average Energy Factor	Error Bound	Sample Size
Standard	1.18	2.5	1.26	0.01	150
Horizontal Axis		2.5	3.95	0.02	5

Table 101: Average Energy Factor and Comparative Standards

The following table summarizes the energy factor distribution relative to efficiency standards. The entire sample of 156 clothes washers with available efficiency data exceeded this minimum standard. However, no surveyed top-loading washers met energy star qualifications. Furthermore all horizontal axis washers with available efficiency data exceeded the energy star minimum energy factor of 2.5.

	Energy Factor		
Type	Less Than 1.18	1.18-2.49	Greater Than 2.5
All Washers	-	96.4%	3.6%
Standard	-	100%	
Horizontal Axis	-	-	100.0%

Table 102: Energy Factor Distribution Relative to Standards

Table 103 shows a finer distribution of washing machine energy factors. The largest percentage of washers have energy factors in the range of 1.21 to 1.3, accounting for more than three-quarters of the washers. The sample size for this distribution is 156[12].

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[12] The sample size for the average energy factor is 1 fewer than the sample size for the distribution of the energy factor. This is due to the fact that the average energy factor was calculated as a weighted average, weighted by the total number of people in the house. One house with a washer was vacant, and thus excluded from the average calculation. For a more detailed explanation of the average calculation see appendix.

	Energy Factor	Percentage (n=156)	Error Bound
Standard	1.1-1.2	8.5%	4.0%
	1.21-1.3	76.6%	6.0%
	1.31-1.4	5.4%	3.3%
	1.41-1.5	5.6%	3.2%
	1.51-1.6	0.3%	0.4%
Horiz. Axis	3.9-4.0	2.9%	2.3%
	4.01-4.1	0.8%	1.3%

Table 103: Distribution of Energy Factors of Clothes Washers

Clothes Dryers

The following section describes the clothes dryers found during the on site audits. Data on clothes dryers were not available in the CEC database. Thus, we were unable to merge in efficiency data or manufacturer dates. This section contains information on the percentage of homes with dryers, the breakdown of the fuel types, and the age of the dryer obtained by the auditor during the site visit.

Approximately 77% of all sites that were visited have a dryer. Table 104 shows the breakdown of the percentage of homes with dryers by residence type. The error bound and sample size for each type of residence is also displayed in the table. Not surprisingly, the percentage of sites with dryers in apartments is significantly lower than the percentage of single family homes with dryers, due to the presence of common laundry facilities.

Type of Residence	Percentage with Dryers	Error Bound	Sample Size
Apt(1 or 2 stories)	29.7%	5.2%	281
Apt(3 or more stories)	30.0%	11.3%	51
Duplex-Triplex-or Quadplex	51.7%	10.5%	82
Mobile Home-Double Wide	87.7%	13.4%	22
Mobile Home-Single Wide	80.6%	28.6%	6
Modular/prefabricated	100.0%	0.0%	7
Other	87.4%	18.2%	4
Single Family-Unattached- >2 stories	92.5%	11.8%	14
Single Family-Unattached-1 story	92.5%	2.0%	546
Single Family-Unattached-2 story	98.4%	1.5%	210
Townhouse or Rowhouse	96.5%	5.7%	35
Overall	76.7%	2.1%	1258

Table 104: Percentage of Homes with Dryers by Type of Residence

Figure 10 shows the breakdown of fuel types among all dryers found during the on site visits. A total of 927 homes in the sample have dryers. The largest percentage of dryers used gas, and a smaller percentage of dryers used electricity.
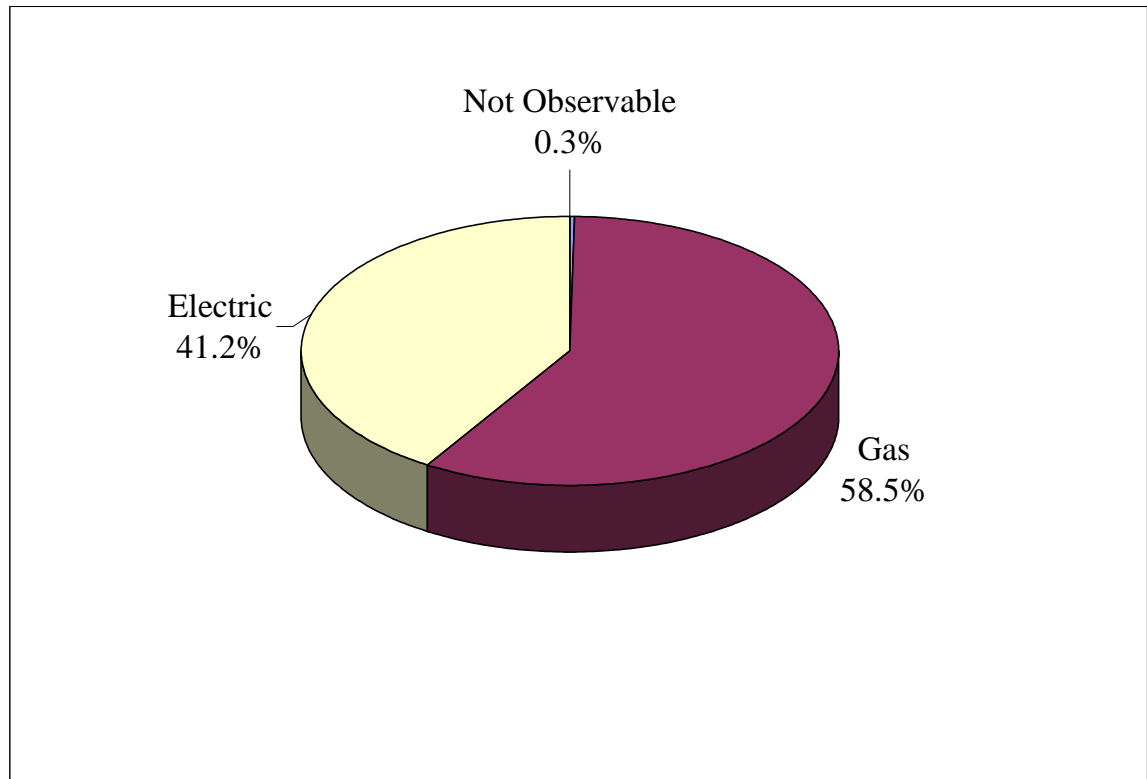
Figure 10: Percentage of Dryers by Fuel Type

The data on the age of the dryers was obtained from either the owner of the house or the auditor estimation of the age. A total of 780 dryers in the sample have an estimated age. The average weighted age of the dryers is 8.4 years with an error bound of 0.4 years. Table 105 shows the distribution of the estimated manufacture date for the dryers. The largest percentage of dryers are between 0 to 5 years old. However, almost one-third of all dryers are between 6 to 10 years old.

Manufacture Date (Years)	Percentage (n=780)	Error Bound
1995-2000	39.3%	3.0%
1990-1994	32.1%	2.9%
1985-1989	18.6%	2.4%
1980-1984	6.6%	1.5%
1975-1979	2.0%	0.9%
1974 and Older	1.4%	0.7%

Table 105: Distribution of Estimated Manufacture Date of Dryers

Dishwashers

The following section summarizes the 871 dishwashers found during the site visit. The data were merged with CEC database to obtain the energy factor for

the model. This section contains information on the percentage of homes with dishwashers, the age of the dishwasher obtained by the auditor during the site visit, and the energy factor from the CEC database.

Table 106 shows the percentage of homes with dishwashers by type of home and overall. Over 70% of all homes have a dishwasher. The table shows that dishwashers are also concentrated in modular and single family homes.

Type of Residence	Percentage with Dishwashers	Error Bound	Sample Size
Apt(1 or 2 stories)	54.0%	5.7%	281
Apt(3 or more stories)	60.9%	12.1%	51
Duplex-Triplex-or Quadplex	32.5%	9.8%	82
Mobile Home-Double Wide	73.8%	17.1%	22
Mobile Home-Single Wide	58.8%	35.2%	6
Modular/prefabricated	100.0%	0.0%	7
Other	87.4%	18.2%	4
Single Family-Unattached- >2 stories	77.7%	18.6%	14
Single Family-Unattached-1 story	71.6%	3.4%	546
Single Family-Unattached-2 story	91.1%	3.3%	210
Townhouse or Rowhouse	99.9%	0.2%	35
Overall	70.1%	2.3%	1258

Table 106: Percentage of Homes with Dishwasher by Type of Residence

The average date of manufacture of the dishwashers is 9.0 years old with an error bound of 0.5 years. The average estimated life expectancy of dishwashers is 10 years old, indicating that many dishwashers will be in need of replacement in the next few years. The number of dishwashers in the sample with data on age is 694. The largest percentage of dishwashers were manufactured between 1995 and 2000. This age range has a significantly higher percentage of dishwashers than any of the other age ranges.

Manufacture Date (Years)	Percentage (n=694)	Error Bound
1995-2000	40.4%	3.2%
1990-1994	24.7%	2.8%
1985-1989	21.8%	2.7%
1980-1984	6.2%	1.6%
1975-1979	4.3%	1.3%
1974 and Older	2.6%	1.0%

Table 107: Distribution of Manufacture Date of Dishwashers

Energy factor for dishwashers is defined as loads per kWh. The average energy factor for all dishwashers that were matched to the CEC database is 0.48 with an error bound of 0.01. The sample size used to calculate this average energy factor is 284. Table 108 displays the average energy next to federal minimum standard enacted in 1994 and the current minimum energy qualifying energy factor.

Dishwasher Energy Factor		
1994 Minimum	Minimum Energy Star Qualification EF	Average EF
0.46	0.52	0.48

Table 108: Comparison of Energy Factor with Federal Standards

The distribution of dishwasher energy factors is found in Table 109. The highest percentage of dishwashers with energy factors falls within the range of 0.460 to 0.519, containing over 80% of the dishwashers, this energy factor range encompasses all dishwasher that met 1994 standards but were below the current energy star minimum. The 0.520 to 0.775 range accounts for all dishwashers that met or exceeded the energy star minimum qualifying energy factor of 0.52. The total percentage of dishwashers meeting 1994 federal standards is 91.5%. The 0.275 to 0.459 energy factor range accounts for the percentage of the population below federal standards. The sample size for the distribution of the energy factors is 286[13].

Energy Factor	Percentage (n=286)	Error Bound
0.275 to 0.459	8.5%	3.0%
0.460 to 0.519	82.1%	4.1%
0.520 to 0.775	9.3%	3.1%

Table 109: Distribution of Energy Factor of Dishwashers

Cooling Equipment

Cooling Overview

This section presents the summary analysis of the data on primary cooling equipment found during the 1258 site visits. The air conditioner model numbers were linked with efficiency databases from the ARI, CEC and the Carrier Bluebook in order to obtain manufacture date, capacity, and seasonal energy efficiency ratio (SEER)

Cooling Equipment

The primary cooling equipment identified during this study was of seven distinct types

- Split System Air Conditioning units

- Packaged System Air Conditioning units

- Evaporative Systems

- Window/Wall Room Air Conditioning units

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[13] The sample size for the average factor is 2 fewer than the sample size for the distribution of the energy factor. This is due to the fact that the average EF was calculated as a weighted average, weighted by the total number of people in the house. Two houses were vacant, and thus excluded from the average calculation. For a more detailed explanation of the average calculation see appendix.

- Packaged Air to Air Heat Pumps

- Split System Air to Air Heat Pumps

- Window unit heat Pumps

The distribution of these cooling equipment types is shown below in Table 110.

	System Type (n=750)	% of Primary Cooling Types	Error Bound
Heat Pumps	Packaged Air to Air Heat Pump	3.1%	1.1%
	Split System Air to Air Heat Pump	4.0%	1.3%
	Window Unit Heat Pump	1.2%	0.7%
Central	Evaporative System	1.2%	0.7%
	Packaged System AC	16.4%	2.5%
	Split System AC	53.6%	3.3%
Space	Evaporative System	4.4%	1.4%
	Window / Wall Room Air Conditioner	16.2%	2.5%

Table 110: Distribution of Cooling System Types in Residences with Cooling Equipment

The analysis of data for cooling equipment is presented here exclusive of heat pumps. A separate analysis for heat pumps is provided in the following section. Because heat pumps are a unique type of heating and cooling system the most appropriate way to handle the analysis was to give them their own section.

From our analysis of the surveyed residences, 51.6% with a 2.5% error bound of homes have some type of cooling equipment in place, exclusive of heat pumps. Of the homes that have primary cooling equipment that does not include heat pumps, the distribution of central systems versus space cooling units is shown below.
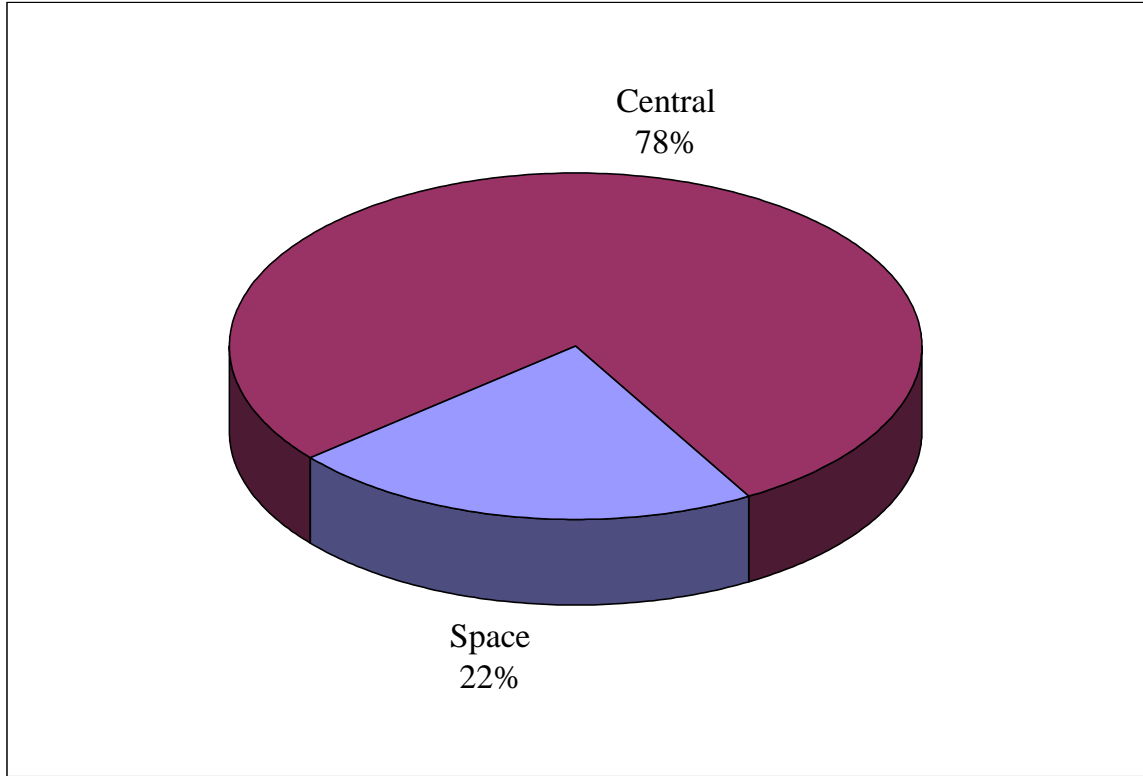
Table 111-The Distribution of Primary Cooling Systems

Non-heat pump cooling equipment was classified into four types; window/wall units, considered space units, evaporative systems, which could be either space or central systems and packaged and split AC systems, both considered central systems.

Equipment Type	Central (n=495)		Space (n=176)	
	Percentage of System Class	Error Bound	Percentage of System Class	Error Bound
Evaporative System	1.7%	1.0%	21.4%	6.1%
Packaged System AC	23.0%	3.3%	0.0%	0.0%
Split System AC	75.3%	3.4%	0.0%	0.0%
Window / Wall Room Air Conditioner	0.0%		78.6%	6.1%

Table 112: Breakdown of Classes of Primary Cooling Systems by Equipment Type

Table 113 below shows the average estimated age and percentage of with an estimated age by system type within manufacture ranges. As explained previously, the estimated ages were obtained from a combination of the dates that were obtained from the manufacturer information and the surveyor estimates during the on site visit. The sample size of 500 represents all sites that were found with some type of non-heat pump cooling equipment. The average central air conditioning system type is 12.3 years old, with an average estimated life expectancy of 13 years. This indicates that it may be necessary to replace many central air conditioners in the next few years.

The average space air conditioning system is 13.0 years old, with an average estimated life expectancy of 13 years. It seems likely that many of these systems will also be replaced in the next few years.

Air Conditioning System Type		Primary Cooling System Estimated Age	Error Bounds	Sample Size
Central	All Types	12.3	0.7	415
	Packaged System	14.9	2.0	70
	Split System	11.7	0.7	338
	Evaporative System	10.8	4.8	7
Space	All Types	13.0	2.2	85
	Evaporative System	13.0	5.3	16
	Window / Wall Room	13.0	2.3	69

Table 113 Average Age of Non-Heat Pump Primary Cooling Equipment

Table 114 shows the percentage distribution for each type of cooling system by age range.

Age Distribution of Cooling System Types													
	Central								Space Systems				
Age Range	All (n=415)		Packaged System (n=70)		Split System AC (n=338)		Evaporative System (n=7)		All (n=85)		Evaporative System (n=16)		Window / Wall (n=69)	
	%	Error Bounds	%	Error Bounds	%	Error Bounds	%	Error Bounds	%	Error Bounds	%	Error Bounds	%	Error Bounds
1995 - 2000	23.7%	3.6%	16.7%	7.1%	25.4%	4.1%	19.9%	29.3%	35.4%	9.4%	37.8%	20.6%	34.7%	10.6%
1990 - 1994	22.6%	3.5%	21.6%	8.2%	22.5%	3.9%	40.2%	35.7%	19.1%	7.8%	27.7%	19.3%	16.8%	8.4%
1985 - 1989	25.2%	3.7%	28.3%	9.0%	24.6%	4.1%	19.7%	29.0%	12.1%	6.4%	6.9%	10.9%	13.5%	7.6%
1980 - 1984	11.7%	2.7%	9.1%	5.8%	12.4%	3.1%	-	-	12.6%	6.5%	7.0%	11.1%	14.2%	7.6%
1975 - 1979	8.0%	2.3%	9.1%	5.8%	7.6%	2.5%	19.7%	29.0%	7.5%	5.2%	6.9%	10.9%	7.7%	5.9%
1974 &before	8.8%	2.4%	15.2%	7.2%	7.5%	2.5%	0.5%	1.0%	13.2%	6.7%	13.9%	14.9%	13.1%	7.6%

Table 114: Age Range Distribution of Cooling System by Types

Since no capacity and efficiency is available for evaporative equipment, no further analysis is reported for these units.

Table 115 below shows bin distributions of capacities for cooling system types exclusive of heat pumps and evaporative systems. The capacities were obtained from a combination of manufacturer information and the surveyor estimates during the on site visit. The sample size of 401 represents all non-heat pump cooling equipment for which capacity data was obtained. All capacities were found to be between 0.5 and 5.0 tons. The largest percentage bin of combined central air conditioning types is 23.3% found in the 3 to 3.49 ton range. The largest percentage bin of space air conditioning types window/wall units is 39.8% found in the 1 to 1.49 ton range.

| Ton Range | Central Air Conditioning Types | | | | | | Space Air Conditioing Types | |
| | Both Types (n-347) | | Packaged System AC (n=42) | | Split System AC (n=305) | | Window / Wall (n=54) | |
	Percentage	Error Bounds	Percentage	Error Bounds	Percentage	Error Bounds	Percentage	Error Bounds
0.5-0.99	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	35.0%	11.6%
1-1.49	1.4%	1.1%	5.5%	6.2%	0.8%	0.9%	39.8%	11.8%
1.5-1.99	5.6%	2.1%	6.7%	6.4%	5.4%	2.2%	17.5%	9.2%
2-2.49	9.6%	2.7%	10.5%	8.1%	9.5%	2.9%	5.4%	5.2%
2.5-2.99	16.4%	3.4%	11.7%	8.4%	17.1%	3.7%	2.2%	3.6%
3-3.49	23.3%	4.0%	13.5%	9.2%	24.7%	4.3%	0.0%	0.0%
3.5-3.99	16.8%	3.5%	25.7%	11.7%	15.5%	3.6%	0.0%	0.0%
4-4.49	12.1%	3.1%	13.8%	9.4%	11.9%	3.2%	0.0%	0.0%
4.5-5	14.7%	3.3%	12.5%	8.7%	15.0%	3.6%	0.0%	0.0%

Table 115: Size Distribution of Cooling Systems by Type

Table 116: Size Distributions by Age Range for Central System Types shows the percentage of cooling systems by type and capacity within age ranges. From the table we can identify that 31% of all types of central cooling units in the range of 4.0 to 4.49 tons were built between 1995 and 2000. This is also useful in identifying which size units tend to be older. For example, the highest concentration of central units built in 1974 or earlier, at 14%, is for the units in the 4.0 to 4.9 ton range.

Central Air Conditioning System Type	Ton Range	1995 to 2000		1990 to 1994		1985 to 1989		1980 to 1984		1975 to 1979		1974 and older		Sample Size
		%	Error Bound	%	Error Bound	%	Error Bound	%	Error Bound	%	Error Bound	%	Error Bound	
All Types	1.0 to 1.49	24.7%	35%	50.0%	41%	25.3%	36%	0.0%	0%	0.0%	0%	0.0%	0%	4
	1.5 to 1.99	21.1%	16%	9.0%	10%	37.6%	19%	18.2%	15%	6.4%	7%	7.7%	10%	26
	2.0 to 2.49	11.1%	10%	25.1%	13%	28.6%	14%	14.7%	11%	16.6%	11%	3.7%	6%	35
	2.5 to 2.9	30.6%	11%	27.4%	10%	17.4%	9%	10.5%	7%	8.7%	7%	5.4%	5%	53
	3.0 to 3.49	27.2%	9%	29.5%	9%	14.8%	7%	13.8%	7%	3.2%	4%	11.7%	6%	73
	3.5 to 3.9	32.9%	11%	32.2%	11%	19.9%	9%	4.2%	5%	3.6%	4%	7.2%	6%	51
	4.0 to 4.49	31.2%	13%	16.1%	10%	29.7%	13%	6.1%	7%	3.1%	5%	13.8%	10%	36
	4.5 to 5	26.5%	11%	25.1%	10%	31.8%	11%	7.3%	6%	4.6%	5%	4.6%	5%	48
	DK	10.9%	5%	9.8%	5%	32.0%	9%	19.1%	7%	16.1%	7%	12.2%	6%	89
Evaporative System	DK	19.9%	29%	40.2%	36%	19.7%	29%	0.0%		19.7%	29%	0.5%	1%	7
Packaged System	All	16.7%	7%	21.6%	8%	28.3%	9%	9.1%	6%	9.1%	6%	15.2%	7%	70
	1.0 to 1.49	0.0%	0%	49.4%	58%	50.6%	58%	0.0%	0%	0.0%	0%	0.0%	0%	2
	1.5 to 1.99	40.5%	50%	59.5%	50%	0.0%	0%	0.0%	0%	0.0%	0%	0.0%	0%	3
	2.0 to 2.49	0.0%	0%	73.7%	37%	0.0%	0%	0.0%	0%	26.3%	37%	0.0%	0%	4
	2.5 to 2.9	42.0%	41%	0.0%	0%	0.0%	0%	29.0%	40%	0.0%	0%	29.0%	40%	4
	3.0 to 3.49	40.0%	36%	20.0%	29%	19.9%	29%	0.0%	0%	0.0%	0%	20.0%	29%	5
	3.5 to 3.9	26.0%	23%	42.2%	26%	21.2%	22%	0.0%	0%	0.0%	0%	10.6%	16%	10
	4.0 to 4.49	20.0%	29%	0.0%	0%	39.9%	36%	0.0%	0%	0.0%	0%	40.1%	36%	5
	4.5 to 5	18.1%	27%	0.0%	0%	60.0%	36%	0.0%	0%	0.0%	0%	21.9%	32%	5
	DK	7.5%	7%	13.3%	10%	32.8%	14%	16.7%	11%	16.6%	11%	13.2%	10%	32
Split System	All	25.3%	4%	22.5%	4%	24.5%	4%	12.7%	3%	7.5%	2%	7.5%	2%	338
	1.0 to 1.49	49.4%	58%	50.6%	58%	0.0%	0%	0.0%	0%	0.0%	0%	0.0%	0%	2
	1.5 to 1.99	17.7%	16%	0.2%	0%	44.1%	21%	21.3%	18%	7.5%	8%	9.1%	12%	23
	2.0 to 2.49	13.0%	11%	17.1%	12%	33.4%	16%	17.2%	12%	15.0%	12%	4.4%	7%	31
	2.5 to 2.9	29.6%	11%	29.7%	11%	18.9%	10%	9.0%	7%	9.4%	7%	3.5%	4%	49
	3.0 to 3.49	26.1%	9%	30.3%	10%	14.3%	7%	14.9%	8%	3.4%	4%	11.0%	7%	68
	3.5 to 3.9	34.6%	12%	29.7%	12%	19.6%	10%	5.2%	6%	4.5%	5%	6.4%	6%	41
	4.0 to 4.49	33.2%	14%	19.0%	12%	27.9%	14%	7.3%	8%	3.6%	6%	9.0%	9%	31
	4.5 to 5	27.5%	11%	28.1%	11%	28.5%	12%	8.2%	7%	5.1%	6%	2.6%	4%	43
	DK	12.2%	8%	3.6%	4%	32.9%	12%	23.1%	10%	15.3%	9%	12.9%	8%	50

Table 116: Size Distributions by Age Range for Central System Types

Table 117: Size Distributions by Age Range for Space System Types shows the percentage of space cooling systems by type and capacity within age ranges. From the table we can see that 35% of all window / wall units were manufactured between 1995 and 2000.

Space Air Conditioning Systems	Ton Range	Estimated Age Ranges												Sample Size
		1995 to 2000		1990 to 1994		1985 to 1989		1980 to 1984		1975 to 1979		1974 and older		
		%	Error Bound	%	Error Bound	%	Error Bound	%	Error Bound	%	Error Bound	%	Error Bound	
Both Types	0.5 to 0.99	18.6%	19%	27.3%	22%	0.0%	0%	35.9%	24%	18.3%	19%	0.0%	0%	12
	1.0 to 1.49	42.1%	21%	7.1%	11%	15.2%	15%	14.2%	15%	0.0%	0%	21.4%	18%	17
	1.5 to 1.99	33.8%	32%	0.0%	0%	0.0%	0%	0.0%	0%	33.3%	32%	32.8%	31%	8
	2.0 to 2.49	0.0%	0%	68.3%	50%	0.0%	0%	31.7%	50%	0.0%	0%	0.0%	0%	2
	DK	39.6%	13%	22.6%	11%	17.2%	10%	6.2%	6%	3.1%	5%	11.3%	9%	46
Evaporative System	DK	37.8%	21%	27.7%	19%	6.9%	11%	7.0%	11%	6.9%	11%	13.9%	15%	16
Window / Wall Room Air Conditioner	All	34.7%	11%	16.8%	8%	13.5%	8%	14.2%	8%	7.7%	6%	13.1%	8%	69
	0.5 to 0.99	18.6%	19%	27.3%	22%	0.0%	0%	35.9%	24%	18.3%	19%	0.0%	0%	12
	1.0 to 1.49	42.1%	21%	7.1%	11%	15.2%	15%	14.2%	15%	0.0%	0%	21.4%	18%	17
	1.5 to 1.99	33.8%	32%	0.0%	0%	0.0%	0%	0.0%	0%	33.3%	32%	32.8%	31%	8
	2.0 to 2.49	0.0%	0%	68.3%	50%	0.0%	0%	31.7%	50%	0.0%	0%	0.0%	0%	2
	DK	40.9%	17%	19.0%	14%	24.4%	15%	5.6%	8%	0.6%	1%	9.5%	11%	30

Table 117: Size Distributions by Age Range for Space System Types

Seasonal energy efficiency ratio (SEER) is a measure of air conditioning efficiency given in kBtu of cooling delivered per kWh of electrical energy consumed. The SEER data for this analysis were obtained strictly from the manufacturer data of matched model numbers. The sample of size of 278, (273 central and 5 space units) represents all of the non-heat pump cooling systems that were successfully matched with manufacturer data.

The distribution of SEER range by cooling system type is shown below in Table 118. The greatest amount of combined central system air conditioners are in the 10 to 10.99 SEER range accounting for 30.0% of central systems with a 4.9% error bound.

	Central						Space	
SEER Range	**Both Central Types (n=273)**		**Packaged System Air Conditioner (n=23)**		**Split System Air Conditioner (n=250)**		**Window / Wall Room Air Conditioner (n=5)**	
	Percentage	**Error Bounds**	**Percentage**	**Error Bounds**	**Percentage**	**Error Bounds**	**Percentage**	**Error Bounds**
13 or Higher	2.5%	1.5%	4.5%	7.3%	2.3%	1.5%	0.0%	0.0%
12 - 12.99	7.8%	2.8%	4.5%	7.3%	8.1%	3.0%	0.0%	0.0%
11 - 11.99	8.0%	2.9%	9.1%	10.1%	7.9%	3.0%	35.9%	43.1%
10 - 10.99	30.0%	4.9%	43.1%	17.1%	28.6%	5.0%	64.1%	43.1%
9 - 9.99	20.6%	4.3%	24.9%	14.9%	20.1%	4.5%	0.0%	0.0%
8 - 8.99	27.8%	4.7%	13.7%	12.1%	29.3%	5.0%	0.0%	0.0%
8 or less	3.4%	1.9%	0.0%	0.0%	3.7%	2.0%	0.0%	0.0%

Table 118: Distribution of Cooling Systems by SEER ranges and Cooling System Type

The distribution of average SEER values across the system capacity ranges is shown in Table 119: Cooling Systems by Type, Ton Range, and Average SEER. The average SEER for capacity range can be observed in this table. For split system units in the range of 3.0 to 3.49 tons, the most saturated capacity range, the average system efficiency is 9.71 with an error bound of .226. Overall, with the exception of the 1.0 to 1.49 ton range, the efficiency of the units increases with capacity.

System Type	Ton Range	Average SEER	Error Bounds	Sample Size
Central Both Types	1.0 to 1.49	10.33	0.448	3
	1.5 to 1.99	8.68	0.490	26
	2.0 to 2.49	9.23	0.292	34
	2.5 to 2.9	9.68	0.348	52
	3.0 to 3.49	9.71	0.226	65
	3.5 to 3.9	9.76	0.307	45
	4.0 to 4.49	10.09	0.737	17
	4.5 to 5	10.07	0.378	31
Central Packaged System Air Conditioning	1.0 to 1.49	10.00	-	1
	1.5 to 1.99	10.25	0.715	3
	2.0 to 2.49	10.38	0.474	3
	2.5 to 2.9	9.87	1.246	4
	3.0 to 3.49	9.66	0.455	3
	3.5 to 3.9	9.72	0.954	7
	4.0 to 4.49	-	-	-
	4.5 to 5	9.74	0.315	2
Central Split System Air Conditioning	1.0 to 1.49	10.49	0.581	2
	1.5 to 1.99	8.41	0.450	23
	2.0 to 2.49	9.08	0.283	31
	2.5 to 2.9	9.66	0.362	48
	3.0 to 3.49	9.71	0.237	62
	3.5 to 3.9	9.77	0.315	38
	4.0 to 4.49	10.09	0.737	17
	4.5 to 5	10.09	0.403	29
Space Window / Wall Air Conditioning	0.5 to 0.99	10.50	-	1
	1.0 to 1.49	10.11	0.230	2
	1.5 to 1.99	11.14	0.021	2

Table 119: Cooling Systems by Type, Ton Range, and Average SEER

The current minimum efficiency standard for split-system air conditioners is a SEER of 10.0 effective 1992. Effective 1993 the federal minimum efficiency standard for packaged air conditioners is a SEER of 9.7. The minimum qualifying Energy Star SEER is 12.0 for both types. Table 120 shows the average SEER compared with current standards. The low average efficiencies relative to standards reflect the fact that the average age of the air conditioners predates the current standards.

SEER			
Type	**Minimum Standard**	**Minimum Energy Star Qualifying**	**Average**
Central- Split system	10.00	12.00	9.73
Central- Packaged	9.70	12.00	9.84

Table 120: Average SEER Standard Comparison

Table 121 shows the distribution of SEER range for comparison with standards. The grayed cells represent efficiencies below existing federal standards. The majority of packaged air conditioners, 56.7%, are above minimum federal standards, however only 4.5% are Energy Star qualified. The majority of packaged air conditioners, 60.2% are below current minimum standards, but 5.9% are energy star qualified.

|	SEER Ranges			
Type	**9.7 or less**	**9.7-9.99**	**10-11.99**	**12 or Higher**
Central- Split system	52.7%	0.5%	36.5%	5.9%
Central- Packaged	38.7%	0.0%	52.2%	4.5%

Table 121: Distribution of Cooling System SEER Relative to Standards

Heat Pumps

The following section describes the heat pump data collected during the on-site survey. Approximately 4.7% of the homes have at least one heat pump. Four of the homes in the sample have two heat pumps. However, only the primary heat pump data was analyzed. Among the homes with two heat pumps, if only one linked with manufacturer data, it was designated as the primary system. If both linked, the larger was designated as the primary system. Of the heat pumps surveyed, only three types of heat pumps were encountered. These were, in respective order of highest to lowest quantity, split system air to air, packaged air to air, and window/wall heat pumps. The efficiency databases used to obtain efficiency information for the heat pumps were the Carrier Bluebook, the CEC databases, and ARI.

The following chart shows the type of heat pumps found by percentage of all heat pumps found.
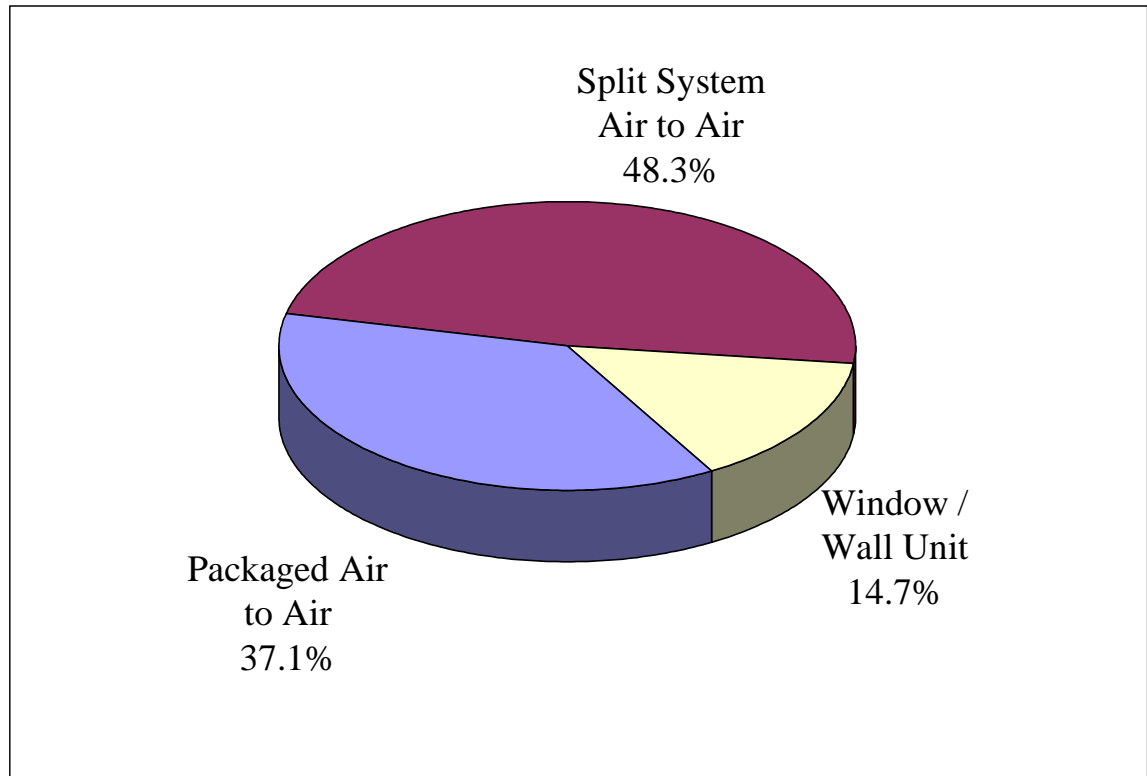
Figure 11: Primary Heat Pumps by Type of Heat Pump

Age

Table 122 shows the average estimated age and average manufacturer reported age for heat pumps. The average estimated age of central heat pumps for which the manufacturer reported age and the auditor reported age were combined is 13.2 years with an error bound of 1.9 years and a sample size of 51. The average manufacturer reported age is 12.2 years old, with an error bound of 2.7 years and a sample size of 26. The manufacturer reported ages were obtained from the efficiency databases only if the model number linked with a model in one of the databases. The average age for the estimated ages is 1 year higher than the average age for the manufacturer reported ages. There were no space heat pumps that matched with the efficiency databases.

		Estimated Ages			Manufacturer Reported Ages		
	Heat Pump System Type	**Average Age**	**Error Bound**	**Sample Size**	**Average Age**	**Error Bound**	**Sample Size**
Central	Overall	13.2	1.9	51	12.2	2.7	26
	Packaged Air to Air	15.5	2.9	20	15.6	3.9	10
	Split System Air to Air	11.5	2.4	31	9.4	2.9	16
Space	Window / Wall Unit	10.3	13.2	4	-	-	-

Table 122: Average Age of Heat Pumps Among those with Manufacturer Reported Ages

Table 123 shows the percentage of heat pumps with an estimated age by type of heat pump within each age range. Among all central systems with an estimated age, the largest percentage of units fell within the age range between 1985 to 1989. The majority of the space units fell within the most recent age range.

	Central and Space Heat Pumps with Estimated Ages							
	Central						Space	
Age Range	Both Types (n=51)		Packaged Air to Air (n=20)		Split System Air to Air (n=31)		Window Wall Units (n=4)	
	Percentage	Error Bound	Percentage	Error Bound	Percentage	Error Bound	Percentage	Error Bound
1995 to 2000	15.8%	9.6%	9.8%	9.7%	20.1%	14.6%	66.7%	44.7%
1990 to 1994	23.2%	11.7%	20.9%	17.4%	24.8%	15.7%	-	-
1985 to 1989	29.5%	12.3%	22.6%	17.5%	34.4%	16.8%	-	-
1980 to 1984	16.3%	9.9%	22.6%	17.5%	11.8%	11.1%	-	-
1975 to 1979	9.5%	7.4%	17.3%	15.2%	3.9%	5.9%	-	-
1974 and Older	5.8%	6.5%	6.9%	10.9%	5.0%	8.0%	33.3%	44.7%

Table 123: Percentage of Heat Pumps by Type and Age Range

Table 124 shows the percentage of heat pumps by type within age ranges for those units with a manufacturer reported age. As with the estimated age heat pumps, the majority of the central heat pumps with manufacturer ages were in the age range between 1985 and 1989.

| | Central Heat Pumps With Manufacturer Data | | | | | |
| Age Range | Packaged Air to Air Heat Pump (n=10) | | Split System Air to Air Heat Pump (n=16) | | Both Types (n=26) | |
	Percentage	Error Bound	Percentage	Error Bound	Percentage	Error Bound
1995 to 2000	4.2%	7.0%	30.9%	24.1%	19.0%	14.9%
1990 to 1994	25.8%	25.5%	20.5%	21.1%	22.8%	16.3%
1985 to 1989	38.3%	27.9%	34.2%	24.2%	36.0%	18.3%
1980 to 1984	3.3%	5.5%	13.8%	16.4%	9.1%	9.7%
1975 to 1979	15.8%	20.1%	0.5%	0.7%	7.3%	9.3%
1974 and older	12.7%	19.4%	-	-	5.6%	9.0%

Table 124: Percentage of Heat Pumps by Type within Age Ranges Among those with Manufacturer Reported Ages

Capacity

Table 125 shows the percentage of heat pumps by system type within size ranges. Over 40% of the central systems for which we obtained tonnage information from the databases were between 2 to 2.99 tons based upon a sample size of 44.

Tons	Central Systems						Space Systems	
	Both Types (n=44)		Packaged Air to Air (n=16)		Split System Air to Air (n=28)		Window Unit (n=1)	
	Percentage	Error Bound	Percentage	Error Bound	Percentage	Error Bound	Percentage	Error Bound
0.0 to .99	-	-	-	-	-	-	100.0%	-
1.0 to 1.99	22.9%	12.4%	30.8%	21.2%	17.7%	14.9%	-	-
2.0 to 2.99	40.4%	14.2%	29.3%	20.4%	47.8%	18.9%	-	-
3.0 to 3.99	30.4%	13.7%	35.0%	22.5%	27.4%	17.1%	-	-
4.0 to 5.0	6.2%	6.2%	4.9%	5.9%	7.1%	9.4%	-	-

Table 125: Percentage of Heat Pumps by System Type within Capacity Ranges

Efficiency

Cooling efficiencies for heat pumps are given in SEER, seasonal efficiency energy ratio in units of kBtu/kWh. Heating efficiencies of heat pumps are typically given in HPSF, heating seasonal performance factor. However since database information on HPSF is incomplete, no heating efficiency information for heat pumps will be reported.

Table 126 shows the percentage of heat pumps by type of system within SEER ranges. Only central systems are included in the following table due to the fact that no space system model numbers linked into an efficiency

Among packaged air to air heat pumps, the largest percentage of heat pumps with a SEER rating is between 8 to 8.99. The largest percentage of split system air to air heat pumps with a SEER rating is in the SEER range from 10 to 10.99.

SEER Range	Both Types (n=30)		Packaged Air to Air (n=11)		Split System Air to Air (n=19)	
	Percentage	Error Bound	Percentage	Error Bound	Percentage	Error Bound
12.0 to 12.99	5.1%	8.2%	-	-	9.1%	14.2%
11.0 to 11.99	5.1%	8.2%	-	-	9.1%	14.2%
10.0 to 10.99	23.8%	14.6%	12.4%	14.9%	32.6%	22.1%
9.0 to 9.99	27.4%	16.1%	23.6%	23.6%	30.4%	22.0%
8.0 to 8.99	28.1%	16.0%	40.7%	26.3%	18.4%	18.8%
7.0 to 7.99	10.5%	11.2%	23.4%	23.5%	0.5%	0.6%

Table 126: Percentage of Heat Pumps by Type within SEER Ranges

Table 127 shows the average SEER by system type and size range. The highest SEER rating is among split system air to air heat pumps, at 12.0 SEER, however the sample size for this calculation is only 1.

System Type	Ton Range	Average SEER	Error Bound	Sample Size
Both Types	Overall	9.21	0.59	30
	0.0 to 0.99	-	-	-
	1.0 to 1.99	8.62	0.58	8
	2.0 to 2.99	8.98	0.44	14
	3.0 to 3.99	9.11	1.24	6
	4.0 to 5.0	11.40	1.14	2
Packaged Air to Air	Overall	8.23	0.51	11
	0.0 to 0.99	-	-	-
	1.0 to 1.99	8.41	0.55	4
	2.0 to 2.99	8.72	1.04	4
	3.0 to 3.99	7.56	0.57	2
	4.0 to 5.0	8.75	0.00	1
Split System Air to Air	Overall	9.87	0.66	19
	0.0 to 0.99	-	-	-
	1.0 to 1.99	8.90	1.1235497	4
	2.0 to 2.99	9.11	0.3790832	10
	3.0 to 3.99	10.47	0.5746358	4
	4.0 to 5.0	12.00	0	1

Table 127: Average SEER of Heat Pumps by Type and Capacity

Table 128 shows the overall average SEER for packaged and split-system heat pumps compared with standards.

Type	SEER Minimum Standard	Minimum Energy Star	Average	Sample Size
Central- Split System	10.00	12.00	9.87	19
Central- Packaged	9.70	12.00	8.23	11

Table 128: Average SEER Standard Comparison

Table 129 shows the distribution of heat pump SEER. The grayed cells represent SEER values that fall below current minimum efficiency standards. 87.7% of packaged systems fall below the current federal minimum standard of 9.7 SEER effective 1993. None of the packaged units in the sample have an Energy Star qualifying SEER of 12 or above. Split systems have a slim majority, 50.8%, above the federal minimum SEER of 10, effective 1992. 9.1% of split-system heat pumps are Energy star qualified.

Type	7.0 to 7.99	8.0 to 8.99	9.0 to 9.69	9.69 to 9.99	10.0 to 10.99	11.0 to 11.99	12.0 to 12.99
Split System	0.5%	18.4%	30.3%	0.1%	32.6%	9.1%	9.1%
Packaged System	23.4%	40.7%	23.6%	0.0%	12.4%	0.0%	0.0%

Table 129: SEER Bin Distribution

Table 130: Percentage of Heat Pumps by Type and SEER within Age Ranges shows the percentage of heat pumps by type and SEER within age ranges. Keep in mind that due to the small sample sizes, the error bounds are very large in the following table, thus, the estimates have a higher variance.

Among both types of systems between 9 to 9.99 SEER, the largest percentage of the units is manufactured between 1985 and 1989.

	SEER Ranges	System Age Ranges												Sample Size
		1995 to 2000		1990 to 1994		1985 to 1989		1980 to 1984		1975 to 1979		1974 and Older		
		%	Error Bound	%	Error Bound	%	Error Bound	%	Error Bound	%	Error Bound	%	Error Bound	
Central — All Types	12 to 12.99	-	-	100.0%	-	-	-	-	-	-	-	-	-	1
	11.0 to 11.99	100.0%	-	-	-	-	-	-	-	-	-	-	-	1
	10.0 to 10.99	87.9%	20.7%	-	-	-	-	12.1%	20.7%	-	-	-	-	4
	9.0 to 9.99	-	-	37.5%	34.0%	62.2%	34.0%	0.3%	0.5%	-	-	-	-	7
	8.0 to 8.99	-	-	18.3%	26.9%	54.6%	33.3%	23.1%	27.2%	4.1%	7.1%	-	-	9
	7.0 to 7.99	-	-	-	-	-	-	-	-	51.6%	56.7%	48.4%	56.7%	4
Packaged Air to Air	10.0 to 10.99	100.0%	-	-	-	-	-	-	-	-	-	-	-	1
	9.0 to 9.99	-	-	100.0%	-	-	-	-	-	-	-	-	-	2
	8.0 to 8.99	-	-	-	-	86.1%	18.0%	7.4%	12.8%	6.5%	11.4%	-	-	5
	7.0 to 7.99	-	-	-	-	-	-	-	-	50.3%	58.2%	49.7%	58.2%	2
Split System Air to Air	12 to 12.99	-	-	100.0%	-	-	-	-	-	-	-	-	-	1
	11.0 to 11.99	100.0%	-	-	-	-	-	-	-	-	-	-	-	1
	10.0 to 10.99	86.2%	24.0%	-	-	-	-	13.8%	24.0%	-	-	-	-	3
	9.0 to 9.99	-	-	-	-	99.6%	0.8%	0.4%	0.8%	-	-	-	-	5
	8.0 to 8.99	-	-	49.4%	57.0%	0.7%	1.5%	49.9%	57.0%	-	-	-	-	2
	7.0 to 7.99	-	-	-	-	-	-	-	-	100.0%	-	-	-	4

Table 130: Percentage of Heat Pumps by Type and SEER within Age Ranges

Heating Equipment

Heating Overview

This section presents the summary analysis of the primary furnaces found during the site visits. The furnaces were linked with efficiency databases from the CEC and the Carrier Bluebook in order to obtain manufacture date, input, output, capacity, and annual fuel utilization efficiency (AFUE, expressed as a percentage). The efficiency of gas units are shown in AFUE, and no distribution of electric unit efficiencies is given due to the fact that all electric units are assumed to be 100% efficient.

Heating Equipment

Table 131 shows the percentage of homes that have one or more furnaces. A very large percentage of the homes have at least one furnace, totaling 93% of the homes. The percentage of homes is smaller with each additional furnace. One home in the sample have a total of 10 furnaces. For the homes with more than one furnace, if only one linked with manufacturer data, it was designated as the

primary system. If more than one linked, the largest and newest was designated as the primary system.

Number of Furnaces	% of Homes (n=1258)	Error Bound
1	83.0%	1.9%
2	8.6%	1.4%
3	1.0%	0.5%
4	0.3%	0.3%
5	-	-
6	-	-
7	0.1%	0.2%
8	-	-
9	-	-
10	0.1%	0.1%

Table 131: Percentage of Homes with Furnace

Table 132 shows the primary heating system type among all houses with heating system types. The following table is the only section in the heating section that includes heat pumps. We included heat pumps due to the fact that the heat pump at the residence may be the only heating system at the home. The majority of all primary heating systems were found to be forced air furnaces, totaling approximately two-thirds of the population of primary heating systems. Space units used as the primary heating system were far less common than central units.

	System Type (n=1196)	% of Primary Heating Types	Error Bound
Heat Pumps	Packaged Air to Air Heat Pump	1.6%	0.6%
	Split System Air to Air Heat Pump	2.2%	0.7%
	Window Unit Heat Pump	0.3%	0.3%
Central	Forced Air Furnace	66.1%	2.4%
	Hydronic System	0.9%	0.5%
Space	Baseboard	1.5%	0.6%
	Ceiling Cable	2.0%	0.7%
	Fireplace	0.3%	0.3%
	Floor	3.5%	1.0%
	Portable	0.1%	0.2%
	Wall	19.9%	2.1%
	Window Unit Resistance	0.2%	0.2%
	Woodstove	1.2%	0.5%

Table 132: Percentage of Primary Heating Types by Type of System

Table 133 shows the percentage of furnaces by fuel type within system types. These fuel types were taken from the auditor information. Among all the system

types found, the majority consumed natural gas. Only 7% of all primary heating systems consumed electricity. Among all forced air furnaces, 94.2% consumed natural gas.

	System Type	Fuel Type												Sample Size
		Natural		Electricity		Fuel Oil		Kerosene		Propane		Wood		
		%	Error Bound	%	Error Bound	%	Error Bound	%	Error Bound	%	Error Bound	%	Error Bound	
	All Types	88.1%	1.7%	7.0%	1.3%	0.1%	0.2%	0.2%	0.2%	2.0%	0.7%	1.2%	0.6%	1129
Central	All Central	94.0%	1.4%	1.7%	0.8%	-	-	0.1%	0.2%	2.3%	0.9%	-	-	782
	Forced Air Furnace	94.2%	1.4%	1.7%	0.8%	-	-	0.2%	0.3%	2.2%	0.9%	-	-	766
	Hydronic System	88.9%	17.2%	-	-	-	-	-	-	11.1%	17.2%	-	-	11
Space	All Space	74.2%	4.2%	19.6%	3.8%	0.3%	0.6%	0.3%	0.6%	1.4%	1.1%	4.1%	1.9%	347
	Baseboard	6.7%	10.6%	93.3%	10.6%	-	-	-	-	-	-	-	-	15
	Ceiling Cable	-	-	95.1%	7.8%	4.9%	7.8%	-	-	-	-	-	-	21
	Fireplace	100.0%	-	-	-	-	-	-	-	-	-	-	-	3
	Floor	100.0%	-	-	-	-	-	-	-	-	-	-	-	40
	Portable	-	-	100.0%	-	-	-	-	-	-	-	-	-	2
	Wall	87.4%	3.8%	10.0%	3.5%	-	-	0.5%	0.8%	2.1%	1.6%	-	-	248
	Window Unit Resistance	-	-	100.0%	-	-	-	-	-	-	-	-	-	5
	Woodstove	-	-	-	-	-	-	-	-	-	-	100.0%	-	13

Table 133: Percentage of Furnaces by Fuel Type within Type of Furnace

Table 134 shows the average estimated age and percentage of furnaces with an estimated age by system type within manufacture ranges. As explained previously, the estimated ages were obtained from a combination of the dates that were obtained from the manufacturer information and the auditor estimates during the on site visit.

	System Type	Avg Mfr. Age	Avg Mfr. Age EB	Manufacture Date and Estimated Mfr Date Ranges													Sample Size
				1995 to 2000		1990 to 1994		1985 to 1989		1980 to 1984		1975 to 1979		1974 and older		
				%	Error Bound	%	Error Bound	%	Error Bound	%	Error Bound	%	Error Bound	%	Error Bound	
	All Types	20.2	0.9	17.8%	2.2%	12.8%	2.0%	19.4%	2.3%	8.8%	1.7%	9.6%	1.7%	31.6%	2.8%	843
Central	All Central	16.7	0.8	19.8%	2.7%	13.9%	2.3%	24.7%	2.9%	9.0%	1.9%	10.2%	2.1%	22.4%	2.8%	637
	Forced Air Furnace	16.7	0.8	19.7%	2.7%	13.6%	2.3%	24.8%	2.9%	9.1%	2.0%	10.4%	2.1%	22.3%	2.8%	629
	Hydronic System	13.0	6.5	25.5%	25.5%	36.3%	27.8%	12.7%	19.5%	-	-	-	-	25.5%	25.5%	8
Space	All Space	31.3	2.3	11.2%	3.8%	9.5%	3.5%	2.7%	2.0%	8.0%	3.2%	7.7%	3.2%	60.8%	5.9%	206
	Baseboard	18.6	5.8	11.1%	17.2%	33.3%	25.8%	-	-	11.1%	17.2%	11.1%	17.2%	33.4%	25.9%	9
	Ceiling Cable	28.9	3.7	-	-	6.4%	10.2%	-	-	19.2%	16.4%	-	-	74.3%	18.2%	16
	Fireplace	32.6	20.8	33.4%	44.8%	-	-	-	-	-	-	-	-	66.6%	44.8%	3
	Floor	49.7	5.7	3.6%	5.9%	-	-	-	-	4.1%	5.9%	3.7%	6.0%	88.6%	9.9%	30
	Wall	29.9	2.7	12.4%	4.9%	8.5%	4.2%	3.4%	2.8%	6.0%	3.6%	10.3%	4.6%	59.3%	7.4%	134
	Window Unit Resistance	1.3	0.7	97.5%	5.7%	-	-	2.5%	5.7%	-	-	-	-	-	-	3
	Woodstove	14.7	5.4	20.3%	21.0%	33.8%	24.1%	10.2%	15.8%	25.4%	22.0%	-	-	10.3%	16.0%	11

Table 134: Average Estimated Age and Percentage of Furnaces by Type within Age Ranges

Table 135 shows the average age of the furnaces with manufacturer-reported ages and the percentage of these furnaces by type within manufacture date ranges. Note that the average age of the forced air furnaces is not significantly different from the manufacturer and auditor estimated ages for forced air furnaces. In fact, the matched units with a manufacturer age were estimated to be on average only 0.1 years or older than the estimated ages. This indicates that for the majority of the forced air furnaces matched there may not be a large bias introduced from older units not matching. The same cannot be said about the other types of heating systems due to the fact that so few of them matched.

	System Type	Avg Mfr. Age	Avg Mfr. Age EB	Manufacture Date Ranges												Sample Size
				1995 to 2000		1990 to 1994		1985 to 1989		1980 to 1984		1975 to 1979		1974 and older		
				%	Error Bound	%	Error Bound	%	Error Bound	%	Error Bound	%	Error Bound	%	Error Bound	
	All Types	17.0	1.0	8.0%	3.0%	13.1%	3.6%	36.2%	5.3%	8.4%	3.1%	10.4%	3.4%	23.9%	4.8%	239
Central	All Central	16.9	1.0	8.1%	3.0%	12.7%	3.6%	36.5%	5.4%	8.5%	3.2%	10.5%	3.5%	23.7%	4.8%	237
Central	Forced Air Furnace	16.8	1.0	8.2%	3.0%	12.8%	3.6%	36.9%	5.4%	8.6%	3.2%	10.6%	3.5%	22.9%	4.7%	235
Central	Hydronic System	30.5	2.9	-	-	-	-	-	-	-	-	-	-	100.0%	-	2
Space	All Space	29.0	22.1	-	-	49.9%	58.2%	-	-	-	-	-	-	50.1%	58.2%	2
Space	Wall	48.0	-	-	-	-	-	-	-	-	-	-	-	100.0%	-	1
Space	Woodstove	10.0	-	-	-	100.0%	-	-	-	-	-	-	-	-	-	1

Table 135: Average Manufacturer Reported Age and Percentage of Furnaces by Type within Age Ranges

Table 136 shows the percentage of all furnaces with capacities by fuel type within capacity ranges. The capacity of the furnaces was obtained from manufacturer information if the model number linked to one of the databases. The on site estimation of the capacity of the furnaces was used if the model number did not link with the database. Among all units regardless of the fuel, over one-quarter of all units were gas units between 70 to 84.99 kBtu. The second largest percentage of furnaces were gas units between 55 and 69.99 kBtu.

	Capacity Ranges (n=691)	% of Furnaces with Capacity	Error Bound
Gas (kbtu)	10 to 24.99	2.0%	0.9%
Gas (kbtu)	25 to 39.99	14.3%	2.3%
Gas (kbtu)	40 to 54.99	14.7%	2.3%
Gas (kbtu)	55 to 69.99	15.4%	2.4%
Gas (kbtu)	70 to 84.99	26.3%	2.9%
Gas (kbtu)	85 to 99.99	4.1%	1.3%
Gas (kbtu)	100 to 114.99	12.4%	2.2%
Gas (kbtu)	115 to 129.99	5.3%	1.5%
Gas (kbtu)	130 to 144.99	1.8%	0.9%
Gas (kbtu)	>160	0.5%	0.5%
Electric (kW)	1 to 2.99	1.7%	0.9%
Electric (kW)	3 to 4.99	0.3%	0.4%
Electric (kW)	5 to 6.99	0.0%	0.0%
Electric (kW)	7 to 9.00	0.2%	0.3%
Electric (kW)	11 to 13.00	0.7%	0.5%
Electric (kW)	>15	0.3%	0.4%

Table 136: Percentage of All Furnaces with Capacity by Fuel Type within Capacity Ranges

Table 137 shows the average AFUE by system type. Only the units that matched with one of the efficiency databases were included in the analysis below. As one would expect, the average AFUE is significantly higher than the AFUE for all space heat systems.

System Type	All Types	Central Forced Air Furnace	Space All Space	Floor	Wall
Average AFUE	77.7	78.2	68.2	56.8	68.3
Error Bound	0.6	0.6	1.0	0.0	1.0
Sample Size	235	213	22	1	21

Table 137: Average AFUE by System Type

Table 138 shows the percentage of furnaces with an AFUE by type within AFUE ranges. The large majority of the forced air furnaces have an AFUE between 72 and 77.99.

System Type	Central Forced Air Furnace Percentage	Error Bound	Space All Space Percentage	Error Bound	Floor Percentage	Error Bound	Wall Percentage	Error Bound
< 60	-	-	0.6%	1.1%	100.0%	-	-	-
60-65.99	1.1%	1.3%	36.6%	18.1%	-	-	36.9%	18.2%
66-71.99	11.2%	3.8%	57.5%	18.5%	-	-	57.9%	18.6%
72-77.99	27.2%	5.3%	5.2%	8.3%	-	-	5.2%	8.4%
78-84	56.3%	5.9%	-	-	-	-	-	-
90-96	4.1%	2.3%	-	-	-	-	-	-

Table 138: Percentage of Furnaces by Type within AFUE Ranges

Table 128 shows the overall average AFUE for gas fired forced air furnaces compared with standards. On average, the forced air furnaces meet 1992 minimum standards, but fall short of energy star qualifying standards.

Annual Fuel Utilization Efficiency (AFUE)			
Tupe	1992 Minimum Standard	Minimum Energy Star Qualifying	Average AFUE
Gas Fired Forced Air Furnaces	78	90	78.2

Table 139: Average AFUE Standard Comparison

Table 129 shows the distribution of gas forced air furnace AFUE. The grayed cells represent SEER values that fall below current minimum efficiency standards. 39.5% of packaged systems fall below the current federal minimum standard of 78 AFUE effective 1993.

Type	AFUE Range 60 to 65.99	66 to 71.99	72 to 77.99	78 to 84	90 to 96	Sample Size
Gas Forced Air Furnace	1.1%	11.2%	27.2%	56.3%	4.1%	213

Table 140: SEER Bin Distribution

Window and Wall Constructions

Overview

The following section describes the window and wall construction types at the residences. Information on the type of window frame and the number of panes in each window were recorded during the site visit. If the customer reported that there were multiple types of frames or panes in their home, the predominant window type was observed and recorded. Data was also collected on the type of wall construction. The auditor observed the type of wall construction during the site visit.

Findings

Windows

Figure 12 shows the breakdown of window frame types among all homes. The overwhelming majority of window frame types found at the homes is metal, constituting more than three-quarters of the homes.
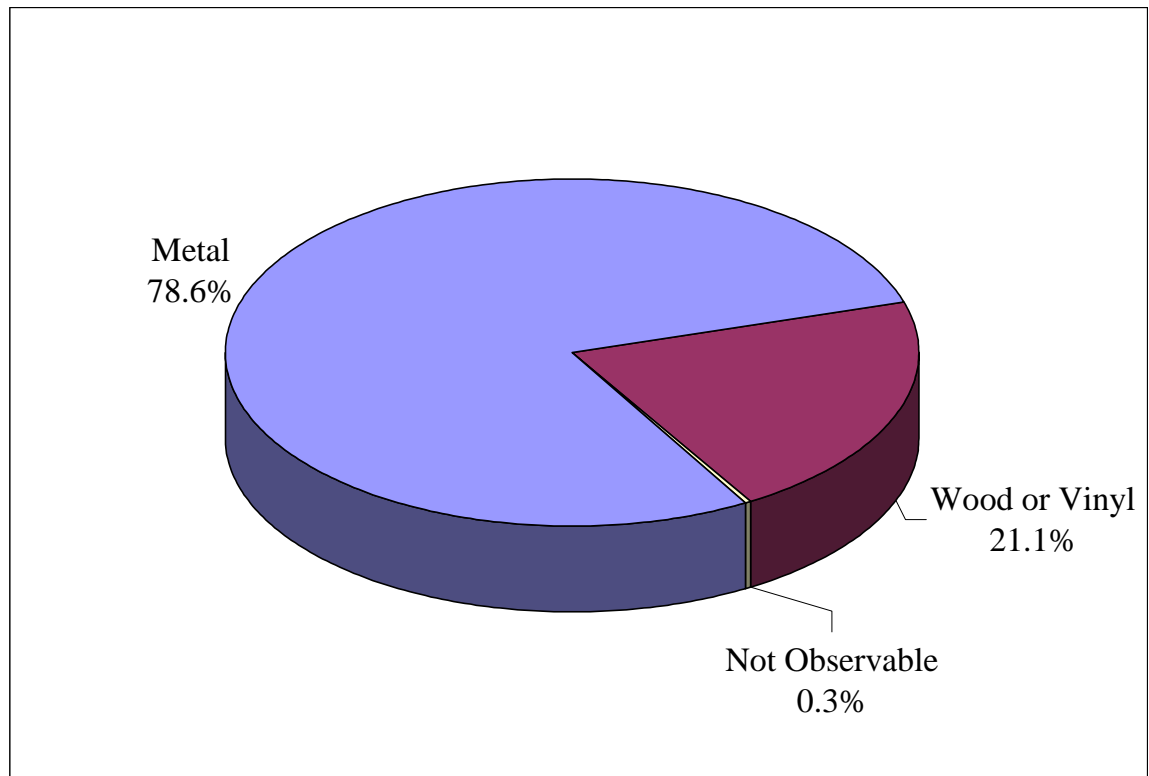
Figure 12: Percentage of Homes by Window Frame Type

Table 141 shows the breakdown of homes by window frame type and number of panes by type of residence. Not surprisingly, over half of all the homes have metal framed, single paned windows. Interestingly, a large majority of the "modular/prefabricated" homes have metal framed, double paned windows. Not surprisingly, only 9.3% of the 1-2 story apartments buildings have metal framed, double paned windows.

Type of Residence	Window and Pane Type												Sample Size
	Metal Single		Metal Double		Metal Triple		Wood or Vinyl Single		Wood or Vinyl Double		Not Observable		
Overall	54.6%	2.5%	23.8%	2.1%	0.1%	0.2%	14.5%	1.8%	6.7%	1.2%	0.3%	0.3%	1258
Apt(1 or 2 stories)	83.4%	4.3%	9.3%	3.3%	-	-	6.3%	2.8%	1.0%	1.2%	-	-	281
Apt(3 or more stories)	65.8%	11.7%	25.1%	10.7%	-	-	9.1%	7.1%	-	-	-	-	51
Duplex-Triplex-or Quadplex	60.5%	10.3%	10.5%	6.5%	-	-	28.1%	9.6%	1.0%	1.4%	-	-	82
Mobile Home-Double Wide	75.8%	16.8%	19.6%	15.8%	-	-	4.5%	7.3%	-	-	-	-	22
Mobile Home-Single Wide	80.4%	28.9%	19.6%	28.9%	-	-	-	-	-	-	-	-	6
Modular/prefabricated	26.2%	36.1%	73.8%	36.1%	-	-	-	-	-	-	-	-	7
Other	43.4%	50.4%	50.3%	51.9%	-	-	6.3%	11.7%	-	-	-	-	4
Single Family-Unattached- >2 stories	7.4%	11.6%	25.6%	19.0%	-	-	52.1%	22.2%	15.0%	16.0%	-	-	14
Single Family-Unattached-1 story	48.8%	3.7%	25.4%	3.2%	0.2%	0.3%	16.6%	2.8%	8.3%	2.0%	0.6%	0.6%	546
Single Family-Unattached-2 story	31.9%	5.5%	39.9%	5.8%	-	-	15.1%	4.2%	13.1%	4.0%	-	-	210
Townhouse or Rowhouse	85.8%	10.7%	10.6%	9.4%	-	-	3.6%	5.7%	0.1%	0.1%	-	-	35

Table 141: Percentage of Homes by Frame Type and Panes Type by Type of Residence

Table 142 shows the percentage of homes by frame and pane type by age of residence. Not surprisingly, a larger percentage of newer homes have double paned windows than the older homes. For example, 63.8% of homes built between 1995-2000 have metal double framed windows, while only 6.8% of homes built between 1950-1954 have those same type of windows.

Age of Residence	Window and Pane Type												Sample Size
	Metal Single		Metal Double		Metal Triple		Wood or Vinyl Single		Wood or Vinyl Double		Not Observable		
Overall	54.6%	2.5%	23.8%	2.1%	0.1%	0.2%	14.5%	1.8%	6.7%	1.2%	0.3%	0.3%	1,258
1950 - 1954	51.1%	10.6%	6.8%	5.4%	-	-	30.3%	9.8%	10.2%	6.4%	1.7%	2.7%	64
1955 - 1959	51.9%	10.9%	13.6%	7.2%	-	-	18.3%	8.5%	14.4%	7.5%	1.8%	3.0%	66
1960 - 1964	66.6%	8.4%	11.1%	5.5%	-	-	13.1%	6.0%	9.2%	5.1%	-	-	96
1965 - 1969	71.3%	8.3%	16.7%	6.9%	-	-	8.9%	5.1%	3.2%	3.1%	-	-	88
1970 - 1974	73.4%	7.2%	19.4%	6.5%	1.0%	1.7%	3.1%	2.9%	3.0%	2.6%	-	-	122
1975 - 1979	82.4%	6.4%	10.3%	5.1%	-	-	1.9%	2.2%	5.4%	3.9%	-	-	110
1980 - 1984	66.0%	9.9%	21.9%	8.4%	-	-	6.9%	5.5%	3.4%	3.9%	1.7%	2.8%	74
1985 - 1989	47.1%	7.6%	52.1%	7.6%	-	-	-	-	0.9%	1.4%	-	-	132
1990 - 1994	27.9%	8.4%	61.8%	9.0%	-	-	1.3%	2.2%	9.0%	5.2%	-	-	88
1995 - 2000	10.2%	6.1%	63.8%	9.7%	-	-	1.5%	2.5%	24.5%	8.6%	-	-	73
Don't Know	68.3%	6.2%	10.8%	4.2%	-	-	18.5%	5.2%	2.4%	2.0%	-	-	213
Older Than 1950	26.8%	6.7%	8.3%	4.2%	-	-	57.8%	7.5%	7.1%	3.8%	-	-	132

Table 142: Percentage of Homes by Frame Type and Panes Type by Age of Residence

Walls

The following figure shows the breakdown of all homes by wall construction type. The large majority of homes were constructed using 2 x 4's, totaling over 83% of all homes.
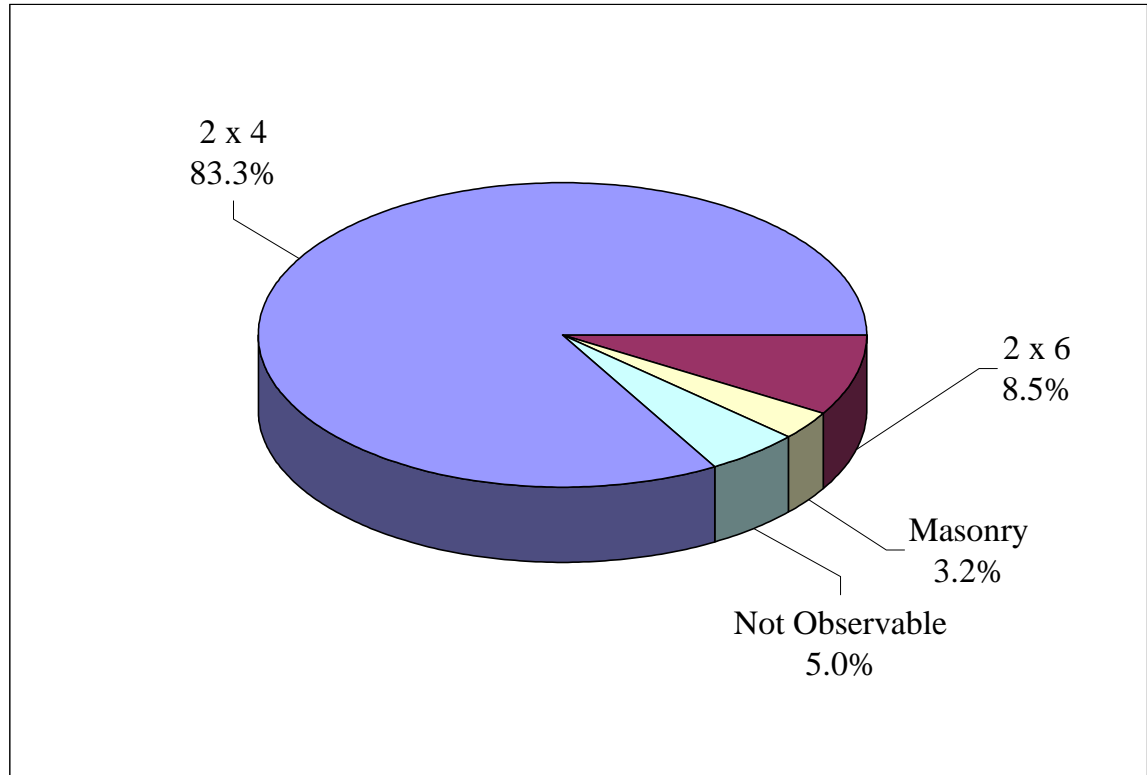
Figure 13: Percentage of Homes by Wall Construction Type

Insulation

Insulation Overview

The following section describes the insulation in walls, floors, and attics. This data was collected with some difficulty during the site visits. The difficulty arose when access to the attic was inaccessible due to the fact that it was located in another apartment unit, blocked by furniture, etc. If the attic was accessible, and there was batt insulation, in some cases the R-Value was not observable, then the auditor estimated the thickness of he insulation.

The percentage of walls that were insulated was also difficult information to collect because in many cases the customer was not aware of the percentage of the exterior walls in their home that were insulated. If this were the case, the surveyor would attempt to remove some faceplates from light switches or plugs if the resident approved. If the plate were successfully removed, the surveyor would then attempt to verify the presence and thickness of the insulation. The surveyor would attempt to remove a few more plates, and then would make an assumption about the percentage of the walls that were insulated. Many times the insulation would not be visible through the hole or the resident did not approve of the removal of the plate, thus the information went uncollected.

Attic

The average R-Value among all homes with an estimated or verified R-Value for attic insulation is 19.7 with an error bound of 0.7. Table 143 shows the average

R-Value and the percentage of homes with R-Values in ranges by age of residence. The largest percent of homes are in the range between R-19 to R-21.99, totaling 37.1% of the homes with an R-Value. Approximately 13% of the homes have no attic insulation.

In the event that the auditor was only able to record the inches of the batt insulation, the CEC residential Title-24 manual was referenced in order to translate the inches into R-Value. In the event that the auditor was only able to record the inches of the blown in insulation, the number of inches was multiplied by 3.5 to arrive at the R-Value. The overall attic R-Value was calculated as the sum of the R-Values for blown-in and batt insulation.

Residence Age Range	Average R-Value	Average R-Value EB	No Insulation		<R-11		R-11 to R-18.99		R-19 to R-21.99		R-22 to R-29.99		R-30 to R-37.99		>R-37.99		Sample Size
			%	Error Bound	%	Error Bound	%	Error Bound	%	Error Bound	%	Error Bound	%	Error Bound	%	Error Bound	
Overall	19.7	0.7	13.5%	2.0%	1.8%	0.8%	16.8%	2.2%	37.1%	2.9%	13.5%	2.0%	7.7%	1.5%	9.6%	1.7%	876
1950 - 1954	18.3	2.6	13.0%	8.1%	4.3%	4.9%	26.8%	10.6%	25.7%	10.5%	19.3%	9.5%	4.3%	4.9%	6.5%	5.9%	49
1955 - 1959	18.9	2.2	10.7%	7.4%	4.3%	4.9%	13.7%	8.1%	45.8%	11.7%	16.1%	8.7%	4.2%	4.8%	5.3%	5.1%	56
1960 - 1964	20.4	2.6	12.0%	6.3%	1.4%	2.3%	20.7%	7.9%	36.8%	9.4%	10.7%	6.0%	7.0%	4.8%	11.3%	6.2%	78
1965 - 1969	18.2	2.2	8.6%	6.0%	6.9%	5.5%	25.7%	9.4%	36.5%	10.3%	7.7%	5.6%	9.4%	6.1%	5.2%	4.8%	66
1970 - 1974	19.7	2.0	9.6%	5.5%	3.9%	3.6%	18.2%	7.5%	43.3%	9.5%	7.1%	5.0%	9.0%	5.3%	8.9%	5.5%	87
1975 - 1979	17.2	1.8	11.4%	6.5%	1.7%	2.7%	26.9%	9.1%	44.2%	10.3%	8.3%	5.8%	3.3%	3.8%	4.1%	4.0%	72
1980 - 1984	18.6	2.2	9.3%	6.9%	1.6%	2.6%	17.7%	9.1%	48.5%	11.9%	11.1%	7.7%	2.9%	3.8%	8.8%	6.9%	54
1985 - 1989	22.0	1.8	5.2%	3.8%	-	-	11.0%	5.5%	46.4%	8.7%	16.8%	6.5%	11.5%	5.4%	9.1%	5.1%	99
1990 - 1994	27.0	2.7	4.8%	4.4%	-	-	3.4%	3.7%	31.4%	9.5%	25.5%	9.0%	13.8%	6.9%	21.1%	8.3%	71
1995 - 2000	26.0	2.6	5.7%	5.3%	-	-	2.8%	3.4%	24.9%	9.6%	28.5%	10.2%	23.0%	9.3%	15.1%	7.9%	60
Don't Know	16.7	3.5	33.7%	10.1%	0.1%	0.1%	12.8%	7.1%	28.9%	9.9%	9.8%	6.5%	0.0%	0.0%	14.7%	7.9%	77
Older Than 1950	14.2	2.1	31.9%	7.9%	-	-	21.4%	7.0%	31.3%	7.9%	6.6%	4.0%	3.2%	2.8%	5.7%	3.8%	107

Table 143: Average R-Value and Percentage of Homes with Attic R-Values within R-Value Bins

Walls

Among those homes where it was possible to observe the percentage of the walls that were insulated, the percentage of homes that have no exterior wall insulation is 26.1%, while the percentage of homes in which all the exterior walls are insulated totals 66.7% of the homes.

Construction Type	Percentage of Walls Insulated										Sample Size
	0%		25%		50%		75%		100%		
	Percent	Error Bound	Percent	Error Bound	Percent	Error Bound	Percent	Error Bound	Percent	Error Bound	
All Types	26.1%	2.6%	3.5%	1.1%	2.4%	0.9%	1.3%	0.7%	66.7%	2.8%	904
2 x 4	26.6%	2.9%	4.1%	1.3%	2.7%	1.0%	1.4%	0.7%	65.2%	3.1%	761
2 x 6	11.8%	6.1%	-	-	1.3%	2.1%	-	-	86.8%	6.3%	86
Masonry	51.2%	14.8%	1.8%	2.9%	-	-	3.8%	6.1%	43.2%	14.4%	43
Not Observable	36.6%	23.8%	-	-	-	-	-	-	63.4%	23.8%	14

Table 144: Percentage of Homes by Wall Construction Type by Percentage of Walls Insulated

Table 145 shows the percentage of homes with any amount of wall insulation by type of residence, regardless of the R-value that was obtained during the site visit. Over two-thirds of the homes have some type of wall insulation.

Type of Residence	Percentage of Homes	Error Bound	Sample Size
Overall	67.4%	2.9%	806
Apt(1 or 2 stories)	61.4%	7.4%	154
Apt(3 or more stories)	67.4%	19.1%	20
Duplex-Triplex-or Quadplex	32.1%	13.8%	41
Mobile Home-Double Wide	90.9%	13.9%	15
Mobile Home-Single Wide	100.0%	0.0%	3
Modular/prefabricated	100.0%	0.0%	6
Other	100.0%	0.0%	3
Single Family-Unattached- >2 stories	76.4%	23.9%	9
Single Family-Unattached-1 story	64.1%	4.3%	380
Single Family-Unattached-2 story	81.2%	5.4%	152
Townhouse or Rowhouse	78.5%	15.6%	23

Table 145: Percentage of Homes with Wall Insulation by Type of Residence

Floor

The following table displays the percentage of homes for which an R-Value was obtained for the floor insulation. Over 59% are slab on grade. Among the other homes, almost 83% have no insulation.

Floor R-Value (n=398)	Percentage	Error Bound
< R-11	2.7%	1.5%
R-11	3.4%	1.6%
R-13	2.2%	1.3%
R-15	1.2%	1.0%
R-19	5.7%	2.1%
R-30	1.8%	1.2%
No Insulation	82.9%	3.4%

Table 146: Percentage of Homes with Floor R-Values within R-Value Sizes

Market Barriers to Energy Efficient Lighting

Overview

While on-site, a supplemental lighting market barrier survey was conducted for a sample of the customers participating in the primary survey. The basis of administering the market barrier supplement was whether or not the customer performed a home remodel in the last three years that incorporated the replacement of or addition of new hard wired lighting fixtures. Applying this time span of three years and hard-wired lighting remodel activity as a basis, the lighting market barrier survey was conducted with thirty-six customers statewide.

This lighting market barrier survey was intended to assist utility managers in understanding the market barriers to common utilization of energy efficient lighting technologies in the residential sector. The survey questions were directed at assessing the customers role in the lamp type decision making process, influence on customer lamp choice by sales persons and contractors, and customer perceptions of an energy efficient lamp versus a standard efficiency level lamp. Survey questions included the following:

- ♦ Which rooms in the house were re-modeled with new hard-wired lighting fixture(s)?

- ♦ Which two rooms' lights are used most (the remaining survey questions focus on these two rooms)?

- ♦ Who selected the fixture (i.e. homeowner, contractor)?

- ♦ Was customer aware of energy efficient lamps at time fixture selection?

- ♦ How did customer learn some lamps were more efficient than others (i.e. sales person, contractor, prior knowledge)?

- ♦ Did customer purchase an energy efficient lamp/fixture?

- ♦ Physical verification of installed lamp technology

Refer to the appendix for a full copy of the Residential Lighting and Appliance and Saturation – Supplemental Lighting Market Barrier Survey.

Of the thirty-six lighting market barrier surveys conducted, seventeen (47.2%) were in the PG&E service territory; twelve (33.3%) were located in the SMUD service territory; and seven (19.4%) in the SCE service territory. Apparently, no customers surveyed in the SDG&E service territory have conducted remodeling of hard-wired lighting fixtures in the last three years.

Findings

The sampling weights have been applied to all of the sample data to obtain the population percentage estimates.

Types of Remodeled Residences

Statewide, single family unattached one-story homes are the most prevalent type of home that have hard-wired lighting remodels in the last three years. Two story single family unattached homes are the second most prevalent type of homes with hard-wired lighting remodels. One or two story apartments, duplexes/triplexes, doublewide mobile homes, and modular homes constitute the remaining home types that were remodeled and consequently participated in the lighting market barrier supplement. Figure 14 below illustrates these findings.
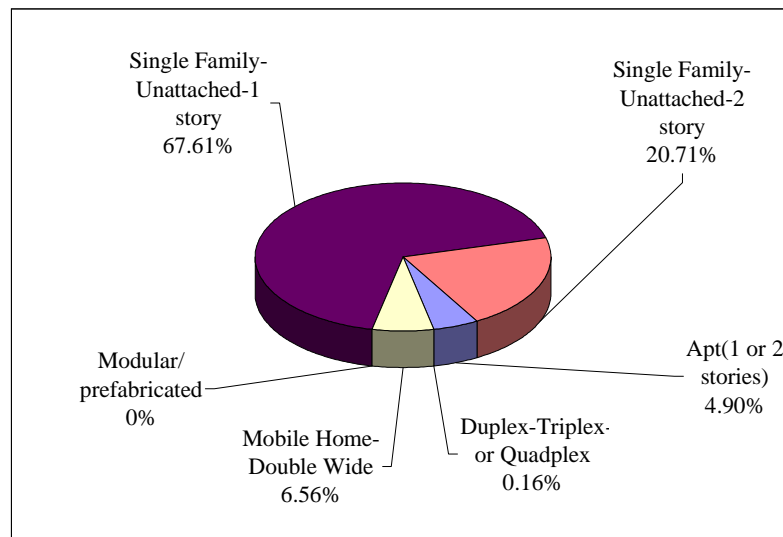
Figure 14: Weighted Percentage of Home Types with Remodeled Hard-Wired Lighting Fixtures in Last Three Years

Room Types

Occupants were asked which room with remodeled hard-wired lighting fixtures the resident uses most often. The rooms were subsequently coded 'one' for the light used most, and 'two' for the next most used light. Other remodeled rooms were not included in the supplemental survey. These two rooms coded 'one' and 'two' were the focus of the remaining questions in the survey. Two-room remodels were not the situation in all cases. In fact, seventeen homes only remodeled one hard-wired lighting fixture.

The survey found that kitchens, with 54% of the total rooms surveyed, were the room that was remodeled most often and bathrooms, with 34% of the total, were the next most common remodeled rooms. Master bedrooms and living rooms, respectively, were the next most prevalent room types being remodeled. The following table displays the room type percentage for homes with remodeled hard-wired lighting fixtures in the last three years.

Room	Percentage
Kitchen	54%
Bathroom1	34%
Bathroom2	0%
Living Room	17%
Dining Room	15%
Kitchen Nook	1%
Bedroom	8%
Master Bedroom	19%
Den/Office	10%
Family Room	0%
Other	8%

Table 147: Room Types with Remodeled Hard-Wired Lighting Fixtures

Lamp Selection Process

As part of the survey, customers were asked what role he/she had in selecting the lamps found in the remodeled fixtures. The responses were than translated to one of the following categories.

- All selections done by homeowner

- Selected from some options provided by contractor

- Selected from some options provided by interior designer

- None, contractor made all decisions

- None interior designer made all decisions

- Other, with description

In all cases, response to this question did not vary much from the first to the second fixture, as one could expect if the remodels were completed at the same time. However, the results for fixture one and fixture two are slightly different because of sample weights and the fact that not all homes have two remodeled rooms. Regardless, the homeowner made the majority of selections themselves. Table 148 shows the breakdown of the selection process for both fixtures.

Selection Process	Percentage of Responses	
	First Fixture	Second Fixture
All Selections by Homeowner	72%	77%
Selected from Contractor Options	11%	6%
Selected from Interior Designer Options	6%	6%
Contractor Made All Decisions	0%	0%
Interior Designer Made All Decisions	0%	0%
Other	11%	11%

Table 148: Lamp Selection Process in Remodels with Hard-Wire Lighting

The five responses of 'other' for the lamp selection process include the following responses:

♦ "Given as a gift"

♦ "Mother-in-law made choice"

♦ "fixture choice by tenant, not homeowner"

♦ "Selected by homeowner with help from contractor and interior designer" (2)

Customers were asked if a sales person, contractor, or interior designed offered the homeowner a choice between high efficiency lamps and standard efficiency lamps. Possible responses to the question were 'Yes', 'No', 'NA', and 'DK". If the customer chose 'NA', indicating they didn't have role in the selection process, then the surveyor proceeded to verify the lamp technology and omit the remaining questions. The responses to this question are closely divided between 'Yes', 'No', and 'DK' indicating that a choice is made available to the customer in roughly one of three instances. The actual response percentages can be found in Table 149.

Response	Percentage	
	1st Fixture	2nd Fixture
Yes	29%	32%
No	33%	37%
NA	8%	6%
DK	30%	25%

Table 149: Percentage of Respondents Offered a Choice between an Energy Efficient Lamp and a Standard Efficient Lamp

Awareness

The survey also investigated the awareness level of the customer regarding energy efficient lamps at the time of purchasing the lamps for the remodel. The customer was asked if he/she was aware of energy efficient lamps at the time of their purchase. Approximately half of the respondents were aware of energy efficient lamps upon purchasing the lamps for their re-modeled hard-wired lighting fixtures.

Response	Percentage	
	1st Fixture	**2nd Fixture**
Yes	57%	48%
No	35%	38%
NA	8%	14%

Table 150: Percentage of Respondents That Were Aware of Energy Efficient Lamps at time of Purchase

If the customer responded 'yes' to this question, he/she was then prompted to explain how he/she became aware that some lamps are more efficient than others. The choices for which method of becoming aware of energy efficient lamps include the following.

- ◆ Sales Person

- ◆ Contractor

- ◆ Interior Designer

- ◆ Advertisements

- ◆ Product Material (catalogs, flyers, utility material)

- ◆ Energy Star Label

- ◆ Had Prior Knowledge

- ◆ Other

Of the respondents who responded 'yes' to being aware of energy efficient lamps, more than half said that they had prior knowledge of the technology--58% of first fixture respondents, and 60% of second fixture respondents, said they had prior knowledge. Advertisements, at 18% for first fixture responses and 20% for second fixture responses, were the next most common method of becoming aware of energy efficient lamps. Contractors and the Energy Star Labels had no influence on customer awareness of energy efficient lamps. All response percentages can be found in Table 151.

Method of Awareness	Percentage	
	1st Fixture	2nd Fixture
Sales Person	7%	20%
Contractor	0%	0%
Interior Designer	7%	0%
Advertisements	18%	20%
Product Material	10%	0%
Energy Star	0%	0%
Prior Knowledge	58%	60%

Table 151: Percentage of Responses to Method of Awareness of Energy Efficient Lamp Technology

Installed Lamps

The survey respondent was asked if they installed an energy efficient lamp in the fixture that was re-modeled. Twenty six percent of the first fixture respondents said that they did install an energy efficient lamp. Seventy percent of the first fixture respondents said no, they did not install an energy efficient lamp. Table 152 shows the response percentages for first and second fixtures.

Response	Percentage	
	1st Fixture	2nd Fixture
Yes	26%	5%
No	70%	88%
Don't Know	4%	7%

Table 152: Percentage of Respondents Who Said They Installed an Energy Efficient Lamp

The surveyor verified the lamp technology of the re-modeled hard-wired lighting fixture while on-site. Of all the lamps installed in the re-models, incandescent lamps were the dominant type constituting 71% of first fixture re-models and 69% of second fixture re-models. Table 153 displays the percentage of lamp types found in the first and second fixtures that were re-modeled.

Lamp Type	Perentage	
	1st Fixture	**2nd Fixture**
T-12	20%	8%
T-8	0%	0%
Incandescent - All Types	71%	69%
CFL - modular	0%	8%
CFL - integral	3%	0%
Halogen - All Types	6%	8%
Other	0%	6%

Table 153: Percentage of Lamp Types Field Verified in Hard-Wired Lighting Fixture Re-models

Market Barriers

Contrary to what Table 153 indicates, that 26% of first fixture respondents said they installed an energy efficient lamp. However, 26% of lamps were not energy efficient. This indicates that a potential market barrier is the lack of awareness of what is an energy efficient lamp. Lack of awareness was 14% of the responses to why the respondent didn't install an energy efficient lamp. We can assume then that lack of awareness is higher than 14% due to the number of people who thought they installed energy efficient, but in fact did not. This leads us to believe that not only are people unaware of the technology, but they may also be confused as to what actually is energy efficient lighting technology. Table 154 shows what reasons were given as to why an energy efficient lamp was not installed.

Reason For Not Buying Energy Efficient Lamp	Percentage
Aesthetics	29.2%
Color Quality	35.1%
Lack of Awareness	14.4%
High Cost of Energy Efficient Lamp	2.7%
Energy Efficiency Technology Unreliability	2.7%
Energy Efficiency Not Priority	1.5%
Not Part of Decision Making Process	2.7%
Don't Know	11.6%

Table 154: Reasons for Not Buying Energy Efficient Lamps

Upon reviewing Table 154, the obvious market barrier to utilization of energy efficient lamps in the residential sector is because of color quality of the lamp and aesthetics related to the shape of the lamps. High cost was not a concern for the majority of the respondents, as neither was technology unreliability or energy efficiency.

Bias from Match Rates

The bias from low match rates for appliances is discussed in this section of the report. A section for each of the major appliances for which data was collected is listed below. The basis for the inclusion of the bias tables in this section was discussed previously in the "Future Study Recommendations" section of the report. Not surprisingly, appliances manufactured more recently were easier to find matches for than older units. The bias that is introduced is a larger amount of efficiency data that resulted from matched appliances, was matched for newer and potentially more efficient appliances. As stated previously, to have unbiased efficiency information, reviewers should look to contractors that propose to match proportionally the age of units by the number of units in the population by age

The ages in the following tables represent the manufacturer and auditor estimated ages. The tables in this section present the percentage of units matched and the percentage of all units found within manufacturer reported and estimated age ranges. Also presented with the discussion of potential bias are some general results for each end-use.

Refrigerator Freezers

Table 155 shows the match rate among all primary refrigerators by age of refrigerator. The second column of Table 155 named "Number of Matched Units" shows the number of refrigerators that were matched. These refrigerators in the second column have a manufacturer reported or a surveyor estimated age, and due to their matching with an efficiency database, we have obtained a UEC for these units. The third column of the table named "Percent of Units Matched" is the percentage of all matched refrigerators manufactured within a specified date range where a manufacturer or auditor estimated date was reported. The fourth column of the table named "Age Distribution of All Refrigerators (n=1137)" contains the distribution of all primary refrigerators with manufacturer or surveyor reported ages of the refrigerators. The fourth column contains all units with a date, regardless of whether the model matched with the efficiency databases.

The percentage difference between unmatched and matched units is slightly larger for newer machines, suggesting that the AHAM and CEC databases are slightly more favorable for matching newer machines. This is important data for anyone wishing to understand statewide refrigerator baseline efficiency levels using this report. Refrigerator efficiency data presented in this report has a certain amount of bias toward newer models.

Age	Number of Units Matched	Percent of Units Matched	Age Distribution of all Refrigerators (n=1137)
1995 -2000	291	37.2%	33.9%
1990 -1994	255	32.6%	31.3%
1985 -1989	149	19.1%	20.4%
1980 -1984	63	8.1%	9.5%
1979 or Older	24	3.1%	4.8%
Total	**782**	100.0%	100.0%

Table 155: Percentage of Matched Refrigerators and All Refrigerators by Estimated or Manufacturer Reported Date

Self Standing Freezers

Table 156 shows the potential bias in matching of freezer units. The percentage difference between unmatched and matched units is larger for newer machines, suggesting that the AHAM and CEC databases are more favorable for matching newer machines. Freezer efficiency data presented in this report has a certain amount of bias toward newer models.

Age	Number of Units Matched	Percent of Units Matched	Age Distribution of all Freezers (n=169)
1995 -2000	14	29.2%	19.5%
1990 -1994	15	31.3%	26.6%
1985 -1989	6	12.5%	18.3%
1980 -1984	8	16.7%	17.8%
1979 or Older	5	10.4%	17.8%
Total	**48**	100.0%	100.0%

Table 156: Percentage of Matched Freezers and All Freezers by Estimated or Manufacturer Reported Date

Cooling Systems

Table 157 shows that the percentage of matched units in the more recent age ranges is slightly higher than the percentage of all units within the same age range. This would indicate that the databases used to match the cooling systems were only slightly biased toward newer models.

Age	Number of Units Matched	Percent of Units Matched	Age Distribution of all Cooling Systems (n=500)
1995 -2000	77	28.7%	26.4%
1990 -1994	72	26.9%	22.0%
1985 -1989	57	21.3%	21.8%
1980 -1984	25	9.3%	12.4%
1979 or Older	37	13.8%	17.4%
Total	**268**	100.0%	100.0%

Table 157: Percentage of Matched Cooling Systems and All Cooling Systems by Estimated or Manufacturer Reported Date

Heat Pumps

Fortunately, the percentage of matched units in the more recent age ranges is similar to the percentage of all units within the same age range. This would indicate that the databases used to match the heat pumps were not biased toward newer models.

Age	Number of Units Matched	Percent of Units Matched	Age Distribution of all Heat Pumps (n=55)
1995 -2000	6	20.7%	21.8%
1990 -1994	4	13.8%	14.5%
1985 -1989	8	27.6%	27.3%
1980 -1984	6	20.7%	18.2%
1979 or Older	5	17.2%	18.2%
Total	**29**	100.0%	100.0%

Table 158: Percentage of Matched Heat Pumps and All Heat Pumps by Estimated or Manufacturer Reported Date

Heating Systems

The percentage of matched units in the more recent age ranges is similar to the percentage of all units within the same age range. However, it was more difficult matching older furnaces because of the great number that are 30-40 years old. Table 159 shows that units 10-15 years old were highly over matched, where units 20 years or older were highly under matched.

Age	Number of Units Matched	Percent of Units Matched	Age Distribution of all Furnaces (n=843)
1995 -2000	69	22.3%	18.5%
1990 -1994	49	15.8%	13.0%
1985 -1989	87	28.1%	19.0%
1980 -1984	21	6.8%	9.6%
1979 or Older	84	27.1%	39.9%
Total	**310**	100.0%	100.0%

Table 159: Percentage of Matched Furnaces and All Furnaces by Estimated or Manufacturer Reported Date

Clothes Washing and Drying Appliances

RLW was not able to locate any efficiency databases that report model efficiency for clothes drying equipment. The CEC has not yet begun testing and benchmarking clothes dryers as they have for all other appliances in this study. Therefor, no efficiency information is presented in this report related to clothes dryers.

The CEC database containing clothes washer data was used to match on-site clothes washer data collected during the survey. This was the only database of its kind available for use in this study. Table 160 shows the number of clothes washers that were matched by date of manufacture (customer reported). Also presented in the table (column four) is the percentage of all clothes washers manufactured within a specified date range where an age estimate was reported. Note that column two, 'Number of Units Matched', only includes those washers for which both an age estimate and energy factor was obtained. One can easily see that the percentage of matched units is much higher for newer machines, suggesting that the CEC database is more favorable for matching newer machines. This is important data for anyone wishing to understand statewide washing machine baseline efficiency levels using this report, whereby washing machine efficiency data presented has a certain amount of bias toward newer washing machines.

Age	Number of Units Matched	Percent of Units Matched	Percent of all Washing Machines (n = 823)
1995 -2000	123	86%	45%
1990 -1994	17	12%	30%
1985 -1989	3	2%	18%
1980 -1984	0	0%	4%
1979 or older	0	0%	2%
Total	**143**	100%	100%

Table 160 Manufactured Date of Matched Clothes Washers

Dishwashers

A certain amount of bias has been introduced because a greater percentage of newer dishwashers were matched than were older dishwashers. Seventy-five percent of the dishwashers shown in Table 161 were manufactured in the 1990's. Of all dishwashers for which an age was obtained, 65% were manufactured in the 1990's. Therefore we are more confident in estimating the efficiency of the newer units than we are the older units.

Age	Number of Units Matched	Percent of Units Matched	Age Distribution of all Dishwashers (n = 694)
1995 -2000	110	49%	40%
1990 -1994	61	27%	25%
1985 -1989	37	16%	22%
1980 -1984	9	4%	6%
1979 or older	8	4%	6%
Total	**225**	100%	100%

Table 161 Manufactured Date of Matched Dishwashers

Hot Water Heaters

Among all the matched hot water heaters, for which we also had an age estimate, 182 or 56% were manufactured in 1995 or later. Since the majority of hot water heaters matched were newer units, a bias is introduced towards the newer and possibly more energy efficient water heaters. This explains why the statewide average is the same as the federal energy standard. Unfortunately, a more comprehensive source of water heater data is not currently available to match the older units.

Age	Number of Units Matched	Percent of Units Matched	Age Distribution of all Water Heaters (n = 754)
1995 -2000	183	56%	38%
1990 -1994	91	28%	29%
1985 -1989	41	13%	21%
1980 -1984	9	3%	7%
1979 or older	3	1%	5%
Total	**327**	100%	100%

Table 162 Manufactured Date of Matched Hot Water Heaters

Although the matching rates were not consistent across age categories, it is important to keep in mind that for the popular 40-gallon water heater, nearly 70% found in homes were manufactured in the 1990s. Couple that with the 85% (56% + 29%) of units matched in the 1990s and we have good estimate of hot water heater efficiency for the majority of the population of water heaters.