2006 MISSOURI STATEWIDE RESIDENTIAL LIGHTING AND APPLIANCE EFFICIENCY SATURATION STUDY

FINAL REPORT

SEPTEMBER 15, 2006

A Joint Study for the Utility Collaborative:

AMERENUE

KANSAS CITY POWER & LIGHT

AQUILA

INDEPENDENCE POWER & LIGHT

EMPIRE DISTRICT ELECTRIC CO.

CITY UTILITIES OF SPRINGFIELD

COLUMBIA WATER & LIGHT

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Executive Summary

Introduction

This study was designed to serve the Missouri investor-owned and municipal utilities to provide baseline information on residential appliance, building, equipment, and lighting saturations and efficiencies. The overarching goals of the Missouri Market Assessment Study ("the assessment") were to provide baselines of saturation and efficiency characteristics for use in understanding future energy savings potential in the residential sector. The seven sponsoring utilities working as the Utility Collaborative ("the Collaborative") were AmerenUE, Kansas City Power & Light, Aquila, Independence Power & Light, Empire District Electric Company, City Utilities of Springfield, and Columbia Water & Light.

The four primary objectives that this study was designed to achieve were:

Objective 1: Complete onsite surveys of approximately 285 single-family homes to build a Missouri baseline inventory and energy use estimate for lighting and appliances in the existing Missouri residential market.

Objective 2: Develop a database of residential lighting and appliance saturations and efficiencies.

Objective 3: Set up a web-based tool to provide utility staff and other parties the ability to conduct "what-if" scenario analyses on the data collected from the sample of homes.

Objective 4: Calculate and present technical, economic, and market potential analyses for energy efficiency opportunities to help target future programs that will have the largest and/or most cost effective impact on peak demand and energy consumption.

Approach

An evenly distributed sample of residential accounts was selected for each major residential rate class of each participating utility. Customers were recruited to participate in the study by phone, and each participant was paid $25 for agreeing to allow an onsite surveyor to visit their home to gather the required information. The onsite survey was implemented using IPAQ hand held personal digital assistants (PDA) and a specially designed application for collecting the specified information. This approach provided fast and cost effective on-site data collection. A total of 287 on-site surveys were successfully completed between October 2005 and May 2006.

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, Cooling Equipment, Heating Equipment, and Spa/Pool Equipment. The surveyors collected lamp, fixture, and wattage data for each lighting fixture within the home, as well as any front porch fixtures. The on-site surveyors also collected data on attic, floor and wall insulation R-values, wall construction, and window type. The survey also included a brief set of demographic and socioeconomic questions, in addition to a few questions regarding recent or planned remodeling of the home.

As the data were collected, the surveyors uploaded the site data from the PDA units to RLW's SQL database. The data underwent quality control measures, and model numbers were matched to databases of appliance efficiencies. The matching function was done using appliance databases RLW had already secured from a previous California study, including appliance model data from the California Energy Commission (CEC), the Air-Conditioning and Refrigeration Institute (ARI), Association of Home Appliance Manufacturers (AHAM), and Carrier's 2003 Electronic Blue Book. Once the model numbers were linked, the corresponding efficiency was assigned to the matched appliance. Matching rates varied greatly by appliance type and age. Table 2 in the following section provides an analysis of the overall match rates for each appliance in the study.

It is important to understand that the appliance and equipment efficiency findings presented in this report do not account for degradation (i.e. the difference between actual efficiency and rated efficiency that occurs with age and use). Most appliances (if not all) have been shown to degrade over time, the result of which can affect performance and energy efficiency. The efficiency information (e.g., SEER, UEC, EF, etc.) presented in this report is based on results from manufacturer compliance testing of new products to federal appliance and equipment standards. Therefore, efficiency data presented in this report is likely conservative since efficiency values are based on manufacturer tested performance.

The analysis for lighting and appliances is summarized in this report at the statewide level. Each site was given its appropriate case 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 data and analysis queries developed for this project can be accessed by any user wishing to do so. As a product of this study, RLW developed a web-based analytical tool that gives users the ability to analyze the various data. The Missouri Residential Efficiency Saturation Tool (MORES^{EST}) allows users to explore this residential sector data in a myriad of ways that go well beyond what is presented in this "statewide" report. The tool can be accessed at www.moresest.com.

Key Findings

In this section we summarize some of the more interesting findings occurring at the statewide level. Findings are grouped in this study by appliance and equipment type, lighting, and building characteristics. Readers can find additional information and details in the sections of the report that pertain to the topic of discussion in this section.

Following this interim report we will provide chapters on our comparative and potential analyses. The comparative analysis will highlight the similarities and differences between the 2006 assessment and the results of the 2003 Illinois Residential Statewide Assessment as well as the American Housing Surveys conducted by the US Census for the Metropolitan Statistical Area for Kansas City (MO) and St. Louis. These additional analyses will not only provide grounds for comparative assessment but will also offer a useful perspective and point of reference for the 2006 assessment.

Lighting

Data were gathered on all fixtures in the home and for the porch light(s). No other exterior lighting data were collected. The data collection parameters included collection of fixture type, number of lamps, lamp technology type and lamp wattage (if accessible). All of the indoor lighting data were characterized by room type. The study also included wattage data collection. All in all, 90% of wattage data were obtained.

Number of fixtures and lamps - The assessment shows that there are, on average overall, roughly 37 fixtures and 59 lamps per household surveyed reflecting that there are roughly 1.6 lamps per fixture. Ceiling fixtures make up the highest average number of fixtures per home, 12.8, while incandescent lamps make up the highest average number of lamps, 49.1.

Fixtures with a compact fluorescent (CFL) – On average, 5% of all fixtures have at least one CFL. Not only are ceiling mounted fixtures the most common fixture type, but also the most likely to contain CFLs. Nearly 46% of the ceiling mounted fixtures, which constitute close to 35% of all fixtures surveyed, contained at least one CFL. Floor lamps and torchieres are the next two most likely to contain CFLs. For perspective, 14.7% of all floor lamps and 9.9% of all torchieres contained CFLs. When considering the entire surveyed population (not just CFLs) of lamp-fixture combinations, 89% are screw-based fixtures leaving 11% pin-based fixtures. With persistence in mind however, further analysis shows that only .6% of all CFLs are dedicated for pin-based fixtures.

Saturation of CFLs – The percentage of CFLs among all lamps is nearly 5%. Of the numerous types of CFLs, spiral/spring lamp styles are the most common. Nearly 26% of homes surveyed have CFLs.

Location of CFLs – The most common room types to have CFLs are family rooms and kitchens. About 18% of family rooms and 16% of kitchens contain at least one CFL. For all frequently used spaces, dining rooms were the least likely to have CFLs. Dining rooms are unlikely to contain a CFL perhaps due to the higher preponderance of fixtures that do not easily accommodate CFLs (such as chandeliers, decorative sockets, and incandescent dimmer controls, which cannot dim CFLs). Table 1 summarizes the proportion of rooms with at least one CFL.

Room Type	Percent with CFL
Family Room	18%
Kitchen	16%
Living Room	14%
Basement	12%
Office	10%
Master Bedroom	10%
Bathroom	9%
Bedroom	8%
Hall	8%
Porch	8%
Garage	8%
Laundry Room	7%
Other	7%
Master Bathroom	6%
Recreation Room	6%
Dining Room	5%
Closet	5%
Breakfast Nook	2%

[1]

Table 1: Percent of Rooms with CFL

According to a recent CFL Metering Study in California (KEMA, 2005)[1], CFLs located in kitchens, living rooms, outside, and in garages are used the most, while those in laundry rooms, bathrooms, and hallways are being used the least. KEMA found that living rooms have the second highest hours of use of any room in the house (second to the Kitchen), which is also the third most likely room (14% of homes) to contain a CFL.

Average Lamp Wattages – The average wattage for incandescent A-type lamps is 63 Watts, while the average wattage for spiral/spring type CFLs is 21 Watts. The CFL Metering Study (KEMA, 2005)[1] found that more than 90% of CFLs installed in residences are in the 13-26 Watt range and have screw-in bases and integrated ballasts. They also found that the *most common* wattage range is 13-17 Watts, while our findings suggest an average closer to 21 Watts.

Refrigerators

Data were gathered for primary, secondary, and tertiary refrigerators.

Primary Refrigerator Age – In the study we found that the average age of primary refrigerators was 8.3 years old. Nearly 75% of these were manufactured after 1995. Additionally, over 44% of all primary refrigerators were between 19.00 and 21.99 cubic feet.

Primary Refrigerator Nameplate Unit Energy Consumption (UEC) – The overall average nameplate UEC for primary refrigerators is 760.3.

ENERGY STAR Qualified – Roughly 7% of all primary refrigerators found would qualify with the 2004 ENERGY STAR standards, while approximately 11% of all refrigerators meet or exceed the 2001 ENERGY STAR standards.

[1] "CFL Metering Study," KEMA. 2005

Secondary Refrigerator Characteristics – The average age of secondary refrigerators is 15 years old. In terms of nameplate UEC, findings estimate that secondary refrigerators each use an average of about 791 kWh/yr (compared to the average primary refrigerator that uses 760 kWh/yr). On average, 42% of secondary refrigerators are between 15.00 and 18.99 cubic feet and were found to be 4 cubic feet smaller, on average, than primary refrigerators. Approximately 29% of the homes surveyed have a second refrigerator. The majority of secondary refrigerators are of the standard, top-mounted freezer refrigerator type, roughly 68%.

Self Standing Freezers

Over 53% of homes have at least one self-standing freezer for food storage, while only about 4% have a second freezer. Upright freezers constitute the majority of primary freezer types (~59%); chest style freezers make up the rest. Primary freezers were found to be on average about 12.9 cubic feet of storage space.

Over 31% of primary freezers consume between 625 and 824.99 kWh/year, with upright freezers consuming twice as much energy as chest freezers in this range. Currently, 14% of freezers use 35% or less energy than the 2001 federal freezer standards. The overall average age of primary freezers is 14.2 years old.

Water Heaters

Data were gathered on many water heater characteristics, including system type, size, age, efficiency, fuel type, output, and insulation. The following summarizes some of the key findings related to water heating equipment.

Water Heater System type – The most common system types are gas storage systems (~74%) and the second most common system is electric storage (~25). Less than 1% of the market consists of gas or electric instantaneous systems.

Water Heater Efficiency – The average energy factor (EF) for 40 gallon gas water heaters (the most common type) is 0.57. This compares closely to the current federal standard for 40 gallon systems of 0.59. The average EF for electric water heaters is .88, also close to the federal standards of .90. Overall, over 96% of all water heater tanks are not wrapped.

Water Heater Age – The average age of water heaters is 8.6 years old. Electric water heaters are slightly older, on average, than gas water heaters.

Clothes Washers

It is estimated that nearly 98% of all homes have a clothes washer. Washers are most common in single-family unattached dwellings.

Clothes Washer Type – About 5% of all machines are horizontal-axis, 1.3% are stacked, and the remaining 93.6% are of the standard type. The low saturation of horizontal-axis washing machines suggests that these types of machines continue to be unaffordable for the majority of Missouri residents and/or have low market awareness and responsiveness.

Clothes Washer Age – Over 60% of washing machines are less than six years old, while roughly 78% are less than eleven years old. The average washing machine age is 7.5 years old.

Clothes Washer Efficiency – In 2004 federal standards switched from rating clothes washer efficiencies from Energy Factor (EF) units to Modified Energy Factor (MEF)

units. The change was made due to differences in the amount of water extracted from the clothing between different models. The MEF accounts for these differences, which have an impact on the energy consumption of the clothes dryer. The efficiency databases used for this study to determine model efficiency only had MEF for a very limited number of horizontal-axis washing machines, and as such we continue to present efficiency in terms of EF.

For the appliances found in this study, the average EF for standard washing machines is 1.55, nearly 24% higher than federal standards. Horizontal-axis units have an average EF of 5.30. If compared to the same federal standard of standard washing machines, horizontal-axis units would be about 78% higher.

Clothes Dryers

Nearly 97% of homes have a clothes dryer. As one would expect, this saturation estimate closely compares to the saturation of washing machines. Findings indicate that 87.7% are electric, 11.9% are gas, and .4% are propane. The average age of clothes dryers is 8.1 years old. Dryer efficiencies were not summarized since dryer efficiency databases continue to be scarce and incomplete.

Dishwashers

Nearly 76% of homes have a dishwasher. Modular/prefabricated homes all have dishwashers and over 87% of 3-story single-family unattached dwellings have dishwashers.

Dishwasher Age – The average age of dishwashers is estimated to be 6.1 years old. Over 64% of these appliances were less than six years old and less than 2% were built before 1980.

Dishwasher Efficiency – The current average EF for dishwashers is 0.508, which is greater than the current federal energy standard (.46), but less than the minimum ENERGY STAR qualification (0.58), which is set 25% higher than the federal standard.

Cooling Systems

It was found that roughly 98% of all homes have some type of cooling system. The vast majority of cooling systems are central systems, reflecting nearly 92% of all sampled homes surveyed.

Cooling System Type – The data reveal that the most common central cooling system types are split-system air-conditioners. Currently this system type represents nearly 90% of all central cooling systems. Of the remaining 10% central cooling units, 72% of them are made up of split-heat pumps. Packaged system air-conditioners make up less than 2% of central cooling system types.

Cooling System Age – The average age of central air-conditioners is 9.5 years old, while the average age of space air-conditioners is 7.7 years old. When considering all central cooling system types, the findings reveal that roughly 43% are less than six years old, while nearly 35% are more than 16 years old.

Cooling System Size – The most common central air-conditioner size is the 2.50 ton category, over 27%, and the next most common size is the 2.00 ton category, just under 27%. About 74% of all central air-conditioners fall within the 2.00-3.49 ton capacity range.

Cooling System Efficiency – Of the 225 central systems surveyed, 137 units were matched to an efficiency database for determining the SEER. The findings show that roughly 6% of all central units that were matched are SEER 13 or greater. For the majority of units that could be matched for efficiency, roughly 68% fell within the 10-10.99 SEER range, while none of the matched units were found to have a SEER rating less than 10.

Heating Systems

The study results show that nearly 54% of homes have one heating system, about 31% have two systems, and nearly 16% have 3 systems or more. While many homes have secondary systems consisting of separate baseboard systems, fireplaces, furnaces, and portable heaters, the primary system is the most used system in the home. Therefore the analyses are specifically aimed at primary heating systems. The secondary systems are represented here to clarify that heating energy is not exclusive to primary systems.

Primary Heating System Type – The most common heating system type are central system forced air furnaces (87%), followed by electric heat pump units (~4%). Fireplaces, portable heaters, and woodstoves make up less than 1% of the various heating systems.

Primary Heating System Fuel – The primary heating fuel is natural gas (~78%), followed by electric systems (~20%). Less than 1% of primary heating systems are wood fired stoves, and only about 1% are propane.

Primary Heating System Age – Overall, heating systems are about 13 years old. Overall central and space systems are very close in average age, 12.8 and 13.1 respectively.

Primary Heating System Efficiency – The average Annual Fuel Utilization Efficiency (AFUE) for gas central heating systems is 82.1, compared to 61.7 for space systems. Nearly 65% of all central systems fall within the 78-84.99 AFUE range and 100% of all space systems are less than 78 AFUE.

Building Envelope

Vinyl frame windows make up about 47% of all window frame types surveyed. Wood frames follow closely behind making up just over 41% of frames surveyed and metal frames make up only about 11%.

Overall, the most common window type is the wood or vinyl double pane combination, with a saturation of about 62%. The second most common type of window type is single pane wood or vinyl, about 25%. All homes surveyed in this study were most likely to have the wood or vinyl double pane combination.

Overall, 9% of homes are thought to have windows with Low-E coatings. Homes built between 2000 and 2006 have the highest saturation, just over 36%, followed by homes built between 1986 and 1990 (19%). Older homes with Low E are due to window retrofits represented by about 4% of the homes surveyed. New homes are increasingly using Low-E as standard practice.

Limitations

For the most part, all of the data this study looked to collect through the on-site surveys were easily obtained. However, in situations where heating and cooling systems had illegible or non-existent nameplate data and indeterminable capacity criteria, best

estimations were made based upon RLW's extensive experience with a myriad of heating and cooling technologies. Moreover, these situations are more characteristic of older homes, which are more likely to have older less efficient units. Since we can only project SEER for units where nameplate data was collected, this particular limitation is likely biasing the baseline efficiency findings (Table 2 summarizes these findings).

It should be noted that the SEER value was matched into the various efficiency databases based on the model number of the condensing unit. The evaporator coil has an impact on the overall SEER of the system, but gathering information on the evaporator coil involves additional effort on the part of both the surveyor and especially the analyst, as there is no available database that caters to the large scale matching of condenser and evaporator units. However, the databases that were used in the matching process use an average SEER value of common condenser/evaporator combinations, and therefore provide a relatively accurate representation of the efficiency of the cooling systems observed (SEER matching is explained further on page 34 of this report). We made use of recent ARI databases but not ARI's online database, a thorough resource for ascertaining SEER values using both condenser and evaporator units. While this online resource is extensive, the unit matching process used is considerably time consuming as no automated process yet exists to facilitate the objectives of large-scale matching. Because this process was beyond the scope of the work plan and budget we did not conduct such an extensive SEER review, leaving slightly more conservative SEER values.

Water heater blankets are fairly uncommon but when encountered completely covered the nameplate data. Blankets were not completely removed to collect this information, but were slightly moved if they were seen to be easily replaceable.

Wattage was also difficult to collect in many circumstances. Surveyors were trained to remove fixture covers only if easily reachable and removable. Fortunately the surveyors were able to obtain wattages for 90% of all fixtures. For the lighting wattage analysis RLW calculated missing wattages based on other homes with the same fixture type in the same room type. About 3% of all lamps found were 3-way, with many variations on wattage. These fixtures were dropped from the analysis due to the difficulty of assigning a reasonable wattage constant.

Field personnel also reported pool and spa information for pumps and heaters to be difficult to access and difficult to locate nameplate data. Compounded by the low overall saturation of homes with pools, limited information was obtained for these particular data points.

Field surveyors also reported difficulties in obtaining model number information for window/wall air-conditioners. These systems often require removal of face plates, which are often delicate, challenging to remove, and at times even more difficult to replace once removed. Surveyors were asked not to remove or tamper with any equipment if they were not comfortable doing so. Other problematic access issues arose when the nameplate faced into the wall mounting.

RLW also encountered some early transmission issues with the electronic data. These were rectified by additional visits that were scheduled to replace missing data, as well as by over-sampling that was built into the recruitment process.

There are some limitations to the databases used for appliance matching. While RLW staff routinely search for updates and additional data added to the efficiency databases, there is no database that is conducive to large numbers of model number matches while

also containing a comprehensive list of models and efficiency information. For example, field staff were able to obtain 216 of 221 dishwasher model numbers, yet through the matching process RLW was only able to match 16%, or 35 models to databases. Dryer efficiencies were very difficult to match due to the lack of a comprehensive dryer efficiency database. The CEC has recently begun to compile a list of dryer efficiencies for newer models, but only 4% of the 272 dryers that we collected model numbers for were in the database. More detailed findings are presented on the model number matching process in Table 2.

None of the appliance efficiency databases (i.e., CEC, AHAM, ARI) used for efficiency matching account for efficiency degradation over time. Appliance efficiencies are based on the manufacturer test data at the time of manufacture. However, over time appliances and equipment do degrade due to various factors that can affect operational performance. Considering this, the efficiencies of matched appliances, particularly of older appliances, are more than likely less efficient than what has been reported here since no attempt has been made to adjust for efficiency degradation.

Comparisons to Other Sources

RLW performed a comparative analysis of the demographic and household information collected for the statewide residential assessment against the 2004 US Census American Housing Surveys (AHS) for the St. Louis Metropolitan Statistical Area (just released in February 2006), and the AHS for the Kansas City Metropolitan Statistical Area in 2002 (released in 2004). The findings below utilized AHS data available for single-family owner occupied homes in both Metropolitan Statistical Areas (MSAs).

These surveys are conducted by the Bureau of the Census for the Department of Housing and Urban Development (HUD). The American Housing Survey (AHS) collects data on the Nation's housing, including apartments, single-family homes, mobile homes, vacant housing units, household characteristics, income, housing and neighborhood quality, housing costs, equipment and fuels, size of housing unit, and recent movers. National data are collected in odd numbered years, and data for each of 47 selected Metropolitan Areas are collected currently about every six years. The national sample covers an average 55,000 housing units. Each metropolitan area sample covers 4,100 or more housing units. The AHS returns to the same housing units year after year to gather data. Each survey is generally updated every four years.

Since this assessment used a stratified sampling to represent the entire state, a breakout of the data RLW collected into similar metropolitan areas would not be statistically valid. The intent here is to view our statewide household data beside the AHS data for these two MSAs to demonstrate comparative similarities or differences between the AHS results and this statewide assessment. As seen from the tables below, the majority of the survey results generally appear consistent with the 2006 Assessment.

Demographics

Comparative Analysis Table 1 first shows that our sampling of home types closely matched to the percentage of single family unattached versus attached homes found in the surveys:

Type of Residence	Percent of Homes		
	St. Louis (MSA)	Kansas City (MSA)	2006 Assessment
Single Family Unattached	91.6%	93.3%	92.5%
Single Family Attached	3.3%	3.8%	5.9%
Modular/Mobile Home	5.1%	3.0%	1.5%

Comparative Analysis Table 1: Percent of Homes by Residence Type

Next, Comparative Analysis Table 2 shows year ranges. We found that comparisons were generally close across most age ranges, with variances of about 2% to 3%. The only exception was for newer homes of five years or less, where the statewide assessment had a higher percentage. We conjecture that the lower numbers in the

MSAs represent the relatively large amount of older housing stock that would be found in major metropolitan areas.

Percent of Homes Built in Specific Year Ranges				
Year Structure Built	**St. Louis (MSA)**	**Kansas City (MSA)**	**Statewide Assessment Ranges and Characteristics**	
2000 to 2004	6.8%	4.7%	2001-2006	12.2%
1995 to 1999	6.8%	9.2%	1996-2000	7.2%
1990 to 1994	7.3%	8.8%	1991-1995	5.9%
1985 to 1989	8.1%	8.5%	1986-1990	6.1%
1980 to 1984	5.6%	5.2%	1981-1985	3.7%
1975 to 1979	7.1%	8.1%	1976-1980	5.6%
1970 to 1974	6.3%	6.9%	1971-1975	9.3%
1960 to 1969	14.9%	14.2%	1966-1970	5.3%
			1961-1965	8.1%
1950 to 1959	14.6%	13.4%	1956-1960	7.5%
			1951-1955	6.0%
1950 or earlier	22.6%	20.9%	1950 or earlier	20.4%
1940 to 1949	7.2%	6.2%		
1930 to 1939	4.6%	6.2%		
1920 to 1929	4.5%	3.9%		
1919 or earlier	6.3%	4.7%		
			Unknown	2.9%

Comparative Analysis Table 2: Homes Built During Specific Year Periods

The next table illustrates that the income matches we found generally matched the AHS levels in the mid-income ranges. We found lower percentages in low income (below $25,000) and high income (above $100,000) ranges; however, the large number of refusals (nearly 14%) suggests that homeowners from both very low and high income types may have been more sensitive about revealing that information.

Income Ranges per Surveyed Region			
Income Ranges	**St. Louis (MSA)**	**Kansas City (MSA)**	**2006 Assessment**
$25,001-$50,000	28.2%	29.3%	35.1%
$50,001-$100,000	29.4%	31.2%	28.1%
< $25,000	28.2%	24.5%	15.9%
>$100,000	16.0%	14.9%	7.3%
Refused	-	-	13.7%

Comparative Analysis Table 3: Income Ranges per Surveyed Region

Comparative Analysis Table 4 and Comparative Analysis Table 5 show how the American Housing Surveys found more single homeowners in the MSAs than the statewide assessment had, and conversely how the assessment found more households with children than the surveys.

Number of People per Home Overall			
Persons	St. Louis (MSA)	Kansas City (MSA)	2006 Assessment
1 person	29.6%	29.5%	19.2%
2 persons	32.3%	32.6%	42.5%
3 persons	16.0%	15.0%	16.7%
4 persons	14.5%	13.9%	13.9%
5 persons	4.9%	6.3%	5.6%
6 persons	2.0%	1.9%	1.0%
7 persons or more	0.7%	0.8%	1.0%

Comparative Analysis Table 4: Percentage of Number of People per Home

Age Groups per Home Overall				
Census Age Groups (years old)	St. Louis (MSA)	Kansas City (MSA)	Assessment Age Groups (years old)	2006 Assessment
Under 25	4.5%	6.3%	Under 1	1.7%
			2 to 5	7.4%
			6 to 18	15.6%
25 to 29	6.9%	8.2%	19 to 29	12.8%
30 to 34	8.1%	10.5%	30 to 49	24.1
35 to 44	20.5%	22.3%		
45 to 54	23.0%	20.4%	50 to 64	19.6
55 to 64	15.8%	13.2%		
65 to 74	10.7%	9.6%	65 and over	18.8
75 and over	10.5%	9.5%		

Comparative Analysis Table 5: Percentage of People in Age Groups

Equipment and Appliances

The next three tables show that heating system by fuel and systems types, as well as cooling systems, both match closely with the AHS for both Kansas City and St. Louis:

Heating System Fuel Type					
St. Louis (MSA)	%	Kansas City (MSA)	%	2006 Assessment	%
Natural Gas	68.7%	Natural Gas	77.2%	Natural Gas	77.8%
Electricity	24.3%	Electricity	17.7%	Electricity	20.3%
Propane	5.0%	Propane	4.2%	Propane	1.1%
Wood	0.6%	Wood	0.4%	Wood	0.7%
Fuel Oil	0.8%	Fuel Oil	0.1%	Fuel Oil	0.0%
Kerosene or Other Liquid Fuel	0.1%	Kerosene or Other Liquid Fuel	0.1%	Kerosene or Other Liquid Fuel	0.0%
Other	0.4%	Other	0.4%	Other	0.0%

Comparative Analysis Table 6: Primary and Secondary Heating Systems by Fuel Type

Heating Systems by System Type					
St. Louis (MSA)	**%**	**Kansas City (MSA)**	**%**	**2006 Assessment**	**%**
Forced-Air Furnace	91.69%	Forced-Air Furnace	92.61%	Forced Air Furnace	87.80%
Floor, wall, or other built-in hot air-units with out ducts	1.45%	*Floor, wall, or other built-in hot air-units with out ducts*	1.91%	*Floor*	0.77%
Baseboards	1.55%	Baseboards	0.86%	Baseboard	2.60%
Hydronic	3.55%	Hydronic	1.17%	Hydronic System	0.87%
Heat Pump w/ Elec Supp	2.49%	Heat Pump w/ Elec Supp	3.77%	Heat Pump	4.72%
Wall Units	0.26%	Wall Units	0.90%	Wall	2.82%
Room heaters with flue	0.20%	*Room heaters with flue*	0.70%		
Room heaters without flue	0.06%	*Room heaters without flue*	0.20%		
Portable	0.29%	Portable	0.09%	Portable	0.22%
Fireplace	0.05%	Fireplace	0.06%	Fireplace	0.24%
Stove	0.00%	Stove	0.23%	Stove	0.35%
Other	0.12%	Other	0.29%	Other	0.38%

Comparative Analysis Table 7: Percentage of Heating System Types

Cooling System Type per Home Overall			
Cooling System Type	**St. Louis (MSA)**	**Kansas City (MSA)**	**2006 Assessment**
CENTRAL	89.2%	87.8%	89.9%
SPACE	10.8%	12.2%	8.4%
NA			1.7%

Comparative Analysis Table 8: Percentage of Cooling System Types

The statewide assessment found slightly higher percentages of household appliances than either of the MSA surveys. It is possible that the AHS results are lower because of a concentration of lower income households in these metropolitan areas; another contributing factor may be that single family households in urban areas have more access to laundromats, and therefore some owners may forego owning a washer and dryer.

Specific Appliances per Home Overall			
Appliance	**St. Louis (MSA)**	**Kansas City (MSA)**	**2006 Assessment**
Refrigerators	99.3%	99.7%	100.0%
Washing Machines	86.0%	84.2%	97.6%
Clothes Dryer	85.1%	83.9%	96.5%
Dishwashers	62.4%	68.3%	77.0%

Comparative Analysis Table 9: Percentage of Specific Appliances per Home

Introduction

This is an interim draft report for the 2006 Missouri Statewide Residential Lighting and Appliance Efficiency Saturation Study. RLW Analytics, Inc. and its subcontractor MDI conducted the study on behalf of the seven sponsoring utilities, the Utility Collaborative (referred to here after as "the Collaborative"): AmerenUE, Kansas City Power & Light, Aquila, Independence Power & Light, Empire District Electric Company, City Utilities of Springfield, and Columbia Water & Light. In addition to the sponsors, Brenda Wilbers from the Missouri Department of Natural Resources, acted as the project facilitator mediating specific general management tasks between RLW and the utilities.

The final study was designed to provide the Collaborative with baseline information on residential appliance, building, equipment, and lighting saturations and efficiencies. The overarching goals of this assessment were to provide baselines of saturation and efficiency characteristics for use in understanding future energy savings potential in the residential sector. This interim draft report provides the first part of the final study.

The four primary objectives that this study was designed to achieve were:

> **Objective 1:** Complete onsite surveys of approximately 285 single-family homes to build a Missouri baseline inventory and energy use estimate for lighting and appliances in the existing Missouri residential market.
>
> **Objective 2:** Develop a database of residential lighting and appliance saturations and efficiencies.
>
> **Objective 3:** Set up a web-based tool to provide utility staff and other parties the ability to conduct "what-if" scenario analyses on the data collected from the sample of homes.
>
> **Objective 4:** Calculate and present technical, economic, and market potential analyses for energy efficiency opportunities to help target future programs that will have the largest and/or most cost effective impact on peak demand and energy consumption.

Approach

An evenly distributed sample of single-family residential accounts was selected from each utility. Customers were recruited to participate in the study by phone, and each participant was paid $25 for agreeing to allow an onsite surveyor to visit their home to gather the required information. The onsite survey was implemented using IPAQ hand held personal digital assistants (PDA) and a specially designed application for collecting the specified information. This approach provided fast and cost effective on-site data collection. A total of 287 successful on-site surveys were completed between October 2005 and May 2006.

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
- Pool and Spa Equipment (heater and pump)

For lighting, the surveyors collected lamp, fixture and wattage data for each lighting fixture within the home, as well as the front porch fixture(s). The on-site surveyors also collected data on attic, floor and wall insulation R-values, wall construction, and window type. The survey also included a brief set of demographic and socioeconomic questions, in addition to a few questions regarding recent or planned remodeling of the home.

As the data were collected, the surveyors uploaded the site data from the PDA units to RLW's SQL database. The data underwent quality control measures and model numbers were matched to databases of appliance efficiencies. RLW used databases from the previous study, in addition to new data sources, including CEC, ARI, AHAM, and Carrier's 2003 Electronic Blue Book. Once the model numbers were linked, the corresponding efficiency was assigned to the matched appliance. Matching rates varied greatly by appliance type and age. In most cases this was due to the comprehensiveness of the efficiency databases that were available for each appliance.

Table 2 below presents each appliance for which we collected data. The tables contain the following data in the same column order as listed below:

1. Name of appliance,
2. Number of each appliance found during all on-site visits,
3. Number of model numbers found for each appliance,
4. Number of model numbers matched to efficiency database(s),
5. Percentage of matched model numbers among appliances with model numbers,
6. Percentage of model numbers that surveyors were unable to identify on-site,

In the assessment, we recorded the presence of 286 refrigerators. During the on-site surveys, the surveyors were able to locate model numbers for 273 of those refrigerators. Thirteen of the 276 (<5%) refrigerators had either an unreadable or a missing nameplate.

When the data were aggregated at RLW's offices and linked to the refrigerator efficiency databases, 166 of the 273 (61%) refrigerators with model numbers were matched. Another way to look at the match rate is to consider the percentage of the *total* number of refrigerators (286) that were successfully matched (166), which for refrigerators was 61%. This statistic combines the success rate of the matching with the success of the auditors in collecting model numbers. A high match rate among the units with model numbers collected is less meaningful if the auditors were only able to collect data on a handful of units.

Appliance Type	Total Number in Database (A)	Model Numbers Found (B)	Model Numbers Matched (C)	% Model Numbers Matched (C/B)	% Model Numbers Not Found (1-(B/A))	% of Total Matched (C/A)
Primary Refrigerators	286	273	166	61%	5%	58%
Secondary Refrigerators	78	65	29	45%	17%	37%
Cooling Overall	282	244	145	59%	13%	51%
Cooling Packaged	2	2	0	0%	0%	0%
Cooling Split	231	206	137	67%	11%	59%
Cooling Win/Wall	24	12	8	67%	50%	33%
Clothes Dryer	277	272	11	4%	2%	4%
Heat Pump	22	21	11	52%	5%	50%
Heating	287	243	157	65%	15%	55%
Primary Freezer	150	114	56	49%	24%	37%
Dishwasher	221	216	35	16%	2%	16%
Washing Machine	280	246	32	13%	12%	11%
Water Heater	287	272	159	58%	5%	55%

Table 2: 2005 Model Number Match Rates by Appliance

Based upon our experience with similar previous studies, we anticipated in the design stages of the project that the match rates would approximate what are shown in the table above. We knew that matching model numbers to appliance databases would be a long process. One of the problems is that wildcards (*, /, #, etc.) are often included in the model number. The wildcards add to the complexity of the query designs and decrease match rates. The "layered" queries that we built searched several databases for matching model numbers. Once the automated process was complete, a second, manual process of looking up the unmatched appliances was undertaken.

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 matched 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 homes we sampled in Missouri is not documented in publicly or privately available efficiency databases. Furthermore, the private data such as the refrigerator-freezer data that were purchased from AHAM have some gaps and are partial in content.

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, efficiency bins, size bins and capacity bins.

The data and analysis queries developed for this project can be accessed by any user wishing to do so. As a product of this study, RLW developed a web-based analytical tool that gives users the ability to analyze various data. The Missouri Residential Efficiency Saturation Tool (MORES^{EST}) allows users to explore this residential sector data in a myriad of ways that go well beyond what is presented in this "statewide" report. The tool can be accessed at www.moresest.com.

Sample Design

Sampling Plan

Table 3 below documents our sample design used in the study. The table reflects the single-family residential populations that are served by AmerenUE, Kansas City Power & Light, Aquila, Independence Power & Light, Empire District Electric Company, City Utilities of Springfield, and Columbia Water & Light together with the proportional sample size for each of the utilities.

The targeted single-family sample of 285 homes was proportionally allocated by the contribution of each utility to the total number of single-family accounts among the seven utilities. The sample was designed at the regional level in order to achieve an error bound of +/-5% at the 90% level of confidence.

The first step in the sample design was to obtain accurate counts of the single-family accounts in each of the utilities' service territories. RLW received requested counts of accounts by residential rate-class from each utility. Most utilities were able to separate the multi-family residential accounts from the single-family accounts using their rate-class designations. For the three utilities where the single-family population was not isolated from the multi-family population of residential accounts, RLW researched the U.S. Census Bureau for counts of single-family and multi-family homes within the utility's coverage region. From the data RLW was able to ascertain a reasonable proportion of single-family homes to the total number of possible residences (AmerenUE – 74%, Aquila – 68%, and Springfield – 68%). These percentages were then applied to the total number of accounts provided by each utility, ascertaining the size of the single-family population.

For those utilities that provided a breakdown of their single-family population into specific rate-classes, the samples were further stratified to each rate-class, maintaining the same proportional allocation. For those utilities that did not originally segregate the single-family populations from their total population, the derived percentages were applied equally across each of the particular rate-classes (AmerenUE – 74%, Aquila – 68%, and Springfield – 68%).

The sample size for each stratum is given by the following formula:

$$\text{Sample Size} = \left(\frac{\text{Utility Population}}{\text{Total Population Across Utilities}} \right) \times \text{Desired Sample Size}$$

In order to attain a sample that is representative of the single-family population across the region, it was important to maintain proportional allocation across the population and likewise across each rate-class. There were instances where certain rate-class populations were too small to qualify for a sample point. RLW maintains that a sample point be assigned to a rate-class if the rate-class population contains at least 2,700 accounts. A rate-class with 2,700 accounts contributes 0.20% of the accounts to the total number of accounts in the region, and would qualify for 0.6 sample points (0.20% x 285 ≈ 0.60).

In the cases where rate-class populations were below 2,700 accounts, we combined, where possible, similar rate-classes within each utility to reach an appropriate size. The accounts across the smaller rate-classes were summed for each utility and were assigned to the grouped rate-classes a sample in proportion to the total account

contribution of all the grouped rate-classes. This was to ensure that the small classes were still represented in the sample, yet we concede that each rate-class did not receive a sample point using this methodology. This was critical to the project since the smaller rate-classes should not be over-represented in the sample, making for a non-representative regional sample.

At the desire of the participating utilities RLW adjusted the originally proposed sample plan allowing each utility to have at least ten sample-points from their coverage area. This strategy has only a minimal effect on the error bounds in the study and does not compromise proportional representation because each utility is weighted according to the true single-family population amongst the seven utilities. According to this methodology, RLW randomly sampled the total number of sample points (n) from each of the individual utility single-family populations. RLW also randomly sampled the number of sample points allocated to each specific rate-class.

Final Sample

Table 3 shows the final sample. As the table illustrates, five out of seven of the utilities were over-sampled. In most cases the over-sampling resulted from the over-sampling during the recruitment process in order to ensure that the sample size was successfully met if drop-outs or no-shows occurred. Recruitment over-sampling was a consistent 20% across each utility. In the case of the City Utilities of Springfield, while their required target sample-size was only twelve, we successfully completed thirteen sites and were able to add an additional seven sites from a study conducted in Springfield concurrently with the market assessment study. Being that this study is specifically a statewide assessment each additional sample collected only enhances the study overall. By using weights that reflect the required sample, proportionality is conserved. RLW did have data transfer and data usability issues with two utilities (AmerenUE and Kansas City Power & Light). The data was considered insufficient and thereby could not be used for analysis. The data losses were 5% and 10%, respectively. Because RLW had over-sampled in the five remaining utilities and had additional Springfield data available, the accuracy of the analysis was not significantly affected and the total number of sites used for analysis was actually larger than statistically required, with 287/285 sites.

Note that the weight for Columbia Water & Light is quite a bit smaller than the weights for the other six utilities. This reflects the modified sample sizes that were used to ensure that even the smallest single-family populations had a minimum of ten sites included in the study. The Columbia Water & Light population was thereby more heavily sampled than the other utilities. The sampling plan and sample weights allow for each of the utilities to conduct statistically representative analyses for the population of customers at the regional level.

A small amount of error entered into the analysis during the ongoing technical development of the project. To be most efficient RLW organized recruitment data as it was sent from each of the utilities. As the project progressed incoming recruitment data was cleaned and organized while field work for a different coverage area was being conducted. During this process and the initial phone recruitment, RLW discovered that Aquila's customer data was inaccurate and requested new data. Aquila promptly delivered new data, and requested that the Aquila gas customers be removed from the analysis as Aquila was no longer concerned with this stratum. While RLW accommodated this request, the population was not adjusted accordingly. Fortunately this error has a minimal overall effect on the study, with errors of only 14.6% for Aquila's coverage area specifically and only 2.0% statewide.

It is important to emphasize that while this study has assessed the diverse coverage areas across the seven participating utilities, it is a regional study across the combined coverage areas those utilities make up. The data is not necessarily able to be generalized across individual utility populations, and no analysis at that level can be conducted with any reasonable confidence levels. Because the seven participating utilities represent roughly 82% of the total single-family Missouri population, it is fair to refer to this Missouri market assessment as truly a “statewide” assessment.

Utility	Stratum	Single-Family Population	1st Proposed Sample Size	Modified Sample Size	Actual Sample Size	Case Weights
AmerenUE	Gas - combined: a-h		17	16	16	
AmerenUE	*a.) MO Res Gas Service - Natural Gas - Postcard =*					
AmerenUE	*b.) MO Res Gas Service - Pan Eastern - Postcard =*					
AmerenUE	*c.) MO Res Gas Service - Texas Eastern - Postcard =*					
AmerenUE	*d.) MO Res Gas Svc - GP - Aq East - Postcard =*					
AmerenUE	*e.) MO Res Gas Svc - Spc Ht - Aq East - Postcard =*					
AmerenUE	*f.) MO Res Gas Svc - Spc Ht - Nat Gas - Postcard =*					
AmerenUE	*g.) MO Res Gas Svc - Spc Ht - Pan East - Postcard =*					
AmerenUE	*h.) MO Res Gas Svc - Spc Ht - Tex East - Postcard =*					
AmerenUE	Electric - combined: i-l		154	148	140	
AmerenUE	*i.) Rate 1M Res Elect Service - Postcard =*					
AmerenUE	*j.) Rate 1M Res Elect Service TOU - Postcard =*					
AmerenUE	*k.) Rate 1M Res Elect Svc - Space Heat - Postcard =*					
AmerenUE	*l.) Residential Electric TOU Pilot w/CPP =*					
AmerenUE	**SUBTOTAL**	**823,587**	**171**	**164**	**156**	**5279.4**
Aquila - MO Public Svc	Residential General Service [Electric] =					
Aquila - MO Public Svc	Residential Space Heating [Electric] =					
Aquila - MO Public Svc	**SUBTOTAL**	**147,186**	**31**	**30**	**30**	**4906.2**
Aquila - SJLP	Residential w/ Space Heat [Electric] =					
Aquila - SJLP	Residential w/Water Heat [Electric] =					
Aquila - SJLP	a,b,& c combined =					
Aquila - SJLP	*a.) Residential General use [Electric] =*					
Aquila - SJLP	*b.) Residential - Fixed Bill [Electric] =*					
Aquila - SJLP	*c.) Residential - Other Use [Electric] =*					
Aquila - SJLP	**SUBTOTAL**	**42,052**	**9**	**10**	**12**	**3504.3**

Utility (cont)	Stratum (cont)	Single-Family Population (cont)	1st Proposed Sample Size (cont)	Modified Sample Size (cont)	Actual Sample Size (cont)	Case Weights (cont)
Columbia Water & Light	a & b combined gas		4	9	9	
Columbia Water & Light	*a.) R1 - Gas heat*					
Columbia Water & Light	*b.) R2 - gas heat*					
Columbia Water & Light	c,d, & e combined electric		0	1	2	
Columbia Water & Light	*c.) R3 -electric*					
Columbia Water & Light	*d.) R4-electric*					
Columbia Water & Light	*e.) R5- Heat pump*					
Columbia Water & Light	**SUBTOTAL**	**19,524**	**4**	**10**	**11**	**1774.9**
Empire District Electric Co.	Single-Family =		19	18	19	
Empire District Electric Co.	**SUBTOTAL**	**91,861**	**19**	**18**	**19**	**4834.8**
Independence Power & Light	Standard Rate + a,b,c,& d =		7	10	11	
Independence Power & Light	*Standard Rate =*					
Independence Power & Light	*a.) All Electric =*					
Independence Power & Light	*b.) Electric Space Heating & Electric Water Heating =*					
Independence Power & Light	*c.) Electric Space Heating =*					
Independence Power & Light	*d.) Electric Water Heating =*					
Independence Power & Light	**SUBTOTAL**	**35,966**	**7**	**10**	**11**	**3269.6**
Kansas City Power & Light	Single Family Standard Service [RS1A]=		29	28	25	
Kansas City Power & Light	a,b,c,&d combined		3	3	3	
Kansas City Power & Light	*a.) Single Family Standard w/ Space Heating [RS2A] =*					
Kansas City Power & Light	*b.) Single Family Standard w/ Space Heating [RS3A] =*					
Kansas City Power & Light	*c.) Single Family Standard w/ Space Heating [RS6A] =*					
Kansas City Power & Light	*d.) Single Family Water heating and space heating (1 meter) [RW7A] =*					
Kansas City Power & Light	**SUBTOTAL**	**152,105**	**32**	**31**	**28**	**5432.3**
City Utilities of Springfield	Single-Family =		12	12	20	
City Utilities of Springfield	**SUBTOTAL**	**60,255**	**12**	**12**	**20**	**3012.8**
	TOTAL	**1,372,536**	**285**	**285**	**287**	

Table 3: Final Sample Plan – Proposed, Modified, and Implemented Accounts

Figure 1 details the site locations of the statewide sample after all seven utility coverage areas were visited. Each flag represents an address where a house was surveyed.

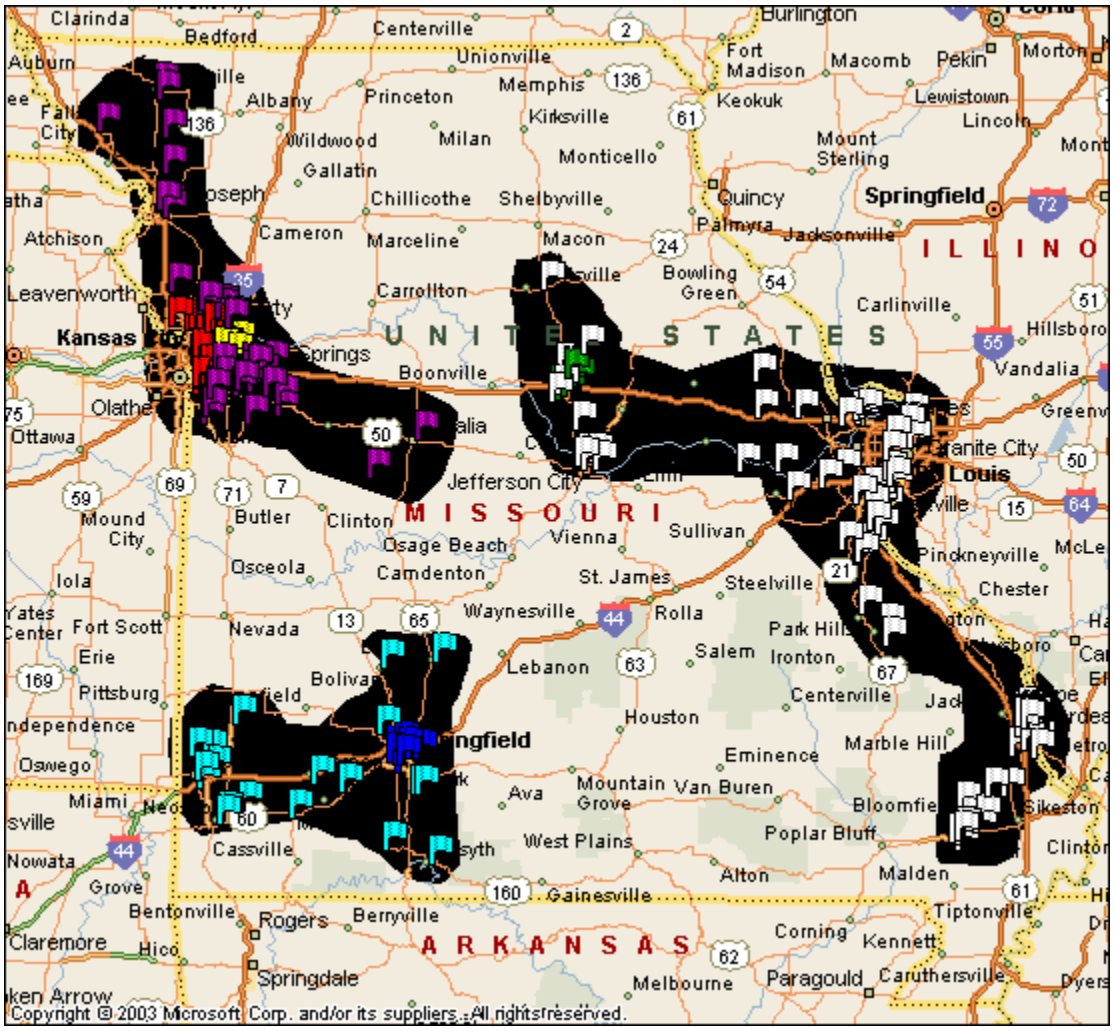

Figure 1: Final Statewide Sample Locations

Data Collection

Overview

The data collection component of the study was resource intensive, taking about eight months to complete. The bulk of the on-site work was completed between February and April; as 192 sites were recruited in AmerenUE's coverage area during this time.

MDI completed the on-site surveys in the territories of AmerenUE and Aquila, and a small portion of Columbia Water & Light. RLW Analytics field staff surveyed sites in Columbia Water & Light, Kansas City Power & Light, Independence Power & Light, and Empire District Electric Co. service territories. Six surveyors overall completed the required on-site surveys.

Each surveyor participated in a one-day training session. The training was focused on demographic, lighting, and appliance data to be collected while in the field. Additionally, the surveyors were trained to use the palm-top computers, data uploading and downloading, and Internet access. One MDI training session was held in the Columbia Water & Light territory.

Recruiting

RLW recruited customers based on their geographic location within each service territory and according to how the seven different service territories were located in Missouri. In general, RLW surveyors primarily conducted audits in the western half of Missouri while MDI primarily conducted audits in the eastern half of Missouri. A $25 incentive was offered to customers that agreed to participate in the study. The recruiters scheduled appointments between the hours of 8AM to 8PM Monday-Friday and occasionally on Saturday. The recruiting manager dispatched the information electronically to the field surveyors at the end of each day. In all, 343 sites were recruited to participate in the study. Table 4 shows the number of sites recruited and surveyed per utility service territory.

Service Territory	Number of Sites Recruited
AmerenUE	192
Kansas City Power & Light	34
Aquila	50
Independence Power & Light	12
Empire District Electric Co.	20
City Utilities of Springfield	21
Columbia Water & Light	14

Table 4: Number of Sites Recruited by Service Territory

Before recruiters contacted them over the phone, each customer selected for the study received a letter from their utility provider. The letter described the purpose of the research and gave them the option to call RLW or their utility provider to voice their

interest or lack of interest in the study. Customer letters were instrumental to the success of the study and absolutely encouraged higher response rates.

Generally speaking, recruiters made up to five attempts to reach the customer by phone. If unsuccessful after the fifth call, the customer was replaced with a back-up customer and the site was designated as 'Unable to Contact'.

When customers missed appointments or refused the on-site, the recruiters attempted to reschedule the audit. Sites were also rescheduled if end-use data was missing for sites believed to be completed. The customers were cooperative in scheduling revisits when this occurred and were rewarded an additional $25 for their assistance.

Table 5 summarizes the disposition codes and final outcomes for customers that the recruiters attempted to contact during the study. It is important to note that the designations in the table are transparent. .For example, if a recruiter was unable to reach a customer after five attempts, those number of attempts were recorded in total as 'Call Back' and not combined with 'Unable to Contact'. Additionally, 'Left Message' and 'Call Back' do not overlap as each case was considered separately.

About 12% of all customers contacted refused to participate in the study, by either calling in directly or through the phone recruitment process. RLW recruiters use this expanded call disposition list from previous market assessment studies with the intent of having a more accurate characterization of the recruitment process.

Itemized Response Rates per Utility														
Call Outcome	AmerenUE		Kansas City Power & Light		Aquila		Independence Power & Light		Empire District Electric Co.		City Utilities of Springfield		Columbia Water & Light	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Scheduled	**192**	**14.9%**	**34**	**12.9%**	**50**	**19.1%**	**12**	**25.5%**	**20**	**25.0%**	**21**	**32.8%**	**14**	**22.2%**
Drop Out/Data Error	*36*	*2.8%*	*6*	*2.3%*	*8*	*3.1%*	*1*	*2.1%*	*1*	*1.3%*	*1*	*1.6%*	*3*	*4.8%*
Pending Customer Call Back/Stratum Filled	19	1.5%	2	0.8%	3	1.1%	1	2.1%	1	1.3%	0	0.0%	0	0.0%
Call Back	397	30.9%	114	43.2%	66	25.2%	9	19.1%	18	22.5%	12	18.8%	2	3.2%
Left Message	271	21.1%	60	22.7%	77	29.4%	0	0.0%	18	22.5%	15	23.4%	14	22.2%
Busy Signal	51	4.0%	0	0.0%	7	2.7%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
No Answer	85	6.6%	8	3.0%	13	5.0%	0	0.0%	9	11.3%	5	7.8%	4	6.3%
Refusal	163	12.7%	30	11.4%	27	10.3%	12	25.5%	9	11.3%	4	6.3%	7	11.1%
Wrong Number	36	2.8%	2	0.8%	8	3.1%	4	8.5%	2	2.5%	1	1.6%	2	3.2%
Disconnected	54	4.2%	13	4.9%	7	2.7%	9	19.1%	4	5.0%	4	6.3%	10	15.9%
Language Barrier	3	0.2%	1	0.4%	3	1.1%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Unable to Contact	6	0.5%	2	0.8%	0	0.0%	1	2.1%	0	0.0%	1	1.6%	10	15.9%
Not Qualified	28	2.2%	0	0.0%	4	1.5%	0	0.0%	0	0.0%	1	1.6%	0	0.0%
TOTAL	**1286**	**100.0%**	**264**	**100.0%**	**262**	**100.0%**	**47**	**100.0%**	**80**	**100.0%**	**64**	**100.0%**	**63**	**100.0%**

**Note: The above response rates are close approximations and not generalizable to the individual utility populations.

Table 5: Recruiting Final Outcome by Service Territory

Out of the 343 sites that were scheduled 287, about 84%, were fulfilled and met the needs of the study. City Utilities of Springfield had the highest final response rate of roughly 33%. Accompanying their high response rates, City Utilities of Springfield had the lowest refusal rates, roughly 6%. The fact that five of the seven utilities were either close to or well exceeding 20% response rates, can most likely be explained by the receptiveness of customers to the letter and that RLW recruiters have had extensive experience with utility sponsored studies.

The greatest percentage of refusals in comparison to total number of calls made came from AmerenUE customers (about 8%). However in comparison to each utility's total number of refused sites and total number sites called within each utility, Independence Power & Light had the greatest percentage of refusals, about 26%. Additionally,

Independence Power & Light had the highest percentage of customers with wrong numbers within a single-family population, approximately 9%. Conversely, Columbia Water & Light had the highest percentage of 'Unable to Contact' designations, with roughly 16%.

Customers from the AmerenUE service areas were the most challenging to recruit as indicated by the high proportion of 'Refusal,' 'Call Backs' and 'Left Message' final outcomes. AmerenUE also had the second lowest success rate of all seven utilities (14.9%). One reason for the difficulty is attributable to the fact that many AmerenUE customers residing in the Cape Girardeau and Dexter regions were not as responsive to participating in the study as relatively compared to the larger Missouri population.

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 the software developed specifically for this project. 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)

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 6 shows the percentage of homes by type of residence. Approximately 63% of all the residences are single family, unattached, 1-story dwellings. The second most commonly visited type of residence was single family, unattached, 2-story dwellings, totaling 26.9% of the sample.

Type of Residence	Percent of Homes
Modular/Prefabricated	1.5%
Single Family-Attached	5.9%
Single Family-Unattached (1 story)	62.5%
Single Family-Unattached (2 story)	26.9%
Single Family-Unattached (3 story)	3.1%

Table 6: Percentage of Homes by Type of Residence

Table 7 shows the percentage of homes by number of people occupying the home. The largest percentage of homes, or 42.3%, has 2 occupants. However, it was also common to visit homes with 1, 3, or 4 occupants. The average number of people per home is 2.5 people.

Total Number of People	Percent of Homes
1	18.7%
2	42.3%
3	16.8%
4	14.3%
5	5.7%
6	1.0%
7	0.8%
9	0.4%

Table 7: Percentage of Homes by Number of People[2]

Table 8 shows the percentage of homes by number of adults occupying the home. Not surprisingly, approximately three-quarters of homes have at least 2 adults present. The average number of adults per home is 2.0.

Total Adults in Home	Percent of Homes
0	0.2%
1	24.8%
2	62.7%
3	8.5%
4	3.4%
6	0.4%

Table 8: Percentage of Homes by Number of Adults

Table 9 shows the percentage of homes by primary language. Not surprisingly, English was the primary language spoken at 99.9% of the homes. The only other primary language found in homes in the sample visited was French.

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

Primary Language	Percent of Homes
English	99.9%
French	0.1%

Table 9: Percentage of Homes by Primary Language

Table 10 shows the percentage of homes by total household income. The largest percentage of residents has an annual income between $25,001 and $50,000, totaling 35.1% of the sample.

Total Household Income	Percent of Homes
$25,001-$50,000	35.1%
$50,001-$75,000	19.7%
$75,001-$100,000	8.3%
< $25,000	15.9%
>$100,000	7.3%
Refused	13.7%

Table 10: Percentage of Homes by Total Household Income

Table 11 shows the percentage of homes by age of home. The age of homes was fairly evenly distributed among the age ranges, with homes built in the 'before 1950' group being more common in the sample.

Home Age Range	Percent of Homes
1950 or Earlier	20.4%
1951-1955	6.0%
1956-1960	7.5%
1961-1965	8.1%
1966-1970	5.3%
1971-1975	9.3%
1976-1980	5.6%
1981-1985	3.7%
1986-1990	6.1%
1991-1995	5.9%
1996-2000	7.2%
2001-2006	12.2%
Unknown	2.9%

Table 11: Percentage of Homes by Age Range of Home

Table 12 shows the percentage of homes by the total heated floorspace of the homes. Approximately, 40% of the homes surveyed were between 1,000 to 1,599 SQFT.

Total Heated Floorspace	Percent of Homes
< 600 sq.ft.	0.8%
1,000 to 1,599 sq.ft.	40.4%
1,600 to 1,999 sq.ft.	20.3%
2,000 to 2,399 sq.ft.	11.0%
2,400 to 2,999 sq.ft.	7.5%
3,000 or more sq.ft.	7.5%
600 to 999 sq.ft.	11.5%

Table 12: Percentage of Homes by Total Heated Floor Space

Table 13 shows the percentage of homes by whether the home was remodeled in the last 10 years. More than half of the homes have not been remodeled.

Remodeled in Last 10 Years	% of Homes
Yes	42.8%
No	57.2%

Table 13: Percentage of Homes that were Remodeled in Last 10 Years

Table 14 shows the percentage of homes by type of remodel among those homes that were remodeled in the last 10 years. 70% of homes were remodeled cosmetically, while 15.7% were completely remodeled. In the table below, “Cosmetic” stands for “Cosmetic/Other” types of remodels.

Type of Remodel	% of Homes
Kitchen Appliance	66.9%
Hardwired Lighting	60.4%
Cosmetic	70.0%
Remodeled All	15.7%

Table 14: Percentage of Homes that were Remodeled by Type of Remodel

Table 15 shows the percentage of residents that plan to remodel in the next 2 years. Nearly three-quarters of the residents replied that they have no plans to remodel within that time frame.

Plan to Remodel in Next 2 Years	% of Homes
Yes	28.4%
No	71.6%

Table 15: Percentage of Residents that Plan to Remodel in Next 2 Years

Table 16 shows the percentage of homes by type of ownership. Nearly 88% of homes were occupied by owners. Renters constituted roughly 12% of the sample.

Rent or Own	Percent of Homes
Own	87.9%
Rent	12.1%

Table 16: Percentage of Homes by Ownership Type

Table 17 shows the percentage of homes that are occupied and have gas or electric by who pays for each fuel type. Only a small fraction of homes have gas paid by someone other than the occupant, 0.4%.

Costs	Renter		Landlord	
	Percentage	EB	Percentage	EB
Electricity	100.0%	0.0%	0.0%	0.0%
Gas	99.6%	0.7%	0.4%	0.7%

Table 17: Who Pays for Electric and Gas Among All Residences

Appliances

Data were collected for heating systems, cooling systems, washing machines, clothes dryers, dishwashers, pools and spas, refrigerator/freezers, self-standing freezers and water heaters. No data were 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 of the appliance whenever possible.
- The classification of each appliance by type was observed from visual inspections of the appliances and recorded. Appliance types that were noted include; standard or horizontal axis washers, side-by-side, freezer on bottom, freezer on top or other refrigerator types, 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 appliances 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, lamp type, and lamp wattage. Fixture control type was also noted for all fixtures in this study.

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, as well as the number of panes found in the predominant window type.

Database

Overview

The data collected during the 287 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 are in MS Access format. In addition to the surveyor information collected on site, the appliance database contains all information linked from the efficiency databases that pertains to the appliance 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 separate tables. 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 performed on the two project databases.

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

- Consolidation of Surveyor Information
- Cleaning of Surveyor Information
- Merge of Weights
- Acquisition of Efficiency Databases to Link with Surveyor Data
- Creation of Efficiency Categories
- Creation of Analysis Queries
- Efficiency Weighting Adjustments for Unmatched Appliances
- 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 Surveyor Information

During the site visit, the surveyors entered all information directly into a palmtop computer as the survey was completed. The hand-held application was designed to automatically download all on-site data to a SQL database that is hosted at RLW's Sonoma, California office. Downloaded data were stored in the SQL database which was structured in the same way as databases in previous saturation studies, allowing RLW to reuse many of the analysis queries that were already developed. As the data were consolidated, an automated Quality Control (QC) process in addition to a manual QC process was performed.

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. The following formula defines the stratum weight to be the ratio of the number of sites in the population in that stratum to the number of sites in the sample in that stratum.

$$w_h = N_h / n_h \text{ , where h is the stratum number}$$

These weights were used to expand the sample to the population. Once the weights were merged, all the lighting data were pasted into a separate database so the databases were more manageable.

Merging of Saturation and Efficiency Information

The surveyors 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). Sources that were used were:

- 2005 California Energy Commission Database of Energy Efficient Appliances,
- 2004 Federal Trade Commission (FTC) databases,
- 2003 AHAM Refrigeration database,
- 2003 Carriers Electronic Blue Book of Heating and Cooling Equipment, and
- 2004 ARI HVAC database.

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 nameplate annual unit energy consumption or UEC.

The difficulty in matching model numbers should not be underestimated by anyone wishing to conduct this type of study in the future. RLW invested a lot of time manually linking sites as a result of model number wildcards 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.

Creation of Efficiency Categories

Efficiency categories from previous saturation studies were altered for each appliance type depending on the distribution of the efficiencies. Size and age categories were also altered 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 incremental periods, starting with 2006-2000, then 1995-1999, and so on until the last category of 1979 and older. The efficiency, size and age categories were linked to the surveyor information using logic statements built into the analysis queries.

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.

Efficiency Weighting Adjustments for Unmatched Appliances

RLW performed a weighting adjustment to the appliance efficiency data in order to remove the upward bias in average efficiencies that resulted from the model number matching. Appliances manufactured more recently were easier to find matches for than older units. Therefore larger amounts of efficiency data were obtained for newer and potentially more efficient appliances. We have good reason to believe that these uneven match rates produced more efficient overall baseline appliance efficiencies than is actually the case.

Due to the low match rates for the older appliances, the older models were under-represented in the average efficiency calculations relative to their representation in the overall appliance stock. The weighting adjustment serves to increase the weight for each of the matched appliances relative to the number of unmatched appliances in each age range. This adjustment will give the older appliances the appropriate amount of influence on the average efficiencies, and ensures that the matched appliances within each age range have the same proportional representation as the total number of appliances within that age range with and without efficiency.

Below are the steps that were taken to calculate the weight adjustments:

1. Count the total number of appliance by age bins for each appliance (**A**)
2. Count the number of matched appliances by age bins for each appliance (**B**)
3. Divide the total number of appliances by the number of matched appliances by age bin (**A/B**)
4. Multiply the appliance weight by the case weight to project the appliance efficiency to the population (upward adjustment of weight to reflect appliances that were unmatched in each age range)

A weighting adjustment was not applied to any matched appliance with unknown age since we could not be certain that they were representative of all the unmatched, unknown age appliances.

Table 18 shows an example of the difference between the percent of cooling units **matched** compared to the **total** (matched and unmatched) percentage of cooling units by age range. Over 14% of the units that were **matched** were between 0 and 5 years old, while only about 13% of **all** cooling units were in this age range.

Without adjusting the case weights to reflect the match rates by age, the efficiency information would be more heavily influenced by the newer and more efficient cooling systems.

Age	Total Number of Units (A)	Number of Matched Units (B)	Weight Adjustment (A/B)	Age Distribution of All Units (n= 287)	Age Distribution of Matched Units (n= 236)
2001 - 2006	36	34	1.06	12.5%	14.4%
1996 - 2000	23	23	1.00	8.0%	9.7%
1991 - 1995	17	14	1.21	5.9%	5.9%
1986 - 1990	18	15	1.20	6.3%	6.4%
1981 - 1985	11	8	1.38	3.8%	3.4%
1980 and older	174	135	1.29	60.6%	57.2%
Unknown	8	7	1.00	2.8%	3.0%
Total	**287**	**236**	**-**	**100%**	**100%**

Table 18: Percentage of Matched Cooling Systems and All Cooling Systems by Estimated or Manufacturer Reported Date

The weight adjustment factors are shown in the table above in the column labeled 'Weight Adjustment' which is calculated as the total number of units divided by the total matched units in the same age range. This weight equates to the number of unmatched appliances in each age range that each matched appliance represents. Once these weight adjustment factors are calculated, they are multiplied by the case weights of each of the matched appliances in the corresponding age group.

The existing case weights that are used for the majority of the saturation calculations were determined by the original sample design. Each site in a rate class is assigned a case weight that represents the number of accounts that the sample point represents in the population. Another way to think about the case weight is at the appliance level. If a site has a cooling unit, the cooling unit represents the same number of cooling units in the population that the site represents.

By multiplying the case weight by the weight adjustment factor for the efficiency calculations, the matched appliance is representing the total number of appliances that it represents in the population *and* representing the unmatched units that were previously being dropped from the analysis.

For example, consider a site with a case weight of 1,000 that has a cooling unit manufactured in 2002 that was successfully matched to an efficiency database (making up one of the 34 units in Column B). This site's new weight would be calculated as follows:

1. *Weight Adjustment Factor = Total Number of Units / Number of Matched Units*

   (36 / 34 = 1.06: This matched appliance represents 1.06 unmatched appliances between 0 and 5 years old)

Next the adjustment factor is applied to the case weight

2. *New case weight = Original Case Weight * Adjustment Factor*

   *(1,000 * 1.06 = 1,060: This appliance now represents 1,060 cooling units in the population)*

Alternatively, a site with a case weight of 1,000 with a cooling unit manufactured in 1982 that was successfully matched to an efficiency database (making up one of the 8 units in Column B) has a very different new case weight:

3. *Weight Adjustment Factor = Total Number of Units / Number of Matched Units*

(11 / 8 = 1.38: This matched appliance represents 1.38 unmatched appliances between 20 and 25 years old)

4. *New case weight = Original Case Weight * Adjustment Factor*

   *(1,000 * 1.38 = 1,380: This appliance now represents 1,380 cooling units in the population)*

As shown, appliances in the age groups that were matched with less frequency were applied to larger adjustment factors to represent the larger quantities of unmatched units for the average efficiency calculations.

Development of Database Summarization Tool (MORES^{EST})

The project was designed to deliver a tool that can be used by program designers, managers, evaluators, and other parties for understanding efficiency and saturation characteristics of Missouri residences. This task was performed in conjunction with the data collection tasks. The collected data were organized by a web-based application developed by the Benningfield Group that allows multiple users to apply stratified ratio estimation methods to the study data. 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 program 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 from the assessment, allowing other parties the ability to produce their own "what-if" trend analyses. The resulting tables can be easily exported to Excel and displayed graphically. 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

- CEC Climate Zone
- 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

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.

MORES^{EST} *Interface*

Given the immense amount of data collected on-site, the endless number of ways to slice-and-dice the data, and the wide variation in needs of program managers and designers, a web based application was developed to give access to the data to any number of potential users. By providing a web-based analysis tool, users have the power to explore the information based on specific needs. This section discusses the technical specifications of MORES^{EST}, the Missouri Residential Efficiency Saturation Tool, located at www.moresest.com. Once on the site users can gain access to the full reports and user help screens for understanding how to use MORES^{EST} .

MORES^{EST} was developed using Macromedia ColdFusion MX, a tag-based server-scripting language for rapid web development, for the user interface and Microsoft Access and SQL for the database storage/engine. Users are required to register, for free, in order to access the tool. Registration is an automated process whereby once the user provides their pertinent contact information and valid email address, ColdFusion generates a unique 8 character password and automatically sends it to the user via email.

MORES^{EST} is a direct port of RLW's MBSS software application. Originally developed in Fortran, MBSS was later reprogrammed in Microsoft Visual Basic in order to support a 32 Bit operating system environment. For the web based tool, all the proprietary algorithms, code, and queries were rewritten in CFScript (ColdFusions server-side implementation of Java style classes). This allows the tool to not only process requests more efficiently, but to also be scalable across multiple servers and OS's (Windows, Linux, Unix, etc.) if load balancing, increased bandwidth, and/or increased demand are desired.

MOResEst.com resides on a standalone hardened Dell Enterprise class server, with a Microsoft Server 2003 SP1 operating system (OS). The server's OS, applications, and data reside on redundant hard drives configured in a RAID (Redundant Array of Independent Disks*)* 10 array. The server has dual Intel Xeon 2.8 GHz CPU's, with 4GB's of RAM (Random Access Memory). In addition, the server has dual redundant power supply units which are connected to an enterprise class UPS (uninterruptible power supply) unit. These all reside in Sonoma, California in a physically secured server room. Internet access is provided via a full T-1 line, with a Service Level Agreement of 99.99% uptime guarantee. In the event there is a service outage, a separate business class broadband connection will automatically act as a failover, as well as provide some load balancing.

The web pages are being served via Microsoft IIS (Internet Information Services) 6.0. The ColdFusion server-side engine resides on the same machine and is tuned for optimum performance. Website Security is provided in several ways. First, a kernel level Intrusion Detection System disables the ability to have the server become compromised via "buffer overflow" style attacks. Last, the server resides behind a Firewall appliance providing SPI packet inspection that detects and blocks DoS (Denial of Service) and other malicious attacks.

Because there are costs associated with hosting a website, and especially an interactive software application, RLW and the Collaborative agreed that a "sunset period" would be most appropriate. The sunset period will be one year from the delivery of the final report, at which time the website and tool for the assessment will no longer be accessible. The Collaborative indicated that any analysis that they would like to conduct independently while using the web-tool would be completed before the sunset period was met. The Collaborative understands that for the website and tool to remain active beyond a year and/or for specific web-tool query update requests to be fulfilled, RLW will require a set fee to accommodate server space, software processing speed, staff time, and additional items associated with hosting the website and tool. RLW is able to meet such requests if members of the Collaborative choose that option.

Lighting

This section of this chapter presents findings from the lighting analysis. Recall that every lighting fixture in each residence was inventoried by fixture type, fixture control type, number of lamps, lamp type, and lamp wattage. A total of 287 residences are included in the lighting analysis. This chapter of the report is broken up into the following three subsections that present the analyses shown below:

- Lighting Overview (by home)
    - number of fixtures and lamps per home,
    - average number of lamps per fixture,
    - percentage of homes having a certain fixture or lamp type[3],
    - prevalence of compact fluorescent lamps,
    - lamp wattage, and
    - fixture control types
- Specific Fixture Overviews (by home)
    - summary of recessed cans, torchieres, and ceiling fans
    - these fixtures were selected for further analysis because efficient lighting technologies are currently being developed for these fixture types
- Room Lighting Analysis (by room)
    - percentage of rooms with fixture types and lamp types

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

Lighting Overview

Table 19 presents the average number of fixtures and lamps per home by type of residence. Overall, homes have approximately 37 fixtures and 59 lamps on average.

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

Type of Residence	Fixtures		Lamps		
	Average #	Error Bounds	Average #	Error Bounds	Sample Size
Overall	36.72	2.38	59.24	3.78	287
Modular/Prefabricated	30.09	5.81	55.23	18.28	4
Single Family Attached	17.30	3.07	27.32	4.85	16
Single Family Unattached (1 story)	34.80	2.38	55.50	3.73	182
Single Family Unattached (2 stories)	44.62	6.19	73.12	9.86	77
Single Family Unattached (3 or more stories)	46.82	14.70	76.46	19.74	8

Table 19: Average Number of Fixtures/Lamps by Type of Residence

Table 20 displays the average number of fixtures per home by fixture type. **The most common fixture types are ceiling mount and recessed cans, with homes having an average of 6.1 recessed cans.** Additionally, homes have on average, 5.3 wall mount fixtures and 4.4 table lamps. Table 20 also tells us that each home averages over three ceiling fans with lights.

Fixture Type	Average # of Fixtures (n=287)	Error Bounds
All Fixture Types	**36.72**	**2.38**
Architectually Integrated	0.21	0.10
Ceiling Fan	3.14	0.22
Ceiling Fixtures	12.80	0.77
Chandelier Hanging	1.45	0.21
Floor Lamp	0.69	0.11
Garage Door Opener	0.62	0.08
Recessed Can	6.14	1.17
Other Recessed	0.65	0.24
Table Lamps	4.42	0.37
Torchiere Fixtures	0.42	0.11
Track Lighting	0.17	0.06
Under Counter	0.76	0.18
Wall Mount	5.25	0.39

Table 20: Average Number of Fixtures by Fixture Type

Table 21 presents the percentage of all fixtures that are of a certain type. Nearly 35% of all fixtures are ceiling mounts, while over 16% are recessed cans. Additionally, wall mounted fixtures and table lamps represent 14.3% and 12.0% of the number of fixtures, respectively.

Fixture Type	Percent of Total Fixtures (n=287)	Error Bounds
All Fixture Types	**100%**	0.0%
Archit Integrated	0.6%	0.3%
Ceiling Fan	8.5%	0.7%
Ceiling Fixtures	34.9%	1.7%
Chandelier Hanging	3.9%	0.5%
Floor Lamp	1.9%	0.3%
Garage Door Opener	1.7%	0.2%
Recessed Can	16.7%	2.4%
Recessed Lighting Other	1.8%	0.6%
Table Lamps	12.0%	0.9%
Torchiere	1.1%	0.3%
Track Lighting	0.5%	0.2%
Under Counter	2.1%	0.4%
Wall Mount	14.3%	0.7%

Table 21: Percentage Fixture Types

Table 22 displays the percentage of homes having each fixture type. Approximately 86% of homes have a ceiling fan, 52% have recessed cans, and 94% have wall mount fixtures. One-hundred percent of all homes are equipped with a ceiling mounted fixture, while over 88% of homes have a table lamp.

Fixture Type	Percent of Home (n=287)	Error Bounds
Archit Integrated	7.0%	2.5%
Ceiling Fan	86.0%	3.4%
Chandelier Hanging	61.5%	4.8%
Ceiling Fixture	100.0%	0.0%
Floor Lamp	41.3%	4.9%
Garage	45.1%	4.9%
Recessed Can	51.7%	4.9%
Other Recessed	20.5%	4.0%
Table Lamp	88.3%	3.2%
Torchiere	23.1%	4.2%
Track	10.0%	3.0%
Under Counter	32.4%	4.6%
Wall Mount	93.7%	2.4%

Table 22: Percentage of Homes with Fixture Types

Table 23 shows the distribution of the number of fixtures per home. Nearly 30% of homes have a total of 21 to 30 fixtures. Approximately 20.6% of homes have more than 50 fixtures present.

Number of Fixtures	Percent of Home (n=287)	Error Bounds
1 - 10	3.3%	1.8%
11 - 20	20.4%	4.0%
21 - 30	27.0%	4.4%
31 - 40	17.6%	3.8%
41 - 50	11.1%	3.1%
> 50	20.6%	4.0%

Table 23: Distribution of Number of Fixtures per Home

Table 24 presents the distribution of the number of fixtures per home by residence type. As might be expected, homes with multiple stories and therefore greater square footage have more fixtures per home than smaller homes. Interestingly enough 25% of modular/prefabricated homes have between 41-50 fixtures.

Type of Residence	1 - 10 Fixtures		11 - 20 Fixtures		21 - 30 Fixtures		31 - 40 Fixtures		41 - 50 Fixtures		> 50 Fixtures		Sample Size
	% of Home	Error Bound	% of Home	Error Bound	% of Home	Error Bound	% of Home	Error Bound	% of Home	Error Bound	% of Home	Error Bound	
Overall	3.3%	1.8%	20.4%	4.0%	27.0%	4.4%	17.6%	3.8%	11.1%	3.1%	20.6%	4.0%	287
Modular/Prefabricated	-	-	-	-	49.1%	41.1%	25.4%	36.0%	25.4%	36.0%	-	-	4
Single Family Attached	19.7%	16.7%	43.7%	20.6%	36.6%	19.9%	-	-	-	-	-	-	16
Single Family Unattached (1 story)	3.3%	2.2%	20.2%	5.0%	26.4%	5.5%	18.7%	4.9%	12.6%	4.1%	18.7%	4.9%	182
Single Family Unattached (2 stories)	-	-	19.2%	7.7%	23.8%	8.1%	18.9%	7.4%	9.2%	5.5%	28.8%	8.6%	77
Single Family Unattached (3 or more stories)	-	-	-	-	37.8%	28.2%	12.6%	19.3%	12.2%	18.9%	37.4%	28.1%	8

Table 24: Distribution of Number of Fixtures per Home by Residence Type

Table 25 displays the percentage of fixtures containing a compact fluorescent lamp by fixture type. **Only about 5% of fixtures contain a compact fluorescent lamp.** Ceiling mounted fixtures are most likely to contain a compact fluorescent lamp, with nearly 46% of all fixtures having such a lamp. Second to ceiling mounts, 14.7% of floor lamps contain compact fluorescents. With persistence in mind, RLW's analysis also demonstrates that only **.6%** of all CFLs are dedicated for pin-based fixtures.

Fixture Type	Percent of Fixtures with CFLs	Error Bound	Sample Size (# of Homes)
Overall	5.4%	1.2%	287
Architectually Integrated	6.8%	10.8%	20
Ceiling Fan	3.2%	1.2%	247
Chandelier Hanging	0.3%	0.2%	287
Ceiling Fixtures	45.8%	11.7%	204
Floor Lamp	14.7%	5.4%	120
Garage Door Opener	1.1%	1.3%	133
Recessed Can	5.6%	4.4%	149
Recessed Lighting-Other	5.9%	7.3%	62
Table Lamps	9.4%	2.3%	254
Torchiere	9.9%	8.0%	67
Track Lighting	0.8%	1.3%	29
Under Counter	4.1%	2.7%	93
Wall Mounted	3.3%	1.1%	269

Table 25: Fixtures Containing Compact Fluorescent Lamps

Table 26 shows the average number of lamps per fixture. Chandeliers/Hanging fixtures contain more lamps (3.59 lamps) than any other fixture type. Ceiling fans contain 2.85 lamps on average. Recessed cans/other, table lamps, torchieres, garage door openers, and under counter fixtures 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
Architecturally Integrated	1.28	0.24	20
Ceiling Fan	2.85	0.11	247
Ceiling Mounted	1.51	0.04	287
Chandelier Hanging	3.59	0.24	180
Floor Lamp	1.51	0.12	120
Garage Door Opener	1.31	0.07	133
Recessed Can	1.03	0.02	149
Recessed Lighting-Other	1.21	0.10	62
Table Lamps	1.07	0.02	254
Torchiere	1.33	0.21	67
Track Lighting	2.73	0.30	29
Under Counter	1.18	0.11	93
Wall Mount	1.88	0.07	269

Table 26: Average Number of Lamps per Fixture

Lamp Type	Average # of Lamps (n= 287)
All Lamp Types	59.24
Compact Flourescent Total	2.76
Fluorescent Total	5.97
Halogen Total	1.38
Incandescent Total	49.07
High Intensity Discharge	0.06

Table 27: Average Number of Lamps by Lamp Type

Table 28 shows the percentage of all lamps by general lamp type. Almost 83% of all lamps are incandescent lamps, while less than 0.1% are high intensity discharge.

Lamp Type	Percent of Total Lamps (n=287)
Compact Flourescent Total	4.6%
Fluorescent Total	10.1%
Halogen Total	2.3%
Incandescent Total	82.7%
High Intensity Discharge	< 0.1%

Table 28: Percentage Lamp Types

Table 29 shows the percentage of homes where a particular lamp type is present. All homes are equipped with at least one incandescent lamp, while nearly 42% have at least one fluorescent (non T-8) lamp. Nearly 26% of all homes contain at least one type of compact fluorescent lamp. Only 13.5% of homes have halogen lamps present.

Lamp Type	Percent of Homes (n=287)	Error Bound
Compact Fluorescent	25.7%	4.3%
Fluorescent	41.9%	4.9%
Halogen	13.5%	3.4%
Incandescent	100.0%	0.0%

Table 29: Percentages of Homes with Lamp Types

Table 30 displays the distribution of the number of lamps per home. Nearly 50% of homes have more than 50 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	Percent of Home (n=287)	Error Bounds
1 - 10	0.6%	0.7%
11 - 20	7.2%	2.6%
21 - 30	12.7%	3.3%
31 - 40	16.0%	3.6%
41 - 50	14.8%	3.5%
> 50	48.7%	4.9%

Table 30: Distribution of Number of Lamps per Home

Table 31 presents the distribution of the number of lamps per home by residence type. As might be expected, as the living space square footage increases so do the number of recorded lamps. Single family, unattached residences contain significantly more lamps than single family attached homes.

Type of Residence	1 - 10 Lamps		11 - 20 Lamps		21 - 30 Lamps		31 - 40 Lamps		41 - 50 Lamps		> 50 Lamps		Sample Size
	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB	
Overall	0.6%	0.7%	7.2%	2.6%	12.7%	3.3%	16.0%	3.6%	14.8%	3.5%	48.7%	4.9%	287
Modular/Prefab	-	-	-	-	-	-	-	-	74.6%	36.0%	25.4%	36.0%	4
SFam-Attached	6.7%	10.6%	26.2%	18.4%	30.5%	19.0%	16.9%	15.0%	19.7%	16.7%	-	-	16
SFam-UN-1s	0.4%	0.6%	8.2%	3.5%	12.5%	4.1%	17.1%	4.7%	12.7%	4.1%	49.0%	6.2%	182
SFam-UN-2s	-	-	1.9%	2.5%	11.5%	6.3%	14.4%	6.9%	15.2%	7.0%	57.0%	9.5%	77
SFam-UN-3s+	-	-	-	-	-	-	12.6%	19.3%	12.6%	19.3%	74.8%	25.3%	8

Table 31: Distribution of Number of Lamps per Home by Residence Type

Specific Fixture Overviews

This section presents in-depth overviews for recessed cans, ceiling fans, and torchieres. These fixture types were selected for further 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.

Recessed Cans

One interesting find in the assessment is that approximately 87% of the homes audited have no recessed cans. Recessed cans account for approximately 17% of all fixtures, and on average, about 6% of all recessed cans contain a compact fluorescent lamp.

Number of Recessed Cans	Percentage of Homes (n= 3695)	Error Bound
0	86.6%	0.9%
1 to 4	9.9%	0.8%
5 to 7	2.1%	0.4%
8 to 10	0.7%	0.2%
11 to 20	0.4%	0.2%
>21	0.1%	0.1%

Table 32: Number of Recessed Cans per Home

Room	Percentage of Homes	Error Bound	Sample Size
Basement	6.1%	3.2%	151
Bathroom	22.0%	4.2%	273
Bathroom - Master	33.5%	6.0%	175
Bedroom	5.9%	2.5%	266
Bedroom - Master	8.9%	3.1%	232
Breakfast Nook	7.5%	5.8%	57
Closet	6.8%	3.1%	185
Dining Room	6.0%	3.0%	174
Family Room	24.5%	5.3%	181
Garage	1.7%	1.6%	172
Hall	19.3%	4.1%	248
Kitchen	36.4%	4.8%	284
Laundry Room	4.6%	2.4%	202
Living Room	13.1%	4.2%	181
Office	5.2%	3.4%	116
Other	3.7%	3.2%	97
Porch	8.5%	3.0%	239
Recreation Room	43.5%	12.5%	45

Table 33: Percentage of Homes with Recessed Cans by Room Type

Age of Home	Percentage of Homes	Error Bound	Sample Size
1950 or Earlier	7.4%	3.9%	58
1951-1955	6.4%	4.4%	16
1956-1960	8.4%	3.8%	21
1961-1965	7.2%	5.0%	21
1966-1970	11.4%	7.3%	14
1971-1975	8.0%	4.2%	26
1976-1980	12.6%	8.5%	16
1981-1985	9.0%	6.9%	11
1986-1990	18.3%	8.4%	18
1991-1995	21.0%	7.2%	17
1996-2000	25.1%	8.2%	23
2001-2006	34.6%	5.1%	36
Unknown	11.5%	11.5%	8

Table 34: Percentage of Homes with Recessed Cans by Age of Home

Table 35 presents the average number of recessed cans per home by age of home. Homes built in 2001 or later contain significantly more recessed cans on average than do homes built prior to 2001, suggesting a trend in residential new construction towards an increased number of recessed cans.

Age of Home	Number of Recessed Cans	Error Bound	Sample Size
1950 or Earlier	2.04	1.30	58
1951-1955	1.81	1.29	16
1956-1960	2.92	1.43	21
1961-1965	2.14	1.54	21
1966-1970	3.51	2.59	14
1971-1975	2.78	1.80	26
1976-1980	4.61	3.66	16
1981-1985	3.12	2.40	11
1986-1990	7.77	4.22	18
1991-1995	9.27	4.70	17
1996-2000	11.38	5.28	23
2001-2006	20.64	5.81	36
Unknown	2.37	2.83	8

Table 35: Number of Recessed Cans per Home by Age of Home

Ceiling Fans

Data were only collected and analyzed for ceiling fans that are designed to contain lamps. Only 21.5% of fans contain at least one lamp, while 77.1% of fans have no lamps. Ceiling fans account for approximately 8.5% of all fixtures, and on average, homes contain 3.14 ceiling fans. About 3% of all ceiling fans contain a compact fluorescent lamp.

Number of Lamps	Percent of Fans (n= 3695 Homes)	Error Bound
0	77.1%	1.2%
1	21.5%	1.1%
2	1.3%	0.3%
3	0.1%	0.1%

Table 36: Number of Ceiling Fans per Home

Room	Percentages of Homes	Error Bound	Sample Size
Whole House	23.0%	1.2%	3278
Basement	2.1%	2.0%	151
Bathroom	0.0%	0.0%	273
Bathroom - Master	0.0%	0.0%	175
Bedroom	58.3%	5.1%	266
Bedroom - Master	71.6%	5.0%	232
Breakfast Nook	27.1%	10.0%	57
Closet	0.6%	1.0%	185
Dining Room	26.2%	5.6%	174
Family Room	53.2%	6.2%	181
Garage	1.5%	1.6%	172
Hall	1.8%	1.4%	248
Kitchen	28.1%	4.5%	284
Laundry Room	3.2%	2.1%	202
Living Room	38.5%	6.1%	181
Office	36.5%	7.5%	116
Other	23.9%	7.4%	97
Porch	10.4%	3.3%	239
Recreation Room	33.4%	12.0%	45

Table 37: Percentage of Homes with Ceiling Fans by Room Type

Table 38 displays the percentage of ceiling fans equipped with each lamp type. Over four-fifths of the ceiling fans surveyed have standard incandescent lamps installed, and another 12% of ceiling fans are equipped with incandescent decorative bulbs. Compact fluorescent lamps were found in only 3.2% of fans equipped with lamps.

Lamp Type	Percent of Ceiling Fans (n= 247)	Error Bound
Compact Fluorescent Circline	0.1%	0.2%
Compact Fluorescent Decorative	0.1%	0.2%
Compact Fluorescent Spring	3.0%	1.2%
Compact Fluorescent Total	**3.2%**	
Fluorescent Circline	0.1%	0.2%
Fluorescent Total	**0.1%**	
Halogen Parabolic Reflector	0.1%	0.2%
Halogen Total	**0.1%**	
Incandescent Decorative	12.2%	2.7%
Incandescent Globe	0.3%	0.3%
Incandescent Mini	0.5%	0.6%
Incandescent Reflector	0.1%	0.2%
Incandescent Standard	83.1%	3.0%
Incandescent Unknown	0.2%	0.2%
Incandescent Total	**96.4%**	

Table 38: Ceiling Fan Lamp Types

Torchieres

Only about 2% of homes have at least one torchiere. Torchieres account for approximately 1.1% of all fixtures, with an average of 0.42 torchieres per home. About 10% of all torchieres contain a compact fluorescent lamp.

Number of Torchieres	Percent of Homes (n= 3695)	Error Bound
0	97.77%	0.41%
1	1.68%	0.35%
2	0.37%	0.17%
3	0.06%	0.07%
4	0.03%	0.05%
5+	0.09%	0.09%

Table 39: Number of Torchieres per Home

Room	Percent of Homes	Error Bound	Sample Size
Whole House	2.5%	0.5%	3278
Basement	0.0%	0.0%	151
Bathroom	0.0%	0.0%	273
Bathroom - Master	0.0%	0.0%	175
Bedroom	1.5%	1.2%	266
Bedroom - Master	1.7%	1.4%	232
Breakfast Nook	1.2%	1.9%	57
Closet	0.0%	0.0%	185
Dining Room	0.6%	1.0%	174
Family Room	6.7%	3.0%	181
Garage	0.0%	0.0%	172
Hall	0.0%	0.0%	248
Kitchen	0.4%	0.6%	284
Laundry Room	0.0%	0.0%	202
Living Room	11.7%	4.0%	181
Office	6.0%	3.7%	116
Other	5.0%	3.7%	97
Porch	9.6%	3.3%	239
Recreation Room	8.9%	7.1%	45

Table 40: Percentage of Homes with Torchieres by Room Type

Table 41 displays the percentage of torchieres equipped with each lamp type. More than half of torchieres have incandescent lamps installed, and another 24% of torchieres are equipped with halogen tube lamps.

Lamp Type	Percent of Torchieres (n=67)	Error Bound
Compact Fluorescent Spring	8.1%	7.8%
Compact Fluorescent Tubular	0.9%	1.5%
Compact Fluorescent Pin Base	0.9%	1.5%
Fluorescent Other	1.2%	1.4%
Compact Fluorescent Total	**11.1%**	
Halogen Tube	19.1%	7.4%
Halogen Unknown	4.7%	5.6%
Halogen Total	**23.8%**	
Incandescent Decorative	6.1%	6.0%
Incandescent Standard	58.6%	10.2%
Incandescent Other	0.3%	0.5%
Incandescent Total	**65.1%**	

Table 41: 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.

Kitchen

Table 42 presents the percentage of homes with a given fixture type and lamp type in the kitchen along with the associated error bound. The most predominant fixture and lamp type combinations are ceiling mounted fixtures, recessed cans, and ceiling fans all with incandescent lamps.

Fixture Type	Lamp Type													
	Overall		CFL		Fluorescent T8		Fluorescent T12		Other Tube Fluorescent		Halogen		Incandescent	
(n= 284)	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB
Overall	-	-	16.0%	3.7%	6.6%	2.5%	21.9%	4.1%	7.6%	2.6%	7.5%	2.6%	87.8%	3.3%
Architectually Integrated	1.1%	1.1%	-	-	0.4%	0.6%	0.4%	0.6%	-	-	-	-	0.4%	0.6%
Ceiling Fan	28.1%	4.5%	1.6%	1.3%	-	-	-	-	-	-	-	-	26.6%	4.4%
Ceiling Fixture	65.3%	3.3%	8.7%	2.9%	2.0%	1.4%	14.0%	3.5%	3.0%	1.7%	0.8%	0.9%	45.5%	5.0%
Chandelier Hanging	12.8%	4.7%	1.0%	1.0%	-	-	-	-	-	-	0.4%	0.6%	11.8%	3.2%
Recessed Can	36.4%	4.8%	3.8%	1.9%	-	-	-	-	-	-	0.7%	0.8%	33.2%	4.7%
Recessed Lighting Other	4.2%	2.0%	0.4%	0.7%	-	-	1.5%	1.1%	-	-	-	-	2.5%	1.6%
Table Lamp	0.6%	0.7%	-	-	-	-	0.4%	0.6%	-	-	0.4%	0.6%	0.6%	0.7%
Tochiere	0.4%	0.6%	-	-	-	-	-	-	-	-	-	-	0.4%	0.6%
Track Lighting	4.2%	2.0%	-	-	-	-	-	-	-	-	0.6%	0.7%	3.6%	1.8%
Wall Mount	7.0%	2.5%	0.4%	0.6%	-	-	0.6%	0.7%	0.4%	0.6%	0.4%	0.6%	5.3%	2.2%

Table 42: Percentage of Homes with Fixture Type and Lamp Type in Kitchen

Bedrooms

Table 43 and Table 44 present the percentage of homes with a given fixture type and lamp type in the bedrooms, as well as the error bounds associated with these estimates. The most predominant fixture and lamp type combinations are ceiling fans, table lamps, and ceiling mounted fixtures with incandescent lamps. This analysis applies across both master and secondary bedrooms surveyed, except that secondary bedrooms have a higher percentage of ceiling mounted fixtures and lower percentage of ceiling fans overall.

Fixture Type	Lamp Type									
	Overall		Compact Fluorescent		Fluorescent T12		Halogen		Incandescent	
(n=232)	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB
Overall	-	-	9.8%	3.2%	0.5%	0.8%	2.2%	1.6%	98.2%	1.5%
Architectually Integrated	0.9%	1.1%	-	-	-	-	-	-	0.9%	1.1%
Ceiling Fan	71.6%	5.0%	1.1%	1.1%	-	-	-	-	70.6%	5.0%
Ceiling Fixtures	19.4%	4.4%	1.9%	1.5%	-	-	-	-	18.0%	4.2%
Chandelier Hanging	3.2%	2.0%	-	-	-	-	-	-	3.2%	2.0%
Floor Lamp	7.7%	2.8%	1.2%	1.2%	-	-	0.5%	0.8%	6.4%	2.6%
Recessed Can	8.9%	3.1%	0.4%	0.7%	-	-	-	-	8.9%	3.1%
Recessed Lighting-Other	1.0%	1.1%	-	-	-	-	-	-	1.0%	1.1%
Table Lamps	63.7%	5.3%	6.7%	2.8%	-	-	0.9%	1.1%	59.8%	5.4%
Tochiere	1.7%	1.4%	-	-	-	-	0.7%	0.9%	0.9%	1.1%
Track Lighting	1.1%	1.1%	0.2%	0.3%	-	-	-	-	0.9%	1.1%
Wall Mount	6.0%	2.6%	0.8%	0.9%	0.5%	0.8%	-	-	4.8%	2.4%

Table 43: Percentage of Homes with Fixture Type and Lamp Type in Master Bedroom

Fixture Type	Lamp Type													
	Overall		Compact Fluorescent		Fluorescent T8		Fluorescent T12		Fluorescent-Other Tube		Halogen		Incandescent	
(n=266)	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB
Overall	-	-	7.5%	2.8%	0.4%	0.7%	1.0%	1.0%	0.1%	0.2%	3.6%	1.9%	97.3%	1.7%
Ceiling Fan	58.3%	5.1%	3.5%	1.9%	-	-	-	-	-	-	-	-	56.5%	5.1%
Ceiling Fixtures	49.7%	5.1%	2.5%	1.6%	0.4%	0.7%	0.6%	0.7%	-	-	-	-	47.2%	5.1%
Chandelier Hanging	2.9%	1.6%	-	-	-	-	-	-	-	-	-	-	2.9%	1.6%
Floor Lamp	10.3%	3.1%	-	-	-	-	-	-	-	-	0.5%	0.6%	9.8%	3.1%
Garage	0.1%	0.2%	-	-	-	-	-	-	-	-	-	-	0.1%	0.2%
Recessed Can	5.9%	2.5%	-	-	-	-	-	-	-	-	-	-	5.9%	2.5%
Other Recessed	2.3%	1.6%	-	-	-	-	-	-	-	-	-	-	2.3%	1.6%
Table Lamp	60.7%	5.0%	3.3%	1.9%	-	-	-	-	-	-	2.6%	1.6%	57.8%	5.1%
Torchiere	1.5%	1.2%	-	-	-	-	-	-	0.1%	0.2%	0.1%	0.2%	1.4%	1.2%
Track Lighting	1.2%	1.1%	-	-	-	-	-	-	-	-	0.4%	0.6%	0.8%	1.0%
Under Counter	0.4%	0.7%	-	-	-	-	-	-	-	-	-	-	0.4%	0.7%
Wall Mount	2.9%	1.6%	0.4%	0.7%	-	-	0.4%	0.7%	-	-	-	-	2.5%	1.5%

Table 44: Percentage of Homes with Fixture Type and Lamp Type in Bedrooms

Living Room

Table 45 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 table lamps, ceiling fans, and floor lamps, with incandescent lamps, as well as table lamps with compact fluorescent lamps.

Fixture Type	Lamp Type											
	Overall		Compact Fluorescent		Fluorescent T8		Fluorescent-Other Tube		Halogen		Incandescent	
(n=181)	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB
Overall	-	-	14.3%	4.4%	0.6%	1.0%	1.2%	1.4%	5.7%	2.9%	95.4%	2.6%
Architectually Integrated	1.2%	1.4%	-	-	-	-	-	-	0.6%	1.0%	0.6%	1.0%
Ceiling Fan	38.5%	6.1%	0.3%	0.6%	-	-	-	-	-	-	38.1%	6.0%
Ceiling Fixtures	14.4%	4.3%	0.6%	1.0%	-	-	-	-	0.9%	1.1%	12.9%	4.1%
Chandelier Hanging	8.2%	3.5%	0.3%	0.6%	-	-	-	-	0.6%	0.9%	7.6%	3.4%
Floor Lamp	23.6%	5.3%	3.6%	2.4%	-	-	0.6%	1.0%	0.6%	1.0%	19.3%	4.9%
Recessed Can	13.1%	4.2%	-	-	-	-	-	-	-	-	13.1%	4.2%
Recessed Lighting-Other	1.2%	1.4%	-	-	-	-	-	-	-	-	1.2%	1.4%
Table Lamps	68.0%	5.8%	9.2%	3.6%	0.6%	1.0%	0.6%	1.0%	0.6%	1.0%	61.0%	6.1%
Torchiere	11.7%	4.0%	3.0%	2.2%	-	-	-	-	2.4%	2.0%	7.4%	3.2%
Track Lighting	1.2%	1.4%	-	-	-	-	-	-	-	-	1.2%	1.4%
Under Counter	1.2%	1.4%	-	-	-	-	-	-	-	-	1.2%	1.4%
Wall Mount	2.5%	1.8%	-	-	-	-	-	-	-	-	2.5%	1.8%

Table 45: Percentage of Homes with Fixture Type and Lamp Type in Living Room

Table 46 presents the percentage of homes with a given fixture type and lamp type in family rooms and the error bounds associated with these estimates. The most commonly found fixture and lamp type combinations are table lamps, ceiling fans, recessed cans, and floor lamps with incandescent lamps and table lamps with compact fluorescents.

Fixture Type	Lamp Type													
	Overall		Compact Fluorescent		Fluorescent T8		Fluorescent T12		Fluorescent-Other Tube		Halogen		Incandescent	
(n= 181)	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB
Overall	-	-	17.8%	4.8%	1.2%	1.4%	5.8%	2.9%	3.5%	2.3%	7.8%	3.2%	94.0%	3.0%
Architectually Integrated	1.8%	1.6%	-	-	-	-	1.2%	1.4%	0.2%	0.3%	0.3%	0.6%	-	-
Ceiling Fan	53.2%	6.2%	2.4%	2.0%	-	-	-	-	0.6%	1.0%	-	-	50.8%	6.2%
Ceiling Fixture	19.8%	5.0%	1.2%	1.4%	-	-	2.4%	2.0%	1.4%	1.5%	1.0%	1.2%	17.8%	4.8%
Chandelier Hanging	7.7%	3.3%	-	-	-	-	0.3%	0.6%	-	-	-	-	7.7%	3.3%
Floor Lamp	23.8%	5.3%	5.9%	2.9%	-	-	-	-	-	-	1.3%	1.3%	18.9%	4.8%
Recessed Can	24.5%	5.3%	-	-	-	-	-	-	-	-	0.6%	1.0%	23.9%	5.3%
Recessed Lighting-Other	6.2%	3.1%	-	-	0.6%	1.0%	0.6%	1.0%	0.6%	1.0%	0.6%	1.0%	3.7%	2.4%
Table Lamp	60.7%	6.1%	12.7%	4.2%	0.6%	0.9%	-	-	0.6%	1.0%	-	-	50.4%	6.2%
Torchiere	6.7%	3.0%	-	-	-	-	-	-	-	-	3.9%	2.3%	3.4%	2.3%
Track Lighting	3.0%	2.2%	-	-	-	-	-	-	-	-	1.2%	1.4%	1.8%	1.6%
Under Counter	1.0%	1.2%	-	-	-	-	0.6%	1.0%	-	-	0.3%	0.6%	-	-
Wall Mount	5.5%	2.7%	-	-	-	-	0.6%	0.9%	-	-	-	-	4.9%	2.6%

Table 46: Percentage of Homes with Fixture Type and Lamp Type in Family Room

Bathrooms

Table 47 and Table 48 present the percentage of homes with a given fixture type and lamp type in master and secondary bathrooms and the error bounds associated with these estimates. The most commonly found fixture and lamp type combinations in both room types are wall mounted fixtures, ceiling mounted fixtures, and recessed cans with incandescent lamps.

Fixture Type	Lamp Type											
	Overall		Compact Fluorescent		Fluorescent T12		Fluorescent-Other Tube		Halogen		Incandescent	
(n=175)	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB
Overall	-	-	5.6%	2.9%	1.6%	1.6%	1.3%	1.5%	0.8%	1.1%	96.5%	2.3%
Ceiling Fixture	50.0%	6.4%	0.6%	1.0%	1.3%	1.5%	-	-	-	-	48.8%	6.4%
Chandelier Hanging	7.0%	3.2%	0.6%	1.0%	-	-	-	-	-	-	6.3%	3.1%
Floor Lamp	0.6%	1.0%	-	-	-	-	-	-	-	-	0.6%	1.0%
Recessed Can	33.5%	6.0%	0.2%	0.4%	-	-	-	-	0.8%	1.1%	33.3%	6.0%
Recessed Lighting-Other	6.1%	2.8%	-	-	-	-	-	-	-	-	6.1%	2.8%
Table Lamp	2.3%	1.7%	0.6%	1.0%	-	-	-	-	-	-	1.7%	1.4%
Track Lighting	0.6%	1.0%	-	-	-	-	-	-	-	-	0.6%	1.0%
Under Counter	0.6%	1.0%	-	-	-	-	-	-	-	-	0.6%	1.0%
Wall Mount	73.3%	5.6%	4.1%	2.5%	0.4%	0.6%	1.3%	1.5%	-	-	68.1%	5.9%

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

Fixture Type	Lamp Type													
	Overall		Compact Fluorescent		Fluorescent T8		Fluorescent T12		Fluorescent-Other Tube		Halogen		Incandescent	
(n= 273)	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB
Overall	-	-	8.7%	2.9%	0.4%	0.7%	4.9%	2.3%	1.2%	1.1%	1.2%	1.1%	96.2%	2.0%
Ceiling Fixture	53.5%	5.1%	4.8%	2.2%	-	-	2.0%	1.5%	0.4%	0.7%	-	-	49.4%	5.1%
Chandelier Hanging	6.8%	2.6%	0.4%	0.7%	-	-	-	-	-	-	-	-	6.8%	2.6%
Floor Lamp	0.8%	0.9%	-	-	-	-	-	-	-	-	-	-	0.8%	0.9%
Recessed Can	22.0%	4.2%	0.8%	0.9%	-	-	-	-	-	-	0.4%	0.7%	21.2%	4.2%
Recessed Lighting-Other	9.0%	2.8%	-	-	-	-	0.4%	0.7%	-	-	-	-	9.0%	2.8%
Table Lamp	3.9%	2.0%	0.4%	0.7%	-	-	-	-	-	-	-	-	3.5%	1.9%
Wall Mount	75.8%	4.4%	3.9%	1.9%	0.4%	0.7%	2.5%	1.6%	0.8%	0.9%	0.4%	0.7%	70.8%	4.7%

Table 48: Percentage of Homes with Fixture Type and Lamp Type in Bathrooms

Halls

Table 49 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 mounted fixtures, wall mounted fixtures, and chandeliers with incandescent lamps.

Fixture Type	Lamp Type											
	Overall		Compact Fluorescent		Fluorescent T12		Fluorescent T8		Halogen		Incandescent	
(n=248)	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB
Overall	-	-	8.3%	2.9%	1.4%	1.2%	0.4%	0.7%	1.6%	1.3%	98.6%	1.2%
Architectually Integrated	0.9%	1.0%	-	-	-	-	-	-	0.4%	0.7%	0.4%	0.7%
Ceiling Fan	1.8%	1.4%	-	-	-	-	-	-	-	-	1.8%	1.4%
Ceiling Fixture	83.2%	3.9%	5.7%	2.5%	1.0%	0.9%	0.4%	0.7%	-	-	80.5%	4.2%
Chandelier Hanging	21.9%	4.3%	-	-	-	-	-	-	-	-	21.9%	4.3%
Floor Lamp	0.1%	0.2%	-	-	-	-	-	-	-	-	0.1%	0.2%
Recessed Can	19.3%	4.1%	0.8%	1.0%	-	-	-	-	0.4%	0.7%	18.9%	4.1%
Recessed Lighting-Other	2.2%	1.6%	0.4%	0.7%	-	-	-	-	-	-	1.8%	1.4%
Table Lamp	5.1%	2.3%	0.4%	0.7%	-	-	-	-	-	-	5.1%	2.3%
Track Lighting	1.2%	1.1%	-	-	-	-	-	-	0.3%	0.5%	0.9%	1.0%
Under Counter	0.4%	0.7%	-	-	-	-	-	-	-	-	0.4%	0.7%
Wall Mount	20.8%	4.3%	0.9%	1.0%	0.4%	0.7%	-	-	0.4%	0.7%	19.9%	4.3%

Table 49: Percentage of Homes with Fixture Type and Lamp Type in Hallway

Dining Room

Table 50 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 chandeliers and ceiling fan fixtures with incandescent bulbs.

Fixture Type	Lamp Type											
	Overall		Compact Fluorescent		Fluorescent T12		Fluorescent T8		Halogen		Incandescent	
(n=174)	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB
Overall	-	-	5.1%	2.8%	0.6%	1.0%	0.4%	0.7%	1.2%	1.4%	94.9%	2.8%
Architectually Integrated	2.8%	2.1%	-	-	-	-	-	-	-	-	2.8%	2.1%
Ceiling Fan	26.2%	5.6%	1.3%	1.4%	-	-	-	-	-	-	24.9%	5.5%
Ceiling Fixture	10.2%	3.8%	-	-	0.6%	1.0%	0.4%	0.7%	0.6%	1.0%	9.1%	3.6%
Chandelier Hanging	62.8%	6.2%	3.2%	2.2%	-	-	-	-	-	-	59.6%	6.2%
Floor Lamp	0.8%	1.0%	-	-	-	-	-	-	-	-	0.8%	1.0%
Recessed Can	6.0%	3.0%	-	-	-	-	-	-	0.6%	1.0%	5.4%	2.9%
Table Lamp	6.2%	3.0%	0.6%	1.0%	-	-	-	-	-	-	6.2%	3.0%
Torchiere	0.6%	1.0%	-	-	-	-	-	-	-	-	0.6%	1.0%
Track Lighting	0.6%	1.0%	-	-	-	-	-	-	-	-	0.6%	1.0%
Under Counter	1.2%	1.4%	-	-	-	-	-	-	-	-	1.2%	1.4%
Wall Mount	1.8%	1.7%	-	-	-	-	-	-	-	-	1.8%	1.7%

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

Breakfast Nook

Table 51 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 mounted fixtures, ceiling fans, and chandeliers with incandescent bulbs.

Fixture Type	Lamp Type							
	Overall		Compact Fluorescent		Fluorescent T12		Incandescent	
(n= 57)	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB
Overall	-	-	2.1%	3.3%	1.9%	3.1%	96.1%	4.5%
Ceiling Fan	27.1%	10.0%	2.1%	3.3%	-	-	25.0%	9.8%
Ceiling Fixture	51.9%	11.2%	-	-	-	-	51.9%	11.2%
Chandelier Hanging	15.7%	8.1%	-	-	1.9%	3.1%	13.8%	7.7%
Floor Lamp	2.1%	3.3%	-	-	-	-	2.1%	3.3%
Recessed Can	7.5%	5.8%	-	-	-	-	7.5%	5.8%
Table Lamp	2.6%	3.3%	-	-	-	-	2.6%	3.3%
Torchiere	1.2%	1.9%	-	-	-	-	1.2%	1.9%

Table 51: Percentage of Homes with Fixture Type and Lamp Type in Breakfast Nook

Home Office

Table 52 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 mounted fixtures, table lamps, and ceiling fans with incandescent bulbs.

Fixture Type	Lamp Type													
	Overall		Compact Fluorescent		Fluorescent T12		Fluorescent T8		Fluorescent-Other Tube		Halogen		Incandescent	
(n= 116)	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB
Overall	-	-	10.0%	4.7%	10.5%	4.8%	4.8%	3.4%	3.8%	3.1%	14.4%	5.6%	86.1%	5.4%
Ceiling Fan	36.5%	7.5%	2.1%	2.2%	-	-	-	-	-	-	-	-	34.3%	7.5%
Ceiling Fixture	53.5%	7.8%	3.8%	3.1%	7.6%	4.1%	1.0%	1.6%	1.9%	2.2%	1.0%	1.6%	40.5%	7.6%
Chandelier Hanging	5.9%	3.6%	-	-	-	-	-	-	-	-	-	-	5.9%	3.6%
Floor Lamp	7.0%	3.9%	-	-	-	-	1.0%	1.6%	-	-	1.0%	1.6%	5.1%	3.3%
Recessed Can	5.2%	3.4%	-	-	-	-	-	-	-	-	1.0%	1.6%	4.2%	3.1%
Recessed Lighting-Other	1.0%	1.6%	-	-	-	-	-	-	-	-	-	-	1.0%	1.6%
Table Lamp	42.5%	7.7%	5.0%	3.4%	1.9%	2.2%	2.9%	2.7%	1.9%	2.2%	8.4%	4.4%	31.3%	7.2%
Torchiere	6.0%	3.7%	-	-	-	-	-	-	-	-	4.1%	3.1%	1.9%	2.2%
Track Lighting	1.3%	1.6%	-	-	-	-	-	-	-	-	-	-	1.3%	1.6%
Under Counter	1.0%	1.6%	-	-	1.0%	1.6%	-	-	-	-	-	-	-	-
Wall Mount	1.6%	1.9%	-	-	-	-	-	-	-	-	-	-	1.6%	1.9%

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

Table 53 presents the percentage of homes with a given fixture type and lamp type in basements and the error bounds associated with these estimates. By far the most commonly found fixture and lamp type combinations are ceiling mounted fixtures with incandescent bulbs, fluorescent T12s, and compact fluorescents.

Fixture Type	Lamp Type													
	Overall		Compact Fluorescent		Fluorescent T8		Fluorescent T12		Fluorescent-Other Tube		Halogen		Incandescent	
(n= 151)	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB
Overall	-	-	11.8%	4.4%	3.1%	2.3%	42.9%	6.7%	0.9%	1.2%	1.4%	1.6%	86.2%	4.6%
Architectually Integrated	0.7%	1.2%	-	-	0.7%	1.2%	0.7%	1.2%	-	-	-	-	-	-
Ceiling Fan	2.1%	2.0%	-	-	-	-	-	-	-	-	-	-	2.1%	2.0%
Ceiling Fixture	95.6%	2.7%	11.0%	4.2%	2.4%	2.0%	37.3%	6.6%	0.2%	0.4%	-	-	80.2%	5.4%
Chandelier Hanging	5.6%	3.1%	-	-	-	-	4.2%	2.7%	-	-	-	-	1.4%	1.6%
Floor Lamp	1.4%	1.6%	-	-	-	-	-	-	-	-	-	-	1.4%	1.6%
Garage	0.7%	1.2%	-	-	-	-	-	-	-	-	-	-	0.7%	1.2%
Recessed Can	6.1%	3.2%	0.7%	1.2%	-	-	-	-	-	-	0.7%	1.2%	4.6%	2.8%
Recessed Lighting-Other	2.9%	2.3%	-	-	-	-	1.4%	1.7%	-	-	-	-	1.4%	1.6%
Table Lamp	7.7%	3.7%	0.7%	1.1%	-	-	-	-	0.7%	1.2%	0.7%	1.2%	6.3%	3.3%
Track Lighting	0.7%	1.2%	-	-	-	-	-	-	-	-	-	-	0.7%	1.2%
Under Counter	0.9%	1.2%	-	-	-	-	0.9%	1.2%	-	-	-	-	-	-
Wall Mount	2.6%	2.1%	-	-	-	-	-	-	-	-	-	-	2.6%	2.1%

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

Table 54 presents the percentage of homes with a given fixture type and lamp type in recreation rooms along with the error bounds associated with these estimates. In the homes surveyed, recreation rooms have the highest average room wattage of all room types overall. On average, recreation rooms were found to use over 600 W. The most predominant fixture and lamp type combinations are ceiling mounted fixtures, recessed cans, ceiling fans, and table lamps with incandescent lamps and ceiling mounted fixtures with fluorescent T12s.

FixtureType	Lamp Type													
	Overall		Compact Fluorescent		Fluorescent T8		Fluorescent T12		Fluorescent- Other Tube		Halogen		Incandescent	
(n= 45)	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB
Overall	-	-	6.2%	5.8%	1.7%	2.0%	15.1%	9.3%	9.2%	7.0%	20.3%	10.1%	92.6%	6.8%
Ceiling Fan	33.4%	12.0%	2.3%	3.8%	-	-	-	-	-	-	-	-	31.1%	11.8%
Ceiling Fixture	48.9%	12.6%	3.8%	4.5%	-	-	15.1%	9.3%	3.2%	4.1%	2.4%	3.8%	31.7%	11.7%
Chandelier Hanging	4.9%	4.9%	-	-	-	-	-	-	-	-	-	-	4.9%	4.9%
Floor Lamp	10.4%	7.4%	2.4%	3.8%	-	-	-	-	-	-	-	-	10.4%	7.4%
Recessed Can	43.5%	12.5%	-	-	-	-	-	-	-	-	2.4%	3.8%	43.5%	12.5%
Recessed Lighting-Other	1.7%	2.0%	-	-	0.9%	1.4%	-	-	-	-	-	-	0.9%	1.4%
Table Lamp	32.0%	11.7%	-	-	-	-	-	-	2.5%	4.1%	4.2%	4.9%	29.5%	11.3%
Torchiere	8.9%	7.1%	-	-	-	-	-	-	-	-	6.4%	6.0%	2.5%	4.1%
Track Lighting	7.5%	6.8%	-	-	-	-	-	-	-	-	-	-	7.5%	6.8%
Under Counter	10.9%	7.9%	-	-	0.9%	1.4%	-	-	5.1%	5.8%	4.9%	5.6%	-	-
Wall Mount	10.4%	7.5%	-	-	-	-	-	-	-	-	-	-	10.4%	7.5%

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

Laundry Room

Table 55 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 mounted fixtures with incandescent lamps and fluorescent T12s.

Fixture Type	Lamp Type											
	Overall		Compact Fluorescent		Fluorescent T12		Fluorescent T8		Fluorescent-Other Tube		Incandescent	
(n=202)	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB
Overall	-	-	6.6%	2.9%	20.8%	4.9%	2.3%	1.8%	1.9%	1.6%	73.7%	5.3%
Ceiling Fan	3.2%	2.1%	-	-	-	-	-	-	-	-	3.2%	2.1%
Ceiling Fixture	92.2%	3.1%	6.2%	2.9%	20.2%	4.8%	2.3%	1.8%	1.4%	1.3%	66.5%	5.6%
Chandelier Hanging	0.9%	1.1%	0.4%	0.6%	0.6%	0.9%	-	-	-	-	-	-
Recessed Can	4.6%	2.4%	-	-	-	-	-	-	-	-	4.6%	2.4%
Table Lamp	0.5%	0.6%	-	-	-	-	-	-	-	-	0.5%	0.6%
Track Lighting	0.5%	0.8%	-	-	-	-	-	-	-	-	0.5%	0.8%
Under Counter	0.5%	0.8%	-	-	-	-	-	-	0.5%	0.8%	-	-
Wall Mount	1.4%	1.3%	-	-	-	-	-	-	-	-	1.4%	1.3%

Table 55: Percentage of Homes with Fixture Type and Lamp Type in Laundry Room

Closets

Table 56 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 mounted fixtures with incandescent bulbs and fluorescent T12s.

Fixture Type	Lamp Type											
	Overall		Compact Fluorescent		Fluorescent T8		Fluorescent T12		Fluorescent- Other Tube		Incandescent	
(n= 185)	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB
Overall	-	-	5.0%	2.7%	2.5%	1.9%	14.4%	4.4%	4.1%	2.4%	95.9%	2.5%
Ceiling Fan	0.6%	1.0%	-	-	-	-	-	-	-	-	0.6%	1.0%
Ceiling Fixture	97.3%	2.0%	5.0%	2.7%	1.7%	1.6%	11.4%	3.9%	2.0%	1.7%	93.2%	3.1%
Recessed Can	6.8%	3.1%	-	-	-	-	-	-	-	-	6.8%	3.1%
Recessed Lighting-Other	1.2%	1.3%	-	-	-	-	-	-	-	-	1.2%	1.3%
Table Lamp	0.3%	0.6%	-	-	-	-	-	-	-	-	0.3%	0.6%
Track Lighting	1.2%	1.3%	-	-	-	-	-	-	-	-	1.2%	1.3%
Wall Mount	13.6%	4.2%	-	-	1.4%	1.4%	3.0%	2.1%	2.1%	1.7%	7.5%	3.3%

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

Garage

Table 57 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 mounted fixtures and garage door openers with incandescent lamps. The next most common combination is ceiling mounted fixtures with fluorescent T12s.

Fixture	Lamp Type													
	Overall		Compact Fluorescent		Fluorescent T8		Fluorescent T12		Fluorescent- Other Tube		Halogen		Incandescent	
(n= 172)	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB
Overall	-	-	8.0%	3.4%	3.1%	2.3%	26.4%	5.7%	1.5%	1.5%	-	-	93.0%	3.2%
Ceiling Fan	1.5%	1.6%	-	-	-	-	-	-	-	-	-	-	1.5%	1.6%
Ceiling Fixture	94.0%	3.1%	7.4%	3.2%	3.1%	2.3%	24.6%	5.6%	1.3%	1.5%	2.0%	1.9%	71.7%	5.8%
Chandelier Hanging	2.0%	1.5%	-	-	-	-	1.8%	1.4%	-	-	-	-	0.2%	0.4%
Floor Lamp	0.7%	1.1%	-	-	-	-	-	-	-	-	-	-	0.7%	1.1%
Garage Door Opener	76.7%	5.4%	1.2%	1.4%	-	-	-	-	-	-	-	-	75.5%	5.5%
Recessed Can	1.7%	1.6%	0.4%	0.7%	-	-	-	-	-	-	-	-	1.3%	1.5%
Recessed Lighting-Other	0.7%	1.1%	-	-	-	-	-	-	-	-	-	-	0.7%	1.1%
Table Lamp	0.9%	1.1%	-	-	-	-	-	-	-	-	-	-	0.9%	1.1%
Under Counter	0.2%	0.4%	-	-	-	-	-	-	0.2%	0.4%	-	-	-	-
Wall Mount	2.7%	2.0%	-	-	-	-	-	-	-	-	0.4%	0.6%	2.4%	1.9%

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

All Other Rooms

Table 58 presents the percentage of homes with a given fixture type and lamp type in all rooms other than the types previously mentioned including the porch as well as the error bounds associated with these estimates. The Other Room type includes attics, bars, basements, music rooms, sewing rooms, as well as pool houses. The most predominant fixture and lamp type combinations are ceiling mounted fixtures, ceiling fans, and table lamps with incandescent lamps, as well as ceiling mounted fixtures with fluorescent T12s.

Fixture Type	Lamp Type													
	Overall		Compact Fluorescent		Fluorescent T12		Fluorescent T8		Fluorescent-Other Tube		Halogen		Incandescent	
(n=97)	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB	% of Homes	EB
Overall	-	-	6.9%	4.5%	19.7%	6.9%	2.3%	2.7%	2.3%	2.7%	6.1%	4.1%	92.4%	4.6%
Architecturally Integrated	3.5%	3.3%	0.0%	0.0%	1.2%	1.9%	1.2%	1.9%	0.0%	0.0%	-	-	1.2%	1.9%
Ceiling Fan	23.9%	7.4%	-	-	-	-	-	-	-	-	1.2%	1.9%	22.8%	7.3%
Ceiling Fixture	68.6%	8.0%	3.4%	3.2%	17.3%	6.6%	-	-	1.2%	1.9%	-	-	58.6%	8.5%
Chandelier Hanging	7.4%	4.6%	-	-	-	-	-	-	-	-	0.4%	0.6%	7.0%	4.5%
Floor Lamp	10.1%	5.3%	2.3%	2.7%	-	-	-	-	-	-	-	-	7.8%	4.7%
Recessed Can	3.7%	3.2%	-	-	-	-	-	-	-	-	-	-	3.7%	3.2%
Other Recessed Table Lamp	2.3%	2.7%	-	-	-	-	-	-	-	-	-	-	2.3%	2.7%
Table Lamp	21.8%	7.2%	2.3%	2.7%	-	-	-	-	-	-	-	-	19.5%	6.9%
Tochiere	5.0%	3.7%	-	-	-	-	-	-	1.2%	1.9%	3.5%	3.3%	1.5%	1.9%
Wall Mount	9.9%	5.0%	-	-	1.2%	1.9%	-	-	-	-	1.1%	1.7%	7.6%	4.4%

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

Porch Lighting

Table 59 presents the percentage of homes utilizing each lamp type for the porch light. Eighty-five percent of all homes are using a standard incandescent lamp for the porch light. Only about 4% of homes are using a compact fluorescent lamp, while nearly 9% are using a halogen lamp.

Lamp Type	Percentage of Homes (n= 239)	Error Bound
Compact Fluorescent	4.1%	2.9%
Fluorescent	1.0%	0.8%
Halogen	8.6%	2.9%
Incandescent	85.0%	3.7%
High Intensity Discharge	1.3%	0.8%

Table 59: Percentage of Homes Having Lamp Type as Porch Light

Fixture Control Types

Table 60 shows the percentage of homes have a given lamp type and lamp control type among all lamps. About 72% of homes are using a standard incandescent lamp controlled manually. Approximately 7% of incandescent lamps are dimmer controlled.

Lamp Type	Percent of Lamps by Control Type											
	Manual		Dimmer		Motion Detector		Motion Detector with Photocell		Photocell		Timer	
(n= 847)	%	EB	%	EB	%	EB	%	EB	%	EB	%	EB
Compact Fluorescent	4.84%	0.40%	0.05%	0.02%	0.05%	0.04%	-	-	0.14%	0.08%	0.01%	0.01%
Fluorescent Other	-	-	0.01%	0.01%	-	-	-	-	-	-	-	-
Fluorescent T8	1.39%	0.22%	-	-	-	-	-	-	-	-	-	-
Fluorescent T12	8.63%	0.61%	0.23%	0.16%	0.19%	0.08%	-	-	-	-	-	-
Halogen	2.15%	0.24%	-	0.20%	0.14%	0.04%	0.09%	0.04%	-	-	-	-
Incandescent	71.89%	0.98%	6.74%	0.61%	0.72%	0.11%	0.59%	0.12%	0.20%	0.11%	0.12%	0.04%
High Intensity Discharge	-	-	-	-	-	-	-	-	0.08%	0.03%	-	-
Other	0.95%	0.21%	-	-	-	-	-	-	-	-	-	-

Table 60: Percent of Lamps by Control Types

Lamp Wattage

Table 61 shows average lamp wattage for each lamp type observed in this study. The highest average wattages were high intensity discharge lamps, heat lamps, and halogen tube lamps. The most common lamp, the standard incandescent representing nearly 43% of all lamp types, has an average wattage of 62.5. The next most common lamp overall was the fluorescent T12 making up only about 10% of all lamp types. The most common compact fluorescent lamp, the spiral/spring lamp representing about 6% of all lamps and 67% of all CFLs, had an average wattage of 21.

Lamp Type	Average Wattage
CFL AStyle	39.3
CFL PinBase	25.2
CFL Circline	23.4
CFL Spring	21.0
CFL Flood	20.0
CFL Reflector	19.5
CFL Unknown	18.8
CFL Tubular	18.0
CFL Decorative	17.0
CFL Mini	16.3
CFL Globe	10.0
Fluorescent T12	40.3
Fluorescent Unknown	35.6
Fluorescent T8	30.4
Fluorescent Circline	25.3
Other Tube Fluorescent	16.8
Fluorescent T5	15.3
Fluorescent T4	14.0
Halogen Tube	227.6
Halogen Parabolic Reflector	71.7
Halogen Other	45.6
Halogen Unknown	37.2
Halogen MR16	28.0
Incandescent Flood	73.5
Incandescent Standard	62.5
Incandescent Reflector	61.2
Incandescent Decorative	48.5
Incandescent Other	47.5
Incandescent Unknown	47.2
Incandescent Globe	45.9
Incandescent Mini	33.9
High Intensity Discharge	262.4
Heat Lamp	241.4

Table 61: Average Lamp Wattage by Lamp Type

Table 62 presents the average wattage per fixture, inclusive of all lamp technology types found in the fixtures, and number of lamps found in the fixture. Torchieres were found to have the highest overall wattage (97W), followed by other recessed (68W), and recessed cans (64W). Both chandeliers and ceiling fans commonly have multiple lamps per fixture, explaining the high wattage for these fixtures. Torchieres on the other hand typically have a single lamp, most commonly halogen quartz, which go as high as 500 watts per lamp. Under counter fixture types have the lowest wattage, with a statewide

average of 26W. These fixtures are more commonly located in kitchens and are usually equipped with fluorescent tubes. Architecturally integrated fixtures have the second lowest average wattage. These fixtures represent a number of lamp types, but are most commonly fluorescent T12s.

Fixture	Average Fixture Wattage	Error Bound	Sample Size
Under Counter	26.0	4.9	296
Architectually Integrated	33.8	14.9	65
Recessed Can	64.4	7.6	934
Table lamps	60.2	5.2	1385
Other Recessed	68.1	12.9	236
Garage Door Opener	53.5	6.4	391
Ceiling Fixtures	57.3	4.0	2685
Floor Lamp	58.4	8.5	434
Track Lighting	52.4	10.5	92
Wall Mount	62.8	4.9	1491
Ceiling Fan	55.0	4.1	1475
Chandelier Hanging	49.4	5.9	767
Torchiere	96.5	26.1	232

Table 62: Average Fixture Wattage

Table 63 looks at the average wattage by room type, when considering all fixtures and lamps within a specific room. The table presents findings at the statewide level. These numbers do vary dramatically when considering size of home, type of home, and income. Recreation rooms top the list in terms of highest overall wattage by room type, more than likely due to frequency of use and occupancy. Porches are second on the list, likely due to frequency of night time use related to leaving lights on for extended periods of time at night. Basements, family rooms, and master bathrooms represent the remaining top five high wattage rooms. Conversely, on the low end of wattages are secondary bedrooms and bathrooms and laundry rooms.

Room	Average Wattage	Error Bound	Sample Size
Whole House	3436.3	217.5	287
Recreation Room	604.3	119.4	45
Porch	456.2	47.2	239
Basement	403.6	47.3	151
Family Room	380.1	33.6	181
Bathroom - Master	318.2	32.6	175
Garage	315.1	36.5	172
Library	315.1	71.6	4
Living Room	314.8	25.4	181
Kitchen	296.8	24.7	284
Bedroom - Master	263.9	18.5	232
Hall	258.3	28.1	248
Dining Room	252.3	17.5	174
Other	251.6	42.1	94
Bathroom - 4	245.9	78.2	5
Bathroom - 3	224.5	59.5	36
Office	223.7	28.0	116
Closet	222.6	25.9	185
Breakfast Nook	212.2	25.5	57
Bathroom - 2	188.6	17.1	132
Bathroom - 1	185.8	11.6	269
Bedroom - 1	182.0	14.1	244
Bedroom - 2	177.3	12.1	194
Bedroom - 4	161.4	38.5	15
Bedroom - 3	154.5	23.3	59
Bedroom - 5	140.0	0.0	1
Laundry Room	117.3	10.1	202

Table 63: Average Wattage by Room Type

Appliances

Refrigerator Freezers

The following section describes the refrigerator/freezers found at the surveyed households. 287 homes surveyed for this study have at least one refrigerator, 28.6% of all homes have a second, and 4.1% of all homes have a third refrigerator. For this analysis any refrigerator with a capacity under 8 cubic feet is considered a "compact" 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.

Type of Residence	Secondary Refrigerator				Third Refrigerator				Sample Size
	Full or Compact		Full Only		Full or Compact		Full Only		
	%	Error Bound	%	Error Bound	%	Error Bound	%	Error Bound	
Overall	28.6%	4.5%	24.2%	4.3%	4.1%	2.0%	2.2%	1.4%	287
Modular/Prefabricated	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	4
Single Family Attached	6.7%	10.6%	6.7%	10.6%	0.0%	0.0%	0.0%	0.0%	16
Single Family Unattached (1 story)	28.3%	5.7%	21.8%	5.2%	2.6%	2.0%	1.4%	1.4%	182
Single Family Unattached (2 stories)	33.2%	9.0%	31.8%	8.9%	9.1%	5.5%	4.9%	4.0%	77
Single Family Unattached (3 stories)	49.6%	29.1%	49.6%	29.1%	0.0%	0.0%	0.0%	0.0%	8

Table 64: 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 nameplate 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 (nameplate UEC) - The usage data was obtained exclusively from the efficiency databases.

- ENERGY STAR Qualification - The unit was marked as ENERGY STAR qualified if its nameplate UEC was calculated as 10% above standard for 2001 standards, and 15% above standard for 2004 standards.

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 and water 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 roughly 50% of all the primary refrigerators. Side-by-side type refrigerators account for over 45% of the primary refrigerators.

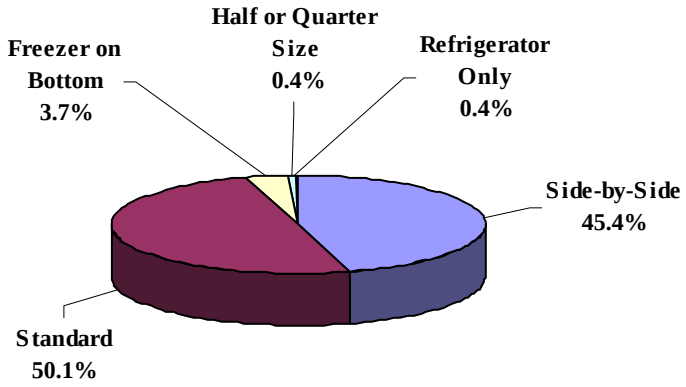

Figure 8: Percentage of Homes with Primary Refrigerator/Freezer by Type

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)
- **CR** = Compact Refrigerator
- **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 or 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 166. This is the number of full size refrigerators, 8 cubic feet or greater, for which we obtained size data from the efficiency databases. The average manufacturer reported size for all refrigerators obtained from the efficiency databases is 21.1 cubic feet.

Refrigerator Type	Manufacturer Reported Size	Error Bound	Sample Size
All Types	21.1	0.5	166
BF	21.4	1.6	7
SI	24.2	0.4	57
SS	22.6	1.2	16
TF	19.0	0.4	85
CR	1.7	0.0	1

Table 65: Average Estimated Size by Refrigerator Type

The following table shows the distribution of the sizes of the refrigerators including matched and unmatched units. The largest percentage of the refrigerators, or 44.4%, is within the size range between 19.00 to 21.99 cubic feet.

Size Range (CuFt)	Refrigerator Type													
	All Types (n= 277)		BF (n= 10)		SI (n= 95)		SS (n= 33)		TF (n= 137)		RO (n= 1)		CR (n= 1)	
	%	Error Bound	%	Error Bound	%	Error Bound	%	Error Bound	%	Error Bound	%	Error Bound	%	Error Bound
<=10	1.6%	1.2%	-	-	1.1%	1.8%	-	-	1.6%	1.6%	-	-	100.0%	-
11.00 to 14.99	2.1%	1.4%	-	-	-	-	-	-	4.2%	2.8%	-	-	-	-
15.00 to 18.99	33.3%	4.8%	31.6%	24.6%	9.0%	5.0%	33.5%	14.1%	50.1%	7.1%	-	-	-	-
19.00 to 21.99	44.4%	5.0%	48.1%	26.2%	46.9%	8.6%	47.2%	14.8%	42.5%	7.1%	-	-	-	-
> 22	18.6%	3.9%	20.3%	21.1%	43.0%	8.6%	19.3%	11.8%	1.6%	1.9%	100.0%	-	-	-

Table 66: Percentage of All Refrigerators by Type within Size Ranges-Estimated Sizes

Age

During the on-site survey, surveyors examined the refrigerator nameplate for a manufactured date and residents were asked for the approximate age of their refrigerators. If the resident was unable to provide an age or the nameplate didn't provide a manufactured date, the surveyor estimated the age of the refrigerators whenever possible. The nameplate manufactured date, resident reported age, and surveyor 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 surveyor reported age, which will inherently have some amount of incorrect information. However, it is our judgment 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. 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 also presented in this section.

Table 67 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 248 primary refrigerator/freezers were obtained in this manner. Based on this sample, the overall average age of these refrigerators is 8.3 years with an error bound of 0.7 years. The average life expectancy for refrigerators is 14 years. It is interesting to note that the overall saturation of primary refrigerators in each age range steadily decreases as the age range decreases.

Manufactured Date and Estimated Mfr Date Ranges										
Ref Type	Size Range (CuFt)	Average Est Age	Average Est Age EB	2000 to 2006	1995 to 1999	1990 to 1994	1985 to 1989	1980 to 1984	1979 and Older	Sample Size
All Types	Overall	8.3	0.7	47.8%	27.0%	16.6%	4.6%	2.2%	1.8%	248
	<=10.00	9.5	7.3	74.6%	-	-	-	25.4%	-	5
	11.00 to 14.99	10.6	4.8	42.3%	-	43.5%	14.2%	-	-	3
	15.00 to 18.99	9.1	1.7	50.5%	23.4%	13.4%	5.3%	1.5%	5.9%	72
	19.00 to 21.99	8.5	0.9	41.4%	30.3%	21.7%	3.5%	3.0%	-	112
	> 22.00	5.7	1.1	61.4%	27.8%	6.1%	4.8%	-	-	47
	Unknown	10.4	3.0	22.2%	33.3%	33.3%	11.1%	-	-	9
BF	Overall	4.9	4.8	88.2%	-	-	-	-	11.8%	9
	15.00 to 18.99	15.0	15.1	50.0%	-	-	-	-	50.0%	2
	19.00 to 21.99	1.9	0.9	100.0%	-	-	-	-	-	5
	>22.00	1.5	0.6	100.0%	-	-	-	-	-	2
SI	Overall	6.7	0.8	55.0%	28.9%	14.8%	1.3%	-	-	89
	<=10.00	5.0	-	100.0%	-	-	-	-	-	1
	15.00 to 18.99	8.3	3.5	42.3%	28.9%	28.9%	-	-	-	7
	19.00 to 21.99	7.3	1.2	48.2%	32.4%	19.4%	-	-	-	43
	>22.00	5.4	1.1	65.4%	26.7%	4.7%	3.1%	-	-	37
	Unknown	15.0	-	-	-	100.0%	-	-	-	1
SS	Overall	8.2	1.9	44.1%	17.3%	29.9%	8.7%	-	-	31
	15.00 to 18.99	5.8	2.9	65.4%	21.6%	13.0%	-	-	-	8
	19.00 to 21.99	9.7	3.2	34.0%	10.4%	52.1%	3.5%	-	-	13
	>22.00	8.6	4.1	28.0%	35.7%	18.4%	17.9%	-	-	6
	Unknown	8.8	5.9	50.0%	-	25.0%	25.0%	-	-	4
TF	Overall	9.5	1.1	41.1%	29.8%	16.2%	6.5%	3.7%	2.7%	117
	<=10.00	3.8	1.4	100.0%	-	-	-	-	-	3
	11.00 to 14.99	10.6	4.8	42.3%	-	43.5%	14.2%	-	-	3
	15.00 to 18.99	9.4	2.0	49.3%	23.9%	11.9%	7.1%	2.0%	5.8%	55
	19.00 to 21.99	9.8	1.4	32.3%	35.6%	19.5%	6.5%	6.1%	-	51
	>22.00	2.0	-	100.0%	-	-	-	-	-	1
	Unknown	11.0	2.5	-	75.0%	25.0%	-	-	-	4
CR	Overall	25.0	0.0	-	-	-	-	100.0%	-	1
	<=10.00	25.0	0.0	-	-	-	-	100.0%	-	1

Table 67: Average Age and Percentage of Refrigerator Manufacturer Reported Ages and On-site Estimated Ages within Size Ranges

Energy Consumption

The average annual nameplate unit energy consumption (UEC) for refrigerator/freezers was obtained from the model number matches to manufacturer data. A sample of 166 nameplate UECs were obtained for the analysis below. Table 68 shows the average nameplate UEC by type of refrigerator and size range.

The average overall nameplate UEC for all types of refrigerators is 760.3 with an error bound of 36.6. Discounting compact refrigerators, the most efficient units on average are refrigerators with bottom-mounted freezers, which overall have the lowest nameplate UEC at 551.1, followed by top-mounted refrigerators without an ice dispenser that have

an average overall nameplate UEC of 718.5. The tables in the next section of the report that summarize the nameplate UECs relative to standards help to put these numbers into perspective.

Ref Type	Size Range (CuFt)	Average UEC	Error Bound	Sample Size
All Types	Overall	760.3	36.6	166
	<=10 cu ft	368.7	0.0	1
	>22 cu Ft	824.9	67.2	52
	11-14 cu ft	728.9	66.5	4
	15-18 cu ft	683.7	60.3	39
	19-22 cu ft	772.8	52.6	70
BF	Overall	551.1	25.2	7
	15 to 18	651.0	-	1
	19 to 22	552.1	24.8	4
	>22	519.0	16.8	2
SI	Overall	822.3	54.7	57
	<=10	724.0	-	1
	15 to 18	768.3	122.8	4
	19 to 22	836.9	61.7	26
	>22	821.6	99.5	26
SS	Overall	945.8	146.6	16
	15 to 18	740.1	148.7	2
	19 to 22	1039.3	237.2	9
	>22	992.6	179.4	4
	Unknown	606.0	-	1
TF	Overall	718.5	45.5	85
	<=10	480.0	0.0	2
	11 to 14	728.9	66.5	4
	15 to 18	676.2	59.8	38
	19 to 22	742.7	69.7	39
	>22	1140.7	-	1
	Unknown	1155.6	-	1
CR	Overall	368.7	-	1
	<=10	368.7	-	1

Table 68: Average Nameplate UEC by Type of Refrigerator

The bin distribution of unit energy consumption of all successfully matched full size primary refrigerators is shown below in Table 69 grouped by size and type. The nameplate UEC range that makes up the largest percentage of all refrigerators is the range between 550 to 749.9 kWh/year, which covers 53.3% of all types of refrigerators.

Unit Energy Consumption Ranges (kWh/Year)										
Ref Type	**Size Range (CuFt)**	**350 to 549.9**	**550 to 749.9**	**750 to 949.9**	**950 to 1149.9**	**1150 to 1349.9**	**1350 to 1549.9**	**1550 to 1749.9**	**1750 to 1949.9**	**1950 to 2150**
All Types	Overall	14.1%	48.5%	21.8%	6.9%	5.4%	2.0%	0.7%	0.8%	-
	<=10.00	80.9%	19.1%	-	-	-	-	-	-	-
	11.00 to 14.99	-	69.5%	30.5%	-	-	-	-	-	-
	15.00 to 18.99	22.7%	53.3%	12.5%	9.9%	-	-	1.6%	-	-
	19.00 to 21.99	8.6%	47.9%	27.9%	4.8%	6.9%	3.3%	0.5%	-	-
	>22.00	6.7%	46.1%	23.5%	10.3%	7.5%	2.0%	-	3.9%	-
	Unknown	-	52.5%	-	-	47.5%	-	-	-	-
BF	Overall	19.7%	51.1%	15.6%	7.9%	4.9%	-	0.8%	-	-
	15.00 to 18.99	-	100.0%	-	-	-	-	-	-	-
	19.00 to 21.99	28.0%	72.0%	-	-	-	-	-	-	-
	>22.00	100.0%	-	-	-	-	-	-	-	-
SI	Overall	-	48.3%	35.3%	6.7%	6.2%	1.2%	-	2.3%	-
	<=10.00	-	100.0%	-	-	-	-	-	-	-
	15.00 to 18.99	-	50.3%	26.1%	23.6%	-	-	-	-	-
	19.00 to 21.99	-	37.6%	48.7%	4.2%	9.5%	-	-	-	-
	>22.00	-	55.9%	25.8%	6.5%	4.4%	2.6%	-	4.9%	-
SS	Overall	-	44.7%	20.0%	6.9%	8.7%	16.9%	2.8%	-	-
	15.00 to 18.99	-	47.3%	52.7%	-	-	-	-	-	-
	19.00 to 21.99	-	50.7%	9.5%	-	-	34.2%	5.6%	-	-
	>22.00	-	16.2%	25.6%	25.6%	32.5%	-	-	-	-
	Unknown	-	100.0%	-	-	-	-	-	-	-
TF	Overall	19.7%	51.1%	15.6%	7.9%	4.9%	-	0.8%	-	-
	<=10.00	100.0%	-	-	-	-	-	-	-	-
	11 to 14	-	69.5%	30.5%	-	-	-	-	-	-
	15.00 to 18.99	27.5%	53.2%	8.3%	9.1%	-	-	1.9%	-	-
	19.00 to 21.99	13.4%	51.1%	21.7%	6.5%	7.4%	-	-	-	-
	>22.00	-	-	-	100.0%	-	-	-	-	-
	Unknown	-	-	-	-	100.0%	-	-	-	-
CR	Overall	100.0%	-	-	-	-	-	-	-	-
	<=10.00	100.0%	-	-	-	-	-	-	-	-

Table 69: Percentage of Primary Refrigerators by Nameplate 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:

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

For example, suppose the nameplate 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:

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

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

Table 70 shows the average percentage above or below the 2001 standard that refrigerators are broken down by type and size. The average percentage below standards for all types of refrigerators is 34.3%. We find that refrigerators with bottom-mounted freezers performed best in comparison to the standards among all refrigerators by averaging 3.3% above standards. However, no conclusions will be drawn since the sample size is very small.

Ref Type	Size Range (CuFt)	Average UEC Relative to 2001 Std	Error Bound	Sample size
All Types	Overall	-34.3%	6.7%	164
	<=10.00	0.6%	0.4%	3
	11.00 to 14.99	-49.1%	14.8%	4
	15.00 to 18.99	-32.6%	10.8%	45
	19.00 to 21.99	-40.4%	10.4%	77
	>22.00	-23.4%	13.8%	33
	Unknown	-62.3%	98.3%	2
BF	Overall	3.3%	5.9%	6
	15.00 to 18.99	-16.7%	0.0%	1
	19.00 to 21.99	0.4%	0.4%	3
	>22.00	12.6%	2.8%	2
SI	Overall	-19.3%	8.5%	57
	<=10.00	0.3%	0.0%	4
	15.00 to 18.99	-8.2%	16.7%	2
	19.00 to 21.99	-22.2%	10.4%	9
	>22.00	-19.4%	15.0%	1
SS	Overall	-50.3%	23.8%	16
	15.00 to 18.99	-18.9%	27.0%	2
	19.00 to 21.99	-66.4%	38.1%	9
	>22.00	-55.0%	31.6%	4
	Unknown	5.0%	0.0%	1
TF	Overall	-47.8%	10.3%	85
	<=10.00	1.0%	0.0%	2
	11.00 to 14.99	-49.1%	14.8%	4
	15.00 to 18.99	-38.5%	12.8%	38
	19.00 to 21.99	-52.9%	16.1%	39
	>22.00	-138.6%	0.0%	1
	Unknown	-175.8%	0.0%	1

Table 70: 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 is presented in Table 71.

As can be seen in the table, 22% of all refrigerators are better than 2001 energy standards for annual energy consumption. Nearly half of refrigerators (54.4%) have a

nameplate UEC of 0.01% to 49.9% worse than 2001 Federal appliance standards for annual energy consumption.

Percentage Comparison to 2001 Federal Appliance Standards												
Ref Type	Size Range (CuFt)	Better		Worse								Sample Size
		35% to 10%	0% to 9.9%	-0.01% to -24.9%	-25.0% to -49.9%	-50.0% to -74.9%	-75.0% to -99.9%	-100.0% to -124.9%	-125.0% to -149.9%	-150.0% to -174.9%	>-175.0%	
All Types	Overall	10.7%	11.3%	28.2%	26.2%	5.3%	6.3%	6.0%	1.3%	3.8%	1.1%	164
	11 to 14	-	-	-	69.5%	30.5%	-	-	-	-	-	4
	15 to 18	8.7%	6.4%	27.3%	35.9%	5.3%	5.4%	7.2%	1.9%	-	1.9%	39
	19 to 22	1.5%	13.8%	28.1%	29.2%	4.5%	9.9%	5.4%	1.0%	6.7%	-	69
	>22	25.9%	12.0%	31.0%	11.8%	4.7%	2.3%	6.5%	1.3%	2.5%	2.1%	52
BF	Overall	37.9%	50.6%	11.5%	-	-	-	-	-	-	-	6
	15 to 18	-	-	100.0%	-	-	-	-	-	-	-	1
	19 to 22	-	100.0%	-	-	-	-	-	-	-	-	3
	>22	100.0%	-	-	-	-	-	-	-	-	-	2
SI	Overall	19.3%	13.1%	33.3%	22.2%	2.3%	3.9%	3.5%	-	2.3%	-	57
	19 to 22	-	14.0%	25.7%	46.1%	-	6.3%	7.8%	-	-	-	16
	>22	27.3%	12.8%	36.4%	12.4%	3.3%	2.9%	1.7%	-	3.2%	-	41
SS	Overall	-	21.8%	22.8%	20.0%	6.9%	-	17.2%	-	11.2%	-	16
	19 to 22	-	32.8%	32.8%	10.2%		-	-	-	24.2%	-	1
	>22	-	14.7%	16.8%	15.2%	15.2%	-	38.0%	-	-	-	7
TF	Overall	4.9%	5.4%	26.9%	31.7%	7.4%	9.4%	6.1%	2.5%	3.7%	2.0%	85
	11 to 14	-	-	-	69.5%	30.5%	-	-	-	-	-	4
	15 to 18	9.2%	6.8%	26.9%	34.2%	5.6%	5.7%	7.6%	2.0%	-	2.0%	37
	19 to 22	2.4%	5.0%	30.1%	27.9%	7.1%	13.4%	5.7%	1.6%	6.9%	-	42
	>22	-	-	-	-	-	-	-	39.3%	-	60.7%	2

Table 71: Percentage of Refrigerators with a Nameplate UEC Better or Worse than 2001 Standards by Percentage Bins and Type within Size Ranges

ENERGY STAR Qualified

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. To qualify for 2004 ENERGY STAR standards, the annual energy consumption of a refrigerator must be at least 15% less than 2004 Federal Appliance Standards for annual energy consumption. The following analysis is based on a sample of 164 primary refrigerators for which we have obtained nameplate 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 Table 72, the percentage of all refrigerators that meet 2001 ENERGY STAR qualifications is 10.7 % with a 4.2% error bound. The percentage of all refrigerators that meet 2004 ENERGY STAR qualifications is 6.9 % with a 3.5% error bound.

Ref Type	Size Range (CuFt)	2004 Energy Star		2001 Energy Star		Sample Size
		%	Error Bound	%	Error Bound	
All Types	Overall	6.9%	3.5%	10.7%	4.2%	164
	<=10.00	-	-	-	-	3
	11.00 to 14.99	-	-	-	-	4
	15.00 to 18.99	7.9%	7.1%	9.6%	7.6%	45
	19.00 to 21.99	5.8%	4.6%	6.8%	4.9%	77
	>22.00	10.2%	9.1%	23.8%	12.8%	33
	Unknown	-	-	-	-	2
BF	Overall	-	-	37.9%	34.0%	6
	15.00 to 18.99	-	-	-	-	1
	19.00 to 21.99	-	-	-	-	3
	>22.00	-	-	100.0%	-	2
SI	Overall	13.9%	8.0%	19.3%	9.0%	57
	<=10.00	-	-	-	-	1
	15.00 to 18.99	24.2%	34.9%	24.2%	34.9%	4
	19.00 to 21.99	13.7%	12.0%	16.8%	12.7%	26
	>22.00	12.9%	11.4%	21.7%	14.0%	26
SS	Overall	-	-	-	-	16
	15.00 to 18.99	-	-	-	-	2
	19.00 to 21.99	-	-	-	-	9
	>22.00	-	-	-	-	4
	Unknown	-	-	-	-	1
TF	Overall	4.0%	3.8%	4.9%	4.0%	85
	<=10.00	-	-	-	-	2
	11.00 to 14.99	-	-	-	-	4
	15.00 to 18.99	6.5%	7.3%	8.7%	8.0%	38
	19.00 to 21.99	2.5%	4.1%	2.5%	4.1%	39
	>22.00	-	-	-	-	1
	Unknown	-	-	-	-	1

Table 72: Percentage of ENERGY STAR Qualified Primary Refrigerators by Type and Size Range

Secondary Refrigerators

Of the 28.6% of homes with second refrigerator/freezers, the majority (67.6%) have top-mount freezers (TF) as their secondary refrigerator type, while 15.9% of homes have half-size or quarter-size models with capacities fewer than 8 cubic feet. A complete breakdown of secondary refrigerator/freezer by type is shown below.

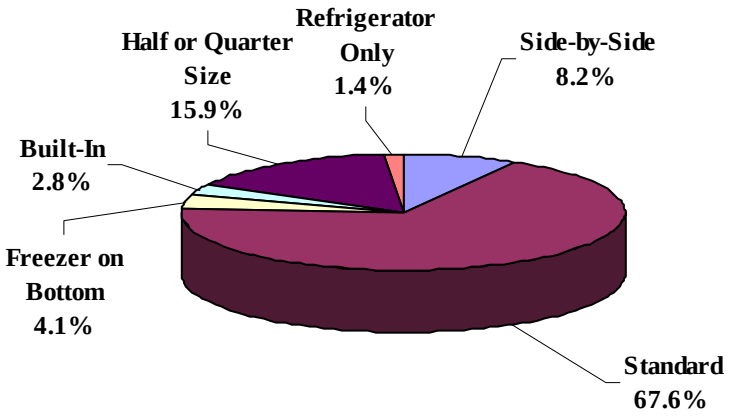

Figure 2: Secondary Refrigerators by Type

Size

The sample size that is used in the following analysis of the secondary refrigerators by size of the unit is 33. Size data for secondary refrigerators was obtained from the manufacturer data and the surveyor estimate.

Table 73 shows the average estimated size of the refrigerators by type. The average of all types of refrigerators is 17.1 cubic feet with an error bound of 1.6 cubic feet. The side-by-side refrigerators with ice dispensers are 21.7 cubic feet on average, the largest of all the types.

Refrigerator Type	Ave Est Size (Cu Ft)	Error Bound	Sample Size
All Types	17.1	1.6	33
BF	20.5	0.0	2
CR	2.1	0.6	3
SI	21.7	0.0	1
SS	21.2	1.4	2
TF	18.5	0.9	24
BI	11.6	0.0	1

Table 73: 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 (41.6%) fall in the size range of 15.00 to 18.99 cubic feet

Size Range (CuFt)	All Types (n= 78)		Built-In (BI) (n= 2)		Compact (CR) (n= 12)		Bottom Freezer (BF) (n= 3)		Side by Side (SS) (n= 4)		Side by Side with Ice Dispenser (SI) (n= 3)		Single Door (SD) (n= 1)		Top Mounted Freezer (TF) (n= 53)	
	%	EB	%	EB	%	EB	%	EB	%	EB	%	EB	%	EB	%	EB
<= 10.99	15.9%	7.0%	-	-	100.0%	0.0%	-	-	-	-	-	-	-	-	-	-
11.00 to 14.99	9.8%	5.6%	50.0%	58.2%	-	-	-	-	-	-	-	-	-	-	12.4%	7.5%
15.00 to 18.99	41.6%	9.3%	50.0%	58.2%	-	-	-	-	-	-	-	-	-	-	59.5%	11.3%
19.00 to 21.99	26.7%	8.4%	-	-	-	-	100.0%	0.0%	71.5%	39.4%	61.6%	48.2%	-	-	25.3%	10.0%
> 22.00	5.9%	4.4%	-	-	-	-	-	-	28.5%	39.4%	38.4%	48.2%	100.0%	0.0%	2.7%	3.5%

Table 74: Estimated Size Distribution of Secondary Refrigerators 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. 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 61 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 15.1 years with an error bound of 2.4 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.

Manufactured Date and Estimated Mfr Date Ranges										
Ref Type	**Size Range (CuFt)**	**Avg Est Age**	**Avg Est Age EB**	**2000 to 2006**	**1995 to 1999**	**1990 to 1994**	**1985 to 1989**	**1980 to 1984**	**1979 and older**	**Sample Size**
All Types	Overall	15.1	2.4	0.3	0.2	0.1	0.1	0.1	0.2	61
	<10	7.1	3.9	0.7	0.2	0.1	-	-	0.1	11
	11 to 14	24.2	8.7	0.2	-	0.2	0.1	-	0.6	6
	15 to 18	17.2	3.8	0.2	0.2	0.1	0.1	0.1	0.2	26
	19 to 22	13.9	3.8	0.2	0.2	0.2	0.2	0.1	0.1	14
	>22 cu Ft	14.7	9.3	0.3	0.4	-	-	-	0.3	4
BF	Overall	3.4	1.7	1.0	-	-	-	-	-	2
	19 to 22	3.4	1.7	1.0	-	-	-	-	-	2
CO	Overall	7.1	3.9	0.7	0.2	0.1	-	-	0.1	11
	<10	7.1	3.9	0.7	0.2	0.1	-	-	0.1	11
SD	Overall	10.0	-	-	1.0	-	-	-	-	1
	>22 cu Ft	10.0	-	-	1.0	-	-	-	-	1
SI	Overall	8.7	22.5	-	-	0.5	-	-	0.5	2
	19-22 cu ft	15.0	0.0	-	-	1.0	-	-	-	1
	>22 cu Ft	30.0	0.0	-	-	-	-	-	1.0	1
SS	Overall	18.6	7.7	-	0.4	-	-	0.6	-	3
	19-22 cu ft	18.6	7.7	-	0.4	-	-	0.6	-	3
TF	Overall	16.4	2.9	0.2	0.2	0.1	0.2	0.1	0.2	40
	11-14 cu ft	22.9	10.6	0.2	-	0.2	0.1	-	0.5	5
	15-18 cu ft	16.3	3.6	0.2	0.2	0.1	0.1	0.1	0.2	25
	19-22 cu ft	14.9	4.8	0.1	0.3	0.1	0.3	-	0.1	8
	>22 cu Ft	6.5	2.6	0.7	0.3	-	-	-	-	2

Table 75: 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 nameplate unit energy consumption (UEC) data for refrigerator/freezers is obtained from the model number matches to manufacturer data. A sample of 29 nameplate UECs were obtained for the analysis below. The bin distribution and the average of nameplate annual energy consumption based upon the sample of all successfully matched secondary refrigerators is shown below grouped by type and size.

The average overall nameplate UEC is 791.4 kWh/year with an error bound of 100.3 kWh/year. The overall largest percentage of refrigerators (31.6%) is within the range from 550 to 749.9 kWh/year.

Unit Energy Consumption Ranges										
Ref Type	**Size Range (CuFt)**	**Average UEC**	**Average UEC EB**	**350-549.9**	**550-749.9**	**750-949.9**	**950-1149.9**	**1150-1349.9**	**1550-1750**	**Sample Size**
All Types	Overall	791.4	100.3	21.6%	28.3%	31.6%	2.8%	10.3%	5.3%	29
	11-14 cu ft	583.0	264.1	78.3%	-	-	21.7%	-	-	2
	15-18 cu ft	747.4	155.3	24.5%	38.3%	17.6%	-	19.5%	-	12
	19-22 cu ft	884.3	149.4	13.0%	14.9%	56.1%	3.1%	-	12.9%	12
	>22 cu Ft	748.9	272.3	-	65.8%	12.7%	-	21.6%	-	3
BF	Overall	761.3	2.3	-	-	100.0%	-	-	-	2
	19-22 cu ft	761.3	2.3	-	-	100.0%	-	-	-	2
SI	Overall	1146.8	0.0	-	-	-	100.0%	-	-	1
	19-22 cu ft	1146.8	0.0	-	-	-	100.0%	-	-	1
SS	Overall	1492.8	208.5	-	-	-	-	35.6%	64.4%	2
	19-22 cu ft	1632.0	0.0	-	-	-	-	-	100.0%	1
	>22 cu Ft	1241.0	0.0	-	-	-	-	100.0%	-	1
TF	Overall	745.7	100.1	25.3%	33.1%	27.8%	1.9%	9.8%	2.2%	24
	11-14 cu ft	583.0	264.1	78.3%	-	-	21.7%	-	-	2
	15-18 cu ft	747.4	155.3	24.5%	38.3%	17.6%	-	19.5%	-	12
	19-22 cu ft	816.9	138.1	18.8%	21.4%	53.2%	-	-	6.6%	8
	>22 cu Ft	613.6	108.4	-	83.8%	16.2%	-	-	-	2

Table 76: Percentage of Refrigerators by Nameplate UEC Ranges and Type within Size Ranges

Percentage Above/Below 2001 Federal Appliance Standards

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

Table 77 shows that on average, the secondary refrigerators are 59.8% less efficient than standard. This is significantly worse than the primary refrigerators that are 34.3% less efficient than standard.

Ref Type	Size Range (CuFt)	Average UEC Relative to 2001 Std	Error Bound	Sample Size
All Types	Overall	-59.8%	20.5%	29
	11-14 cu ft	-32.0%	59.4%	2
	15-18 cu ft	-63.4%	36.7%	12
	19-22 cu ft	-65.7%	25.9%	12
	>22 cu Ft	-38.2%	30.1%	3
SI	Overall	-71.7%	0.0%	1
	19-22 cu ft	-71.7%	0.0%	1
SS	Overall	-140.7%	41.1%	2
	>22 cu Ft	-91.1%	0.0%	1
	19-22 cu ft	-168.2%	0.0%	1
TF	Overall	-57.1%	22.6%	24
	11-14 cu ft	-32.0%	59.4%	2
	15-18 cu ft	-63.4%	36.7%	12
	19-22 cu ft	-62.0%	28.6%	8
	>22 cu Ft	-23.6%	13.3%	2

Table 77: Percentage Comparison to 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.

More than 16% of all secondary refrigerators met or exceeded the 2001 standard, while over half (~58%) have a nameplate UEC of 0.01% to 74.9% worse than 2001 Federal Appliance standards for annual energy consumption.

Ref Type	Size Range (CuFt)	Percentage Comparison to 2001 Federal Appliance Standards										Sample Size
		Better		Worse								
		10 to 35%	0 to 9.9%	0.01 % to 24.9%	25% to 49.9%	50% to 74.9%	75% to 99.9%	199% to 124.9%	125% to 149.9%	150% to 174.9%	175% to 199.9%	
All Types	Overall	-	16.3%	12.9%	28.5%	17.0%	9.9%	-	1.6%	4.7%	7.1%	29
	11-14 cu ft	-	78.3%	-	-	-	-	-	21.7%	-	-	2
	15-18 cu ft	-	24.5%	4.3%	26.4%	17.6%	7.6%	-	-	3.1%	16.4%	12
	19-22 cu ft	-	-	13.0%	42.1%	20.4%	11.6%	-	-	8.3%	-	12
	>22 cu Ft	-	-	65.8%	-	12.7%	21.6%	-	-	-	-	3
SI	Overall	-	-	-	-	100.0%	-	-	-	-	-	1
	19-22 cu ft	-	-	-	-	100.0%	-	-	-	-	-	1
SS	Overall	-	-	-	-	-	35.6%	-	-	64.4%	-	2
	19-22 cu ft	-	-	-	-	-	-	-	-	100.0%	-	1
	>22 cu Ft	-	-	-	-	-	100.0%	-	-	-	-	1
TF	Overall	-	19.0%	15.1%	24.2%	18.4%	9.3%	-	1.9%	1.6%	8.3%	24
	11-14 cu ft	-	78.3%	-	-	-	-	-	21.7%	-	-	2
	15-18 cu ft	-	24.5%	4.3%	26.4%	17.6%	7.6%	-	-	3.1%	16.4%	12
	19-22 cu ft	-	-	18.8%	33.0%	25.0%	16.6%	-	-	-	-	8
	>22 cu Ft	-	-	83.8%	-	16.2%	-	-	-	-	-	2

Table 78: Percentage range of Secondary Refrigerators with a Nameplate UEC Better or Worse than 2001 Standards by Percentage Bins and Type within Size Ranges

Self-standing Freezers

The following section describes the self-standing freezers. Over 50% of all homes have one self-standing freezer and approximately 4% of all homes have a second self-

standing freezer. Since the number of homes with more that one freezer is significantly smaller than that of primary freezers, the following summary will be based strictly upon primary freezers. For a simple cross-comparison however, the following figure illustrates the percentage breakdown of secondary freezer types marking the similarities across primary and secondary units.

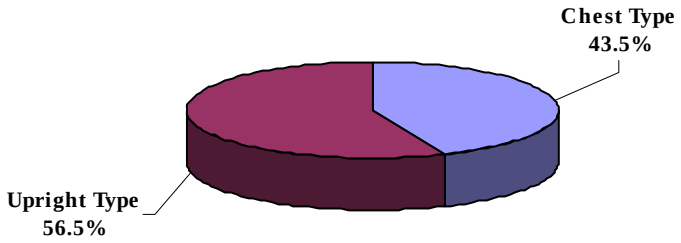

Figure 3: Percentage of Freezer Types among All Secondary Freezers

This section summarizes the freezers by type, size, age, and usage. The type of the freezer 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 surveyor 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 were 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.

The following figure shows the percentage breakdown of primary freezers by freezer type. The majority of the primary freezers found were the chest type, totaling 58.8% of all the primary freezers. Upright type freezers accounted for the remaining 41.2% of the primary freezers.

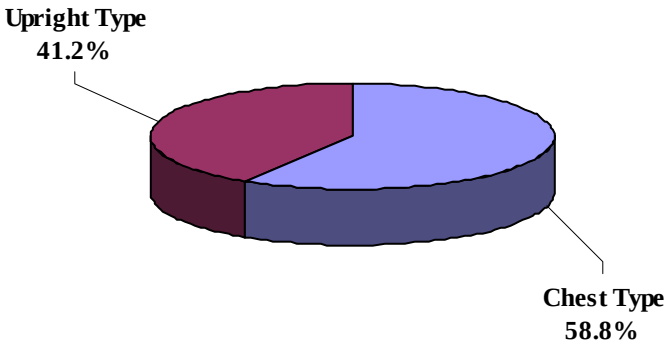

Figure 4: Percentage of Freezer Types among All Primary Freezers

Size

Table 79 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 sizes for the freezers used in this analysis are also presented in the following table. The average size of chest units is found to be approximately 5 cubic feet smaller than the average size of the upright units.

Freezer Type	Average Size (CuFt)	Error Bound	Sample Size
All	12.9	1.1	70
Chest	10.1	1.7	29
Upright	15.0	1.3	41

Table 79: Average Size of Primary Freezers by Type

Table 80 shows the distribution of the size of the primary freezers by type of freezer. The largest percentage of chest freezers is in the size range between 15.00 and 18.00 cubic feet, totaling 31.2% of the chest freezers. The largest percentage of upright freezers also in the size range between 15.00 and 18.00 cubic feet totals 33.5% of the upright freezers.

Size Range (CuFt)	All Stand Alone Freezers (n= 150)		Chest (n= 87)		Upright (n= 63)	
	Percentage	Error Bound	Percentage	Error Bound	Percentage	Error Bound
< 10.99	20.4%	5.5%	27.9%	8.0%	9.8%	6.3%
11.00 - 14.00	21.4%	5.6%	20.1%	7.1%	23.3%	8.9%
15.00 - 18.00	32.1%	6.4%	31.2%	8.3%	33.5%	10.0%
19.00 - 21.99	18.4%	5.3%	10.3%	5.4%	29.9%	9.7%
> 22.00	4.7%	2.9%	6.7%	4.4%	1.7%	2.8%
Unknown	2.9%	2.3%	3.7%	3.5%	1.7%	2.8%

Table 80: Distribution of Size of Primary Freezers and Type

Annual Energy Consumption

Table 81 shows the distribution of the freezer nameplate UECs by type. The sample sizes for the analyses by nameplate UEC are smaller than those for the size analyses due to the fact that we were only able to match a small percentage of the units with the efficiency databases that contained the nameplate UEC.

Annual Usage Range (kWh/Yr)	Chest and Freezer (n=43)		Chest (n=16)		Upright (n=27)	
	%	Error Bound	%	Error Bound	%	Error Bound
225 to 424.9	30.0%	12.3%	68.0%	21.4%	9.8%	9.1%
425 to 624.9	21.1%	10.8%	17.1%	15.2%	23.2%	14.3%
625 to 824.99	31.2%	13.9%	14.9%	18.7%	39.8%	18.3%
825 to 1024.99	2.7%	3.4%	0.0%	0.0%	4.1%	5.2%
1025 to 1224.99	6.5%	9.1%	0.0%	0.0%	10.0%	13.6%
>1225	8.5%	9.5%	0.0%	0.0%	13.1%	14.1%

Table 81: Distribution of Nameplate Annual Usage of Primary Freezers by Type

Table 82 shows the nameplate 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 since there were more large upright freezers than chest freezers.

Federal efficiency standards for residential freezers were increased in 2001. The standard is a maximum UEC equation as a function of capacity and type. Since the minimum standard UEC is a function of capacity, the 2001 standards presented for comparison are based upon the capacities of the sample. The average nameplate UECs for both chest and upright freezers combined are just below the federal maximum, and therefore on average are **.4%** more efficient than current standards.

Freezer Type	Sample Size	Manufacturer Data		2001 Standard	
		UEC (kWh/yr)	Error Bound	UEC (kWh/yr)	Error Bound
Chest and Upright	43	466.7	40.5	468.4	38.5
Chest	16	310.9	59.0	250.7	31.9
Upright	27	549.3	40.5	540.6	33.2

Table 82: Nameplate Average Annual Usage of Primary Freezers by Type

Table 83 compares the nameplate UEC from the efficiency databases to the calculated current federal maximum UEC for each model. The 15.9% of freezers that are over 100% worse than the 2001 standard consume more than twice the electricity than the maximum allowed for a freezer manufactured today, and 14.4% of freezers meet or exceed the 2001 minimum standards.

Comparisons to 2001 Standards	(n= 43)	
	Percentage	Error Bound
35% to 10% Better	11.1%	11.1%
0% to 9.9% Better	3.3%	3.3%
0.01 % to 24.9% Worse	46.4%	46.4%
25.0% to 49.9% Worse	15.6%	15.6%
50.0% to 74.9% Worse	1.9%	1.9%
75.0% to 99.9% Worse	0.0%	0.0%
100.0% to 124.9% Worse	1.9%	1.9%
> 125.0% Worse	14.0%	14.0%

Table 83: Comparison of Primary Freezers to Federal Standards

Age

Table 84 shows the average age of the primary freezers by type. The average age of chest type freezers is on average higher than that of upright freezers.

Freezer Type	Estimated and Manufacturer Reported Average Age	Error Bound	Sample Size
All	14.2	1.6	128
Chest	16.1	2.3	71
Upright	11.7	2.1	57

Table 84: Average Manufacture Date of Primary Freezers by Type

Table 85 shows the distribution of the age of the primary freezers within 5 year age ranges. The largest percentage of all the primary freezers was in the manufacture range from 2000 to 2006.

Estimated Manufacturer Reported Age	All Types (n= 128)		Chest (n= 71)		Upright (n= 57)	
	%	EB	%	EB	%	EB
2000-2006	29.3%	6.7%	22.3%	8.1%	38.2%	10.8%
1995-1999	21.3%	6.0%	21.8%	8.2%	20.6%	8.9%
1990-1994	12.7%	5.0%	9.0%	5.8%	17.4%	8.6%
1985-1989	15.3%	5.3%	21.1%	8.1%	7.9%	5.8%
1980-1984	5.9%	3.5%	6.1%	4.8%	5.6%	5.2%
1979 and Older	15.5%	5.3%	19.6%	7.8%	10.3%	6.8%

Table 85: Distribution of Manufacture Date of Primary Freezers by Type

Water Heaters

The following section summarizes the data on the water heaters that were collected during the on-site visits. As can be seen in Figure 5, the heavy majority of water heaters currently in homes are storage-type water heaters, and in particular gas storage.

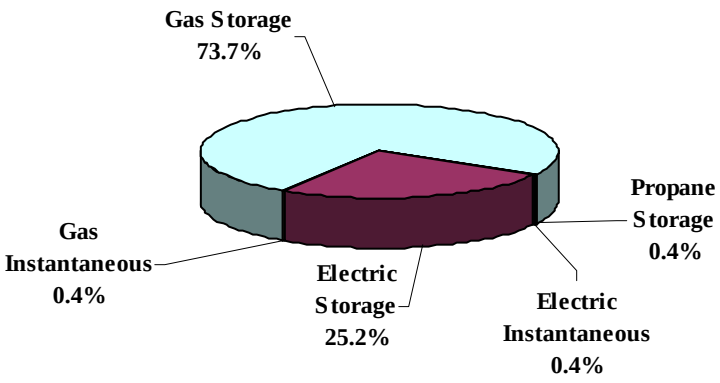

Figure 5: Water Heaters by Type

Fuel Type

Figure 6 shows the breakdown of water heaters by fuel type. The large majority of water heaters are gas totaling over 70% of all water heaters found. Over 25% of the water heaters are electric.

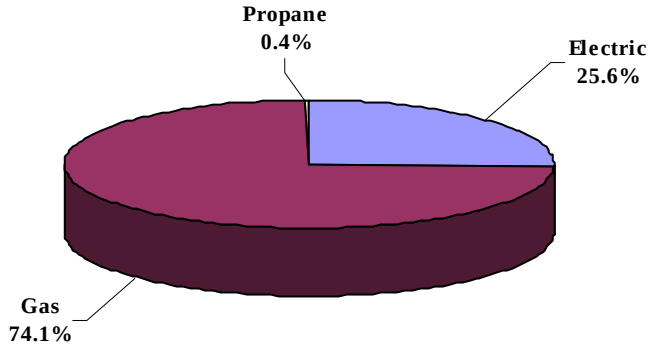

Figure 6: Water Heaters by Fuel Type

Table 86 shows the average size of the water heaters, overall and for each of the fuel types. The average sizes of the units were 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 surveyor 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	Average Size (Gallons)	Error Bound	Sample Size
All Types	41.6	0.8	283
Electric	45.0	1.9	73
Gas	40.3	0.8	209
Propane	50.0	0.0	1

Table 86: Average Size of Water Heaters by Fuel Type

Table 87 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 differs only slightly for electric and gas units. A heavy majority of gas units are in the 40 to 49 gallon range, whereas with the electric units there is a wide distribution of capacities from 40 to 59 gallons. However, the majority of all the water heaters combined by fuel type are still in the size range from 40 to 49 gallons.

Size (Gallons)	Fuel Type							
	Overall (n= 283)		Electric (n= 73)		Gas (n= 209)		Propane (n= 1)	
	%	EB	%	EB	%	EB	%	EB
Less than 30	13.1%	3.4%	5.4%	4.4%	15.8%	4.3%	-	-
30 to 49	12.3%	3.3%	3.9%	3.7%	15.3%	4.2%	-	-
40 to 49	58.9%	4.9%	45.0%	9.7%	64.1%	5.6%	-	-
50 to 59	27.0%	4.4%	47.1%	9.8%	19.5%	4.6%	100.0%	0.0%
60 to 69	0.4%	0.6%	-	-	0.5%	0.9%	-	-
80 to 89	0.6%	0.8%	2.5%	2.9%	-	-	-	-

Table 87: Percentage of Water Heaters by Size Range and Fuel Type

Table 88 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 table better displays the actual percentage of the population of water heaters in each size range. The previous table shows that the 40 to 59 gallon size range accounts for 92.1% of all electric water heaters and Table 88 shows that the same size electric heaters constitute only 23.6% of the entire population. This emphasizes the market dominance that exists with these gas fired water heaters.

(n= 287)	Fuel Type					
	Electric		Natural Gas		Propane	
Size (Gallons)	%	EB	%	EB	%	EB
Tankless	0.4%	0.6%	0.4%	0.6%	-	-
30 to 39	1.0%	1.0%	11.1%	3.1%	-	-
40 to 49	11.5%	3.2%	46.6%	4.9%	-	-
50 to 59	12.1%	3.2%	14.1%	3.4%	0.4%	0.6%
60 to 69	-	-	0.4%	0.6%	-	-
80 to 89	0.6%	0.8%	-	-	-	-
Size Unknown	-	-	1.5%	1.2%	-	-

Table 88: Percentage of Water Heaters within each Size Range Among all Water Heaters

Age

Table 89 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 8.6 years old. The ages of the known electric and gas water heaters are not significantly different.

Size (Gallons)	Fuel Type											
	All Types			Electric			Natural Gas			Propane		
	Average Age	Error Bound	Sample Size	Average Age	Error Bound	Sample Size	Average Age	Error Bound	Sample Size	Average Age	Error Bound	Sample Size
All Sizes	8.6	0.7	250	9.0	1.6	2	8.4	0.8	184	-	-	-
Tankless	3.0	1.2	2	4.0	0.0	1	2.0	0.0	1	-	-	-
30 to 39	9.5	1.8	30	10.5	4.3	3	9.3	1.9	27	-	-	-
40 to 49	8.5	0.9	143	10.3	2.8	28	8.1	0.9	115	-	-	-
50 to 59	7.7	1.5	70	7.4	2.0	31	7.9	2.1	38	5.0	0.0	1
80 to 89	17.0	11.2	2	17.0	11.2	2	-	-	-	-	-	-
Unknown	21.1	8.1	3	-	-	-	21.1	8.1	3	-	-	-

Table 89: Average Age of Water Heaters by Fuel Type within Size Ranges

Table 90 shows the percentage of water heaters within each fuel type and size range that fall into each of the manufacture date ranges. The first row of data, representing all water heaters, shows the largest percentage was manufactured in the last six years, totaling 51% of all the units.

All size/fuel categories with a substantial sample show a similar distribution of age ranges. The largest percentage of water heaters is found in the most recent age range and the percentage decreases with each successive older age range ending with a few percent in the 1979 and older category.

Fuel Type	Estimated Manufacture Date							Sample Size
	Size Range (Gallons)	2000-2006	1995-1999	1990-1994	1985-1989	1980-1984	1979 and Older	
All Types	All Sizes	51.0%	20.8%	15.7%	7.6%	3.3%	1.6%	250
	Tankless	100.0%	-	-	-	-	-	2
	30 to 39	36.1%	23.6%	27.0%	9.7%	3.6%	-	30
	40 to 49	51.3%	22.8%	13.9%	7.7%	2.8%	1.6%	143
	50 to 59	58.1%	17.5%	13.0%	7.3%	3.2%	1.0%	70
	80 to 89	39.9%	-	-	-	60.1%	-	2
	Unknown	-	-	66.0%	-	-	34.0%	3
Electric	All Sizes	54.8%	12.7%	14.7%	9.5%	6.7%	1.7%	65
	Tankless	100.0%	-	-	-	-	-	1
	30 to 39	38.8%	35.5%	-	25.7%	-	-	3
	40 to 49	50.7%	10.3%	15.8%	11.5%	7.7%	4.0%	28
	50 to 59	59.1%	13.8%	16.5%	7.1%	3.5%	-	31
	80 to 89	39.9%	-	-	-	60.1%	-	2
Natural Gas	All Sizes	49.4%	23.7%	16.2%	7.0%	2.2%	1.6%	184
	Tankless	100.0%	-	-	-	-	-	1
	30 to 39	35.8%	22.4%	29.8%	8.0%	4.0%	-	27
	40 to 49	51.4%	25.9%	13.5%	6.7%	1.6%	1.0%	115
	50 to 59	56.0%	21.1%	10.5%	7.7%	2.9%	1.8%	38
	80 to 89	-	-	-	-	-	-	2
	Unknown	-	-	66.0%	-	-	34.0%	3
Propane	All Sizes	100.0%	-	-	-	-	-	1
	50 to 59	100.0%	-	-	-	-	-	1

Table 90: Percentage of Water Heaters in Purchase Date Ranges by Fuel Type

Energy Factor

Energy factor for water heaters is a measure of efficiency expressed as the ratio defined below, where a higher energy factor equates to a more efficient water heater:

$$\frac{\text{heater supplied energy content of the delivered hot water}}{\text{energy consumed by the water heater}}$$

The average energy factor for the popular 40 gallon gas fired water heater is 0.57, which is slightly below the average of 0.59 from the National Appliance Energy Conservation Act Standards (NAECA), implemented in 2004. The average energy factor for electric models of the most popular 50 gallon size is also slightly below standard.

Energy Factor Comparison			
Size	Fuel Type	Energy Factor Standard	Average Energy Factor
40 Gallons	Gas	0.59	0.57
50 Gallons	Electric	0.90	0.88

Table 91: Energy Factor Comparison

Table 92 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					
	Gas			Electric		
	Average Energy Factor	Error Bound	Sample Size	Average Energy Factor	Error Bound	Sample Size
Overall	0.57	0.01	119	0.89	0.01	40
Tankless	0.84	0.00	1	-	-	0
30 to 39	0.58	0.00	18	0.89	0.00	1
40 to 49	0.57	0.01	73	0.89	0.01	19
50 to 59	0.57	0.01	27	0.88	0.01	19
80 to 89	0.00	0.00	0	0.85	0.00	1

Table 92: Average Energy Factor by Fuel Type in Size Ranges

Table 93 shows the percentage of water heaters within each fuel type and size range that fall into each of the energy factor ranges. Energy factors of gas water heaters seem to be well distributed throughout the range from 0.52 to 0.64, while the majority of electric water heaters fall within the range from 0.88 to 0.92. It is difficult to make any comprehensive comparisons between these data and the 2004 federal standard due to the standard being a function of water heater volume, but a table containing the federal standard is in the Appendix so that comparisons can be made as desired.

Fuel Type	Size Range (Gallons)	Energy Factor																
		0.52 to 0.559	Error Bound	0.56 to 0.599	Error Bound	0.60 to 0.639	Error Bound	0.64 to 0.679	Error Bound	0.84 to 0.879	Error Bound	0.88 to 0.919	Error Bound	0.92 to 0.959	Error Bound	0.96 to 0.99	Error Bound	Sample Size
Electric	All Sizes	-	-	-	-	-	-	-	-	23.2%	11.2%	64.8%	12.7%	9.2%	7.6%	2.8%	4.6%	40
	30 to 39	-	-	-	-	-	-	-	-	-	-	100.0%	-	-	-	-	-	1
	40 to 49	-	-	-	-	-	-	-	-	-	-	85.8%	13.5%	8.1%	10.2%	6.1%	9.7%	19
	50 to 59	-	-	-	-	-	-	-	-	43.5%	19.1%	45.4%	19.1%	11.1%	12.1%	-	-	19
	80 to 89	-	-	-	-	-	-	-	-	100.0%	-	-	-	-	-	-	-	1
Gas	All Sizes	31.5%	7.1%	59.2%	7.6%	6.6%	3.9%	0.9%	6.7%	0.9%	1.4%	1.0%	1.6%	-	-	-	-	119
	Tankless	-	-	-	-	-	-	-	-	100.0%	-	-	-	-	-	-	-	1
	30 to 39	6.2%	9.8%	87.7%	13.4%	6.2%	9.8%	-	-	-	-	-	-	-	-	-	-	18
	40 to 49	25.5%	8.5%	69.9%	9.0%	3.1%	3.5%	-	-	-	-	1.6%	2.5%	-	-	-	-	73
	50 to 59	66.4%	15.3%	12.7%	10.2%	16.7%	12.5%	4.2%	1.5%	-	-	-	-	-	-	-	-	27

Table 93: Percentage of Water Heaters in Energy Factor Ranges by Fuel Type and Size

Table 94 shows the percentage of all water heaters broken down by whether the tank was wrapped with insulation or unwrapped. The unknown category contains tanks that were unobservable. Over vast majority of the observed water heaters were unwrapped.

Fuel Type	Size Range (Gallons)	Tank Wrapped		Tank Not Wrapped		Sample Size
		%	Error Bound	%	Error Bound	
All Types	Overall	3.6%	1.7%	96.4%	1.7%	287
	Tankless	-	-	100.0%	0.0%	2
	30 to 39	-	-	100.0%	0.0%	34
	40 to 49	2.2%	1.7%	97.8%	1.7%	168
	50 to 59	3.0%	2.9%	97.0%	2.9%	76
	60 to 69	-	-	100.0%	0.0%	1
	80 to 89	-	-	100.0%	0.0%	2
	Unknown	100.0%	0.0%	-	-	4

Table 94: Percentage of Water Heaters that were Wrapped and Unwrapped

Clothes Washers

This 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 97.5% of all homes have a clothes washing machine. All single family unattached 2-story and 3-story homes in our sample were found to have a washer, thus the weighted percentage of these homes with washers is also 100%. A large majority of single family unattached 1-story homes and single family attached have a washer in the house.

Type of Residence	%	Error Bound	Sample Size
Overall	97.5%	1.6%	287
Modular/Prefabricated	74.6%	36.0%	4
Sing Family Attached	93.3%	10.6%	16
Single Family Unattached (1 story)	97.2%	2.1%	182
Single Family Unattached (2 stories)	100.0%	0.0%	77
Single Family Unattached (3 or more stories)	100.0%	0.0%	8

Table 95: Percentage of Homes with Clothes Washers by Type of Residence

Table 96 shows the distribution of the 280 clothes washers found on-site, presented by type of washer and type of residence. Nearly 5% of all washers found were horizontal-axis washing machines. The largest percentage of homes with horizontal-axis washers occurred in single family 2-story homes. As might be expected, the most common type of washer throughout the sample of homes was standard.

Type of Residence	Horizontal Axis		Standard		Stacked		Sample Size
	%	Error Bound	%	Error Bound	%	Error Bound	
Overall	5.1%	0.0%	93.6%	2.4%	1.3%	1.1%	280
Modular/Prefabricated	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	3
Single Family Attached	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	15
Single Family Unattached (1 story)	5.1%	2.8%	93.4%	3.1%	1.5%	1.5%	177
Single Family Unattached (2 stories)	7.1%	4.7%	91.5%	5.2%	1.4%	2.3%	77
Single Family Unattached (3 stories)	0.0%	2.2%	100.0%	0.0%	0.0%	0.0%	8

Table 96: Distribution of Clothes Washers by Type of Washer and by Type of Residence

The sample size of washers with ages was 232 washers. Again, the age data reported is the 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 the age of the machine. The average overall self-reported age of clothes washers is 7.5 years old.

Manufactured Date Range	% (n= 232)	Error Bound
2000-2006	60.4%	5.4%
1995-1999	18.3%	4.3%
1990-1994	11.3%	3.5%
1985-1989	5.5%	2.5%
1980-1984	2.2%	1.6%
1979 and Older	2.4%	1.7%

Table 97: Distribution of Manufactured Date of Clothes Washers

In 2004 federal standards switched from rating clothes washer efficiencies from Energy Factor (EF) units to Modified Energy Factor (MEF) units. The change was made due to differences in the amount of water extracted from the clothing between different models. The MEF accounts for these differences, which have an impact on the energy consumption of the clothes dryer. The efficiency databases used for this study to determine model efficiency only had MEF for a very limited number of horizontal-axis washing machines, therefore we continue to present efficiency in terms of EF.

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 in 1994, set a minimum energy factor of 1.18. The minimum ENERGY STAR qualifying energy factor is 2.5 for all clothes washers. The average energy factor of each of the types of clothes washers, based upon the sample of clothes washers that were successfully linked with the efficiency database, meets the 1994 minimum standard energy factor. Additionally, it seems apparent that horizontal axis washers, which easily achieved ENERGY STAR qualifying levels on average, perform significantly better than standard or stacked units.

Type of Washer	1994 EF Minimum Standard	Energy Star Qualifying EF	Energy Factor	Error Bound	Sample Size
Standard	1.18	2.5	1.55	0.25	28
H-Axis	-	2.5	5.30	0.00	1
Stacked Washer & Dryer	-	2.5	1.29	0.06	3

Table 98: Average Energy Factor and Comparative Standards

The following table summarizes the energy factor distribution relative to efficiency standards. It shows that all of the horizontal axis washers far exceed the minimum federal requirements as well as exceed ENERGY STAR minimum requirements. Eighty-six percent of the standard units exceeded the minimum federal requirements and nearly 14% exceeded ENERGY STAR minimum requirements. While no stacked washer and dryer exceeded minimum ENERGY STAR requirements, 100% exceeded the minimum standard requirements.

Type of Washer	Energy Factor	
	1.18 to 2.49	Greater than 2.5
All Washers	83.9%	16.1%
H-Axis	-	100.0%
Stacked Washer & Dryer	100.0%	-
Standard	86.4%	13.6%

Table 99: Energy Factor Distribution Relative to Standards

Clothes Dryers

The following section describes the clothes dryers found during the on-site surveys. 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 dryers obtained by the surveyors during the site visits.

Approximately 97% of all sites that were visited have a dryer. Table 100 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.

Type of Residence	% with Dryers	Error Bound	Sample Size
Overall	96.5%	1.8%	287
Modular/Prefabricated	74.6%	36.0%	4
Single Family Attached	93.3%	10.6%	16
Single Family Unattached (1 Story)	95.7%	2.5%	182
Single Family Unattached (2 Stories)	100.0%	0.0%	77
Single Family Unattached (3 Stories)	100.0%	0.0%	8

Table 100: Percentage of Homes with Dryers by Type of Residence

Figure 7 shows the breakdown of fuel types among all dryers found during the on-site visits. A total of 277 homes in the sample have dryers. The vast majority of homes used electric dryers.

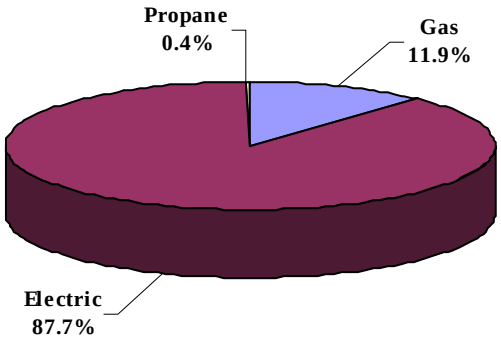

Figure 7: Percentage of Dryers by Fuel Type

The data on the age of the dryers were obtained from either the owner of the house or the surveyor estimation of the age. A total of 225 dryers in the sample have an estimated age. The average weighted age of the dryers is 8.1 years old. Table 101 shows the distribution of the estimated manufacture date for the dryers. The largest percentage of dryers is between 0 to 6 years old. However, over 20% of all dryers are between 6 and 10 years old.

Manufacture Date Ranges	% (n= 225)	Error Bound
2000-2006	54.4%	5.6%
1995-1999	20.5%	4.5%
1990-1994	12.7%	3.8%
1985-1989	7.6%	3.0%
1980-1984	3.1%	2.0%
1979 and Older	1.8%	1.5%

Table 101: Distribution of Estimated Manufacture Date of Dryers

Dishwashers

The following section summarizes the 217 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 surveyor during the site visit, and the energy factor from the CEC database.

Table 102 shows the percentage of homes with dishwashers by type of home. Approximately 75.6% of all homes have a dishwasher. The table shows that there is a fair spread of dishwashers among the different types of homes.

Type of Residence	% with Dishwashers	Error Bound	Sample Size
Overall	75.6%	4.3%	287
Modular/Prefabricated	100.0%	0.0%	4
Single Family Attached	63.0%	20.0%	16
Single Family Unattached (1 story)	75.9%	5.4%	182
Single Family Unattached (2 stories)	75.2%	8.4%	77
Single Family Unattached (3 stories)	87.4%	19.3%	8

Table 102: Percentage of Homes with Dishwasher by Type of Residence

Based on the subset of 189 dishwashers for which age information was found, the average age of dishwashers is 6.1 years old. Table 103 shows that the majority of dishwashers (64.3%) were reported to have been manufactured between 2000 and 2006, and nearly 90% of dishwashers were manufactured in the last 10 years.

Manufacture Date Range	% (n= 189)	Error Bound
2000-2006	64.3%	5.9%
1995-1999	23.2%	5.2%
1990-1994	8.2%	3.3%
1985-1989	2.3%	1.9%
1980-1984	0.9%	1.1%
1979 and Older	0.9%	1.1%

Table 103: 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 0.508, about 9% higher than federal standards and just over 12% less than ENERGY STAR standards. Table 104 displays the average energy factor compared to the current federal minimum standard, enacted in 1994.

Dishwasher Energy Factor		
Current Federal Standards	Minimum Energy Star Qualification	Average Energy Factor
0.460	0.580	0.508

Table 104: Comparison of Energy Factor with Federal Standards

The distribution of dishwasher energy factors is found in Table 105. The highest percentage of dishwashers with energy factors falls within the range of 0.460 to 0.579, containing over 80% of the dishwashers. This energy factor range encompasses all dishwashers that met 1994 standards but were below the current ENERGY STAR minimum. The range of 0.580 to 0.775 accounts for all dishwashers that met or exceeded the ENERGY STAR minimum qualifying energy factor of 0.58. The total percentage of dishwashers meeting 1994 federal standards is 98.6%. The sample size for the distribution of the energy factors is 35, which is the total number of dishwashers that we were able to match with the CEC database.

Energy Factor	% (n= 35)	Error Bound
0.275 to 0.459	1.4%	2.3%
0.460 to 0.579	81.5%	14.3%
0.580 to 0.775	17.1%	14.2%

Table 105: Distribution of Energy Factor of Dishwashers

Cooling Equipment

This section presents the summary analysis of the data on primary cooling equipment found at the 282 sites that had air conditioning. The air conditioner model numbers were linked with efficiency databases from the ARI, CEC, Carrier Bluebook, and FTC in order to obtain manufacture date, capacity, seasonal energy efficiency ratio (SEER), and energy efficiency ratio (EER).

Cooling Equipment

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

- Packaged System Air Conditioning units
- Split System Air Conditioning units
- Packaged Air to Air Heat Pumps
- Split System Air to Air Heat Pumps
- Evaporative Systems
- Window/Wall Room Air Conditioning units

The distribution of these cooling equipment types is shown below in Table 106.

System Type (n=282)		% of Primary Cooling Types	Error Bound
Central	Packaged System AC	1.8%	1.3%
	Split System A/C	89.9%	3.1%
	Split Heat Pump	7.2%	2.7%
	Packaged Heat Pump	0.7%	0.8%
	Ground Source Heat Pump	0.4%	0.7%
Space	Window Unit	100.0%	0.0%

Table 106: Distribution of Cooling System Types in Residences with Cooling Equipment

The analysis of cooling equipment is presented in this section and will consider heat pumps the same as air conditioners. This is because the cooling portion of a heat pump is very similar in terms of energy use to a standard A/C.

From our analysis of the surveyed residences, 98.3% with a 2.7% error bound of homes have some type of cooling equipment in place, including non-mechanical systems such as evaporative coolers. Of the homes that have primary cooling equipment, the distribution of central systems versus space cooling units is shown below.

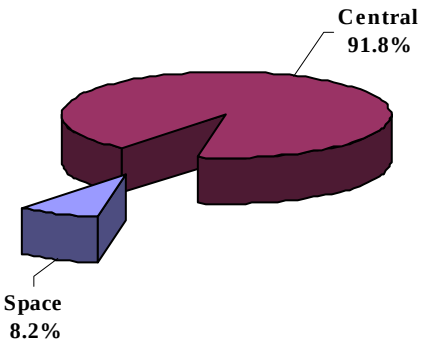

Figure 8: The Distribution of Primary Cooling Systems

Cooling equipment was classified into six types; evaporative systems, all of which were central systems, split system A/C, split heat pump, packaged system A/C, and packaged heat pump, all classified as central systems, and window/wall units, considered space units. The data show that the majority of systems are split A/C which corresponds to common building practices. The second most predominant systems were split heat pump units but were considerably less than the number of split systems A/Cs.

Equipment Type	Central (n=258)		Space (n= 24)	
	% of System Class	Error Bound	% of System Class	Error Bound
Split System A/C	89.9%	3.1%	-	-
Split Heat Pump	7.2%	2.7%	-	-
Packaged System A/C	1.8%	1.3%	-	-
Packaged Heat Pump	0.7%	0.8%	-	-
Ground Souce Heat Pump	0.4%	0.7%	-	-
Window Unit	-	-	100.0%	0.0%

Table 107: Breakdown of Classes of Primary Cooling Systems by Equipment Type

Table 108 below shows the average estimated age of the primary system found at a residence. The estimated ages were obtained from a combination of dates that were gathered from the manufacturer nameplate and the surveyor estimates during the on-site visit. The sample size of 221 (summing central and space units) represents all sites that were found with some type of cooling equipment and age estimate. The average age of a central air conditioning system type is 9.5 years old. The average space air conditioning system is 7.7 years old.

Air Conditioning System Type		Primary Cooling System Estimated Age	Error Bounds	Sample Size
Central	All Types	9.5	0.9	203
	Packaged System A/C	6.1	4.7	3
	Packaged System HP	7.0	2.1	1
	Split System A/C	9.8	1.0	182
	Split System HP	7.3	2.1	17
Space	All Types	7.7	2.7	18
	Windows/Wall	7.7	2.7	18

Table 108 Average Age of Primary Cooling Equipment

Table 109 shows the percentage distribution for each type of cooling system by age range. Over half of all primary central and space type air conditioners have been manufactured in the past 10 years.

Age Range	Central										Space			
	All Types (n=203)		Packaged System A/C (n=3)		Packaged System HP (n=1)		Split System A/C (n=182)		Split System HP (n=17)		All Types (n=18)		Window/Wall (n=18)	
	%	EB	%	EB	%	EB	%	EB	%	EB	%	EB	%	EB
2000-2006	43.1%	5.8%	61.1%	48.5%	-	-	41.5%	6.1%	57.7%	20.0%	63.9%	19.2%	63.9%	19.2%
1995-1999	22.1%	4.9%	-	-	100.0%	0.0%	23.1%	5.3%	11.9%	13.0%	12.5%	13.6%	12.5%	13.6%
1990-1994	23.5%	5.0%	38.9%	48.5%	-	-	22.6%	5.2%	30.4%	18.7%	12.0%	13.1%	12.0%	13.1%
1985-1989	5.8%	2.8%	-	-	-	-	6.4%	3.1%	-	-	5.7%	9.2%	5.7%	9.2%
1980-1984	1.5%	1.3%	-	-	-	-	1.7%	1.4%	-	-	5.8%	9.3%	5.8%	9.3%
1979 and older	4.1%	2.4%	-	-	-	-	4.6%	2.6%	-	-	-	-	-	-

Table 109: Age Range Distribution of Cooling System by Types

Table 110 below shows bin distributions of capacities for cooling system types. The capacities were obtained from a combination of manufacturer information and the

surveyor estimates during the on-site visit. The sample size of 238 represents all cooling equipment for which capacity data was obtained. The largest percentage bin of combined central air conditioning types is 27.3% found in the 2.50 to 2.99 ton range. The largest percentage bin of space air conditioning type window/wall units is 35.6% and falls in the 1.50 to 1.99 ton range.

Ton Range	Central Type												Space Type	
	All HP and A/C Types (n= 225)		Ground Source HP (n= 1)		Packaged System A/C (n= 4)		Packaged System HP (n= 2)		Split System A/C (n= 199)		Split System HP (n= 19)		Window/Wall (n= 13)	
	%	EB	%	EB	%	EB	%	EB	%	EB	%	EB	%	EB
0.25 - 0.99	0.9%	1.1%	-	-	28.0%	38.6%	-	-	0.5%	0.8%	-	-	29.4%	20.0%
1.00 - 1.49	1.3%	1.2%	-	-	-	-	36.3%	53.8%	1.1%	1.3%	-	-	17.9%	18.7%
1.50 - 1.99	6.8%	2.8%	-	-	-	-	-	-	6.7%	2.9%	9.8%	11.1%	35.6%	22.9%
2.00 - 2.49	26.7%	4.9%	-	-	28.0%	38.6%	63.7%	53.8%	26.8%	5.2%	22.6%	16.2%	8.5%	13.4%
2.50 - 2.99	27.3%	5.0%	-	-	-	-	-	-	28.0%	5.4%	30.0%	17.3%	8.6%	13.5%
3.00 - 3.49	19.5%	4.5%	100.0%	0.0%	-	-	-	-	20.9%	4.9%	5.9%	9.4%	-	-
3.50 - 3.99	9.9%	3.3%	-	-	28.0%	38.6%	-	-	8.6%	3.3%	20.8%	15.4%	-	-
4.00 - 4.49	5.2%	2.5%	-	-	-	-	-	-	4.9%	2.6%	11.0%	12.0%	-	-
4.50 - 5.00	2.5%	1.7%	-	-	16.0%	25.5%	-	-	2.5%	1.9%	-	-	-	-

Table 110: Size Distribution of Cooling Systems by Type

Table 111: Size Distributions by Age Range for Central System Types shows the percentage of cooling systems by type and capacity within age ranges. For example, from the table we can identify that 74.6% of all types of central cooling units in the range of 4.0 to 4.49 tons were built between 2000 and 2006. This is also useful in identifying which size units tend to be older. The table shows the highest concentration of central units with a known tonnage built in 1979 or earlier, at 8.5%, is for the units in the 3.0 to 3.49 ton range.

Central Air Conditioning System Type	Ton Range	Age Range												Sample Size
		2000 to 2006		1995 to 1999		1990 to 1994		1985 to 1989		1980 to 1984		1979 and older		
		%	EB	%	EB	%	EB	%	EB	%	EB	%	EB	
All Types	All Ranges	43.1%	5.8%	22.1%	4.9%	23.5%	5.0%	5.8%	2.8%	1.5%	1.3%	4.1%	2.4%	203
	0.5 to 0.99	-	-	47.8%	58.0%	52.2%	58.0%	-	-	-	-	-	-	2
	1.0 to 1.49	-	-	100.0%	0.0%	-	-	-	-	-	-	-	-	1
	1.5 to 1.99	30.0%	20.4%	33.3%	22.4%	36.7%	23.3%	-	-	-	-	-	-	13
	2.0 to 2.49	49.9%	12.5%	28.0%	11.4%	18.7%	9.9%	0.8%	1.4%	-	-	2.5%	4.1%	47
	2.5 to 2.9	40.5%	12.2%	22.8%	10.5%	24.4%	10.7%	6.4%	6.0%	3.8%	4.5%	2.2%	3.6%	45
	3.0 to 3.49	38.3%	13.3%	20.8%	11.1%	23.8%	11.7%	8.5%	7.7%	-	-	8.5%	7.7%	37
	3.5 to 3.9	67.8%	16.9%	15.1%	13.2%	17.0%	13.2%	-	-	-	-	-	-	21
	4.0 to 4.49	74.6%	25.5%	-	-	-	-	25.4%	25.5%	-	-	-	-	8
	4.5 to 5	61.1%	34.3%	19.5%	28.4%	19.5%	28.4%	-	-	-	-	-	-	6
	Unknown	14.9%	13.0%	16.6%	13.2%	37.3%	17.2%	12.7%	11.6%	5.6%	6.5%	12.8%	11.7%	23
Packaged System A/C	All Ranges	61.1%	48.5%	-	-	38.9%	48.5%	-	-	-	-	-	-	3
	0.5 to 0.99	-	-	-	-	100.0%	0.0%	-	-	-	-	-	-	1
	3.5 to 3.9	100.0%	0.0%	-	-	-	-	-	-	-	-	-	-	1
	4.5 to 5	100.0%	0.0%	-	-	-	-	-	-	-	-	-	-	1
Packaged System HP	All Ranges	-	-	100.0%	0.0%	-	-	-	-	-	-	-	-	1
	1.0 to 1.49	-	-	100.0%	0.0%	-	-	-	-	-	-	-	-	1
Split System A/C	All Ranges	41.5%	6.1%	23.1%	5.3%	22.6%	5.2%	6.4%	3.1%	1.7%	1.4%	4.6%	2.6%	182
	0.5 to 0.99	-	-	100.0%	0.0%	-	-	-	-	-	-	-	-	1
	1.5 to 1.99	28.2%	21.9%	39.3%	25.2%	32.5%	24.8%	-	-	-	-	-	-	11
	2.0 to 2.49	47.4%	13.0%	31.0%	12.3%	17.9%	10.2%	0.9%	1.5%	-	-	2.8%	4.5%	43
	2.5 to 2.9	41.3%	13.0%	23.0%	11.1%	21.9%	10.8%	7.1%	6.7%	4.2%	5.0%	2.5%	4.0%	40
	3.0 to 3.49	36.5%	13.4%	21.4%	11.4%	24.5%	12.0%	8.8%	8.0%	-	-	8.8%	8.0%	36
	3.5 to 3.9	68.7%	19.4%	13.6%	14.6%	17.8%	15.7%	-	-	-	-	-	-	16
	4.0 to 4.49	71.1%	28.3%	-	-	-	-	28.9%	28.3%	-	-	-	-	7
	4.5 to 5	56.2%	37.4%	21.9%	31.6%	21.9%	31.6%	-	-	-	-	-	-	5
	Unknown	14.9%	13.0%	16.6%	13.2%	37.3%	17.2%	12.7%	11.6%	5.6%	6.5%	12.8%	11.7%	23
Split System HP	All Ranges	57.7%	20.0%	11.9%	13.0%	30.4%	18.7%	-	-	-	-	-	-	17
	1.5 to 1.99	39.9%	55.8%	-	-	60.1%	55.8%	-	-	-	-	-	-	2
	2.0 to 2.49	73.9%	36.6%	-	-	26.1%	36.6%	-	-	-	-	-	-	4
	2.5 to 2.9	34.0%	34.3%	20.7%	30.4%	45.3%	37.5%	-	-	-	-	-	-	5
	3.0 to 3.49	100.0%	0.0%	-	-	-	-	-	-	-	-	-	-	1
	3.5 to 3.9	55.2%	41.0%	26.0%	36.7%	18.8%	29.0%	-	-	-	-	-	-	4
	4.0 to 4.49	100.0%	0.0%	-	-	-	-	-	-	-	-	-	-	1

Table 111: Size Distributions by Age Range for Central System Types

Table 112 shows the percentage of space cooling systems by type and capacity within age ranges. From the table, we can see that 63.9% of all window/wall units were manufactured between 2000 and 2006.

Space Air Conditioning System Type	Cooling Tons	Age 2000 to 2006		Age 1995 to 1999		Age 1990 to 1994		Age 1985 to 1989		Age 1980 to 1984		Sample Size
		%	EB	%	EB	%	EB	%	EB	%	EB	
Window/Wall Air Conditioner	All Ranges	63.9%	19.2%	12.5%	13.6%	12.0%	13.1%	5.7%	9.2%	5.8%	9.3%	18
	0.5 to 0.99	100.0%	0.0%	-	-	-	-	-	-	-	-	3
	1.0 to 1.49	100.0%	0.0%	-	-	-	-	-	-	-	-	2
	1.5 to 1.99	76.1%	34.6%	-	-	23.9%	34.6%	-	-	-	-	4
	2.0 to 2.49	100.0%	0.0%	-	-	-	-	-	-	-	-	1
	2.5 to 2.9	100.0%	0.0%	-	-	-	-	-	-	-	-	1
	Unknown	28.3%	28.0%	29.6%	28.7%	14.8%	22.4%	13.5%	20.8%	13.7%	21.1%	7

Table 112: 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 137 represents all of the cooling systems that were successfully matched with manufacturer data.

The distribution of SEER range by cooling system type is shown below in Table 113. The greatest amount of combined central system air conditioners are in the 10 to 10.99 SEER range accounting for 68.3% of central systems with a 7.4% error bound.

Efficiency Range	Central							
	All Central Types (n= 137)		Packaged System A/C (n= 2)		Split System A/C (n=124)		Split System HP (n= 11)	
	%	EB	%	EB	%	EB	%	EB
13 or Higher SEER	6.3%	3.3%	63.7%	53.8%	4.6%	3.1%	17.8%	17.2%
12-12.99 SEER	19.1%	6.5%	-	-	16.9%	6.5%	47.0%	28.2%
11-11.99 SEER	6.3%	4.0%	-	-	6.9%	4.3%	-	-
10-10.99 SEER	68.3%	7.4%	36.3%	53.8%	71.6%	7.6%	35.2%	25.1%

Table 113: Distribution of Cooling Systems by SEER/EER ranges and Cooling System Type

The distribution of average SEER values across the system capacity ranges is shown in Table 114: Cooling Systems by Type, Tonnage Range, and Average . The average SEER for capacity range can be observed in this table. For split system units in the range of 2.0 to 2.49 tons, the most saturated capacity range, the average system efficiency is 10.5 with an error bound of 0.3. The most efficient units are packaged central units in the 3.5 to 3.99 range with an efficiency of 13.3. Note however, the small sample sizes for this system and range as well as for other systems with high efficiencies.

Type of Central System	Ton Range	Average SEER	Error Bounds	Sample Size
All Types	1.5 to 1.99	10.4	0.4	11
	2.0 to 2.49	10.6	0.3	51
	2.5 to 2.9	10.9	0.3	35
	3.0 to 3.49	10.8	0.4	20
	3.5 to 3.9	11.3	0.5	15
	4.0 to 4.49	13.1	0.0	2
	4.5 to 5	11.4	1.5	3
Packaged System A/C	3.5 to 3.9	13.3	0.0	1
	4.5 to 5	10.0	0.0	1
Split System A/C	1.5 to 1.99	10.3	0.3	10
	2.0 to 2.49	10.5	0.3	48
	2.5 to 2.9	10.7	0.2	31
	3.0 to 3.49	10.8	0.4	19
	3.5 to 3.9	10.9	0.5	12
	4.0 to 4.49	13.1	0.0	2
	4.5 to 5	11.9	1.6	2
Split System HP	1.5 to 1.99	12.0	0.0	1
	2.0 to 2.49	11.1	1.2	3
	2.5 to 2.9	12.6	1.7	4
	3.0 to 3.49	10.5	0.0	1
	3.5 to 3.9	13.0	0.6	2

Table 114: Cooling Systems by Type, Tonnage Range, and Average Efficiency

The current minimum efficiency standard for split-system air conditioners and packaged systems is a SEER of 13.0 (effective January 2006). The minimum qualifying ENERGY STAR SEER is 14.0 for split-system air conditioners and heat pumps, and packaged system air conditioners and heat pumps. Table 115 shows the average SEER compared with both the previous and recently updated standards. Both comparisons were included because the SEER updates occurred recently. The close correlation in average efficiencies relative to the previous standards reflects the fact that nearly 89% of the units surveyed were installed after 1990.

Type of System	SEER					Sample Size
	Minimum Federal Standard Before 2006 Update	Minimum ENERGY STAR Standard Before 2006 Update	Minimum Federal Standard After 2006 Update	Minimum ENERGY STAR Standard After 2006 Update	Average SEER	
Packaged System	9.7	12	13	14	12.1	2
Split System A/C	10	13	13	14	10.7	124
Split System HP	10	13	13	14	12.1	11

Table 115: Average SEER Standard Comparison

Heating Equipment

This section presents the summary analysis of the primary heating systems found during the site visits. The heating systems 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 is 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. Heat pumps are included in the next several tables due to the fact that the heat pump may be the only

heating system at the home. They are excluded from the efficiency tables due to low efficiency matching rates.

Heating Equipment

Table 116 shows the percentage of homes that have one or more heating system. A large percentage of the homes have at least one heating system, totaling 53.7% of the homes. Interestingly enough though over 30% have at least two heating systems. The percentage of homes is smaller with each additional heating system. For the homes with more than one heating system, the surveyor determined which system was primary and noted it accordingly.

Number of Heating Systems	% of Homes (n=287)	Error Bound
1	53.7%	4.9%
2	30.6%	4.6%
3	9.1%	2.8%
4	3.0%	1.7%
5 or more	3.5%	1.8%

Table 116: Percentage of Homes with Heating System

Table 117 shows the primary heating system type among all houses with heating system types. The majority of all primary heating systems were found to be forced air furnaces, totaling just below 90% 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= 287)		% of Primary Heating Types	Error Bounds
Central	Common - Shared Heating	0.4%	0.6%
	Forced Air Furnace	87.0%	3.3%
	Heat Pump w/Elec. Supp	4.1%	1.9%
	Heat Pump w/out Elec. Supp	0.6%	0.7%
	Hydronic System	0.9%	0.9%
Space	Baseboards	2.6%	1.5%
	Fireplace	0.2%	0.4%
	Floor	0.8%	0.9%
	Portable	0.2%	0.4%
	Wall Unit w/Fan	2.1%	1.4%
	Wall Unit w/out Fan	0.8%	0.9%
	Woodstove	0.4%	0.6%

Table 117: Percentage of Primary Heating Types by Type of System

Table 118 shows the percentage of heating systems by fuel type and system type. These fuel types were taken from the surveyor information. Among all the system types found, the vast majority consumed natural gas. Just over 20% of all primary heating systems consumed electricity. Interestingly, among all forced air furnaces, nearly 85% consumed natural gas.

System Type		Fuel Type								Sample Size
		Gas		Electricity		Propane		Wood		
		%	EB	%	EB	%	EB	%	EB	
All Types		77.8%	4.1%	20.3%	4.0%	1.1%	1.0%	0.7%	0.9%	287
Central	All Central	80.4%	4.1%	18.1%	4.0%	1.2%	1.1%	0.4%	0.7%	266
	Forced Air Furnace	84.8%	3.9%	13.5%	3.7%	1.3%	1.2%	0.4%	0.7%	248
	Heat Pump w/Elec. Supp	-	-	100.0%	-	-	-	-	-	12
	Heat Pump w/out Elec Supp	-	-	100.0%	-	-	-	-	-	2
	Hydronic System	59.0%	50.7%	41.0%	50.7%	-	-	-	-	3
	Common-Shared Heating	100.0%	-	-	-	-	-	-	-	1
Space	All Space	44.2%	18.3%	50.8%	18.4%	-	-	5.0%	8.1%	21
	Baseboards	-	-	100.0%	-	-	-	-	-	8
	Fireplace	100.0%	-	-	-	-	-	-	-	1
	Floor	100.0%	-	-	-	-	-	-	-	2
	Portable	-	-	100.0%	-	-	-	-	-	1
	Wall Unit w/Fan	64.1%	33.0%	35.9%	33.0%	-	-	-	-	6
	Wall Unit w/out Fan	100.0%	-	-	-	-	-	-	-	2
	Woodstove	-	-	-	-	-	-	100.0%	-	1

Table 118: Percentage of Heating Systems by Fuel Type within Type of Heating System

Table 119 shows the average estimated age of each type of heating system, and the percentage of each type of heating systems in various manufacture date 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. On average, forced air furnaces were 13.1 years old.

System Type		Manufactured Date and Estimated Manufactured Date Ranges														Sample Size
		Avg Mfr Age	Avg Mfr Age EB	2000 to 2006		1995 to 1999		1990 to 1994		1985 to 1989		1980 to 1984		1979 and older		
				%	EB	%	EB	%	EB	%	EB	%	EB	%	EB	
All Types		12.8	1.2	38.0%	5.4%	18.2%	4.3%	15.1%	4.0%	12.1%	3.6%	3.1%	1.9%	13.5%	3.8%	229
Central	All Central	12.8	1.3	38.1%	5.6%	17.4%	4.4%	16.3%	4.3%	11.9%	3.8%	2.8%	1.9%	13.5%	4.0%	212
	Forced Air Furnace	13.1	1.4	37.8%	5.8%	16.8%	4.5%	16.9%	4.5%	11.1%	3.8%	3.1%	2.1%	14.3%	4.2%	197
	Heat Pump w/Elec Supp	9.4	3.9	43.2%	27.1%	10.7%	16.7%	11.7%	18.0%	34.3%	26.2%	-	-	-	-	9
	Heat Pump w/out Elec Supp	7.0	0.0	-	-	100.0%	0.0%	-	-	-	-	-	-	-	-	2
	Hydronic	6.7	8.1	85.2%	25.5%	-	-	-	-	-	-	-	-	14.8%	25.5%	3
	Common- Shared Heating	10.0	0.0	-	-	100.0%	-	-	-	-	-	-	-	-	-	1
Space	All Space	13.1	4.6	35.7%	19.6%	29.2%	18.8%	-	-	15.3%	14.0%	7.0%	11.1%	12.8%	13.9%	17
	Baseboards	21.1	0.0	27.7%	28.2%	5.8%	9.8%	-	-	17.4%	25.6%	17.4%	25.6%	31.8%	30.3%	7
	Fireplace	20.0	0.0	-	-	-	-	-	-	100.0%	0.0%	-	-	-	-	1
	Floor	8.0	0.0	-	-	100.0%	0.0%	-	-	-	-	-	-	-	-	1
	Portable	1.0	0.0	100.0%	0.0%	-	-	-	-	-	-	-	-	-	-	1
	Wall Unit w/Fan	6.2	3.8	66.3%	34.1%	20.7%	30.4%	-	-	12.9%	20.7%	-	-	-	-	5
	Wall Unit w/out Fan	8.0	0.0	-	-	100.0%	0.0%	-	-	-	-	-	-	-	-	1
	Woodstove	10.0	0.0	-	-	100.0%	0.0%	-	-	-	-	-	-	-	-	1

Table 119: Average Estimated Age and Percentage of Heating System by Type within Age Ranges

Table 120 shows the percentage of all furnaces by fuel type and capacity range. 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. Over 30% of all units were gas units between 70 and 84.99 kBtu. The second largest percentage of furnaces was gas units between 55 and 69.99 kBtu.

Capacity Ranges (n= 161)		% of Furnaces with Capacity	Error Bound
Gas (kBtuh)	10 to 24.99	0.7%	1.1%
	25 to 39.99	1.3%	1.4%
	40 to 54.99	14.6%	4.6%
	55 to 69.99	27.8%	5.9%
	70 to 84.99	32.1%	6.2%
	85 to 99.99	10.0%	4.0%
	100 to 114.99	4.9%	2.9%
	115 to 129.99	1.7%	1.7%
Electric (kW)	1 to 2.99	2.2%	1.9%
	5 to 6.99	0.6%	1.1%
	7 to 8.99	1.3%	1.5%
	9 or Greater	2.7%	2.2%

Table 120: Percentage of All Furnaces with Capacity by Fuel Type within Capacity Ranges

Table 121 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 for central systems is significantly higher than the AFUE for all space heat systems at 82.1 and 61.7, respectively.

System Type	All Types	Central				Space		
		All Central	Forced Air Furnace	Hydronic System	Common-Shared Heating	All Space	Floor	Fireplace
Average AFUE	81.8	82.1	82.1	87.1	65.0	61.7	60.0	63.8
Error Bound	1.2	1.2	1.2	8.0	0.0	2.2	0.0	0.0
Sample Size	156	154	151	2	1	2	1	1

Table 121: Average AFUE by System Type

Table 122 shows the percentage of heating systems with an AFUE by type and AFUE range. The large majority of the forced air furnaces have an AFUE between 78 and 84.99.

AFUE Range	Central										Space					
	All Types (n=156)		All Central (n=154)		Forced Air Furnace (n= 151)		Hydronic System (n=2)		Common- Shared Heating (n= 1)		All Space (n= 2)		Fireplace (n= 1)		Floor (n= 1)	
	%	EB	%	EB	%	EB	%	EB	%	EB	%	EB	%	EB	%	EB
<78	9.2%	4.6%	8.2%	4.5%	7.7%	4.5%	-	-	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%
78 to 84.99	63.4%	7.1%	64.2%	7.1%	64.7%	7.1%	51.6%	58.1%	-	-	-	-	-	-	-	-
85 to 89.99	0.8%	1.4%	0.9%	1.4%	0.9%	1.4%	-	-	-	-	-	-	-	-	-	-
90 to 96	26.5%	6.2%	26.8%	6.2%	26.7%	6.3%	48.4%	58.1%	-	-	-	-	-	-	-	-

Table 122: Percentage of Heating Systems by Type within AFUE Ranges

Table 123 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			
Type	**Minimum Federal Standard**	**Minimum Energy Star Standard**	**Average AFUE**
Gas Forced Air Furnace	78	90	82.1

Table 123: Average AFUE Standard Comparison

Table 124 shows the distribution of gas forced air furnace AFUE. The gas furnaces in our sample are above the current minimum efficiency standards.

AFUE Range				Sample Size
Type	**<78**	**78.00 to 84.99**	**90 to 96**	
Gas Forced Air Furnace	7.7%	64.7%	0.9%	151

Table 124: AFUE 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 was 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.

Windows

Figure 9 shows the breakdown of window frame types among all homes. The majority of window frame types found in homes are vinyl, constituting nearly 50% of the homes.

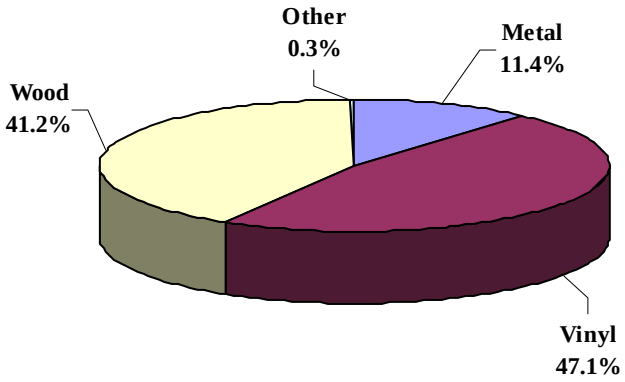

Figure 9: Percentage of Homes by Window Frame Type

Table 125 shows the breakdown of homes by window frame type and type of panes by type of residence. More than half of all the homes have wood or vinyl double paned windows, with 100% of 'modular/prefabricated' homes having this combination. Over 60% of 1 to 2-story unattached single-family homes and 50% of 3-story homes have the wood or vinyl double pane combination.

Type of Residence	Window and Pane Type														Sample Size
	Metal Single		Metal Double		Metal Triple		Wood or Vinyl Single		Wood or Vinyl Double		Wood or Vinyl Triple		Other Double		
	%	EB	%	EB	%	EB	%	EB	%	EB	%	EB	%	EB	
Overall	5.5%	2.3%	5.5%	2.3%	0.4%	0.6%	25.3%	4.3%	62.1%	4.8%	0.9%	0.9%	0.3%	0.4%	287
Modular/Prefabrication	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	4
Single Family Attached	20.1%	17.0%	25.8%	18.2%	0.0%	0.0%	10.7%	12.2%	43.4%	20.5%	0.0%	0.0%	0.0%	0.0%	16
Single Family Unattached (1 story)	5.7%	2.9%	4.6%	2.6%	0.6%	1.0%	24.7%	5.3%	62.5%	6.0%	1.4%	1.4%	0.6%	0.7%	182
Single Family Unattached (2 stories)	2.8%	3.2%	4.1%	3.8%	0.0%	0.0%	28.5%	8.6%	64.6%	9.1%	0.0%	0.0%	0.0%	0.0%	77
Single Family Unattached (3 stories)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	50.0%	29.1%	50.0%	29.1%	0.0%	0.0%	0.0%	0.0%	8

Table 125: Percentage of Homes by Frame Type and Panes Type by Type of Residence

Table 126 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, 97% of homes built between the years 2000-2006 have wood or vinyl framed double paned windows.

Age of Residence	Window and Pane Types														Sample Size
	Metal Single		Metal Double		Metal Triple		Wood or Vinyl Single		Wood or Vinyl Double		Wood or Vinyl Triple		Other Double		
	%	EB	%	EB	%	EB	%	EB	%	EB	%	EB	%	EB	
Overall	5.5%	2.3%	5.5%	2.3%	0.4%	0.6%	25.3%	4.3%	62.1%	4.8%	0.9%	0.9%	0.3%	0.4%	287
1950 or Earlier	0.0%	0.0%	1.9%	3.1%	0.0%	0.0%	55.6%	11.0%	42.5%	10.9%	0.0%	0.0%	0.0%	0.0%	58
1951-1955	10.2%	11.7%	6.5%	10.3%	0.0%	0.0%	19.0%	16.3%	57.9%	20.4%	6.5%	10.3%	0.0%	0.0%	16
1956-1960	15.4%	13.4%	5.1%	8.2%	0.0%	0.0%	20.3%	14.8%	59.2%	18.0%	0.0%	0.0%	0.0%	0.0%	21
1961-1965	14.5%	12.7%	4.8%	7.7%	0.0%	0.0%	38.3%	17.5%	38.1%	17.4%	4.4%	7.1%	0.0%	0.0%	21
1966-1970	14.9%	15.9%	4.2%	6.8%	0.0%	0.0%	44.4%	22.0%	36.6%	21.4%	0.0%	0.0%	0.0%	0.0%	14
1971-1975	8.5%	9.4%	12.5%	11.1%	4.1%	6.7%	23.3%	13.2%	51.5%	16.2%	0.0%	0.0%	0.0%	0.0%	27
1976-1980	11.3%	12.8%	6.4%	10.1%	0.0%	0.0%	6.9%	10.9%	73.2%	18.0%	2.3%	3.8%	0.0%	0.0%	17
1981-1985	9.7%	15.1%	9.7%	15.1%	0.0%	0.0%	6.4%	10.4%	68.3%	22.7%	0.0%	0.0%	5.9%	9.6%	11
1986-1990	0.0%	0.0%	20.6%	16.0%	0.0%	0.0%	10.4%	11.9%	68.9%	18.3%	0.0%	0.0%	0.0%	0.0%	18
1991-1995	0.0%	0.0%	3.7%	6.0%	0.0%	0.0%	6.5%	10.3%	89.8%	11.7%	0.0%	0.0%	0.0%	0.0%	17
1996-2000	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	5.4%	8.6%	92.8%	9.0%	0.0%	0.0%	1.8%	3.0%	23
2001-2006	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.9%	4.7%	97.1%	4.7%	0.0%	0.0%	0.0%	0.0%	36
Unknown	0.0%	0.0%	13.4%	20.4%	0.0%	0.0%	47.7%	29.3%	38.9%	28.8%	0.0%	0.0%	0.0%	0.0%	8

Table 126: Percentage of Homes by Frame Type and Panes Type by Age of Residence

Table 134 shows the percentage of homes by glazing characteristics and age of residence. Low-e glazing constitutes 9% of the overall window glazing. The residences built between 2000 and 2006 had the highest percentage of low e glazing, 36.3%. This is probably due to renovation activity in older homes that included window upgrades.

Age of Residence	Window Glazing Characteristics						Sample Size
	Low E Glazing		Clear Glazing		Unknown Glazing		
	%	EB	%	EB	%	EB	
Overall	9.0%	2.9%	71.3%	4.5%	19.6%	3.9%	287
1950 or Earlier	3.6%	4.1%	85.0%	8.0%	11.4%	7.2%	58
1951-1955	6.5%	10.3%	80.6%	16.5%	12.9%	14.0%	16
1956-1960	5.1%	8.2%	67.6%	16.9%	27.2%	16.0%	21
1961-1965	4.8%	7.7%	81.7%	13.7%	13.5%	12.0%	21
1966-1970	0.0%	0.0%	92.7%	11.6%	7.3%	11.6%	14
1971-1975	0.0%	0.0%	83.4%	12.4%	16.6%	12.4%	27
1976-1980	13.9%	14.9%	64.5%	19.7%	21.5%	16.4%	17
1981-1985	0.0%	0.0%	48.9%	25.2%	51.1%	25.2%	11
1986-1990	19.0%	16.1%	62.1%	19.7%	19.0%	16.1%	18
1991-1995	0.0%	0.0%	64.5%	19.4%	35.5%	19.4%	17
1996-2000	10.7%	11.7%	62.5%	17.5%	26.7%	15.8%	23
2001-2006	36.3%	13.6%	40.5%	13.7%	23.2%	11.6%	36
Unknown	0.0%	0.0%	87.8%	18.9%	12.2%	18.9%	8

Table 127: Percentage of Homes by Glazing Type and Age Range

Walls

Figure 10 shows the breakdown of all homes by wall construction type. The large majority of homes were constructed using 2 x 4s, totaling over 75% of all homes.

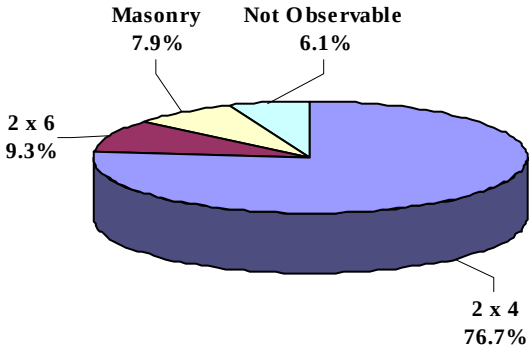

Figure 10: Percentage of Homes by Wall Construction Type

Insulation

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

Attic

The average R-Value among all homes with an estimated or verified R-Value for attic insulation is 25.7 with an error bound of 1.6. Table 128 shows the average R-Value and the percentage of homes with R-Values in ranges by age of residence. The largest percent of homes have R-Values greater 37.99, totaling 22.9%. The second largest percent of homes have R-Values between 22 and 29.99. Approximately 4% of the homes have no attic insulation.

In the event that the surveyor 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 surveyor 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 Error Bounds	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
			%	EB	%	EB	%	EB	%	EB	%	EB	%	EB	%	EB	
Overall	25.7	1.6	3.6%	2.5%	5.5%	3.1%	14.4%	4.6%	17.8%	5.1%	22.6%	5.6%	13.2%	4.4%	22.9%	5.5%	163
1950 or Earlier	20.8	4.0	10.3%	8.5%	9.4%	8.5%	21.5%	11.4%	17.8%	10.9%	14.8%	10.1%	6.4%	7.2%	19.9%	11.2%	35
1951-1955	19.5	6.1	-	-	11.7%	18.0%	46.7%	27.7%	18.3%	20.3%	-	-	11.7%	18.0%	11.7%	18.0%	9
1956-1960	24.2	5.6	-	-	21.8%	18.2%	11.7%	13.2%	18.9%	16.6%	14.1%	15.2%	4.8%	7.8%	28.8%	19.8%	15
1961-1965	30.4	5.1	7.7%	12.2%	-	-	-	-	7.9%	12.5%	31.3%	21.3%	22.8%	19.1%	30.2%	20.9%	13
1966-1970	17.8	11.8	32.7%	44.3%	-	-	-	-	-	-	67.3%	44.3%	-	-	-	-	3
1971-1975	31.3	5.1	-	-	-	-	8.3%	13.0%	34.4%	22.6%	5.1%	8.3%	14.4%	16.0%	37.9%	22.8%	13
1976-1980	28.4	4.5	-	-	-	-	11.6%	17.8%	22.3%	22.7%	34.7%	26.0%	13.2%	14.9%	18.2%	20.0%	10
1981-1985	25.1	6.3	-	-	-	-	26.6%	27.4%	17.3%	25.6%	17.3%	25.6%	17.3%	25.6%	21.4%	23.3%	7
1986-1990	20.7	6.8	-	-	16.8%	25.0%	5.6%	9.5%	33.6%	31.2%	27.2%	28.1%	16.8%	25.0%	-	-	7
1991-1995	27.6	4.7	-	-	-	-	10.2%	15.8%	20.4%	21.0%	36.4%	24.4%	16.0%	17.9%	17.0%	18.5%	11
1996-2000	29.0	3.2	-	-	-	-	-	-	17.7%	18.5%	53.5%	23.0%	8.3%	9.9%	20.5%	17.3%	14
2001-2006	30.2	2.9	-	-	-	-	13.8%	12.1%	7.2%	8.4%	22.3%	14.6%	26.1%	15.2%	30.6%	16.0%	23
Unknown	23.2	11.7	-	-	-	-	34.3%	45.4%	34.3%	45.4%	-	-	-	-	31.4%	43.4%	3

Table 128: 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 7.3%, while the percentage of homes in which all the exterior walls are insulated totals 62.7% of the homes.

Construction Type	Percentage of Walls Insulated										Sample Size
	0%		50%		75%		100%		Unknown		
	%	EB	%	EB	%	EB	%	EB	%	EB	
All Types	7.3%	2.6%	0.4%	0.6%	0.4%	0.6%	62.7%	4.8%	29.3%	4.5%	287
2x4	5.7%	2.6%	0.5%	0.8%	-	-	69.3%	5.2%	24.5%	4.9%	222
2x6	8.3%	9.2%	-	-	-	-	65.6%	15.3%	26.1%	14.1%	28
Masonry	12.6%	11.6%	-	-	4.9%	7.8%	33.7%	17.1%	48.8%	18.0%	21
Unknown	9.1%	14.3%	-	-	-	-	8.5%	29.7%	82.3%	18.7%	11
Other	39.1%	35.8%	-	-	-	-	20.3%	13.4%	40.6%	36.2%	5

Table 129: Percentage of Homes by Wall Construction Type by Percentage of Walls Insulated

Table 130 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. Nearly 90% of the homes have some type of wall insulation.

Type of Residence	% of Homes	Error Bound	Sample Size
Overall	89.7%	3.6%	207
Modular/Prefabrication	100.0%	0.0%	4
Single Family Attached	100.0%	0.0%	6
Single Family Unattached (1 story)	90.4%	4.2%	135
Single Family Unattached (2 stories)	85.5%	8.0%	58
Single Family Unattached (3 Stories)	100.0%	0.0%	4

Table 130: 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 63% of the homes surveyed are slab on grade. Among the other homes, over 91% have no floor insulation.

Floor R-Value (n= 65)	%	EB
< R-11	1.6%	2.6%
Floor R-11	3.5%	4.0%
Floor R-13	-	-
Floor R-19	3.1%	3.6%
No Insulation	91.8%	5.8%

Table 131: Percentage of Homes with Floor R-Values within R-Value Sizes

Pool and Spa

The following section describes the pools and spas found at the residences. Information on the fuel type, pump horsepower, and pump efficiency were recorded during the site visit. However, surveyors found this data very difficult to access and record given the project time limitations along with various access issues. Of course, the overall lack of data is compounded by a low overall saturation of homes with pools and spas. This report examined fuel type for both pools and spas, and pump horsepower for pools. Due to a small sample size and difficulty in matching with databases, the pump efficiency data is not presented in this report.

Pool and Spas

Only one site visited had a below ground swimming pool and was heated with gas. This being the case, there are no general conclusions that can be drawn. Roughly 4% of homes in the Collaborative service territories have a spa. As Figure 11 illustrates, nearly 90% of all spas are electrically powered.

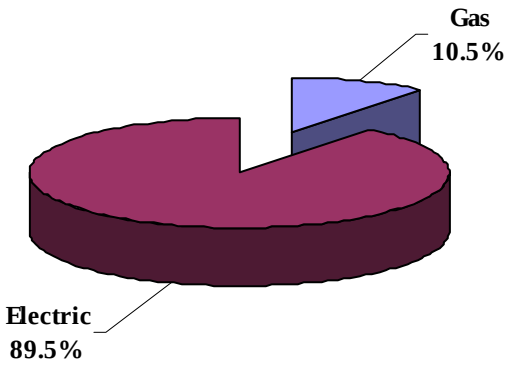

Figure 11: **Percentages of Spas by Fuel Type**