What types of Appliances and Lighting are being used in California Residences?

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Abstract
In 2000, RLW Analytics, Inc. conducted the California Statewide Residential Lighting and Appliance Saturation Study (CLASS). The study included 1,250 on-site surveys representing all types of residential housing (with the exception of master-metered multifamily housing) throughout the state of California. The purpose of the study was to understand baseline levels of appliance and lighting saturation and efficiencies in the existing residential sector. The study collected data on the types and efficiencies of major appliances, HVAC equipment, lighting saturations and wattages, and housing characteristics (e.g., window type, insulation levels, etc.).
In 2005, RLW completed another 1,000 residential surveys for a 2005 update to the original 2000 CLASS. Identical data were collected in order to allow RLW to conduct trend and comparison analyses of saturations and efficiencies between the two CLASS studies and to other studies of residential appliances. This paper discusses how the study was designed and implemented, as well as some reasons for and conjecture on some of they key trends.

Study Goals
The 2005 California Statewide Lighting and Appliance Efficiency Saturation Study (CLASS) is a follow-on study to the 2000 Statewide Lighting and Appliance Efficiency Saturation Study. Each of these studies were paid for by Public Purpose funds for the purpose of understanding current levels of appliance and lighting saturation and efficiencies in the existing residential sector.
Subsequent to the 1999-2000 study, a tremendous amount of Public Purpose funds were invested in energy conservation programs that served customers of the four California investor owned utilities. These Public Purpose dollars were invested in a multitude of ways, all with the goal of achieving lasting energy savings in California's energy markets. The overarching goals of the 2004-05 update study was to provide revised baselines of saturation and efficiency characteristics for use in understanding future energy savings potential and past accomplishments in the residential sector.

The four primary objectives of this study were:

Objective 1: Complete 850 onsite surveys of single-family, multi-family and modular homes in the service territories of the four California Investor Owned Utilities (IOUs) (another 250 sites were completed for a California municipal utility).

Objective 2: Develop a database of residential building characteristics, lighting and appliance saturations and efficiencies, expanded to represent the population of IOU customers.

Objective 3: Develop a web-based tool to provide utility staff and other parties the ability to conduct "what-if" scenario analyses on the data collected.

Objective 4: Conduct trend and comparison analyses of saturations and efficiencies between the two California Statewide Lighting and Appliance Saturation and Efficiency Studies, in addition to a comparison of results between the Residential Market Share Tracking Study (RMST) and the 2003 Residential Appliance Saturation Study (RASS).

The following sections describe how these objectives were achieved.

Methodology

An evenly distributed sample of residential accounts was selected for each utility for each residential rate class offered by the four participating IOUs. Customers were recruited to participate in the study by phone, and each participant was paid $25.00 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 850 on-site surveys were completed between November 2004 and May 2005.
While on-site, the surveyors collected data on the major appliances and lighting systems in the home. The surveyors collected nameplate data for eight major appliances: Refrigerator-Freezers, Self-standing Freezers, Dishwashers, Clothes Washers, Clothes Dryers, Water Heaters, Heating Equipment, Spa/Pool Equipment and Cooling Equipment. The surveyors collected lamp, fixture and wattage data for each lighting fixture within the home, as well as the front porch fixture. The on-site surveyors also collected data on attic, floor and wall insulation R-values, wall construction, and window type. 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 more. 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 1 presents each appliance for which we collected data in 2004-05. The table contains the following data in the column order 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,
7. Percentage of matched model numbers among **all** appliances recorded.

For example, we recorded the presence 848 refrigerators. During the on-site surveys, the surveyors were able to locate model numbers for 773 of those refrigerators. Seventy-five of the 848 (9%) 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, only 530 of the 773 (69%) 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 (848) that were successfully matched (530), which for refrigerators was 63%. 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.

Table 1: 2005 Model Number Match Rates by Appliance

2005	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	848	773	530	69%	9%	63%
Secondary Refrigerators	160	119	70	59%	26%	44%
Cooling Overall	490	266	167	63%	46%	34%
Cooling Packaged	99	47	34	72%	53%	34%
Cooling Split	230	188	118	63%	18%	51%
Cooling Win/Wall	65	15	6	40%	77%	9%
Clothes Dryer	680	644	21	3%	5%	3%
Heat Pump	27	13	10	77%	52%	37%
Heating	809	400	233	58%	51%	29%
Primary Freezer	164	109	51	47%	34%	31%
Dishwasher	583	559	148	26%	4%	25%
Washing Machine	696	602	106	18%	14%	15%
Water Heater	848	564	276	49%	33%	33%

Based upon our experience with the 2000 study, we anticipated in the design stages of the project that the match rates would approximate what are shown in the tables and graphs 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 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 state of California 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 were not in the best condition, and somewhat partial in content.
It is important to understand that the appliance and equipment efficiency findings presented in this report do not account for degradation. 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 slightly higher than the actual efficiency, as equipment in this study operated under different conditions than the manufacturer compliance testing.
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 "slice and dice" the data from the 2000 and 2005 studies. The California Residential Efficiency Saturation Tool (CALRES^{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.calresest.com.

Sampling Plan
RLW utilized a proportionally allocated sampling plan to select the surveyed homes for inclusion in the study. The table below shows the number of residences served by SCE, SDG&E, PG&E, and SMUD as well as the sample allocation by utility.

Table 2: Sample Size by Utility

Utility	Population	Planned Sample	Actual Sample (Appliance)	Actual Sample (Lighting)
SCE	3,907,843	355	354	353
SDG&E	1,085,981	100	99	99
PG&E	4,196,869	395	395	395
SMUD	504,303	225	225	224
Total	**9,694,996**	**1,075**	**1,073**	**1,071**

For SCE, SDG&E, and PG&E, we allocated the sample by rate class for each utility by the proportion of the number of accounts in each rate class. The sample includes at least one site from every rate class. SMUD added funding for surveys after the statewide sample was designed and the project was underway, therefore their sample is not in proportion to the other utility sample sizes. SMUD data were analyzed separately from the three IOUs and the results in this paper do not include SMUD data.

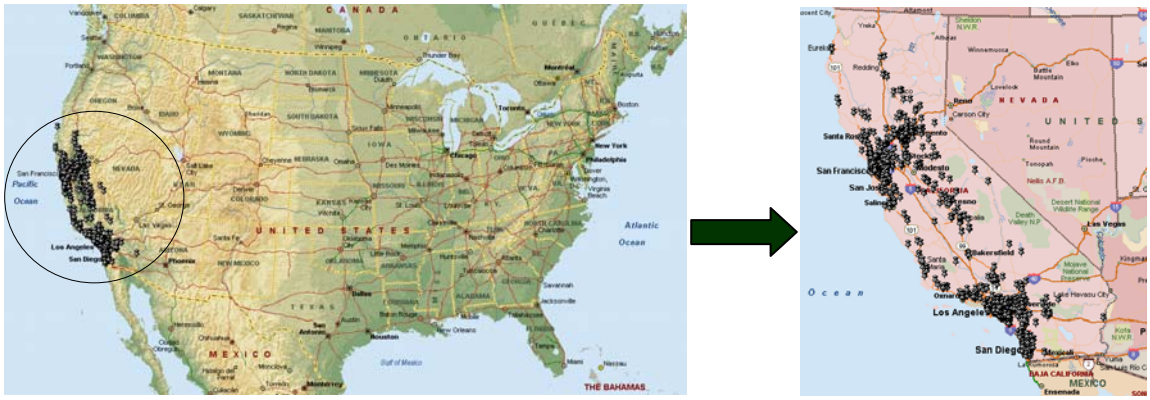

Figure 1: Statewide Final Sample Location

Data Collection

The data collection component of the study was highly resource intensive, taking about seven months to complete. The bulk of the on-sites were completed between mid-January and April 2005. Customers were recruited by geographic location. 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, 1075 sites were recruited to participate in the study.

Each customer selected for the study received a letter from their utility provider before they were contacted by the recruiters. 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 improved the overall completion rate from the previous study. The recruiters attempted to contact each customer a maximum of five times. If unsuccessful after the fifth call, the customer was replaced with a back-up customer and the site was designated 'unable to contact'. The statewide completion rate was 28%.

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:

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.

1. The residents were asked for the age of each appliance. If the resident did not know the age of the appliance, the surveyor would estimate the age or the appliance whenever possible.
2. 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, refrigerator/freezer compartment configuration (freezer on top, freezer on bottom, etc), among others.
3. Fuel types, such as electricity, natural gas or propane for heating systems, washing machines and water heaters were noted from visual inspection.
4. The manufacturer, model number and size were taken from nameplate data when observable. If possible, sizes of some appliance were estimated in the case of missing, or unreadable data tags.
5. Residents were asked to estimate the percentage of time in use for refrigerators and freezers to establish seasonal usage.
6. 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, as opposed to just for the porch fixtures in the previous 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 was noted, as was the number of panes found of the predominant window type. Low-E detectors were used to determine whether the window had a Low-E glazing.

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:
1. Type of residence
2. Number of residents by age
3. Primary language of residents
4. Total annual income for the home
5. Year residence was built
6. Total heated floor space of the home
7. 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)
8. Are there plans to remodel in the future
9. Whether the residence is rented or owner occupied
10. If rented, the party responsible for the utility bills, (owner or renter)

These following results summarize some demographics of the sampled homes. Over 45% of all the residences surveyed are single family, unattached, 1-story dwellings. The second most commonly visited type of residence was single family, unattached, 2 story housing, totaling 19.7% of the sample. The largest percentage of homes, or 32.7% of homes, 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 2.8 people. Not surprisingly, English was the primary language spoken at over 83% of the homes. Spanish was the second most common language, with over 10% of all respondents speaking Spanish as their primary language. The largest percentage of surveyed residents has an annual income between $25,000 and $50,000, totaling 21.5% of the sample. Almost one-third of the homes surveyed were between 1,000 to 1,599 SQFT.

Key Findings

In this section we summarize some of the more interesting findings occurring at the statewide level. Findings are grouped 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 section is a comparison of the 2005 CLASS results to the 2003 Residential Appliance Saturation Study (RASS) and the most recent Residential Market Share Tracking (RMST) study. Overall, results from these studies seem to validate the majority of the 2005 CLASS study findings. In addition, the following section provides a comparison of the 2005 CLASS results to the 2000 CLASS results. Additionally, some of the interior lighting results are also compared with 2005 Residential CFL metering Study. Some very interesting trends that have occurred over the past 5 years are highlighted in that section.

Lighting
Data were gathered on all fixtures in the home and for the porch light. 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 2005 study included wattage data collection, whereas the 2000 study did not. All in all, 90% of wattage data were obtained.

Number of fixtures and lamps - The 2005 study shows an overall increase in the number of fixtures and lamps per home. Up from 20 fixtures and 34 lamps in 2000, current estimates show that, on average, homes now have 23 fixtures and 41 lamps.

Fixtures with a compact fluorescent (CFL) – On average, 11% of all fixtures have at least one CFL; this is up from less than 1% in 2000. Although ceiling mounted fixtures are the most common fixture type, floor and table lamps are most likely to contain a CFL.

Saturation of CFLs – The percentage of CFLs among all lamps has increased since the previous finding less than 1% of lamps were CFL; the current findings reveal this number has increased to nearly 9%. Of the numerous types of CFLs, spring lamp styles are the most common. In terms of homes with CFLs, 57% of all homes have one or more CFLs installed, as compared to the 2003 Residential Appliance Saturation Study (RASS) which found that 51% of all homes contained at least one CFL and compared to the 2000 CLASS study which found that 12% of all homes contained at least one CFL.

Location of CFLs – The most common room type to have a CFL are living rooms and bedrooms. About 24% of living rooms and 20% of master bedrooms and bedrooms contain a CFL. Dining rooms are least likely to contain a CFL, perhaps due to the higher preponderance of fixtures (e.g., chandelier, dimmer controls) that do not easily accommodate CFLs.
According to the CFL Metering Study (KEMA, 2005), 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 room most likely (24% of homes) to contain a CFL.

Average Lamp Wattages – The average wattage for incandescent A-type lamps is 64 watts, while the average wattage for spring type CFLs is 18 watts. The CFL Metering Study (KEMA, 2005) found that more than 90 percent of CFLs installed in residences are in the 13-to-26-Watt range and have screw-in bases and integrated ballasts, they also found that the *most common* wattage range is 13-17 watts, similar to RLW's finding of 18 watts.

Refrigerators
Data were gathered for primary, secondary, and tertiary refrigerators. Since the last study, the number of homes with secondary refrigerators has slightly increased, up 5% from the previous finding of 14%. Only 1% of homes have a third refrigerator.

Primary Refrigerator Age – Previously, the 2000 CLASS study found that 34% of all refrigerators were reported to be 16-30 years old; in the 2005 study we found a tremendous reduction in primary refrigerators of this age, new findings suggest that only 5% are 16-30 years old. This is likely due in part to the aggressive refrigerator recycling and rebate campaigns offered by the IOUs. Based on manufacturer data obtained through the model number matching process, the overall (groups all types of refrigerators) average age of refrigerators is 6.6 years. This compares closely to the self-reported age data, which estimates the overall average age to be 7.4 years old. Previously, the average age of primary refrigerators was estimated to be 9 years old.

Primary Refrigerator Nameplate Unit Energy Consumption (UEC) – The overall average nameplate UEC for primary refrigerators is 721 kWh/year. This estimate is down from a nameplate UEC of 913 kWh/year in 2000. This equates to a 21% efficiency improvement. These encouraging results are likely due to new federal energy standards and utility rebate and recycling programs.

ENERGY STAR Qualified – Overall, 7% of all primary refrigerators qualify with the 2004 ENERGY STAR standards, while 23% of all refrigerators meet or exceed the 2001 ENERGY STAR standards. In 2000, only 1% of refrigerators met the 2001 ENERGY STAR standards. These findings suggest a significant boost in the adoption rate of ENERGY STAR refrigerator products by consumers. This is likely due, in part, to ENERGY STAR promotional campaigns and incentive programs aimed at achieving a greater market share of ENERGY STAR qualifying products.

Age and Efficiency of Secondary Refrigerators – In 2000 the average age of secondary refrigerators was 13 years, the current estimate is nine years old. In terms of nameplate UEC, the

2000 study estimated that secondary refrigerators use 1,034 kWh/yr, the 2005 findings estimated secondary refrigerators use about 731 kWh/yr, a 29% reduction in annual energy consumption. On average, secondary refrigerators are 3 cubic feet smaller than primary refrigerators (22 vs. 19).

Self Standing Freezers
Nearly 19% of homes have a self-standing freezer for food storage. This finding is up 2% from the previous study. Upright freezers constitute the majority of freezer types (65%); chest style freezers make up the rest. Freezers have on average 13 cubic feet of storage space, and upright freezers tend to have twice the storage space when compared to chest type freezers.
Freezers do appear to be consuming less energy when compared to the previous study findings. Currently, 16% of freezers use 10% or less energy than the 2001 federal freezer standards, compared to 2000 when 9% of freezers consumed 10% or less energy than the 1993 federal standards. This is likely directly correlated to the finding that the overall average age of freezers has decreased from 14 years to 12 years.

Clothes Washers
The amount of homes with a clothes washer remains virtually unchanged; up 3% from 2000, it is now estimated that 82% of all homes have a clothes washer. Washers are least common in apartment buildings, where about 35% of individual dwelling units have a washing machine.

Clothes Washer Type – Nine percent of all machines are horizontal-axis, the remaining 91% 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 Californians.

Clothes Washer Age – Fifty-six percent of washing machines are less than five years old, while 80% are less than ten years old. The average washing machine age is 6.7 years old, as compared to 2000 when the average age was estimated to be 7.4 years.

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, therefore we continue to present efficiency in terms of EF.
The average EF for standard washing machines is 1.22, closely related to the 2000 finding of 1.26. Horizontal-axis units have an average EF of 4.13, an improvement over the 2000 findings of 3.95.

Clothes Dryers
Overall, 80% of homes have a clothes dryer. As one would expect, this saturation estimate closely compares to the saturation of washing machines. Clothes dryer fuel saturation remains virtually unchanged from the previous study; findings indicate that 57% are gas, 41% are electric and less than 2% are propane. The average age of clothes dryers is 7.6 years old, compared to 2000 when the average age was 8.4 years. Dryer efficiencies were not summarized since dryer efficiency databases continue to be scarce and incomplete.

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. This finding remains unchanged from the previous study. However, a slight emergence of instantaneous natural gas systems was identified, 1.4% of homes have one of these systems, whereas previously this system type had virtually no market share.

Water Heater Efficiency – The average energy factor (EF) for 40 gallon gas water heaters (the most common type) is 0.58, compared to the previous finding of 0.57. This compares closely to the current federal standard for 40 gallon systems of 0.58. The average EF for electric water heaters remains unchanged from the previous study at 0.89.

Water Heater Age – The average age of water heaters has dropped somewhat, from 9 years old five years ago to 7 years old currently. This finding explains the slight increase in efficiency, since newer systems are generally more energy efficient than older systems.

Cooling Systems
As in the previous study, the 2005 results confirm that about half (53% in 2005, 52% in 2000) of all homes have some type of cooling system. The majority of cooling systems are central systems, 86%, up 8% from five years ago, which found that 78% of all cooling systems to be central. As a result, the saturation of space systems has dropped, moving from 22% five years ago to the current estimate of 14%.

Cooling System Type – The data reveal an increase in the most common primary system type, split-system central air-conditioners. Currently this system type represents 62% of all central cooling systems, up from 54% five years ago. Package unit air-conditioners comprise 30% of central systems, with the remainder made up by evaporative systems.

Cooling System Age – The average age of central air-conditioners has been slightly reduced, going from 12.2 years to 10.8. A similar trend has occurred with space air-conditioners. The average age of these systems in 2000 was 13.1 years, down to the current estimate of 11.9. However, when considering all cooling system types, the findings reveal that 40% of all cooling systems are less than five years old, while 25% are more than 15 years old.

Cooling System Size – The most common central air-conditioner size is the 4-ton category, 23%, and the next most common size is the 3 ton category. About 60% of all central air-conditioners fall within the 3-4.5 ton capacity range. This is up about 10% from the previous study, suggesting primary systems are getting larger, perhaps due to the growing size of new homes.

Cooling System Efficiency – Of the 257 central systems surveyed, 164 units were matched to an efficiency database for determining the SEER. The findings show that 5% of all units are SEER 13 or greater. The majority of units, 40%, fell within the 10-10.99 SEER range, while 7% of all units were found to have a SEER rating of 8 or less. Five years ago, only 2% were 13 SEER or greater, 30% of central air-conditioners fell within the 10-10.99 SEER range, and 3.4% were less SEER 8 or less. These results suggest that central air-conditioner efficiency has only slightly increased in the last five years.

Heating Systems
The study results show that 84% of homes have one heating system, 13% have two systems, and 3% have 3 systems or more. These findings are extremely similar to the previous CLASS findings.

Primary Heating System Type – The most common heating system type are central system forced air furnaces (63%), followed by wall unit space systems (13%). These results are very similar to the 2000 study which found 66% and 16% saturation for these system types, respectively. Heat pump systems comprise 5% of all system types.

Primary Heating System Fuel – The primary heating fuel is natural gas (79%), followed by electric systems (11%). About 2% of primary heating systems are wood and pellet stoves, and another 3% are propane. These findings are strikingly similar to the 2000 findings and the 2003 RASS.

Primary Heating System Age – Overall, heating systems are about 17 years old. Central systems are on average younger than space systems, 14 and 27 years old respectively.

Primary Heating System Efficiency – The average Annual Fuel Utilization Efficiency (AFUE) for gas central heating systems is 80.6, compared to 72.2 for space systems. Ninety percent of all central systems fall with 78-85 AFUE, and 75% of all space systems are between 66 and 72 AFUE.

Dishwashers
Just less than 70% of homes have a dishwasher, which is a close comparison to the 2000 study which found that just more than 70% of homes had a dishwasher.

Dishwasher Age – The average age of dishwashers has decreased over time, down from 9 years, the average age of dishwashers is now estimated to be 7 years old.

Dishwasher Efficiency – The current average EF for dishwashers is 0.495, 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. Current overall efficiency is slightly greater than what was found in 2000 (0.48).

Building Envelope
The saturation of metal frame windows has decreased significantly since 2000, down from 75% to 62%. At the same time the saturation of wood and vinyl has dramatically increased. 2005 CLASS results show saturation of vinyl windows at 25% and wood at 12%, a combined total of 37%, up from a combined total of 21% five years ago. This may be due to low interest rates during this period of time that afforded many Californians' the ability to refinance mortgages and invest in high capital home improvement projects, such as window retrofits.
Overall, the most common window type is single pane metal frame windows, with a saturation of 43%. The second most common type of window type is dual pane wood or vinyl. Apartment buildings have the highest potential for having single pane aluminum glazing and single family two and three story homes are most likely to have double pane vinyl/wood glazing products.
Field surveyors carried Low-E detectors for determining the presence of Low-E coatings. Overall, 10% of homes are thought to have Low-E coatings. Interestingly, homes built between 1951 and 1955 have the highest saturation, 19%, followed closely by homes built between 2001-2005 (17%). Older homes with Low E are due to window retrofits, while new homes are increasingly using Low-E as standard practice. Low-E data were not gathered in 2000, therefore comparisons are not possible.

Trends and Comparisons

Lighting
In the past five years we have seen a tremendous growth in the saturation of compact fluorescent lighting. Previously less than one percent of all residential lamps were CFL; currently this estimate is closer to 10%. Sales data reported in the California Residential Market Share Tracking Lamp Report 2004 support this finding. According to recent findings, the share of medium screw-based compact fluorescent lamp sales has shown strong growth in the last five years, peaking in 2001 at 8.7% market share, then averaging approximately 5% in following years. Previous sales numbers were much lower, demonstrating a less than 1% market share for CFLs. The sharp increase in CFL sales over the last 4 years seems to be directly tied to the increased saturation of CFLs in homes over the last 5 years found in this study.
Since the previous CLASS study in 2000, we have noted a sharp increase in the number of recessed can lighting fixtures. Often found in kitchens, hallways, and foyers, recessed cans often have higher wattage lamps (e.g., parabolic spot, halogen) that can easily be retrofitted with parabolic CFLs. In 2000 we found that 12% of all lighting fixtures were recessed cans. The 2005 estimates place this number closer to 18% of all fixtures, a 6% increase. Other increases in total fixture share include 'recessed lighting other' and 'table lamps', both increasing by about 3%. Figure 2 summarizes the 2005 and the 2000 statewide fixture shares for all home types.

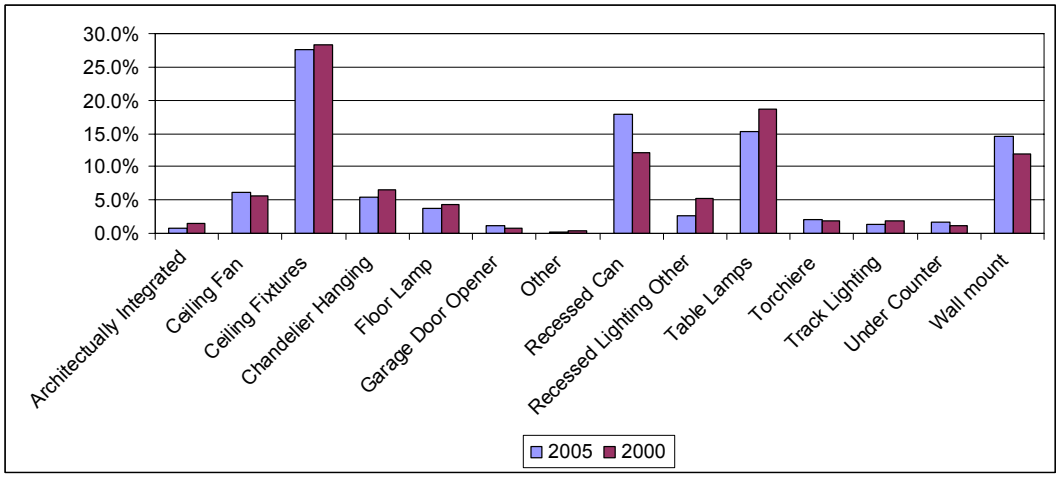

Figure 2: 2005 and 2000 Statewide Fixture Distribution

Refrigerators

As we compare findings from the previous study, there are some very notable trends occurring. To begin with, the results of the two CLASS studies demonstrate ever increasing efficiencies among primary and secondary refrigerators. Furthermore, the average age of both primary and secondary units has also dropped. This decrease in average unit energy consumption does not appear to be a function of smaller overall sized refrigerators. In fact, to the contrary, the average size of refrigerators seems to have increased in the last five years, moving from 20 cubic feet to 21 cubic feet.

We find similar findings when directly comparing the CLASS results to the RASS study. The RASS conditional demand analysis (CDA) results estimate primary refrigerator energy use to be 788 kWh/year. This is very comparable to the 2005 CLASS results which estimates primary refrigerator nameplate annual energy consumption to be 721 kWh/year.

When looking at UEC estimates for secondary refrigerators we find significant differences between the CLASS and the RASS. RASS reports secondary refrigerators use 1,021 kWh/year, while the CLASS findings suggest this number to be closer to 740 kWh/yr. Although the nameplate UEC for secondary units is similar to the nameplate UEC for primary units (720 vs. 740), it is important to note that secondary units were found to be smaller in size on average (18 vs. 21 cubic feet).

While similar, it should be noted that the RASS disaggregated refrigerator use from the total home electric usage, while the CLASS data is based on initial energy use based on manufacturer test conditions, so there may be a larger difference between the two results than appears.

Finally, the RASS findings indicate that 12% of households replaced major kitchen appliances during “the previous year”, most likely in the 2003 time period. If this estimate were extrapolated to the five year period between the last CLASS study and this study, results would show a significant proportion of Californians having replaced major kitchen appliances. These findings further support the positive trends we are seeing in California in regards to refrigerator age and efficiency.

Heating and Air Conditioning

One of the trends we see with air-conditioning is an increase in the saturation of central systems, and a decrease in room/space conditioning systems. The RASS study findings are similar; they also report room and evaporative type systems going out of favor and central air-conditioning systems becoming more popular.

Though somewhat difficult to directly compare, there is general agreement between the RASS findings and the CLASS findings regarding the age of cooling equipment. The RASS findings suggest that 32% of air-conditioners are 15 years or older, while the CLASS findings estimate that 26% of all cooling systems are 15 years or older.

In terms of heating fuel type, the CLASS study is in agreement with the RASS study. The CLASS results and the RASS results estimate 80% of heating systems use natural gas, while only 11% utilize electricity as the primary heating fuel. Single family detached homes are much more likely to be heated using natural gas, while apartments are more likely to be heated by electric systems.

Appliance and Equipment Age and Efficiency Trends

There certainly is a notable trend occurring regarding the average age and efficiency of appliances and equipment. Figure 3 is an illustration of the average age of major appliances based on the 2000 and 2005 study findings. The results demonstrate a steady, across the board reduction in the average

age of appliances. For example, 2005 findings reveal that, currently, secondary refrigerators are nearly the same age as primary refrigerators were five years ago.

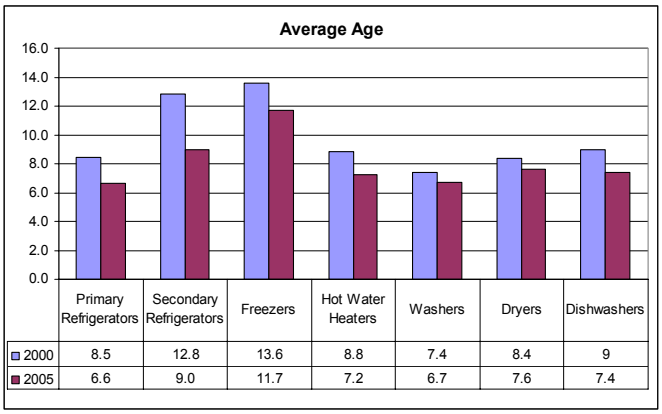

Figure 3: Average Age Comparison for Major Appliances

Figure 4 is an illustration of the average age of HVAC systems based on the 2000 and 2005 study findings. The results again demonstrate a steady, across the board reduction in the average age of HVAC systems.

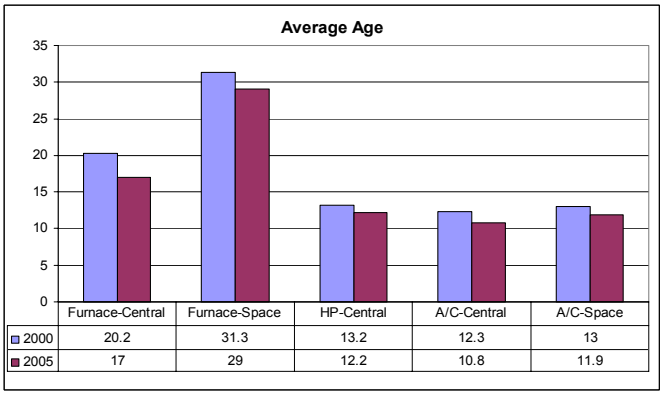

Figure 4: Statewide Comparison of HVAC Average Age 2000-2005

As one might expect, with a decrease in the average age of appliances, the base efficiency has also improved. The following figures demonstrate the efficiency improvements that have been made in the last five years, beginning with refrigerators and freezers that are rated using labeled energy consumption, then appliances that are rated using energy factor (EF), then heating equipment that is AFUE rated and finally cooling equipment that is rated using SEER.

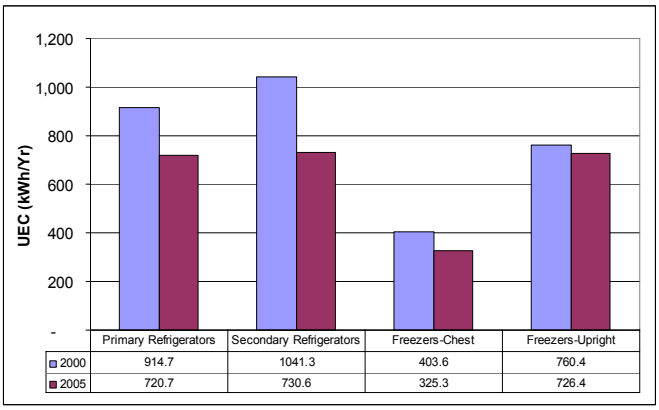

Figure 5: Statewide Comparison of Primary and Secondary Refrigerator Efficiency 2000-2005

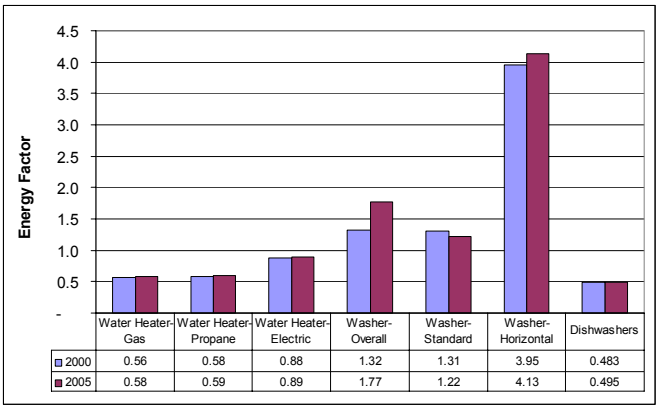

Figure 6: Statewide Comparison of Efficiency for Energy Factor Rated Appliances 2000-2005

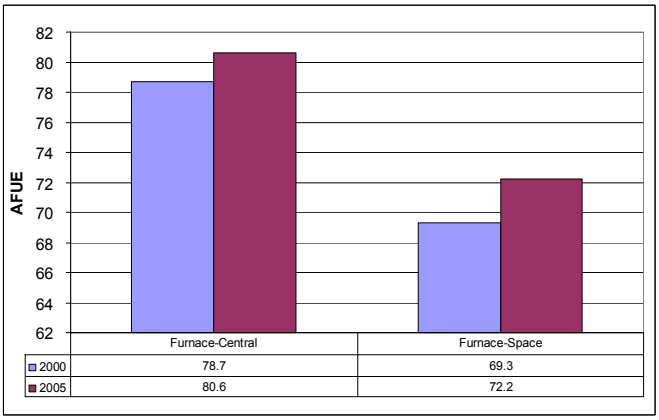

Figure 7: Statewide Comparison of Efficiency for AFUE Rated Heating Equipment 2000-2005

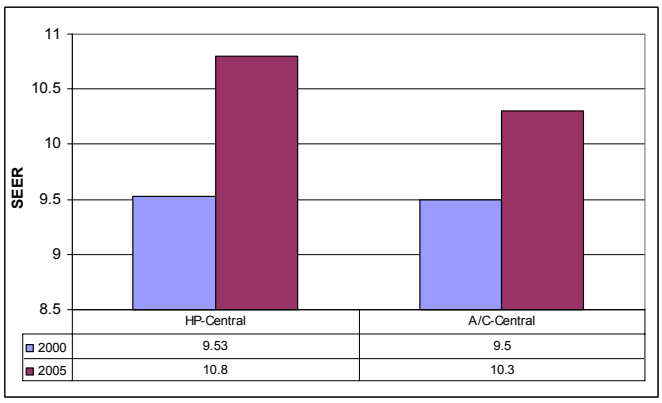

Figure 8: Statewide Comparison of Efficiency for SEER Rated Central Cooling Equipment 2000-2005

Attributing these findings is difficult and somewhat subjective. Part of the explanation for this trend is in the huge quantities of new homes being built each year in California[1] (e.g., 200,000 homes in 2004). However, it is not reasonable to think that such large improvements in the age and efficiency stock of appliances and equipment is due exclusively to the increasing contribution of new construction.

We believe that there are at least two other relevant drivers. During the period of 2000-2005, interest rates reached an all time low; during the same period, property values in California ascended at

[1]California Building Industry Association

unprecedented rates. These two forces afforded many Californians the opportunity to refinance and borrow against their property in order to make upgrades and improvements. Within our own survey sample, customers were asked if they had remodeled in the last 10 years and 26% of customers indicated that they had. Of those stating they had remodeled, 50% reported having replaced kitchen appliances, another 50% reported hard wired lighting remodels, and 17% reported having completed a full remodel of the home[2].

Secondly, during 2000 and 2001 California experienced blackouts and deregulation, which in turn created an energy efficiency resurgence, perhaps unsurpassed by any other prior event or period. Through programs like the 20/20 program, CPUC mandated energy efficiency programs, and marketing, education and information programs like Flex Your Power and ENERGY STAR, Californians were the target of many mass market energy efficiency programs that sought to change behavior and purchasing habits. As time passes, it may be necessary to remind customers about the 2001 energy crisis that prompted many new efficiency programs, so that conservation remains relevant in the minds of the customers and they opt to replace older, less efficient equipment with newer, more efficient equipment.

The CLASS study did not explore attribution, therefore these are merely educated guesses, and certainly more forces may be at work. Regardless of the cause, it certainly appears as though Californians are on the right track to creating a more energy conscious state.

Study Limitations

For the most part, all of the data the study hoped to collect through the on-site surveys was easily obtained. However, in situations where heating and cooling systems were on the roof of the customer's residence, we were not able to collect model number data. This is fairly common in the Central Valley. These units are commonly package air conditioners, package heat pumps and evaporative cooling systems. Moreover, this style of construction is 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 1 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.

Water heater blankets are fairly common and in many circumstances covered the nameplate data. Blankets were not completely removed to collect this information, only slightly moved if easily replaceable. In many cases, homes that comply with earthquake safety codes (e.g., metal strapping intended to hold water heaters in place in the event of an earthquake) have hardware in place that obstruct the nameplate or prevent the blanket from being removed for nameplate identification.

Wattage was also difficult to collect in many circumstances. Surveyors were trained to remove luminaire covers if easily reachable and removable. Yet surprisingly, overall, 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 2-3% 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.

Further information was reported back by field surveyors regarding the difficulty of 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 equipment if they were not

[2] Multiple responses were allowed, therefore results do not sum to 100%.

comfortable doing so. Other access issues were also problematic, such as location of the nameplate with respect to the mounting of the unit in the wall.
Limitations continue to be a problem with regard to the databases used for appliance matching. For example, field staff were able to obtain 559 of 583 dishwasher model numbers, yet through the matching process RLW was only able to match 25%, or 148 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 3% of the 644 dryers that we collected model numbers for were in the database. More detailed findings are presented on the model number matching process in Table 1.
Finally, 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.

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