

CONSULTANT REPORT

2009 CALIFORNIA RESIDENTIAL APPLIANCE SATURATION STUDY

Executive Summary

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ABSTRACT

In 2009, the California Energy Commission funded and administered a Residential Appliance Saturation Study that serves as an update to the 2003 RASS, with the same utilities participating – Pacific Gas and Electric Company (PG&E), Southern California Edison (SCE), San Diego Gas & Electric Company (SDG&E), Southern California Gas Company (SoCal Gas), and Los Angeles Department of Water and Power (LADWP). KEMA was the prime consultant.

The study was implemented as a mail survey with an option for respondents to complete it on-line. The survey requested households to provide information on appliances, equipment, and general consumption patterns. Data collection was completed in early 2010.

The study yielded energy consumption estimates for 27 electric and 10 natural gas residential end-uses and appliance saturations for households. These consumption estimates were developed using a conditional demand analysis, an approach that applied statistical methods to combine survey data, household energy consumption data and weather information to calculate average annual consumption estimates per appliance. The 2009 RASS resulted in end-use saturations for 24,464 individually metered and 1,257 master-metered households. Survey and conditional demand analysis results were weighted to provide population level estimates representative of the participating utilities that allow comparison across utility service territories, forecast climate zones and other variables of interest- dwelling type, dwelling age group, and income.

Keywords: California Energy Commission, conditional demand analysis, CDA, unit energy consumption, UEC, residential, appliance, saturations, degree day normalization, energy survey, data collection

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EXECUTIVE SUMMARY

This executive summary presents key findings from the *2009 California Residential Appliance Saturation Study* (RASS) that was sponsored by the California Energy Commission. The study yielded unit energy consumption estimates for 27 electric and 10 natural gas residential end uses and appliance saturations for households within the California territories of the participating utilities.

The executive summary is a companion document to a thorough methodologies' and results' report that includes detailed energy consumption tables from the conditional demand analysis along with a series of tables which display the survey results in a comprehensive format.

The sections of this summary report include:

- Study overview.
- Unit energy consumption and appliance saturation summaries. Presents electric and natural gas results from the conditional demand analysis that was performed on the RASS data.
- Fuel shares. Shows how the proportion of fuel type for equipment varies.
- Air conditioning.
- New dwellings. Compares energy consumption and equipment by building age group.
- Income effects.
- Adoption of energy-efficiency measures.
- Technology.
- Data comparisons.

Study Overview

In 2009, the California Energy Commission funded and administered a Residential Appliance Saturation Study that was implemented across the territories of the large investor-owned utilities. The 2009 study served as an update to the 2003 RASS, with the same utilities participating—Pacific Gas and Electric Company (PG&E), Southern California Edison Company (SCE), San Diego Gas & Electric Company (SDG&E), Southern California Gas Company (SoCal Gas), and Los Angeles Department of Water and Power (LADWP). KEMA was the prime consultant.

The study was initiated in 2008, with the sampling plans and implementation beginning in the spring of 2009. Data was collected using a two-stage direct-mail approach to a representative sample of Californian households. The survey requested households to provide information on appliances, equipment, and general consumption patterns. The 2003 RASS survey instrument was updated to reflect changes in available energy-consuming technologies in households. An online version of the survey was also developed. A non-response follow-up was implemented

after the initial double mailing stage to a sample of the non-respondents. The non-response effort consisted of telephone calls and in-person survey completion assistance. Data collection was completed in early 2010.

The study yielded unit energy consumption (UEC) estimates for 27 electric and 10 natural gas residential enduses and appliance saturations for households. A UEC represents the amount of energy a single appliance is estimated to use in a single year. The UEC estimates were developed using a conditional demand analysis, an approach that applied statistical methods to combine survey data, household energy consumption data, and weather information to calculate average annual consumption estimates per appliance. Details of the conditional demand analysis methodology are presented in Volume One.

The 2009 RASS resulted in end-use saturations for 24,464 individually metered and 1,257 master-metered households. UEC estimates were provided for individually metered households only, while end-use saturations reflected both individually and master-metered households. Survey and conditional demand analysis results were weighted to provide population-level estimates representative of the participating utilities that allow comparison across utility service territories, forecast climate zones, and other variables of interest—dwelling type, dwelling age-group, and income, for example.

By using a statewide survey instrument, the Energy Commission and other parties were provided with a consistent set of questions and study results to use for statewide planning and cross-utility comparisons. The Commission-sponsored sample included sufficient data for utility-specific analyses, but SCE and SDG&E both sponsored an additional sample that provided them with supplemental data. The project required a joint effort among the study partners, as they collaborated on a research plan, program materials, and implementation strategy. Each utility provided the data necessary to create a unified sampling plan, as well as household-specific information for households that were selected for the sample. The research team provided survey participants with anonymity by assigning a generic identification code that represented the sampling stratification variables. Each participating utility was provided a key to the identification code that allowed it to match survey respondents to a specific account.

Unit Energy Consumption and Appliance Saturation Summaries

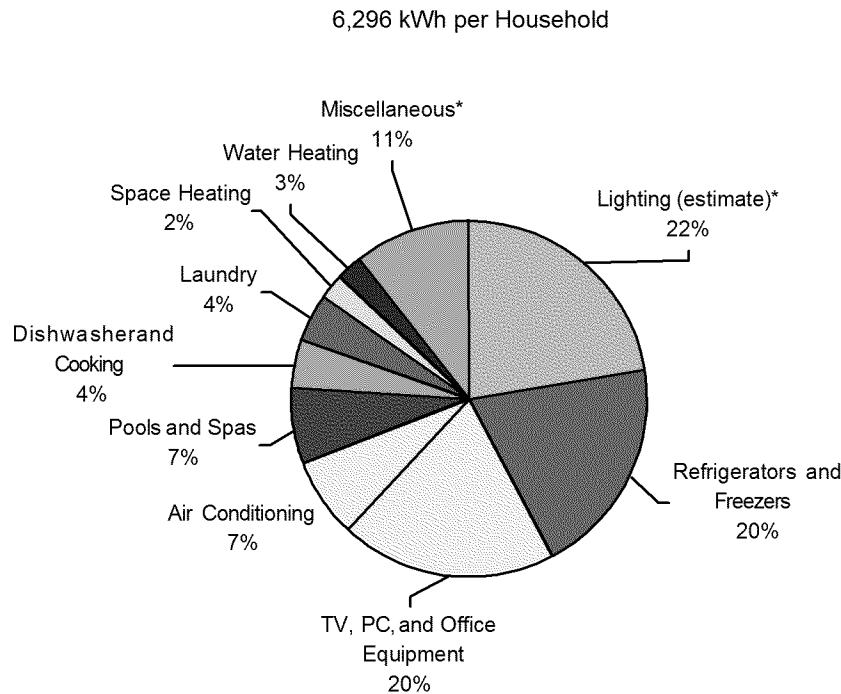
The conditional demand analysis used a billing series from 2008 through mid-2009 to produce UEC estimates for electric and natural gas end uses in households. UECs were calculated only for the 24,464 individually metered households in the study. This section presents key results for electric and natural gas end uses.

Electricity Consumption and UECs

The average annual electricity consumption in California was 6,296 kilowatt-hours (kWh) per household, based on the 2009 RASS billing data from 24,457 households. This was an increase of approximately 6 percent compared to the 5,914 kWh per household reported in the 2003 RASS. Televisions, personal computers, and office equipment consume a 5 percent higher

proportion of the total consumption compared with the results from the 2003 RASS. Figure ES-1 details the breakdown of the 2009 annual household electricity consumption by end use.

Figure ES-1: Statewide Electricity Consumption per Household



*Note: An estimate of 1,200 kWh per household (20% of the total consumption) has been designated as interior lighting and was shifted from the *Miscellaneous* category to *Lighting* category where it is combined with exterior lighting consumption. This number comes from other lighting studies¹ that are better able to pinpoint this estimate than a conditional demand model as was used for the RASS.

Source: 2010 California Residential Appliance Saturation Survey

Table ES-1 and Table ES-2 present electric UECs with saturation estimates, by electric utility and by dwelling type, respectively. Table ES-1 depicts a 36 percent increase in the household UEC for households served by LADWP compared to the 4,071 kWh reported in the 2003 RASS. The population frame that was supplied for the 2003 RASS excluded a portion of the LADWP population of single-family households, as suggested by the percentage of single-family households in the 2003 RASS results of 25.6 percent. The 2009 population frame provided by LADWP included those omitted from the 2003 population frame, and the percentage of single-family homes in the 2009 RASS results is shown to be a more realistic 56 percent. The other

¹ Lighting numbers triangulated from *Baseline Energy Use Characteristics, Technology Energy Savings*, Volume I, California Energy Commission, May 1994, Publication p300-94-006 as well as various KEMA RECAP Program results.

three electric utilities had more modest increases for household UECs, with PG&E having an increase of 3 percent, SDG&E of 10 percent, and SCE of 6 percent.

Table ES-1: Electric UECs and Appliance Saturation Summaries by Electric Utility

| | PG&E | | SDG&E | | SCE | | LADWP | |
|------------------------------------|-------|------|-------|------|-------|------|-------|------|
| | UEC | Sat. | UEC | Sat. | UEC | Sat. | UEC | Sat. |
| All Households | 6,458 | | 5,970 | | 6,444 | | 5,538 | |
| Primary Conventional Space Heating | 1,032 | 5% | 353 | 3% | 371 | 3% | 169 | 2% |
| Primary Heat Pump Space Heating | 818 | 1% | 483 | 2% | 508 | 1% | 228 | 0% |
| Auxiliary Space Heating | 267 | 2% | 98 | 1% | 141 | 1% | 66 | 0% |
| Furnace Fan | 245 | 65% | 133 | 62% | 143 | 66% | 99 | 48% |
| Attic Fan | 104 | 15% | 118 | 13% | 156 | 15% | 139 | 10% |
| Central Air Conditioning | 709 | 44% | 493 | 43% | 883 | 58% | 699 | 41% |
| Room Air Conditioning | 221 | 11% | 107 | 13% | 238 | 18% | 152 | 24% |
| Evaporative Cooling | 458 | 6% | 494 | 2% | 716 | 7% | 345 | 3% |
| Water Heating | 2,680 | 9% | 2,149 | 7% | 2,143 | 5% | 1,737 | 5% |
| Solar Water Heating | 1,897 | 0% | 2,231 | 0% | 1,838 | 0% | . | 0% |
| Dryer | 648 | 46% | 587 | 28% | 693 | 19% | 639 | 15% |
| Clothes Washer | 88 | 83% | 110 | 78% | 119 | 82% | 107 | 59% |
| Dish Washer | 71 | 73% | 76 | 71% | 77 | 68% | 73 | 49% |
| First Refrigerator | 774 | 100% | 725 | 100% | 784 | 100% | 766 | 100% |
| Additional Refrigerator | 1,226 | 25% | 1,188 | 20% | 1,174 | 26% | 1,344 | 18% |
| Freezer | 959 | 22% | 898 | 15% | 914 | 16% | 964 | 12% |
| Pool Pump | 3,250 | 9% | 3,794 | 12% | 3,442 | 11% | 4,360 | 8% |
| Spa | 274 | 8% | 283 | 13% | 294 | 10% | 381 | 4% |
| Outdoor Lighting | 319 | 67% | 345 | 67% | 348 | 66% | 423 | 50% |
| Range/Oven | 251 | 58% | 271 | 51% | 282 | 32% | 255 | 27% |
| Television | 672 | 100% | 620 | 100% | 735 | 100% | 696 | 100% |
| Spa Electric Heat | 1,056 | 6% | 956 | 6% | 951 | 4% | 1,003 | 1% |
| Microwave | 119 | 93% | 117 | 94% | 128 | 93% | 123 | 88% |
| Home Office Equipment | 82 | 19% | 83 | 25% | 80 | 21% | 85 | 20% |
| Personal Computer | 593 | 86% | 638 | 87% | 618 | 85% | 625 | 80% |
| Well Pump | 547 | 8% | 513 | 1% | 594 | 2% | 428 | 1% |
| Miscellaneous | 1,798 | | 1,835 | | 1,909 | | 1,740 | |

| | | | | |
|------------------------------|-------|-------|-------|-------|
| Ave. Dwelling Size | 1,584 | 1,637 | 1,618 | 1,384 |
| Ave. Residents | 2.78 | 2.94 | 3.09 | 2.92 |
| Percent Single Family | 73.5% | 71.2% | 73.8% | 56.0% |
| Percent of Population | 30.2% | 15.9% | 43.0% | 10.9% |

Source: 2010 California Residential Appliance Saturation Survey

Table ES-2: Electric UECs and Appliance Saturation Summaries by Dwelling Type

| | All | | Single Family | | Multi Family | | Mobile Home | |
|------------------------------------|-------|------|---------------|------|--------------|------|-------------|------|
| | UEC | Sat. | UEC | Sat. | UEC | Sat. | UEC | Sat. |
| All Households | 6,296 | | 7,605 | | 3,929 | | 5,580 | |
| Primary Conventional Space Heating | 709 | 4% | 1,171 | 1% | 558 | 8% | 739 | 7% |
| Primary Heat Pump Space Heating | 642 | 1% | 994 | 1% | 487 | 2% | 504 | 2% |
| Auxiliary Space Heating | 222 | 1% | 382 | 1% | 89 | 2% | 342 | 1% |
| Furnace Fan | 180 | 63% | 216 | 73% | 76 | 45% | 157 | 66% |
| Attic Fan | 129 | 14% | 96 | 19% | 276 | 7% | 280 | 11% |
| Central Air Conditioning | 766 | 49% | 894 | 56% | 401 | 37% | 876 | 48% |
| Room Air Conditioning | 206 | 15% | 293 | 13% | 92 | 20% | 423 | 16% |
| Evaporative Cooling | 583 | 5% | 650 | 6% | 324 | 3% | 552 | 28% |
| Water Heating | 2,393 | 7% | 3,169 | 5% | 1,580 | 9% | 2,575 | 16% |
| Solar Water Heating | 1,959 | 0% | 1,877 | 0% | 2,075 | 0% | . | 0% |
| Dryer | 652 | 30% | 719 | 33% | 502 | 25% | 489 | 37% |
| Clothes Washer | 104 | 79% | 121 | 96% | 49 | 48% | 7 | 81% |
| Dish Washer | 74 | 68% | 83 | 74% | 55 | 58% | 52 | 56% |
| First Refrigerator | 772 | 100% | 827 | 100% | 672 | 100% | 740 | 100% |
| Additional Refrigerator | 1,212 | 24% | 1,286 | 33% | 664 | 8% | 1,123 | 18% |
| Freezer | 938 | 18% | 968 | 23% | 818 | 9% | 802 | 27% |
| Pool Pump | 3,502 | 10% | 3,502 | 16% | . | 0% | . | 0% |
| Spa | 290 | 9% | 293 | 14% | 134 | 0% | 264 | 3% |
| Outdoor Lighting | 342 | 64% | 388 | 78% | 194 | 40% | 204 | 65% |
| Range/Oven | 262 | 44% | 310 | 42% | 190 | 50% | 224 | 30% |
| Television | 693 | 100% | 738 | 100% | 610 | 100% | 697 | 100% |
| Spa Electric Heat | 1,006 | 4% | 1,013 | 7% | 764 | 0% | 981 | 3% |
| Microwave | 123 | 92% | 133 | 94% | 104 | 89% | 109 | 88% |
| Home Office Equipment | 82 | 21% | 89 | 23% | 62 | 17% | 132 | 8% |
| Personal Computer | 611 | 85% | 673 | 88% | 493 | 80% | 437 | 72% |
| Well Pump | 552 | 4% | 562 | 6% | 556 | 1% | 447 | 20% |
| Miscellaneous | 1,838 | | 2,177 | | 1,231 | | 1,510 | |

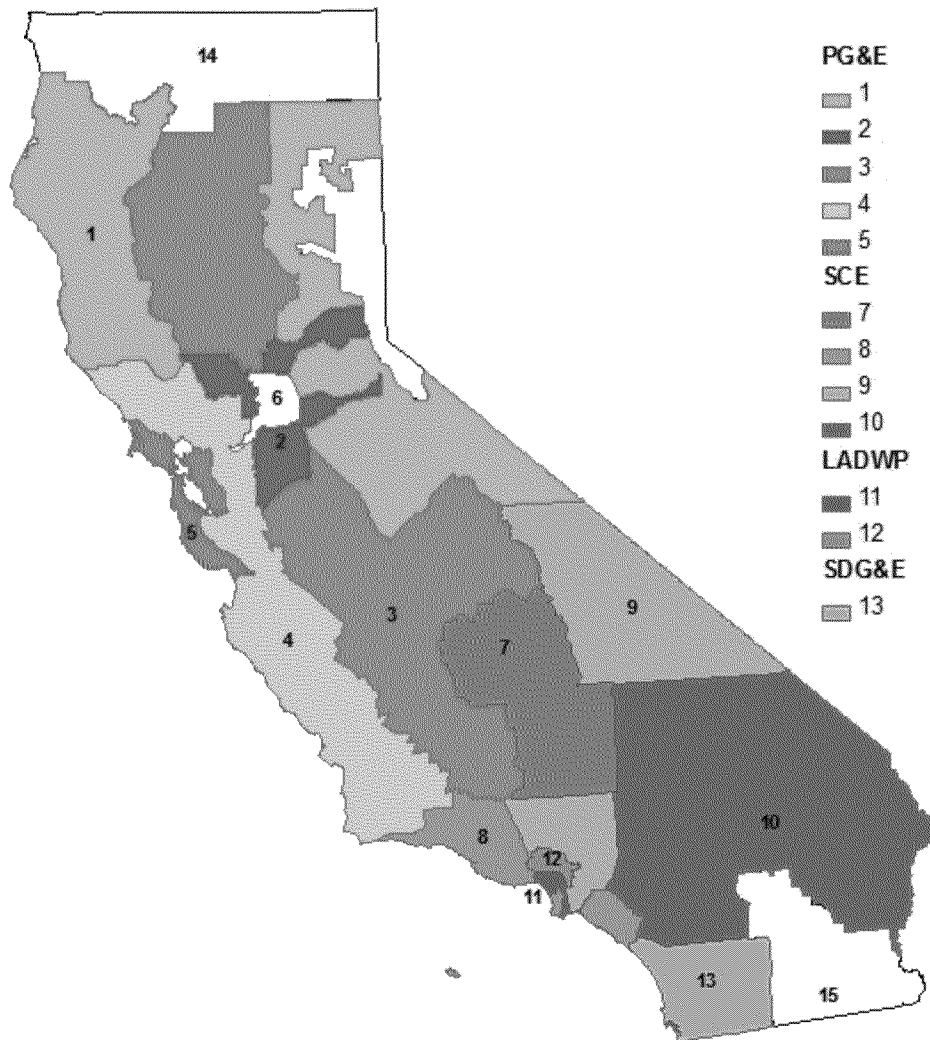
| | | | | |
|------------------------------|--------|-------|-------|-------|
| Ave. Dwelling Size | 1,579 | 1,882 | 1,038 | 1,315 |
| Ave. Residents | 2.93 | 3.17 | 2.51 | 2.37 |
| Percent of Population | 100.0% | 62.8% | 33.7% | 3.5% |

Source: 2010 California Residential Appliance Saturation Survey

Figure ES-2 is a map of the Energy Commission's forecast climate zones. These zones were used in the conditional demand analysis modeling and provide regional summaries by climate.

- Zones 1-5 are served by PG&E (Zones 3 and 4 have some SoCal Gas overlap).
- Zone 6 is served by Sacramento Municipal Utility District (SMUD) and not included in the results.
- Zones 7-10 are served by SCE/SoCal Gas.
- Zones 11-12 are served by LADWP/SoCal Gas.
- Zone 13 is served by SDG&E with some SoCal Gas overlap.
- Zones 14-15 are served by other electric utilities not included in the results.

Figure ES-2: California Energy Commission Forecast Climate Zones

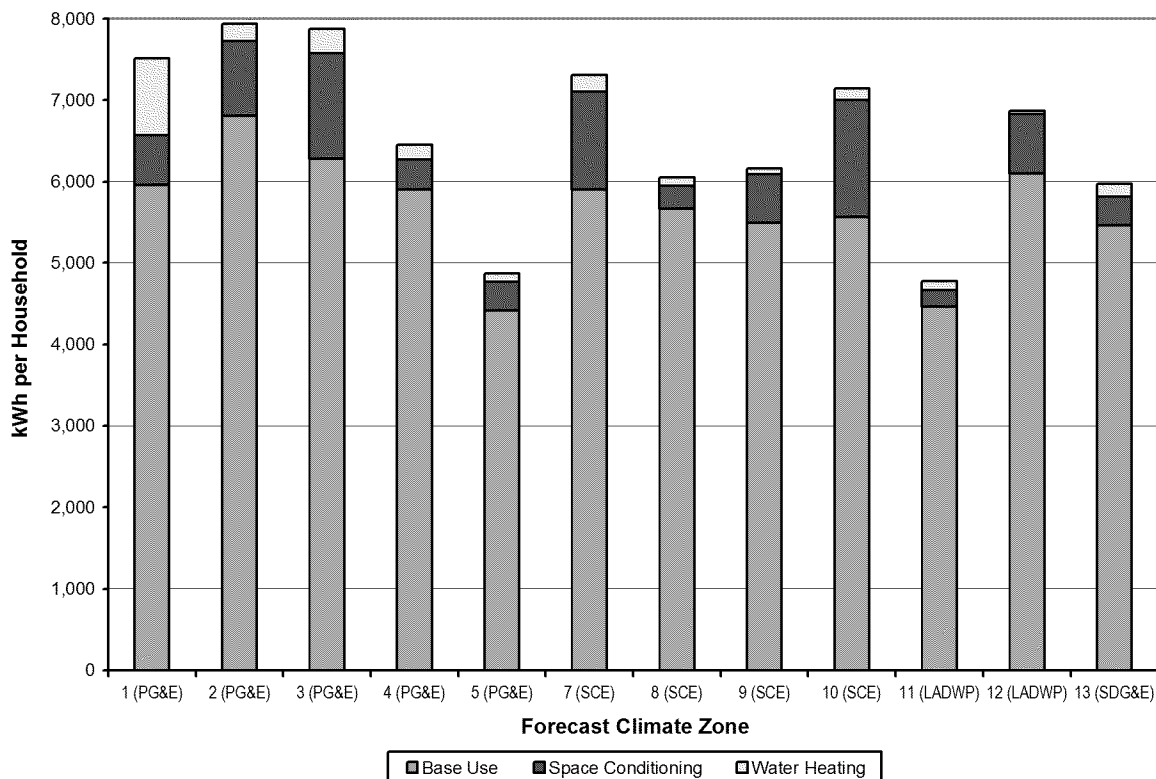


Source: 2010 California Residential Appliance Saturation Survey

Figure ES-3 shows that both base energy consumption and space conditioning vary by Energy Commission forecast zone. Households in forecast Zone 1 have a lower availability of gas service, which contributes to its electric water heating UEC being larger than in the other zones.

Compared to the electric consumption reported in the 2003 RASS, household energy consumption increased by the largest amounts in the LADWP zones: by 41 percent in Zone 12 and by 28 percent in Zone 11, most likely due to the inclusion of a portion of high-consumption single-family households in the LADWP population frame in the 2009 study that had been excluded in the 2003 RASS. Several other zones also had increases in consumption: 18 percent in Zone 2 and 13 percent in Zone 3, both PG&E service areas, and 11 percent in Zone 8 serviced by SCE.

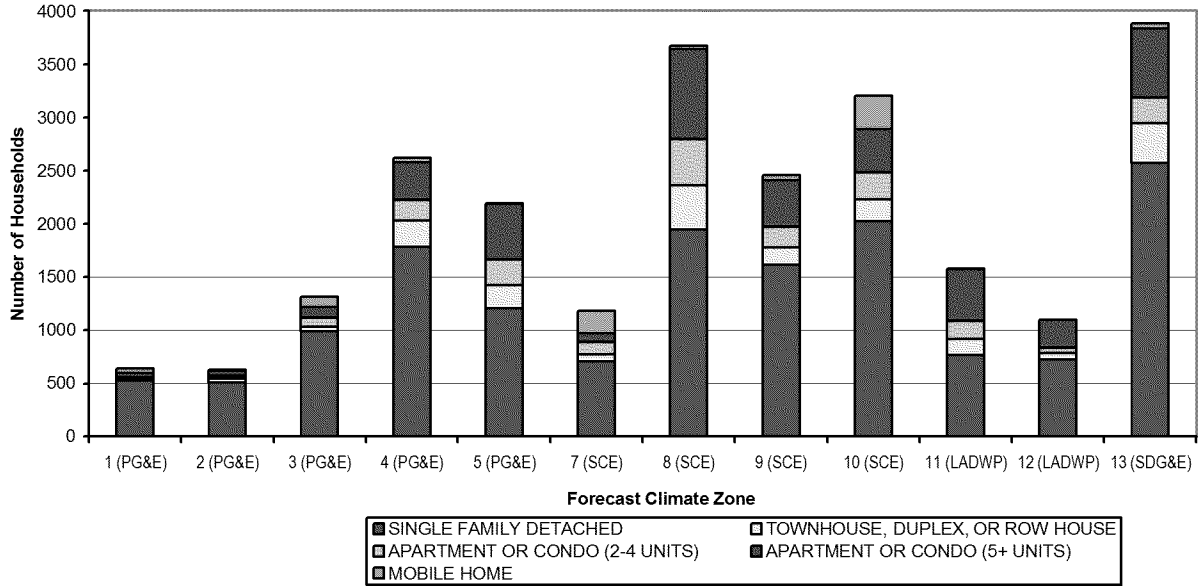
Figure ES-3: Electric UECs by Forecast Climate Zone



Source: 2010 California Residential Appliance Saturation Survey

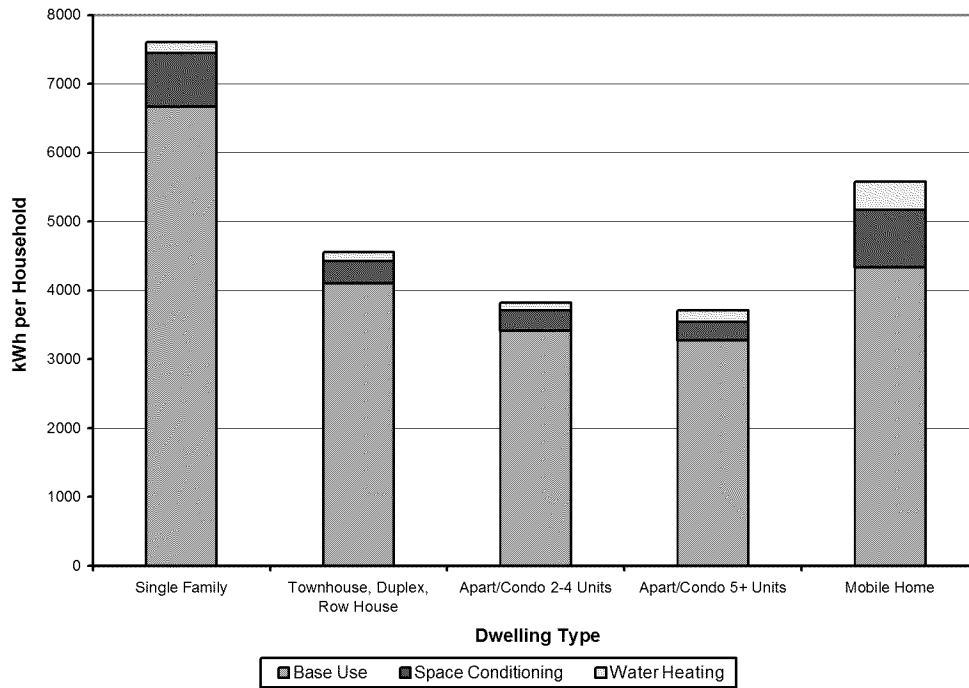
Although households in all forecast climate zones are predominantly single-family homes, Figure ES-4 shows how the proportions of housing type vary by forecast climate zone, which helps to explain the differences in the base consumption shown in Figure ES-3. Annual electric consumption is highest in single-family homes as shown in Figure ES-5.

Figure ES-4: Home Types by Forecast Climate Zones



Source: 2010 California Residential Appliance Saturation Survey

Figure ES-5: Electric UECs by Dwelling Type

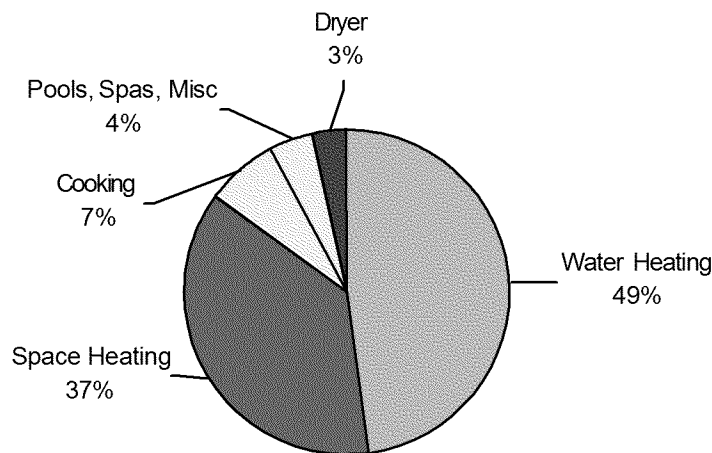


Source: 2010 California Residential Appliance Saturation Survey

Natural Gas Consumption and UECs

The average annual natural gas consumption in California households for which billing data was available (77 percent of the study population) was 354 therms per household, as calculated from 2009 RASS billing data. Billing data were obtained from PG&E, SDG&E, and SoCal Gas. Natural gas UECs were calculated for 85 percent of the study population, as the estimates were made for all households that were identified as having a natural gas line to their home. The household natural gas UEC decreased by approximately 18 percent from the 431 therms per household reported in the 2003 RASS. Figure ES-6 details the breakdown of the 2009 annual household natural gas consumption by enduse. Compared to the 2003 RASS, consumption for water heating increased by 5 percent to 49 percent, whereas space heating decreased by 7 percent to 37 percent.

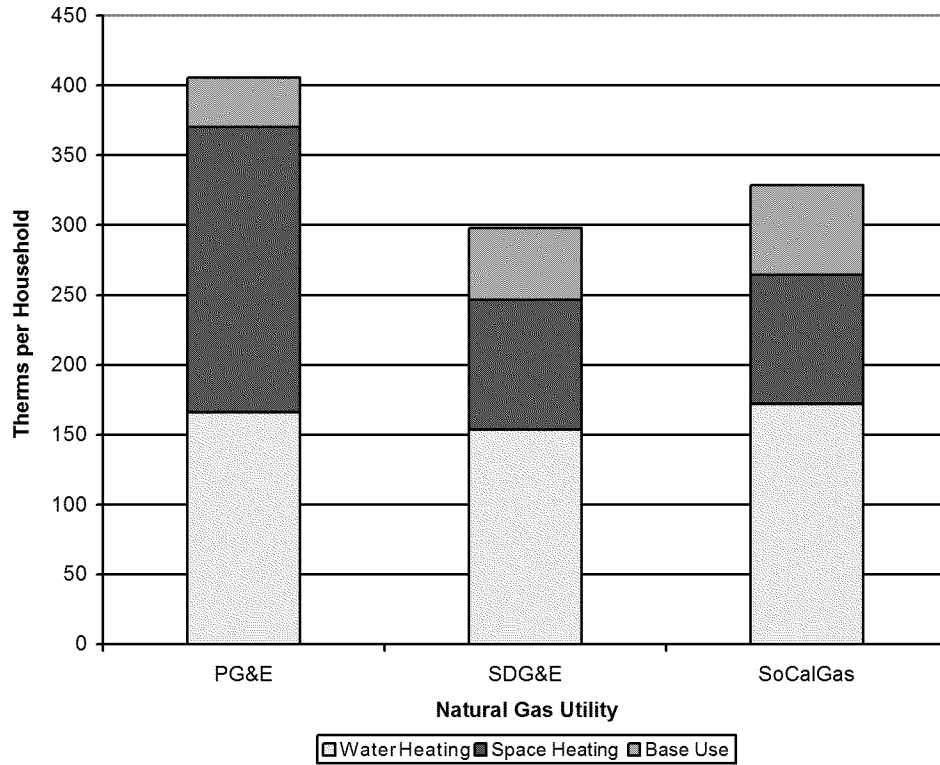
Figure ES-6: Statewide Natural Gas Energy Consumption
354 therms per household



Source: 2010 California Residential Appliance Saturation Survey

PG&E has the largest natural gas consumption, along with the highest consumption attributed to space heating compared to the other two gas utilities, as shown in Figure ES-7.

Figure ES-7: Natural Gas UECs by Gas Utility



Source: 2010 California Residential Appliance Saturation Survey

Table ES-3 and Table ES-4 present natural gas UECs with saturation estimates for households for which billing data was available, by gas utility and by dwelling type, respectively. The final row in each table represents the household natural gas UEC for all households in the study population that were identified as having natural gas service. The study sample was based on the electric population of the participating utilities, so the natural gas consumption results are not fully representative of statewide gas consumption.

Table ES-3 depicts a decrease of 26 percent in the household natural gas UEC for households served by SoCal Gas from the 443 therms reported in the 2003 RASS. The other two gas utilities had less dramatic decreases for household natural gas UECs, with SDG&E having a decrease of 15 percent and PG&E having a decrease of 7 percent.

Table ES-3: Natural Gas UEC and Appliance Saturation Summaries by Utility

| Homes with Gas Accounts | All | | PG&E | | SDG&E | | SoCal Gas | |
|---|-----|--------------------------------------|------|--------------------------------------|-------|--------------------------------------|----------------|--------------------------------------|
| | UEC | Saturation of Homes with Gas Account | UEC | Saturation of Homes with Gas Account | UEC | Saturation of Homes with Gas Account | UEC | Saturation of Homes with Gas Account |
| All Households | 354 | | 405 | | 298 | | 328 | |
| Space Heating | 144 | 93% | 213 | 95% | 100 | 93% | 102 | 91% |
| Water Heating | 193 | 87% | 188 | 88% | 175 | 88% | 200 | 86% |
| Dryer | 25 | 46% | 22 | 31% | 25 | 52% | 27 | 55% |
| Range/Oven | 34 | 73% | 31 | 58% | 32 | 74% | 36 | 83% |
| Pool Heating | 208 | 5% | 183 | 3% | 179 | 4% | 222 | 6% |
| Spa Heating | 52 | 6% | 52 | 4% | 53 | 7% | 52 | 7% |
| Miscellaneous | 24 | 12% | 23 | 8% | 21 | 16% | 25 | 13% |
| Gas Use Across Electrically Based Population | 348 | | 402 | | 291 | | Not Applicable | |

Source: 2010 California Residential Appliance Saturation Survey

Table ES-4 presents natural gas UECs by dwelling type. The household natural gas UECs decreased for all dwelling types. The household natural gas UEC for multifamily dwellings decreased by 27 percent from the results from the 2003 RASS. Household gas consumption for mobile homes dropped by 19 percent and for single-family homes decreased by 16 percent.

Table ES-4: Natural Gas UEC and Appliance Saturation Summaries by Dwelling Type

| Homes with Gas Accounts | Single Family | | Multi Family | | Mobile Home | |
|-------------------------|---------------|--------------------------------------|--------------|--------------------------------------|-------------|--------------------------------------|
| | UEC | Saturation of Homes with Gas Account | UEC | Saturation of Homes with Gas Account | UEC | Saturation of Homes with Gas Account |
| All Households | 425 | | 198 | | 352 | |
| Space Heating | 184 | 94% | 48 | 88% | 146 | 97% |
| Water Heating | 195 | 95% | 186 | 69% | 193 | 91% |
| Dryer | 26 | 57% | 21 | 22% | 20 | 48% |
| Range/Oven | 36 | 76% | 31 | 66% | 23 | 87% |
| Pool Heating | 219 | 6% | 47 | 1% | 5 | 0% |
| Spa Heating | 52 | 8% | 72 | 0% | 29 | 0% |
| Miscellaneous | 23 | 14% | 25 | 6% | 66 | 5% |

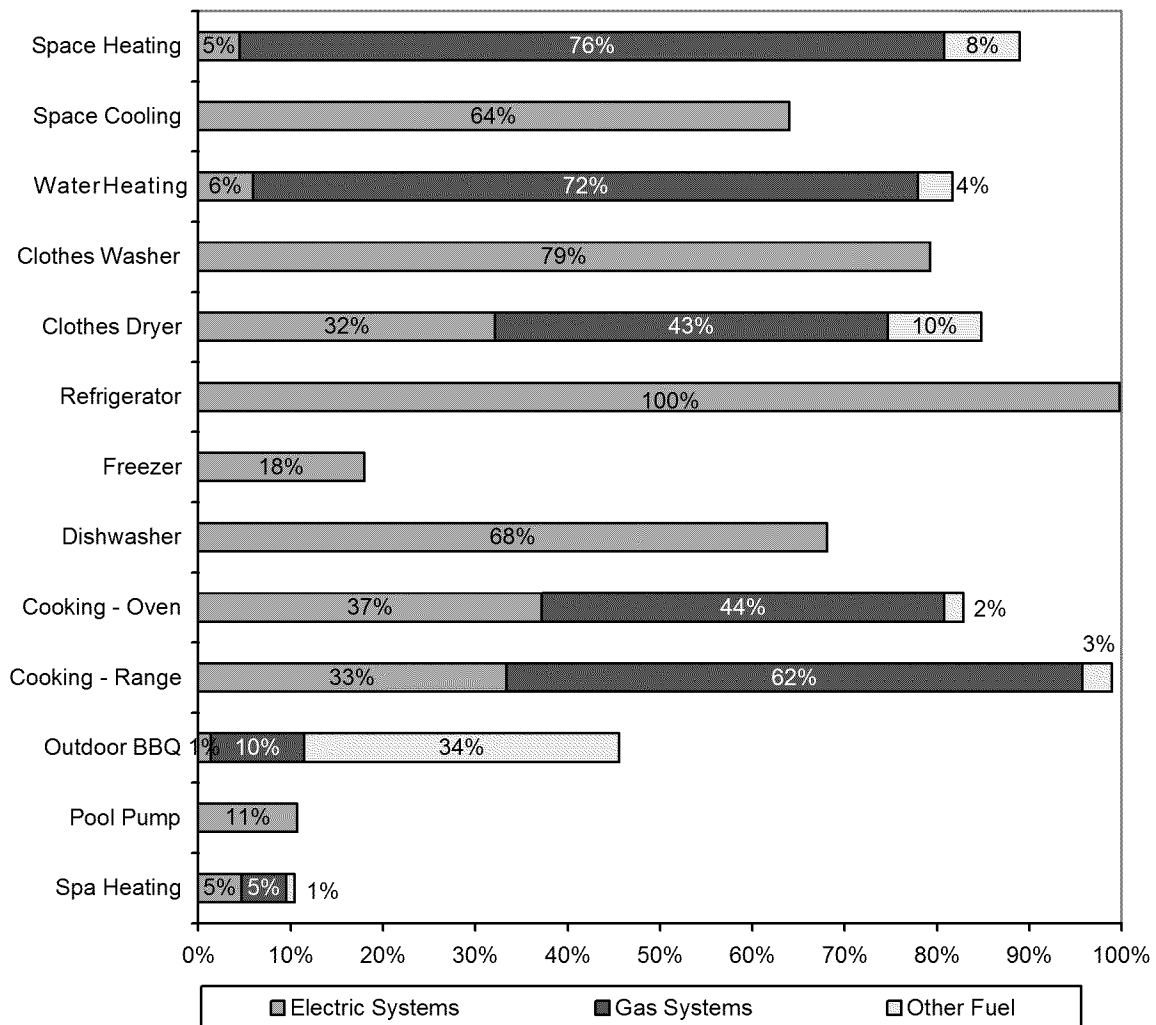
| | | | |
|---|-----|-----|-----|
| Gas Use Across Electrically Based Population | 421 | 194 | 339 |
|---|-----|-----|-----|

Source: 2010 California Residential Appliance Saturation Survey

Fuel Type for Common Enduses

The saturations of fuel type by major household end uses are presented in Figure ES-8 for all of the individually metered households in the study sample. Several changes are noted when compared to the results from the 2003 RASS. The saturation for space cooling increased by 8 percent, and dishwasher saturation increased by 6 percent. The saturation of clothes dryers increased by approximately 20 percent, with electric clothes dryers increasing by 4 percent, gas dryers increasing by 7 percent, and other fuel dryers increasing by 9 percent. The saturation of electric ovens decreased by 6 percent whereas gas ovens increased by 11 percent. Outdoor barbeques increased by 4 percent, with gas barbeques expanding by 5 percent.

Figure ES-8: Combined Electric, Natural Gas, and Other Fuel Saturations

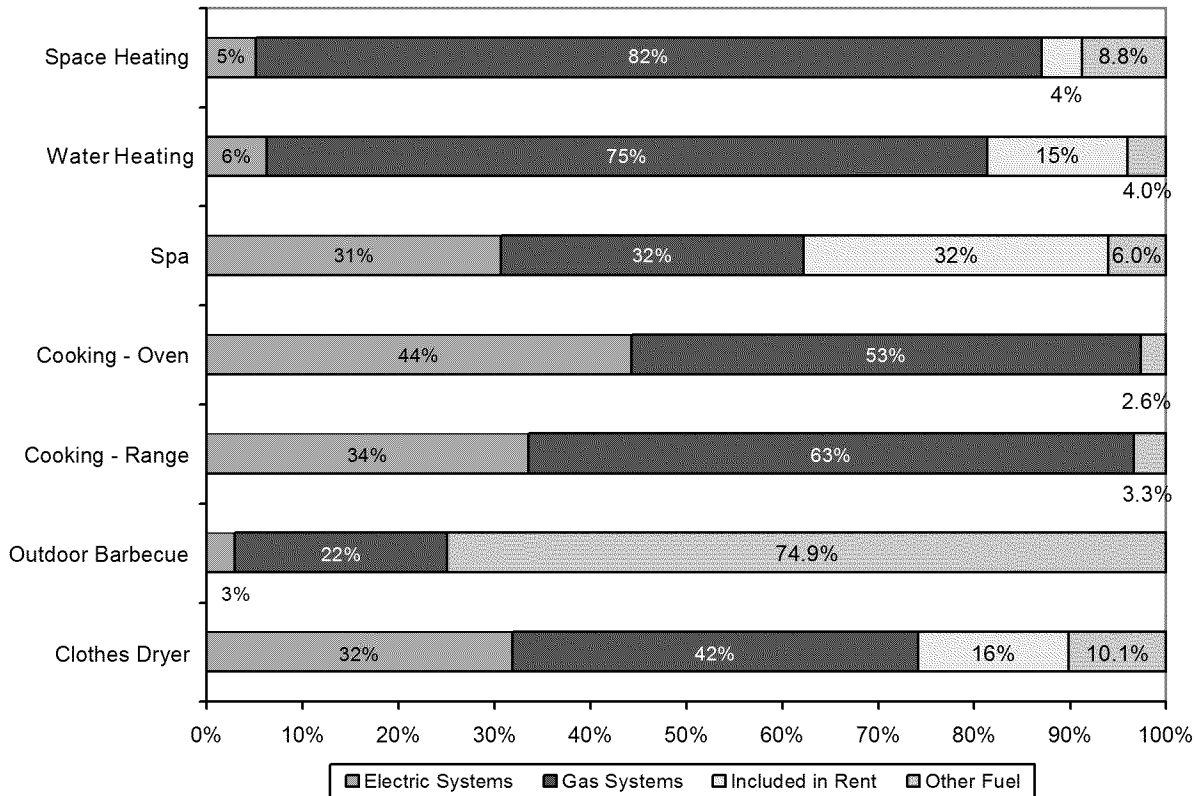


Source: 2010 California Residential Appliance Saturation Survey

Fuel Shares²

Overall fuel shares are shown in Figure ES-9. Figures ES-9 and ES-10 include equipment that serves multiple households, which are typically included in a tenant's rent. Shares represent the fuel share for households that have the equipment.

Figure ES-9: Overall Shares of Electric and Gas Systems

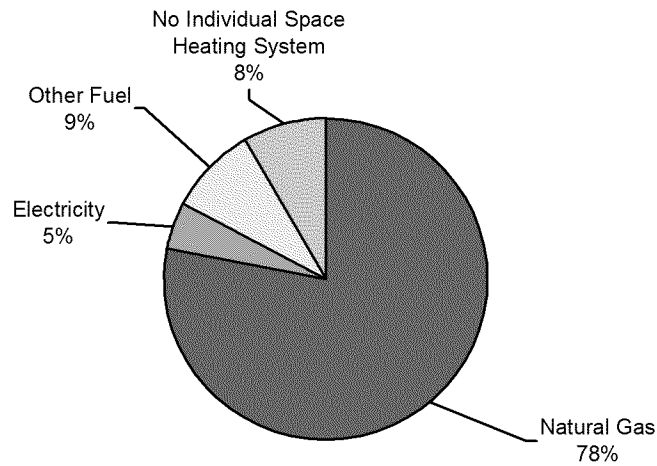


Source: 2010 California Residential Appliance Saturation Survey

Space heating systems are fueled primarily by natural gas for households in the study, as shown in Figure ES-10. The *No Individual Space Heating System* category includes households that do not have space heating or households that are heated by a central building system that serves multiple apartments or dwellings. Compared to the 2003 RASS, the proportion of electric space heating systems has decreased by 6 percent, with 4 percent shifting to other fuels and 2 percent to not having an individual space heating system.

² **NOTE:** The remainder of the report (except where UECs are explicitly included) includes data from both individually metered and master-metered households. Master-metered households were not included in the CDA.

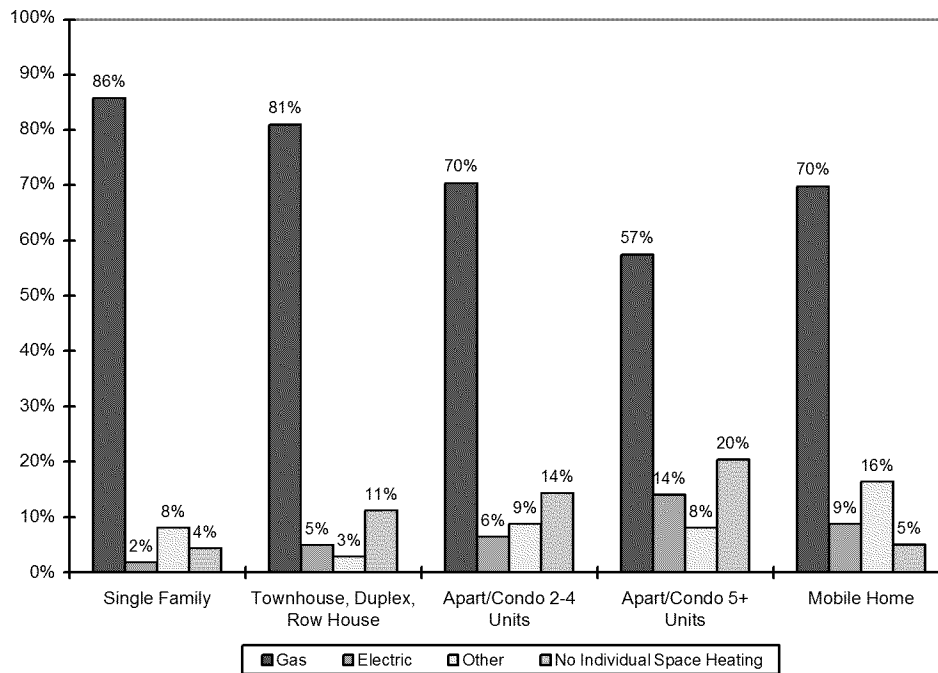
Figure ES-10: Primary Space Heating Fuel



Source: 2010 California Residential Appliance Saturation Survey

Figure ES-11 shows that electric space heating is more common in apartments and condominiums than in single-family homes. The *Other* fuel category includes propane, wood, and other, as reported by the respondent.

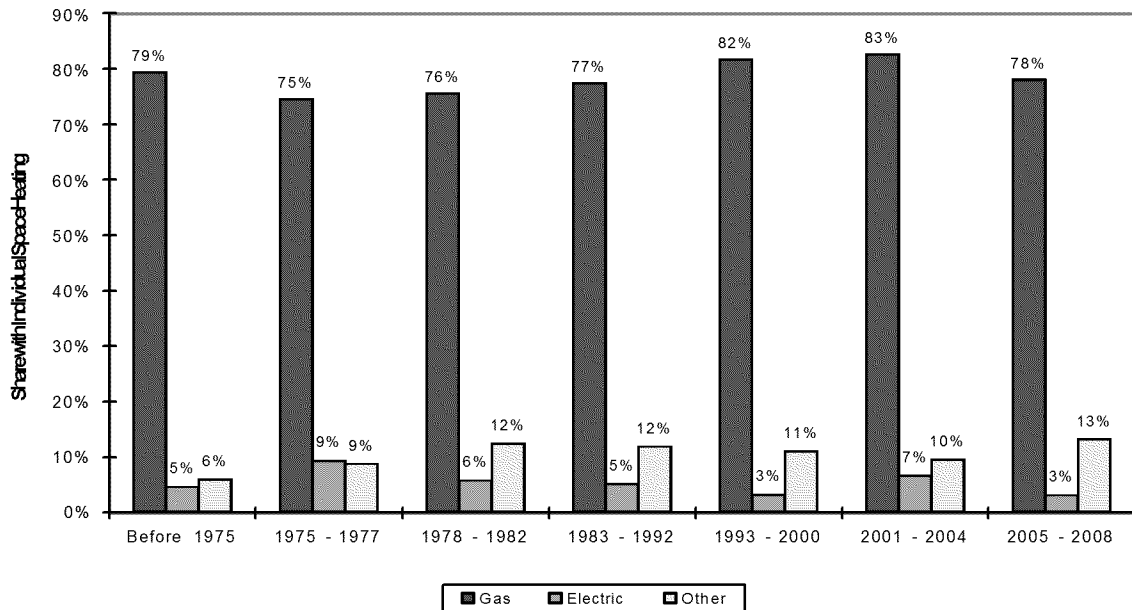
Figure ES-11: Space Heating Fuel by Dwelling Type



Source: 2010 California Residential Appliance Saturation Survey

Electric space heating is most common in dwellings built between 1975 and 1977, as shown in Figure ES-12. Only heating systems for individual households are included; systems that heat multiple households are excluded.

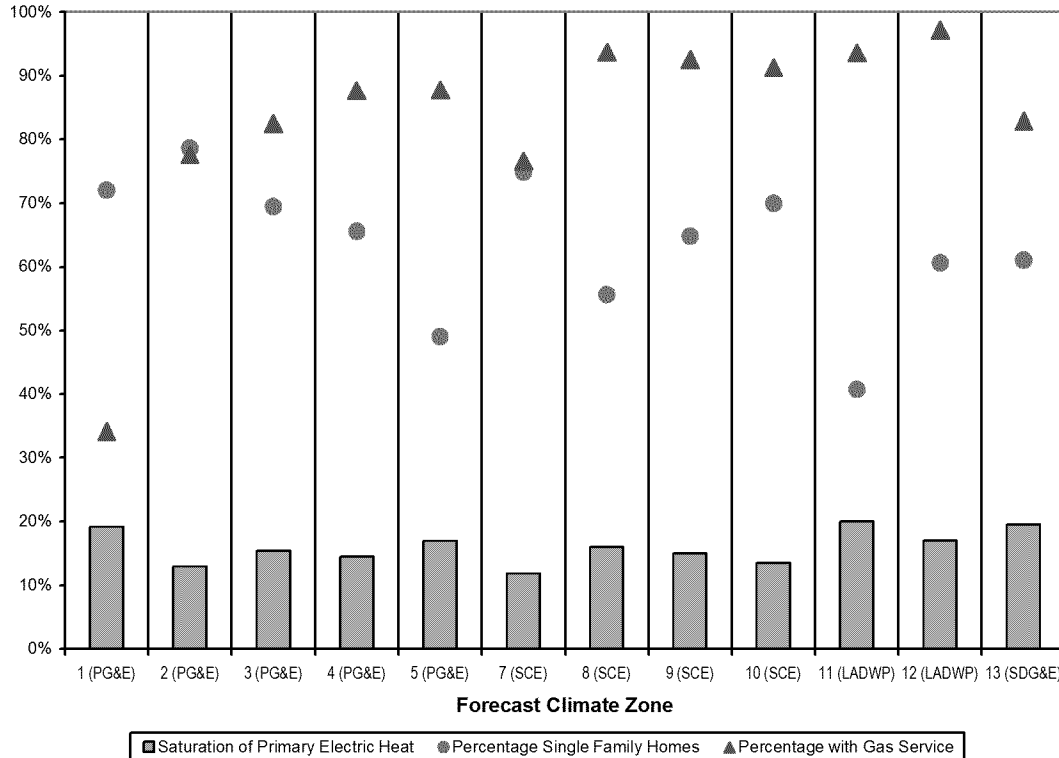
Figure ES-12: Space Heating Fuel by Dwelling Age



Source: 2010 California Residential Appliance Saturation Survey

Figure ES-13 presents shares of electric space heating along with the percentage of single-family homes and percentage of households having natural gas service by forecast climate zones. Electric space heating is most common in forecast climate Zones 1, 11, and 13.

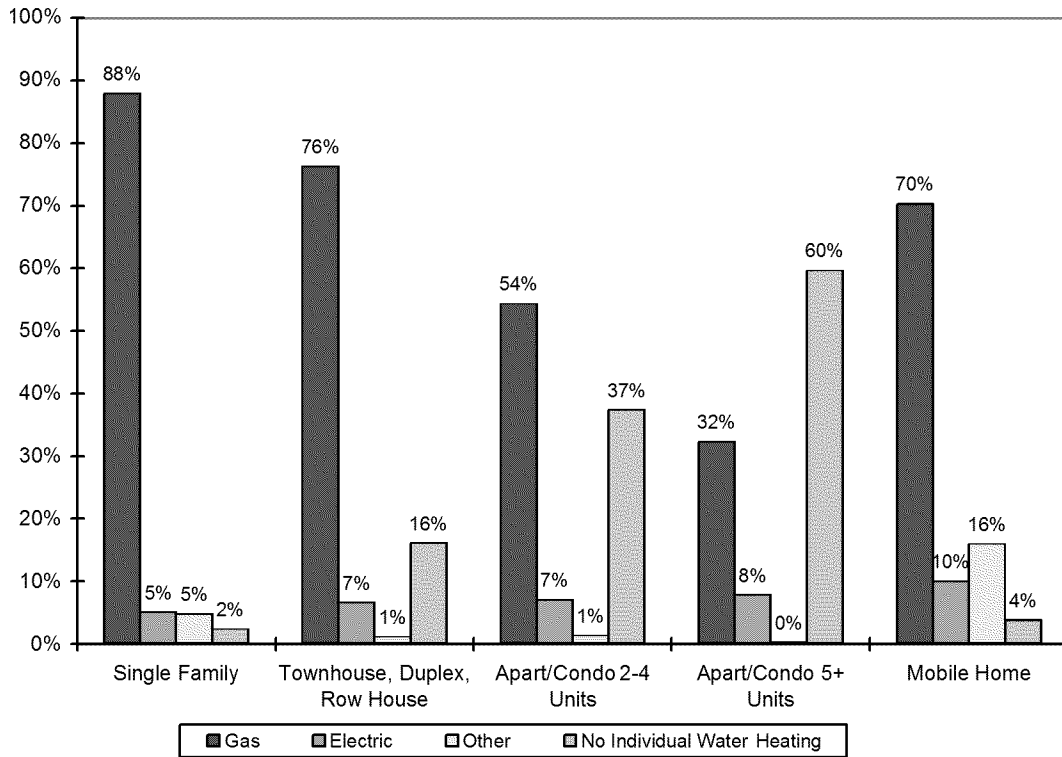
Figure ES-13: Saturation of Electric Space Heating by Forecast Climate Zone



Source: 2010 California Residential Appliance Saturation Survey

Figure ES-14 shows that electric water heating is more common in mobile homes and multifamily dwellings than in single-family homes.

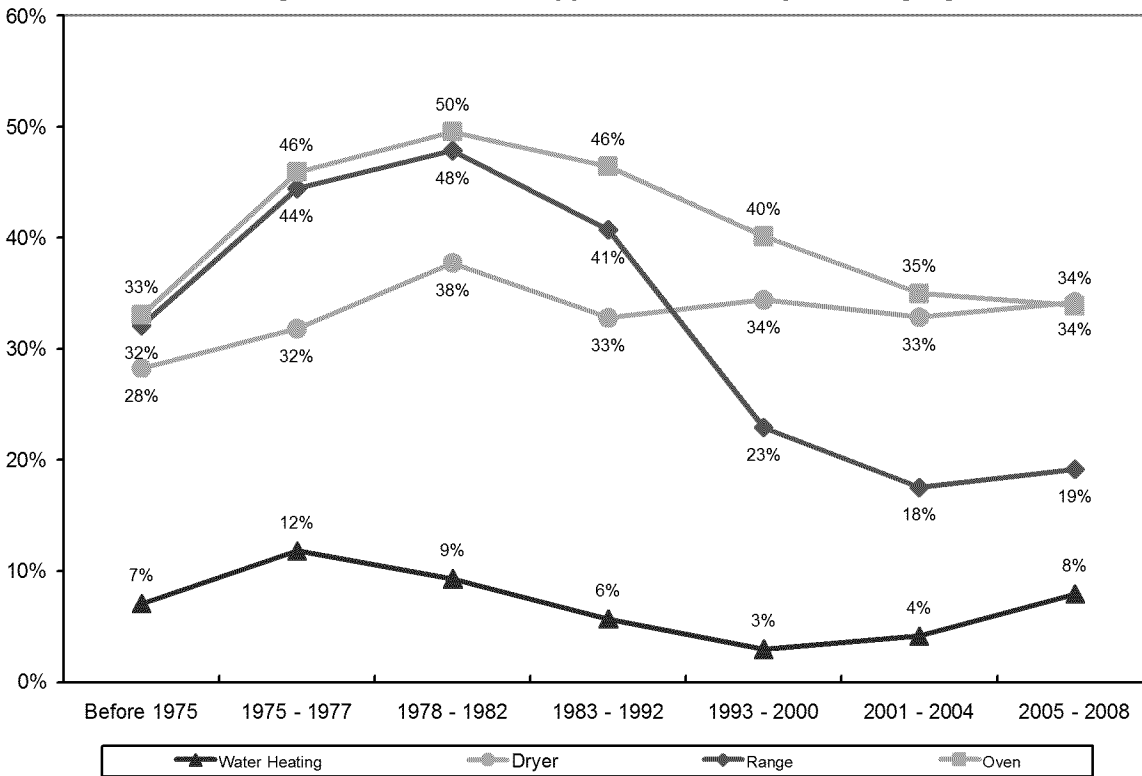
Figure ES-14: Water Heating Fuel by Dwelling Type



Source: 2010 California Residential Appliance Saturation Survey

Electric appliances are most commonly found in dwellings built between 1975 and 1982, as shown in Figure ES-15.

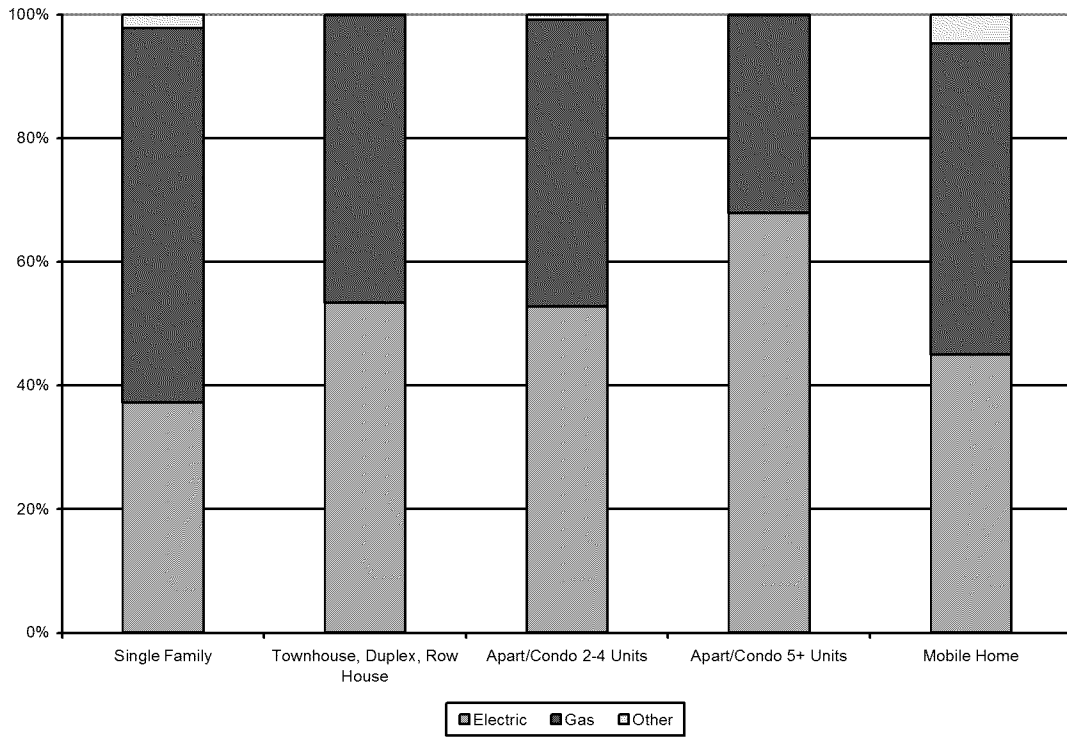
Figure ES-15: Electric Appliances Share by Dwelling Age



Source: 2010 California Residential Appliance Saturation Survey

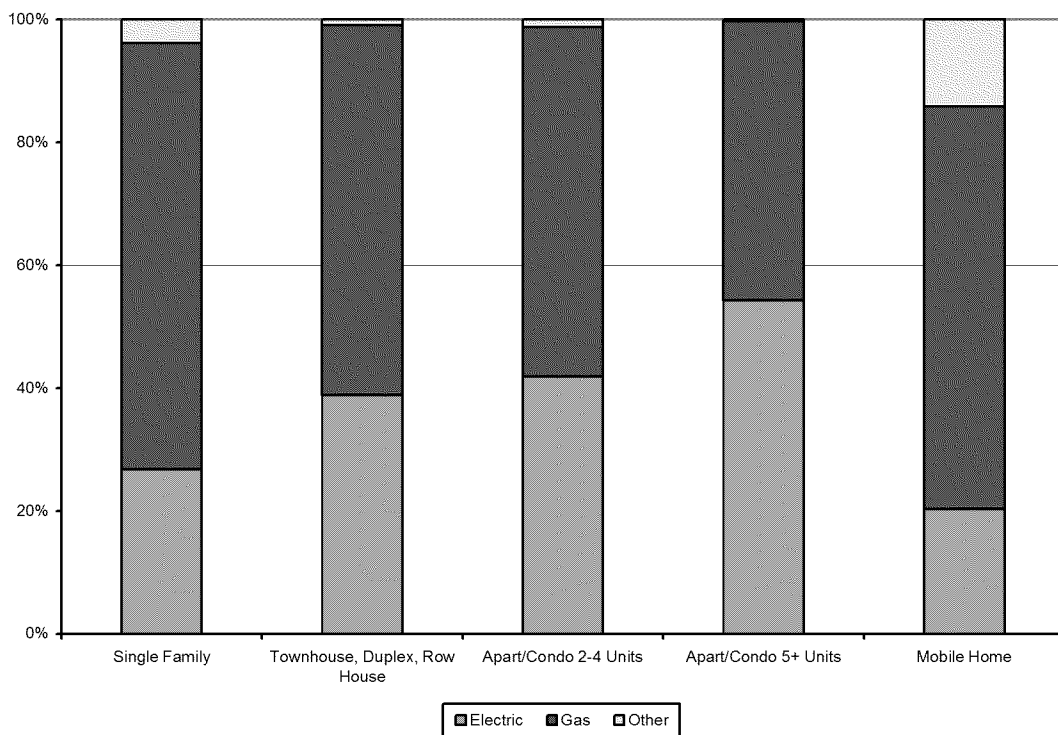
Figures ES-16 through ES-18 show fuel shares by dwelling type for dryers, ranges, and ovens, respectively. Across the three figures, electric fuel shares are higher in apartments in buildings with five or more units than in single-family homes or mobile homes. Overall, the fuel shares have remained relatively stable compared with the 2003 RASS. The only categories to shift more than 5 percent from the 2003 RASS are fuel shares for kitchen ranges for apartments in buildings with five or more units where electric shares increased 7 percent and for mobile homes where electric shares increased 6 percent. The *Other* fuel category primarily represents propane. All fuel share tables represent the fuel share for households that have the equipment.

Figure ES-16: Fuel Shares for Dryers by Dwelling Type



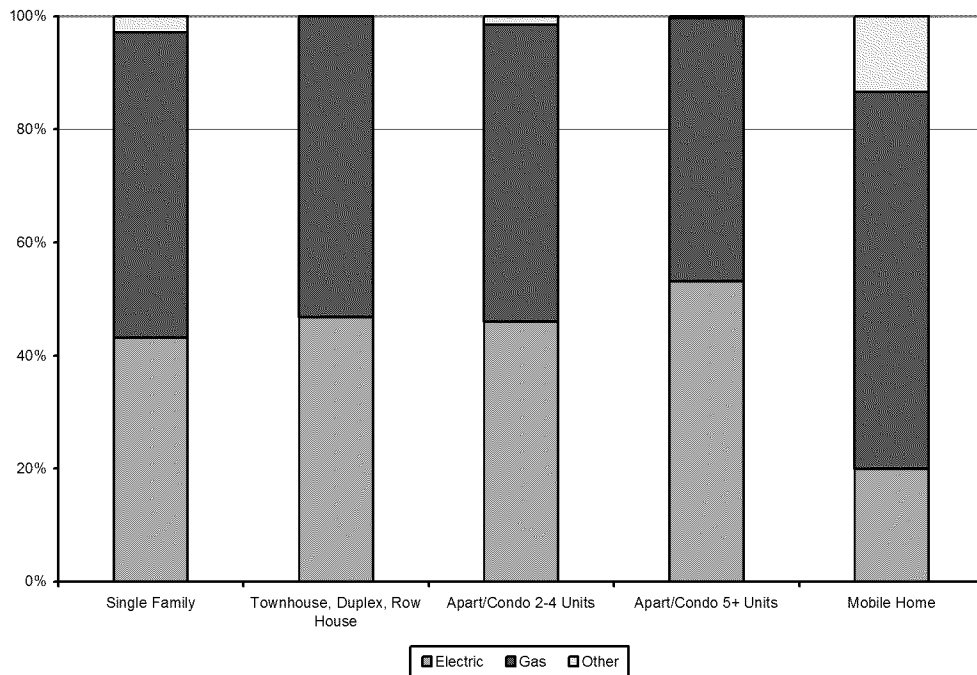
Source: 2010 California Residential Appliance Saturation Survey

Figure ES-17: Fuel Shares for Ranges by Dwelling Type



Source: 2010 California Residential Appliance Saturation Survey

Figure ES-18: Fuel Shares for Ovens by Dwelling Type

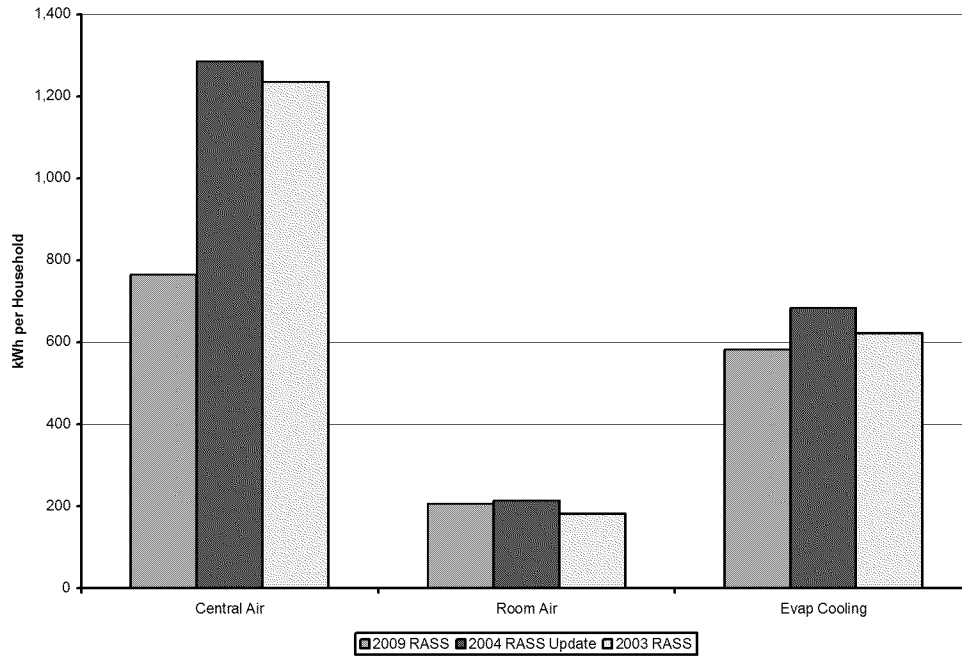


Source: 2010 California Residential Appliance Saturation Survey

Air Conditioning

Although space cooling consumes only 7 percent of annual residential electricity consumption, it is the main driver of residential peak load. The overall UEC for central air conditioning is 766 kWh, with the UEC for evaporative systems at 583 kWh and room air conditioning at 206 kWh per household. The UEC for central air conditioning changed the most compared to both the 2003 RASS and 2004 RASS Update. Figure ES-19 shows the air conditioning UECs by the RASS study year. The UEC for central air conditioning decreased about 40 percent compared to the estimated UECs from the other two RASS studies.

Figure ES-19: Air Conditioning UECs by AC Type for RASS Studies



Source: 2010 California Residential Appliance Saturation Survey

Several factors may have contributed to the lower central air conditioning UEC. First, the use of degree-day normalization allowed for the statistically adjusted engineering model to include an indicator variable that identifies households that reported having central air conditioning. This indicator variable would also allow the identification of households with no central air conditioning, and therefore, no cooling load. The degree-day normalization model also did not identify a significant relationship between cooling degree days and electric usage. In addition, the cooling degree days (CDDs) used for the 2009 RASS varied significantly from the cooling degree days used in the 2003 RASS, as will be discussed later in this section.

Table ES-5 presents central air conditioning UECs along with cooling degree days by Energy Commission forecast climate zone. UECs for central air conditioning vary significantly by forecast climate zone. All cooling degree days represent normalized weather. UECs throughout this report are based on normalized weather.

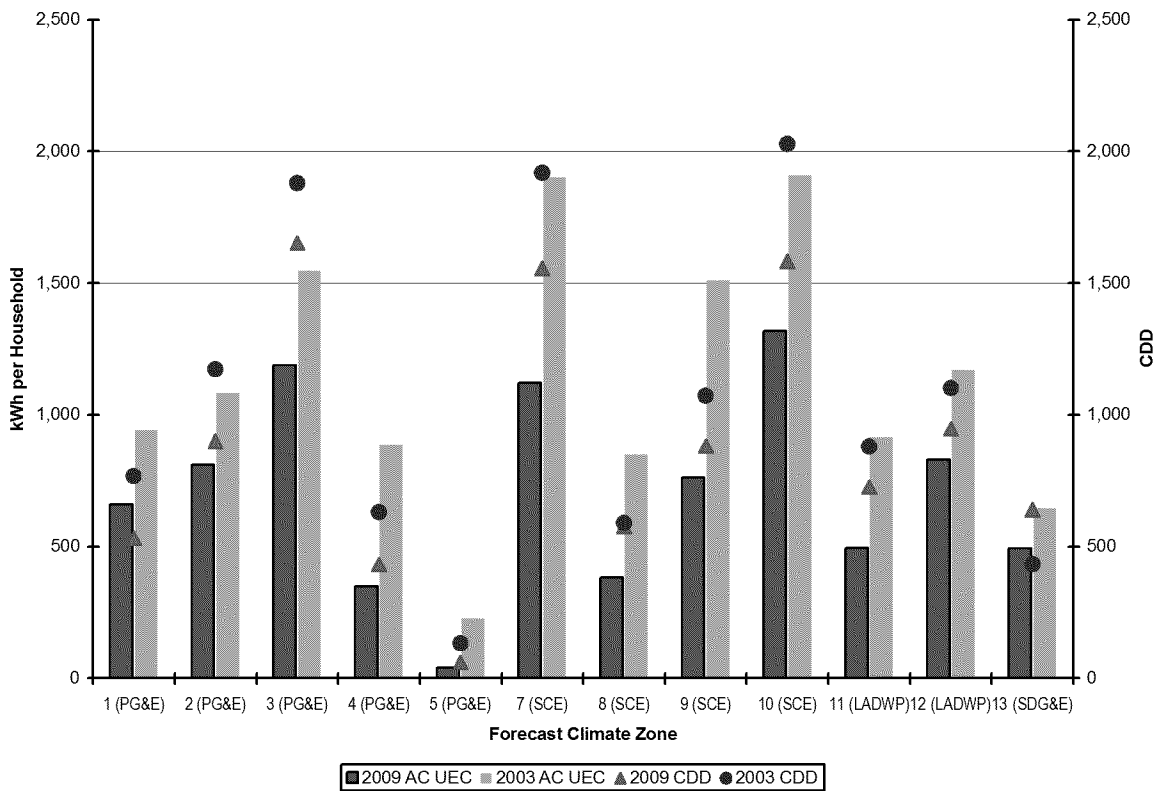
Table ES-5: Central Air Conditioning UECs by Forecast Climate Zone With Cooling Degree Days

| Energy Commission Forecast Climate Zone | Central AC UEC (kWh/Household) | CDD |
|---|--------------------------------|-------|
| Zone 1 (PG&E) | 660 | 532 |
| Zone 2 (PG&E) | 811 | 900 |
| Zone 3 (PG&E) | 1,189 | 1,654 |
| Zone 4 (PG&E) | 348 | 433 |
| Zone 5 (PG&E) | 40 | 61 |
| Zone 7 (SCE) | 1,122 | 1,557 |
| Zone 8 (SCE) | 382 | 575 |
| Zone 9 (SCE) | 763 | 882 |
| Zone 10 (SCE) | 1,318 | 1,583 |
| Zone 11 (LADWP) | 494 | 725 |
| Zone 12 (LADWP) | 829 | 948 |
| Zone 13 (SDG&E) | 493 | 639 |

Source: 2010 California Residential Appliance Saturation Survey

Figure ES-20 shows the central air conditioning UECs along with the cooling degree days for the 2009 RASS and the 2003 RASS. For the majority of climate zones, the cooling degree days for the 2009 RASS were fewer than the cooling degree days for the 2003 RASS. This difference contributed to the lower estimated UECs in every forecast climate zone for the 2009 RASS.

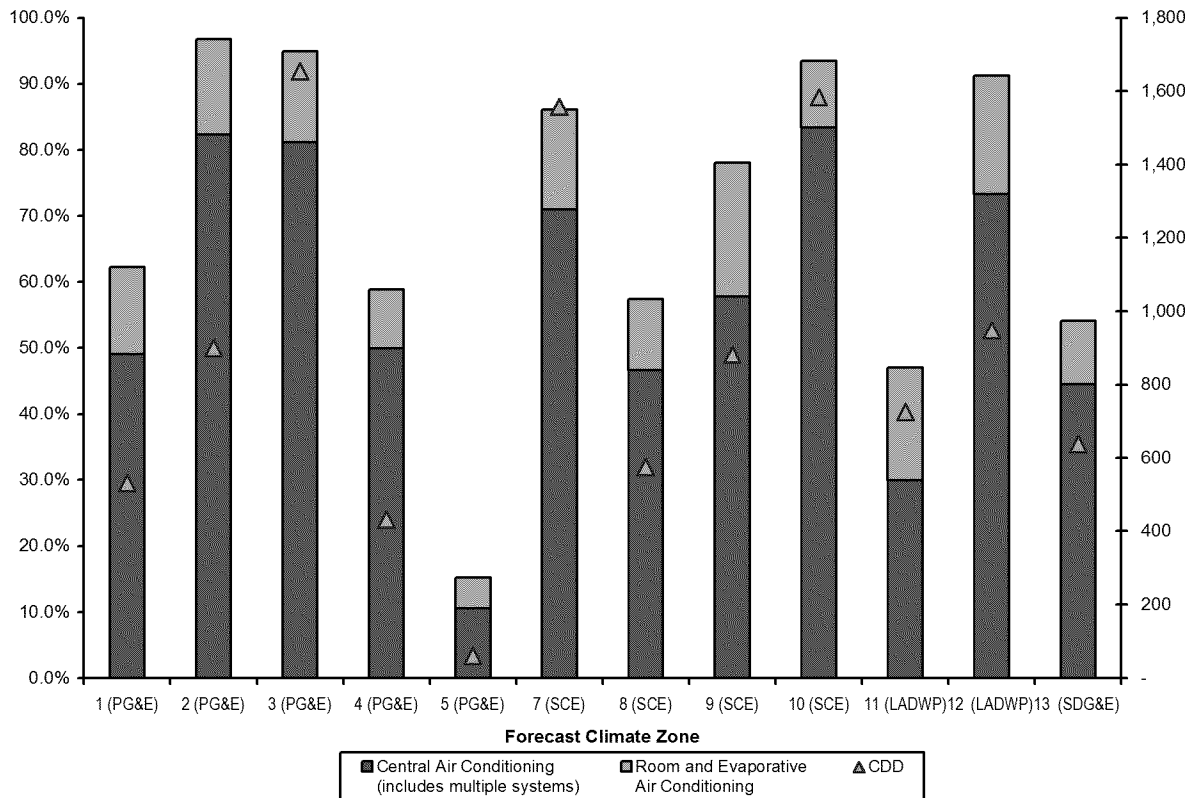
Figure ES-20: AC UEC and Cooling Degree Days (CDD) by Forecast Climate Zone



Source: 2010 California Residential Appliance Saturation Survey

Figure ES-21 shows the saturations by type of air conditioning system along with the cooling degree days by forecast climate zones for the 2009 RASS.

Figure ES-21: Saturation of Air Conditioning by Forecast Climate Zone

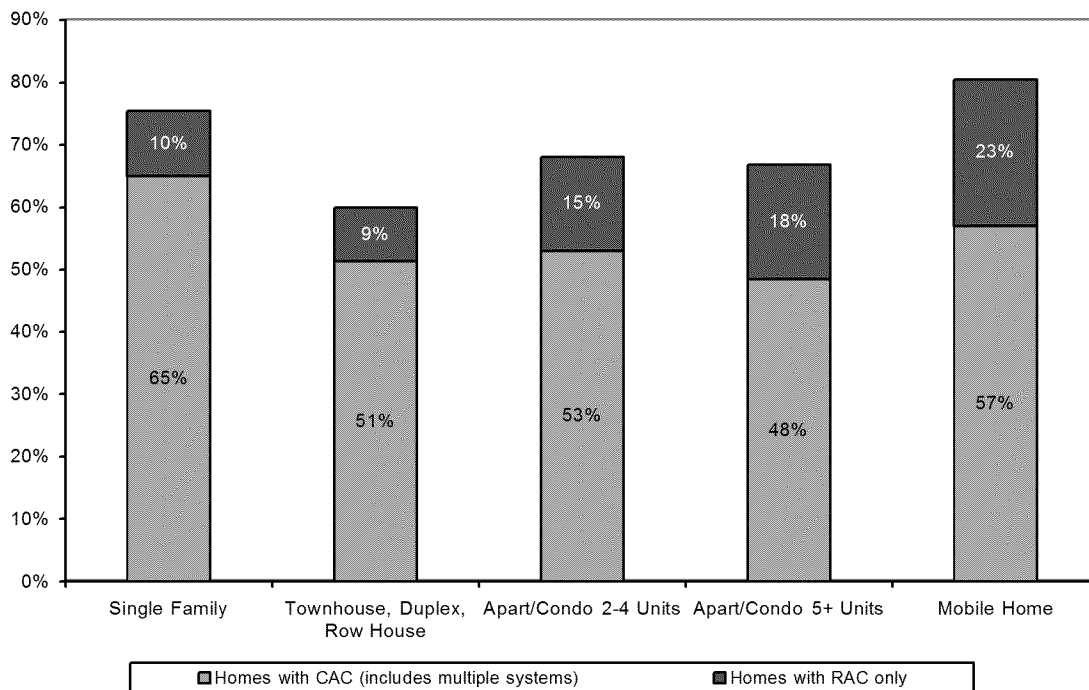


Source: 2010 California Residential Appliance Saturation Survey

Forecast climate Zones 5 and 11 have a combination of relatively low air-conditioning saturations along with a high percentage of multifamily dwellings. Figure ES-22 presents air-conditioning type by dwelling type, with forecast climate Zones 5 and 11 removed to show how air conditioning differs between dwelling types in hot climates.

In Figure ES-22, 67 percent of the households are single-family homes, 15 percent are apartments in buildings with 5 or more units, 6 percent are townhouses or duplexes, 6 percent are apartments in buildings with 2-4 units, and 5 percent are mobile homes. Central air conditioning is more common in single-family homes than in the other dwelling types. Compared to the 2003 RASS, central air conditioning has increased by more than 10 percent in single family dwellings, apartments in buildings with 2-4 units, and mobile homes.

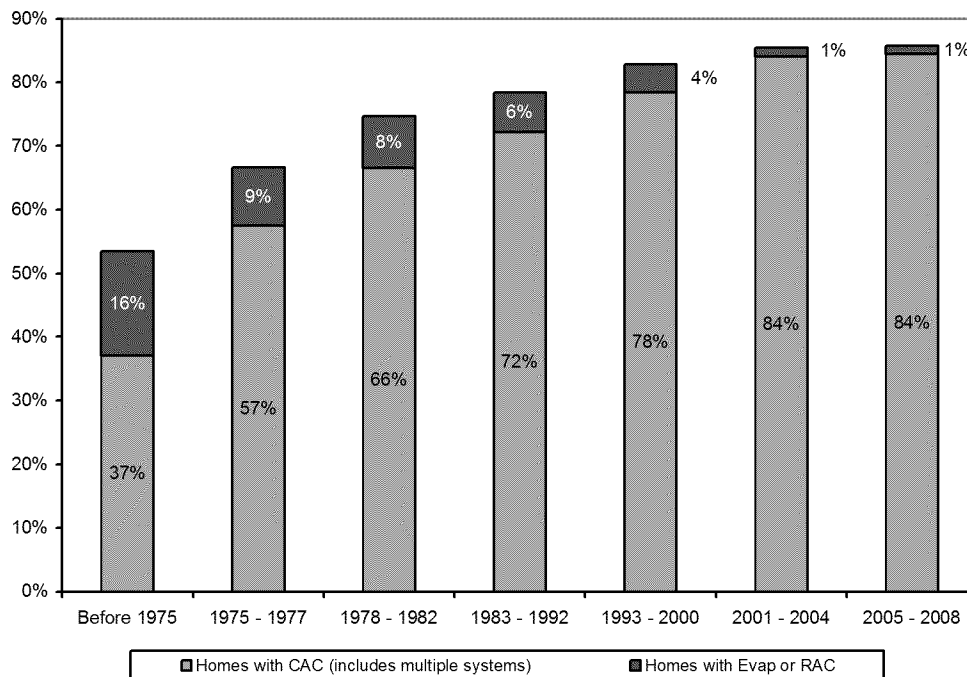
Figure ES-22: Air Conditioning by Dwelling Type for All Forecast Climate Zones Except 5 and 11



Source: 2010 California Residential Appliance Saturation Survey

Figure ES-23 shows the type of air conditioning by dwelling age. Overall, the prevalence of air conditioning has increased with newer dwellings. Likewise, central air conditioning is more common in newer dwellings compared to evaporative coolers or room air conditioners.

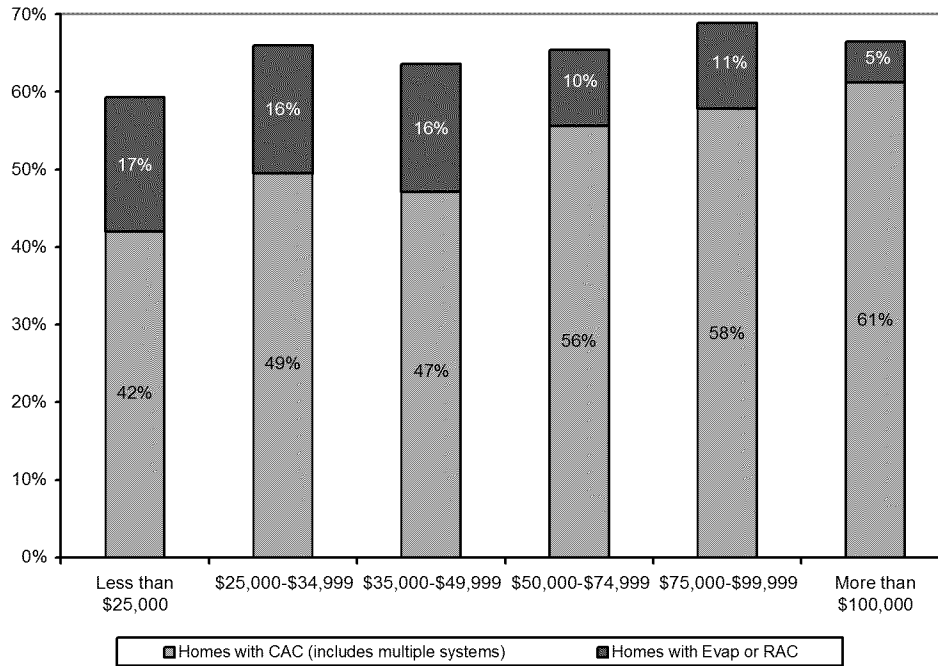
Figure ES-23: Air Conditioning Type by Dwelling Age



Source: 2010 California Residential Appliance Saturation Survey

Although income is correlated both with having air conditioning and the type of air conditioning as shown in Figure ES-24, it is not as big of a driver as dwelling age.

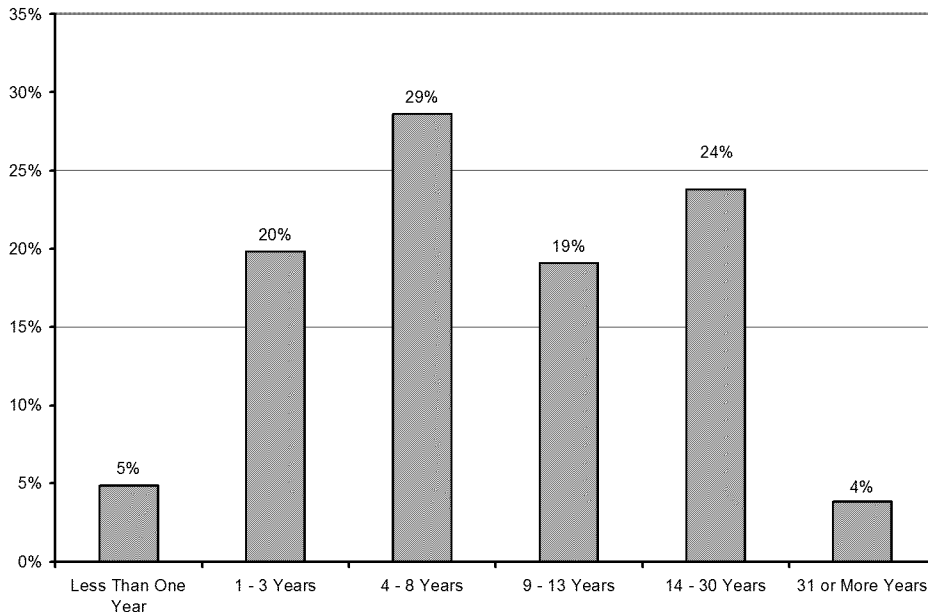
Figure ES-24: Air Conditioning Type by Income



Source: 2010 California Residential Appliance Saturation Survey

Figure ES-25 shows the age distribution of central air conditioners, with 25 percent of units being 3 years old or newer and 28 percent of units being 14 years old or older.

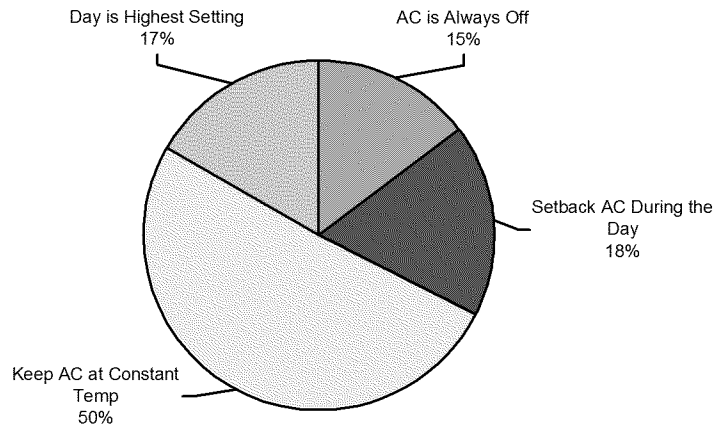
Figure ES-25: Age Distribution of Central Air Conditioners



Source: 2010 California Residential Appliance Saturation Survey

Figure ES-26 depicts the breakdown of how households with central air conditioning set their thermostats. Fifty percent of households reported keeping their thermostats at a constant temperature throughout the day. The average temperature setting using the midpoint of the survey ranges provided is 79.8° Fahrenheit (F) in the morning, 78.2°F degrees during the day, 77.3°F in the evening, and 79.5°F at night.

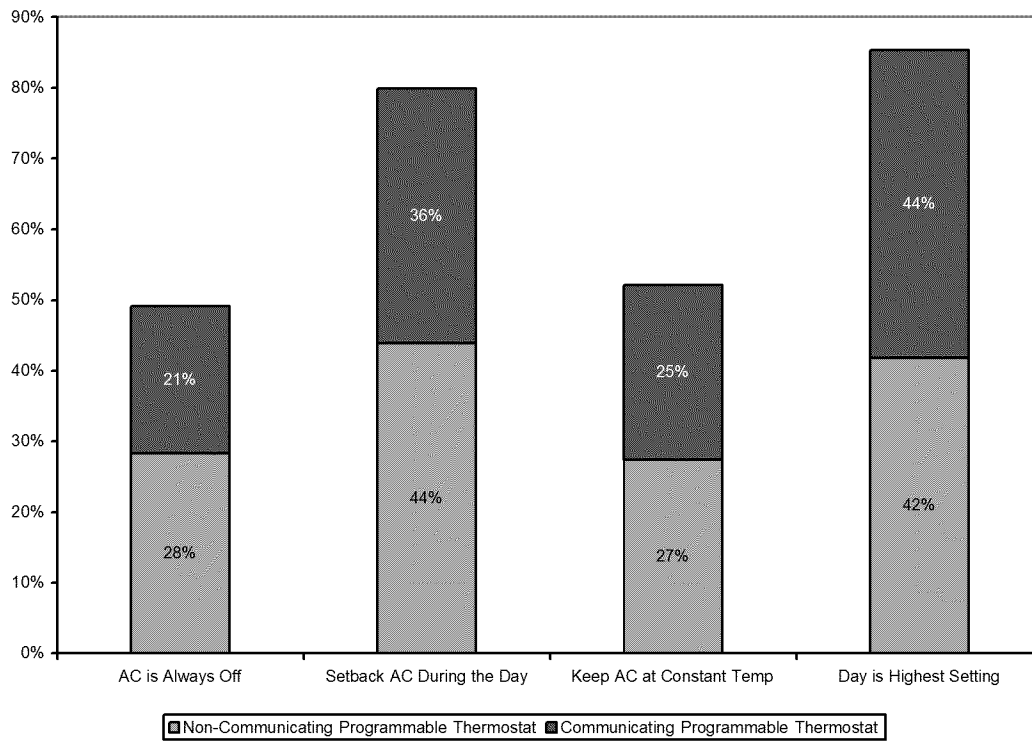
Figure ES-26: Air Conditioning Setback Habits



Source: 2010 California Residential Appliance Saturation Survey

Overall, 69 percent of households have programmable thermostats. Of the households that have programmable thermostats, 36 percent of them have programmable communicating thermostats. Figure ES-27 shows differences in setback habits for households that have programmable or programmable communicating thermostats. Households with either type of programmable thermostat are more likely to change the temperature setting.

Figure ES-27: Presence and Type of Programmable Thermostats by Setback Habits



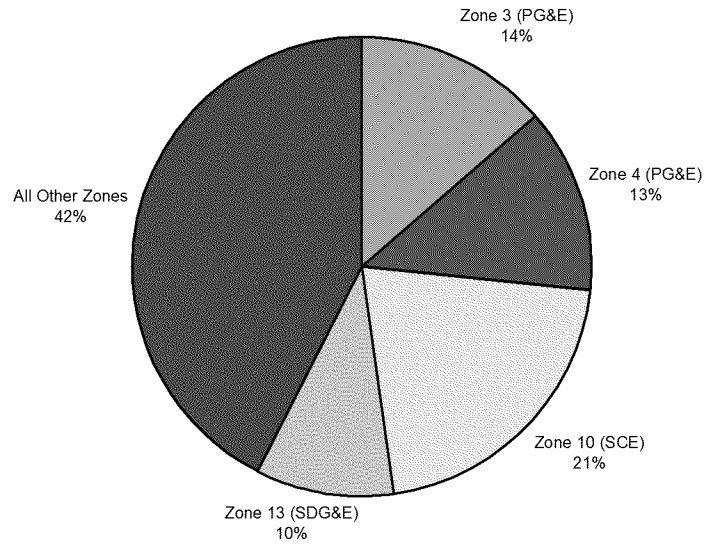
Source: 2010 California Residential Appliance Saturation Survey

New Dwellings

Dwellings built from 2001 and after are considered new dwellings in the 2009 RASS.

Fifty-eight percent of the new residential dwellings are located in four forecast climate zones, as shown in Figure ES-28. Figure ES-2, near the beginning of this report, shows a map of the forecast climate zones.

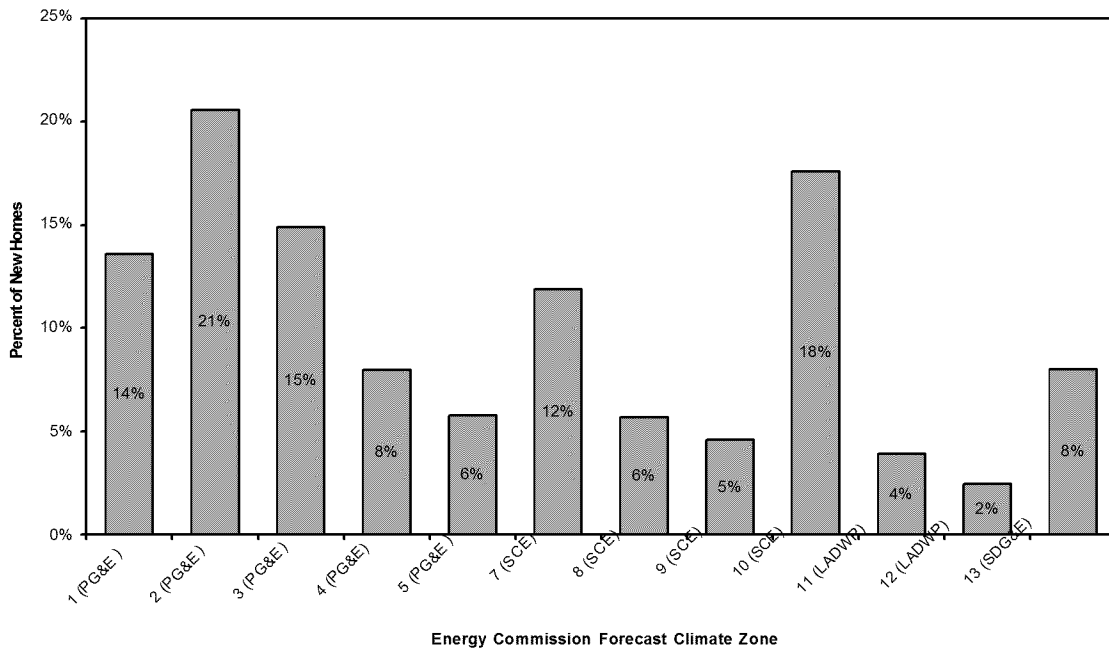
Figure ES-28: Distribution of New Dwellings by Energy Commission Forecast Climate Zone



Source: 2010 California Residential Appliance Saturation Survey

Figure ES-29 shows the housing growth rate by climate zone as the percentage of new dwellings within the total housing population in each climate zone.

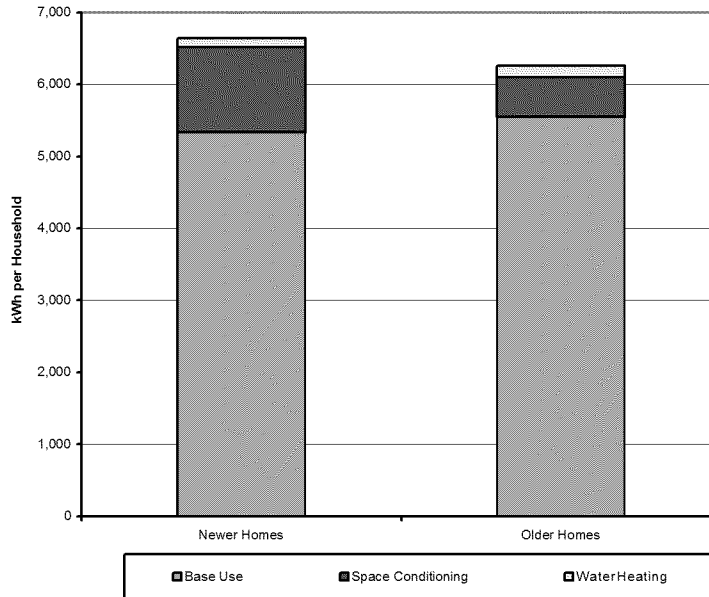
Figure ES-29: Housing Growth Rate by Forecast Climate Zone



Source: 2010 California Residential Appliance Saturation Survey

Household average electric consumption in newer dwellings is 6,645 kWh per year compared to 6,262 kWh in older dwellings, as shown in Figure ES-30. Consumption for space conditioning is the largest difference between the two age groups. On average, newer dwellings are about 500 square feet larger than older dwellings and are more likely to have central air conditioning (84 percent for newer dwellings versus 51 percent for older).

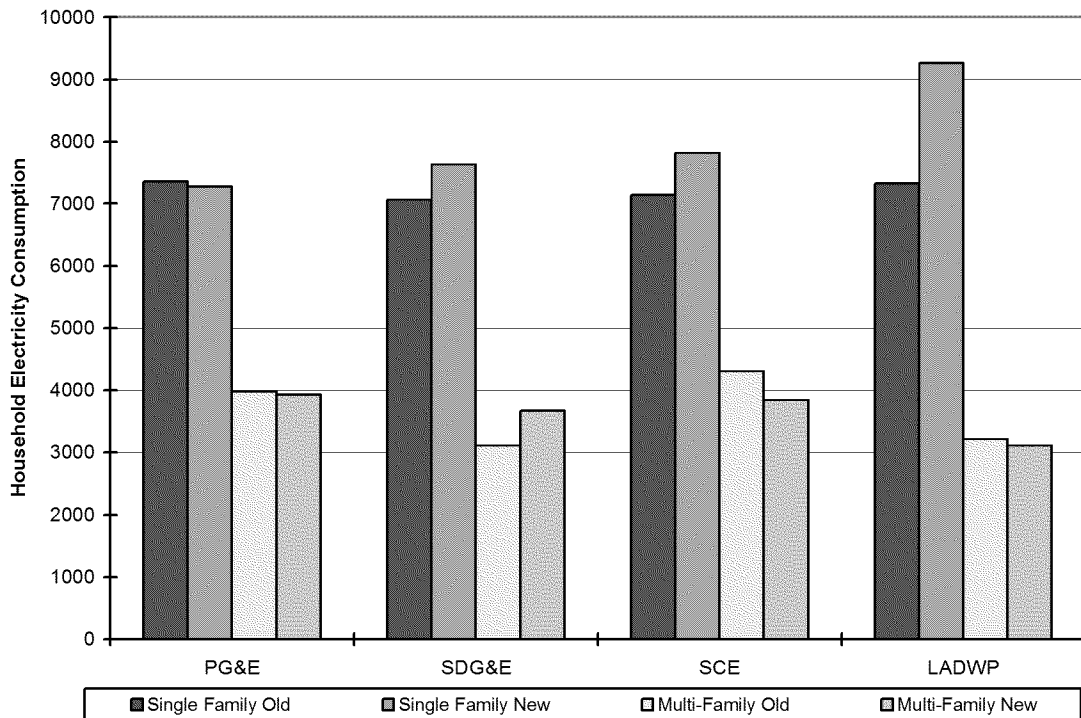
Figure ES-30: Electric UECs for Newer and Older Dwellings



Source: 2010 California Residential Appliance Saturation Survey

The overall average electric consumption is higher in newer dwellings, but the increase is predominantly within single-family dwellings, as shown in Figure ES-31. Newer multifamily dwellings have similar or slightly higher consumption than older dwellings, except for within SCE territory, where consumption decreased for newer multifamily dwellings.

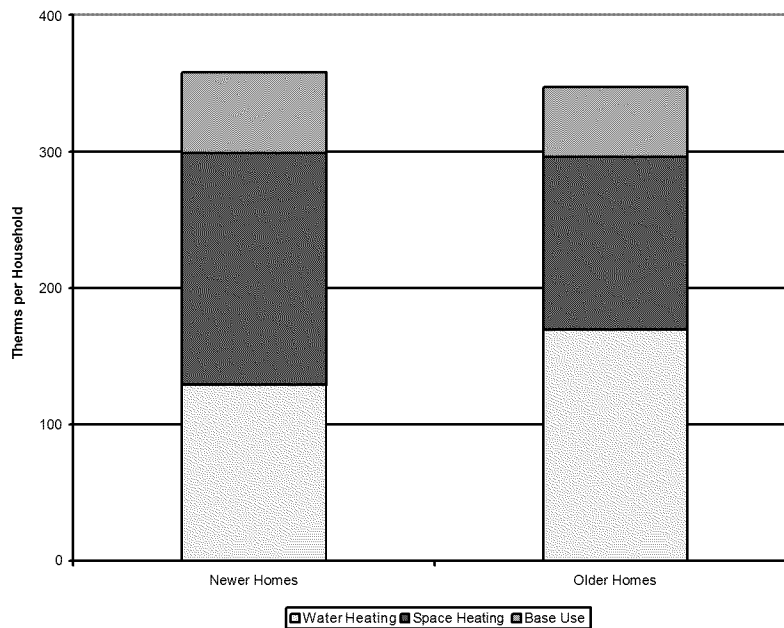
Figure ES-31: Electric UECs for Newer and Older Dwellings by Dwelling Type



Source: 2010 California Residential Appliance Saturation Survey

Total household natural gas consumption is similar for newer and older dwellings, but space heating consumes a higher proportion of the total for newer dwellings than for older, as shown in Figure ES-32.

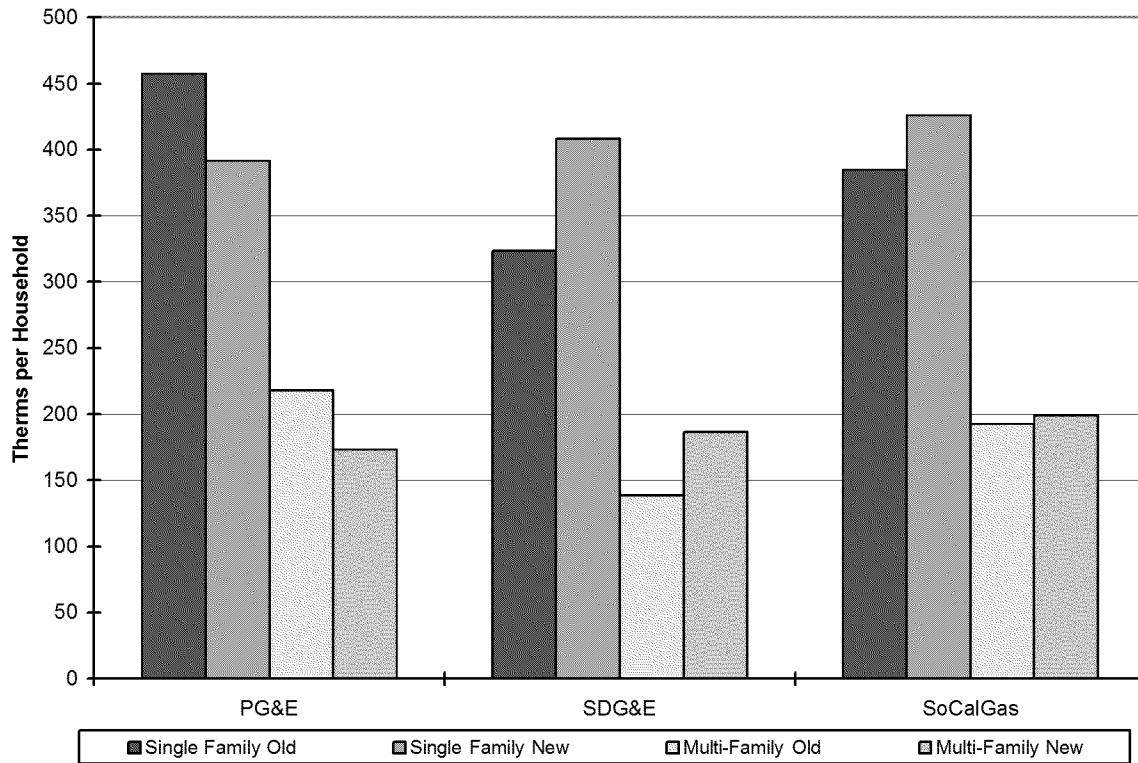
Figure ES-32: Natural Gas UECs for Newer and Older Dwellings



Source: 2010 California Residential Appliance Saturation Survey

The overall average natural gas consumption is similar for newer and older dwellings, but Figure ES-33 shows the variation between home types and utility service areas. Consumption is declining for newer single-family and multifamily dwellings within PG&E service area but increasing for both newer home types within the SDG&E service area.

Figure ES-33: Natural Gas UECs for Newer and Older Dwellings by Dwelling Type



Source: 2010 California Residential Appliance Saturation Survey

Table ES-6 compares household characteristics of newer dwellings and older dwellings. Newer dwellings are 28 percent larger but have fewer residents in the household. As mentioned earlier, central air conditioning is more prevalent in newer homes, but these newer homes are also more likely to have more energy-efficient measures, such as insulated exterior walls and attics insulated, dual-paned windows installed, and more CFLs.

Table ES-6: Comparison of Newer and Older Dwellings

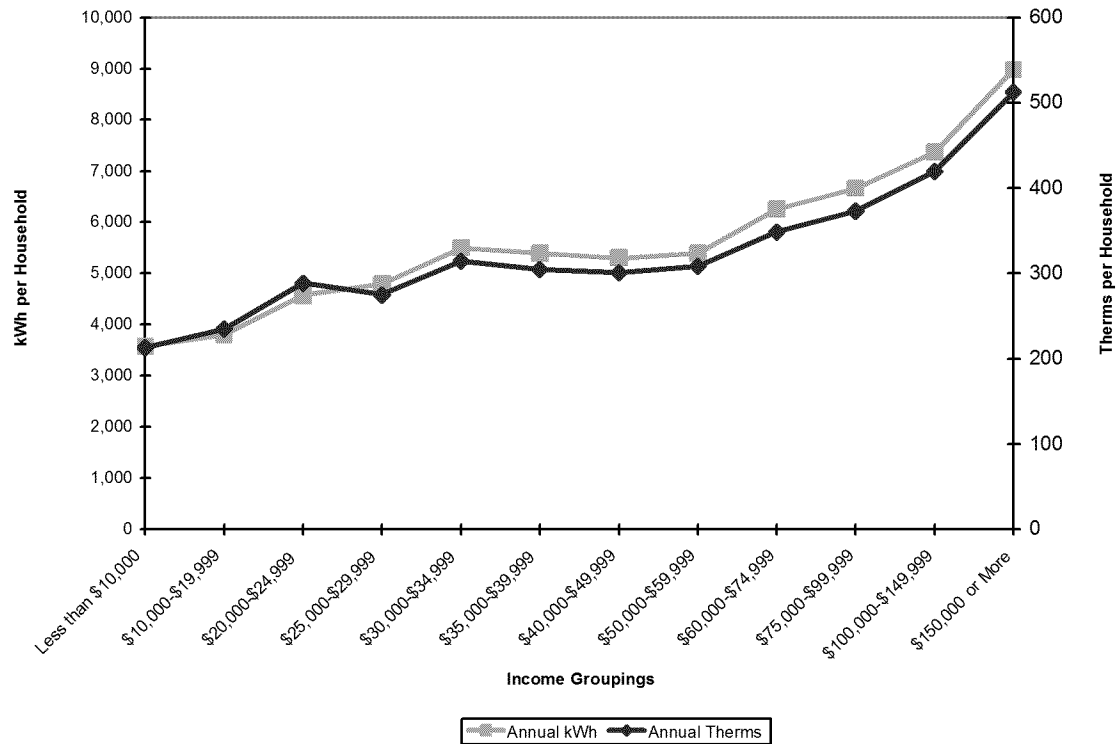
| | Newer Dwellings | Older Dwellings | Percent Difference |
|---------------------------------------|------------------------|------------------------|---------------------------|
| Annual Electric Household Consumption | 6,645 | 6,262 | 6% |
| Annual Gas Household Consumption | 358 | 347 | 3% |
| Dwelling Size | 2,020 | 1,521 | 28% |
| Number of Residents | 4.16 | 5.12 | -21% |
| Average Income | 84,837 | 68,051 | 22% |
| Percent Single Family | 68% | 60% | 12% |
| Owners | 78% | 67% | 15% |
| Saturation of Central AC | 84% | 51% | 50% |
| Cooling Degree Days | 1,029 | 757 | 30% |
| Cooling Degree Days (those with CAC) | 1,157 | 1,013 | 13% |
| Programmable Cooling Thermostat | 87% | 66% | 28% |
| Pool Saturation | 18% | 24% | -25% |
| Average Number of Computers per Home | 1.81 | 1.57 | 14% |
| Gas Primary Heating | 78% | 78% | 0% |
| Heating Degree Days | 2,292 | 2,159 | 6% |
| Exterior Wall Insulation Throughout | 88% | 48% | 58% |
| Attic Insulation | 90% | 70% | 25% |
| Double Pane Windows Throughout | 80% | 42% | 62% |
| Low Flow Showerheads Throughout | 69% | 59% | 14% |
| Average Number of CFLs per Home | 12.25 | 8.79 | 33% |
| Horizontal Access Washers | 32% | 22% | 38% |

Source: 2010 California Residential Appliance Saturation Survey

Income Effects

Both overall average household electric and natural gas consumption increase as income increases, as shown in Figure ES-34.

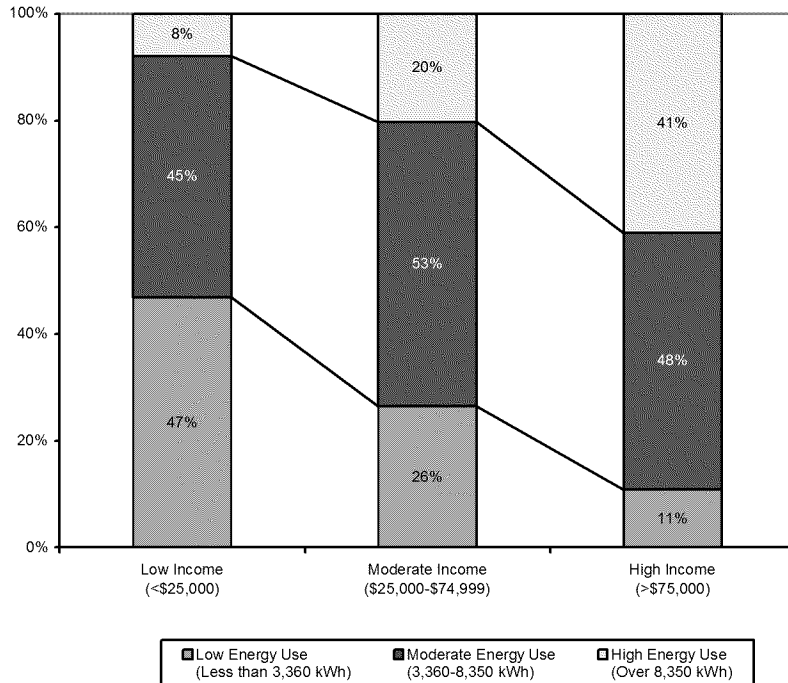
Figure ES-34: Average Electricity and Natural Gas Consumption by Income



Source: 2010 California Residential Appliance Saturation Survey

Although income is correlated with energy consumption, Figure ES-35 shows that all levels of electric consumption are present in all income categories, but their proportions vary. The electric consumption is broken down into quartiles (four equal parts), with the two middle quartiles comprising the moderate consumption category. Eight percent of households in the low-income category have electric consumption at the highest quartile (use more than 8,350 kWh per year). Conversely, 11 percent of households in the high-income category have electric consumption in the lowest quartile (use less than 3,360 kWh per year).

Figure ES-35: Electricity Consumption Compared With Income



Source: 2010 California Residential Appliance Saturation Survey

Table ES-7 provides a comparison of household characteristics by income category. Households with higher incomes are more likely to be owners and have larger and newer homes.

Table ES-7: Comparison of Household Characteristics by Income

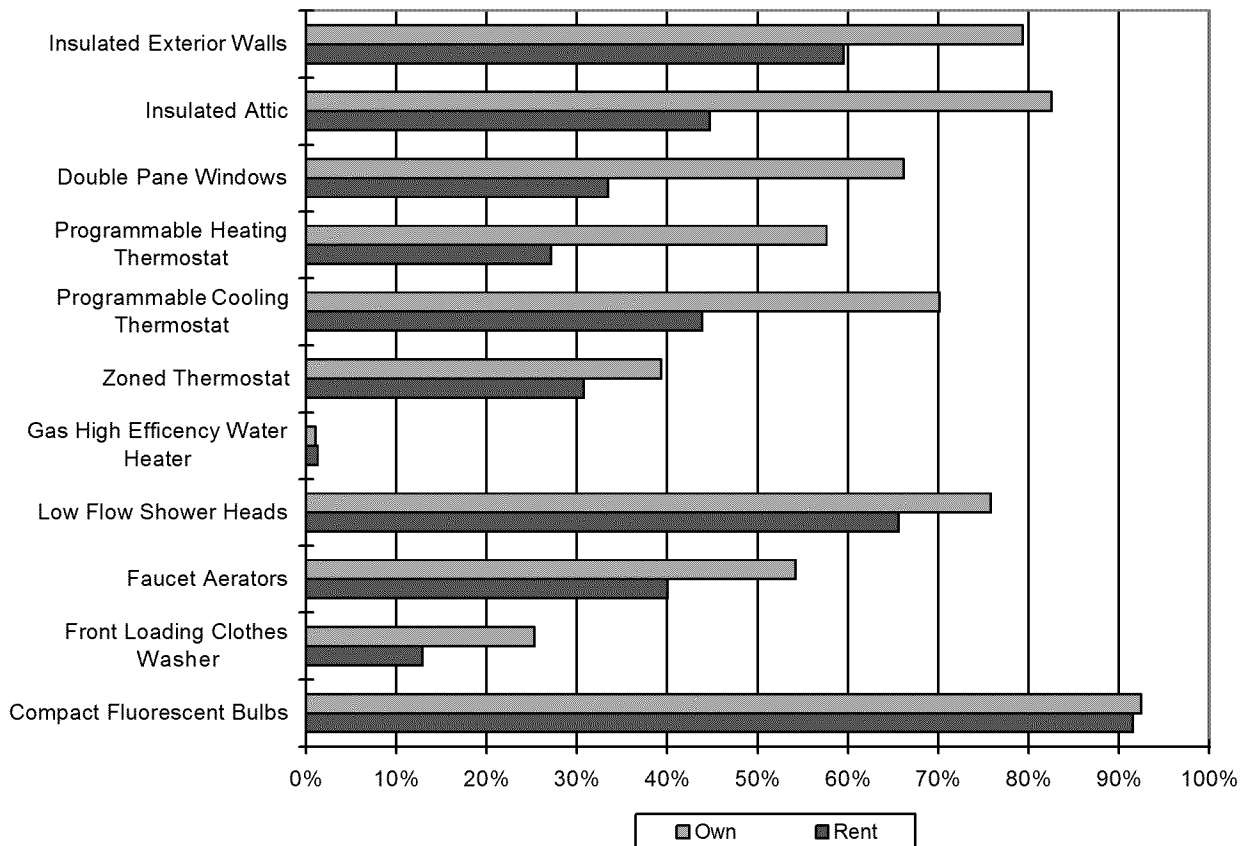
| | Low Income (<\$25,000) | Moderate Income (\$25,000-\$74,999) | High Income (>\$75,000) |
|--|------------------------|-------------------------------------|-------------------------|
| Percentage of Population | 24% | 40% | 36% |
| Dwelling Size | 1,149 | 1,420 | 1,942 |
| Dwelling Age | 37.8 | 36.7 | 33.9 |
| Percentage Single Family | 41% | 58% | 75% |
| Percentage Own | 42% | 65% | 84% |
| Number of People | 6.38 | 4.30 | 3.78 |
| Annual Electric Household Consumption | 4313 | 5887 | 8013 |
| Annual Gas Household Consumption | 249 | 316 | 437 |
| Central Air Conditioning Saturation | 45% | 53% | 61% |
| Gas Heating Saturation | 68% | 78% | 84% |
| Pool Saturation | 19% | 22% | 28% |
| Average Number of Computers per Home | 0.93 | 1.48 | 2.17 |
| Work at Home | 13% | 17% | 32% |
| Programmable Heating Thermostat | 57% | 63% | 78% |
| Dwellings With CFLs | 83% | 87% | 85% |

Source: 2010 California Residential Appliance Saturation Survey

Adoption of Energy-Efficient Measures

Often the adoption of energy efficiency measures rests with the building owner, either by choice or by a change in building codes. Even though renters may not have the opportunity to install some energy efficient measures, they may be able to choose a unit with energy efficient attributes. Figure ES-36 shows that households in which the dwellings are owned are more likely to have energy efficient measures in place. Compared to the 2003 RASS, saturations of all measures have increased, with the most dramatic increase occurring with compact fluorescent light bulbs. The 2003 RASS found only 57 percent of owners and 40 percent of renters had compact fluorescent light bulbs, compared with the 2009 RASS where 92 percent of both owners and renters have compact fluorescent light bulbs.

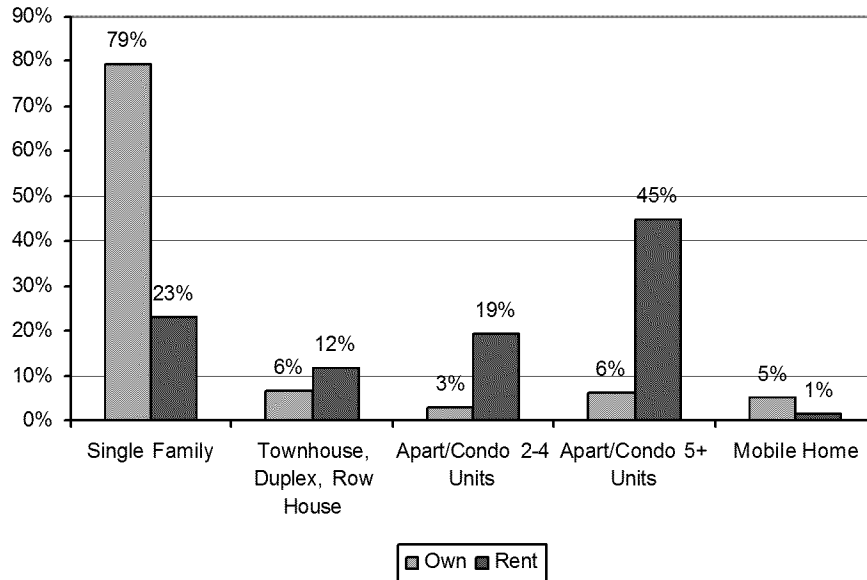
Figure ES-36: Energy Efficiency Measures by Ownership



Source: 2010 California Residential Appliance Saturation Survey

Owners comprise 68 percent of the study population, with the remaining 32 percent being renters. Figure ES-37 shows ownership by dwelling type. Seventy-nine percent of owners have single-family homes, while 45 percent of renters have apartments or condominiums in buildings with five or more units.

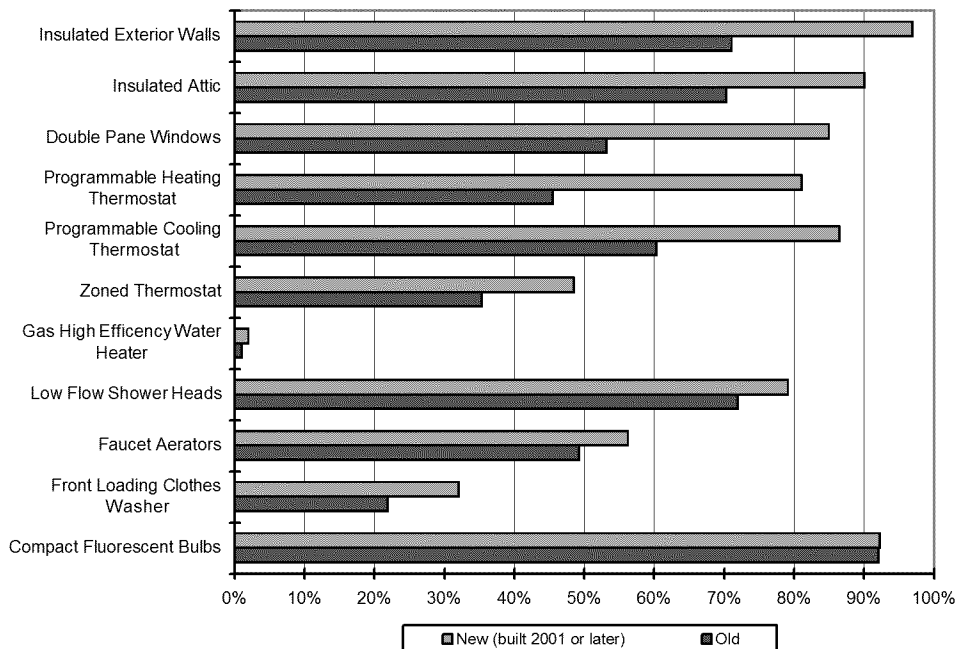
Figure ES-37: Ownership by Dwelling Type



Source: 2010 California Residential Appliance Saturation Survey

Figure ES-38 compares the same energy efficiency measures as listed above across newer and older dwellings. The measures included in building standards have higher saturations for newer dwellings, but the saturations of less than 100 percent suggest that respondents are not familiar with some of the characteristics of their dwelling.

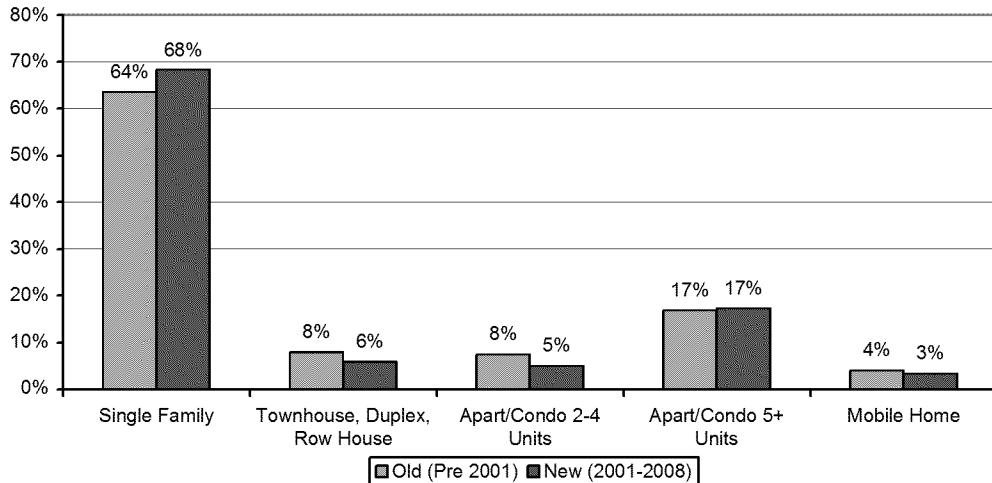
Figure ES-38: Energy Efficiency Measures by Dwelling Age



Source: 2010 California Residential Appliance Saturation Survey

Ninety percent of the dwellings in the study population were built prior to 2001. Figure ES-39 shows the distribution of dwelling age group across dwelling types.

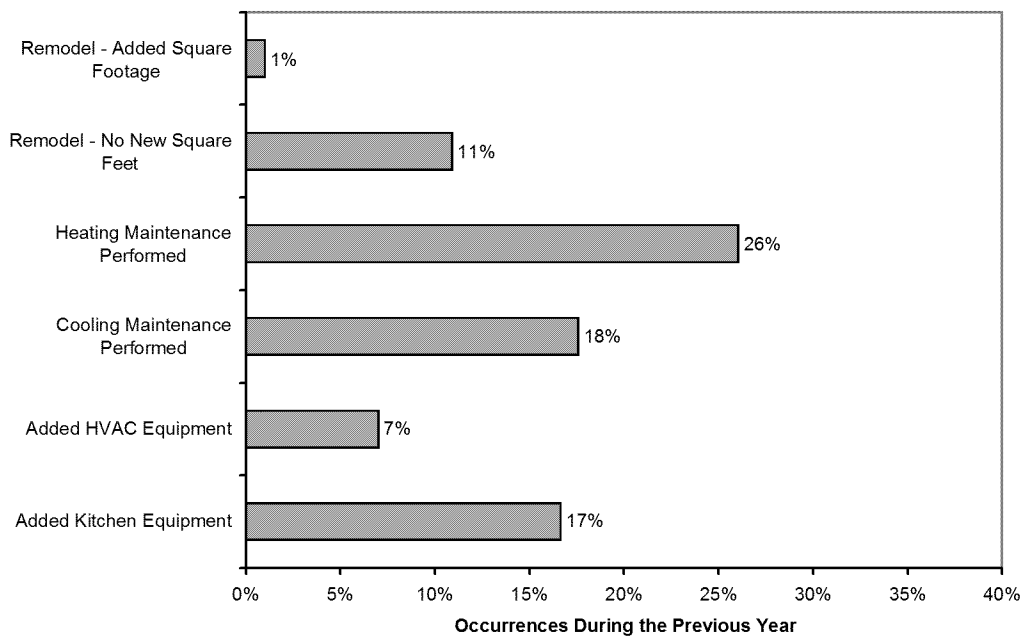
Figure ES-39: Dwelling Type by Dwelling Age



Source: 2010 California Residential Appliance Saturation Survey

Figure ES-40 provides examples of opportunities for energy efficiency communications or sales with customers. On average, one in eight dwellings was remodeled in the previous 12 months. Eleven percent of those remodels included the addition of square footage. Maintenance, major equipment replacement, and kitchen appliance remodels also raise opportunities for households to increase efficiency.

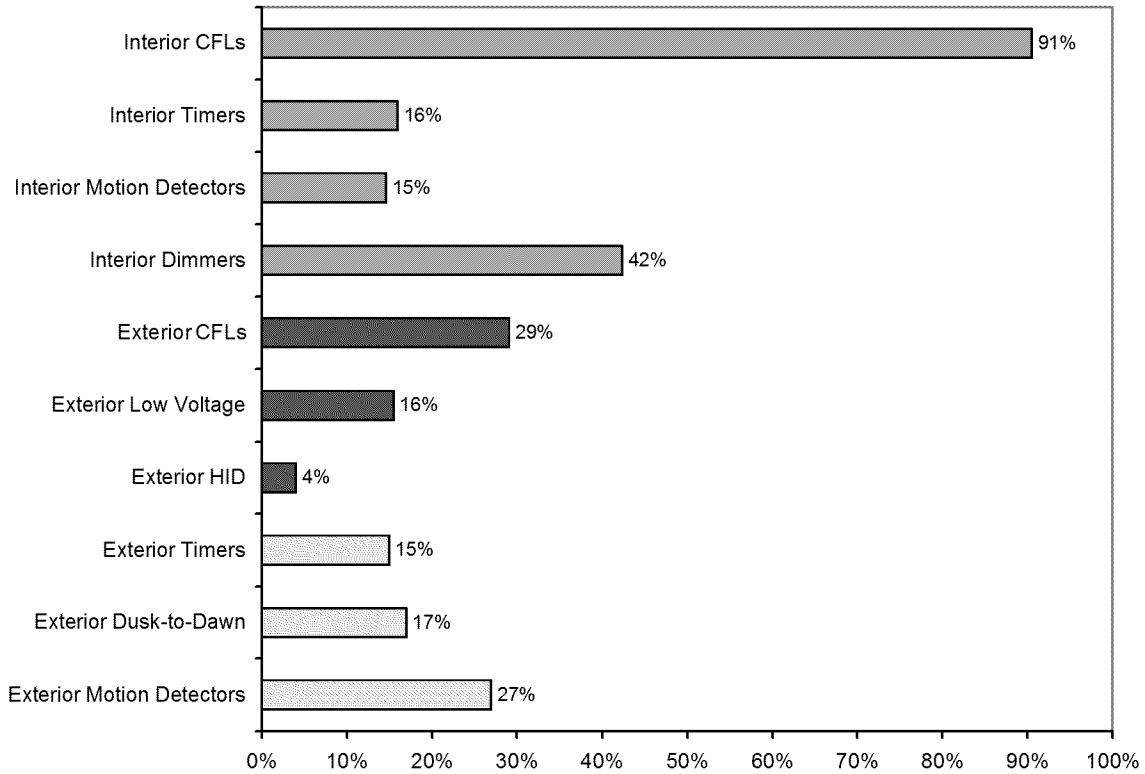
Figure ES-40: Remodeling and Repair Opportunities



Source: 2010 California Residential Appliance Saturation Survey

Compact fluorescent light (CFL) bulbs have been heavily marketed through various program initiatives throughout the state. Interior CFLs can be found in 91 percent of households and exterior CFLs in 29 percent of households, as shown in Figure ES-41.

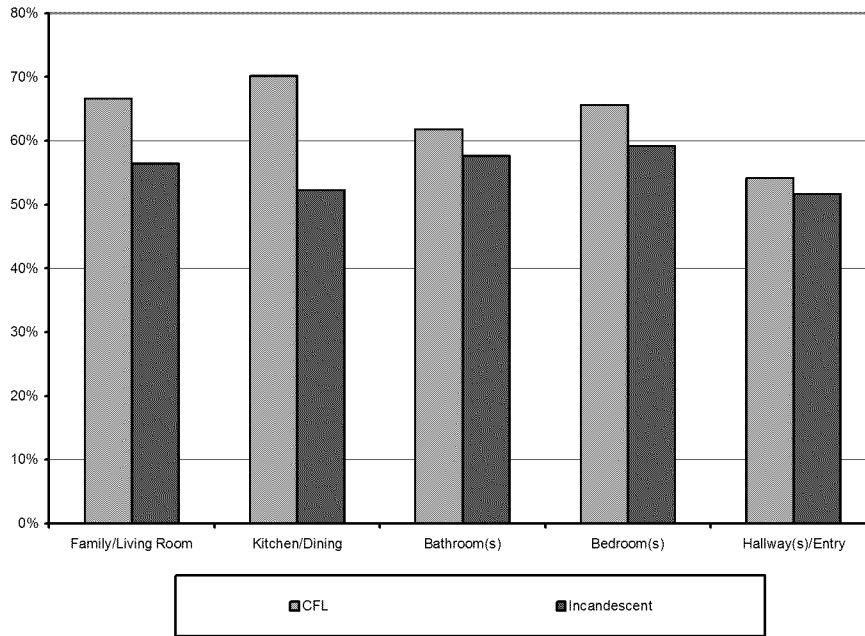
Figure ES-41: Penetration of Various Lighting Equipment and Devices



Source: 2010 California Residential Appliance Saturation Survey

Figure ES-42 shows the penetration of CFLs and incandescent bulbs by home area. The survey asked for the number of bulbs per home area for CFLs, then for incandescents by home area. Only respondents who marked a response for all home area types both for CFLs and incandescent bulbs are included in the figure. CFLs appear most popular in the kitchen or dining area of the home.

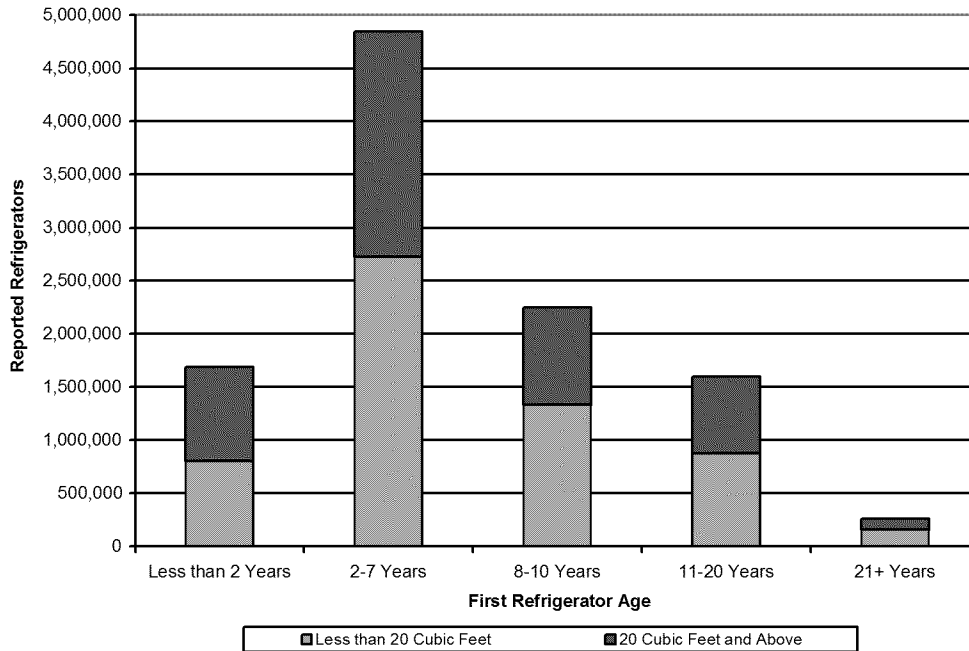
Figure ES-42: Penetration of CFLs and Incandescents by Home Area



Source: 2010 California Residential Appliance Saturation Survey

The UEC for first refrigerators is 772 kWh per household. Figure ES-43 shows that almost 2 million refrigerators are at least 11 years old and might need to be replaced in the next 5 years. Eight percent of all customers reported that they discarded a refrigerator in the prior 12 months.

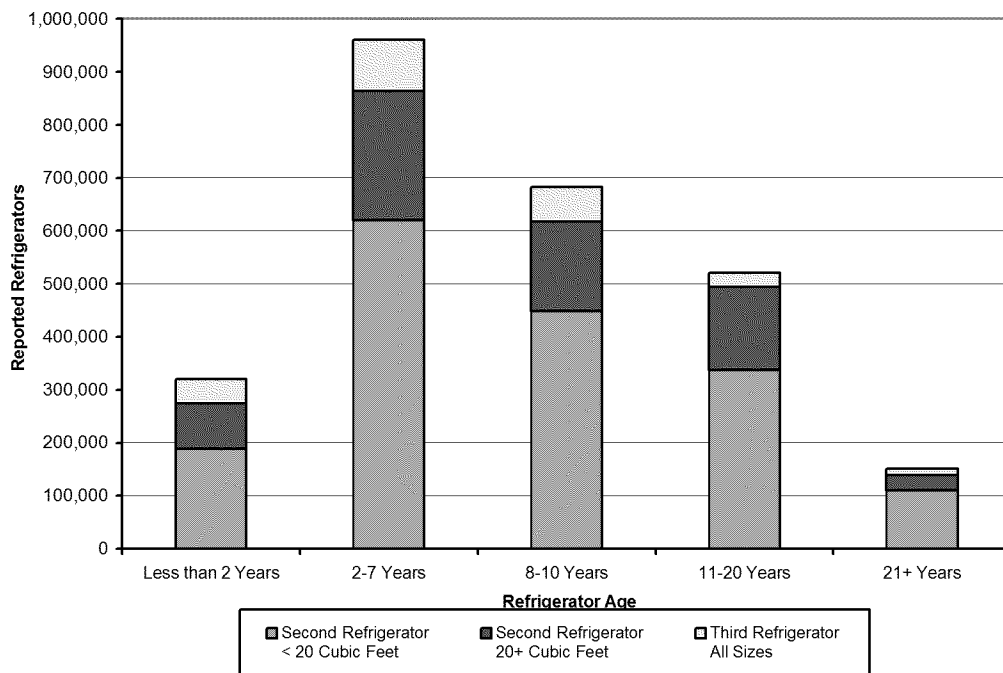
Figure ES-43: First Refrigerators by Size and Age



Source: 2010 California Residential Appliance Saturation Survey

Twenty-four percent of households report having at least one additional refrigerator. Second and third refrigerators use an average of 1,212 kWh per unit. Figure ES-44 shows that there are 632,000 additional refrigerator units that are at least 11 years old or older.

Figure ES-44: Second and Third Refrigerators by Size and Age



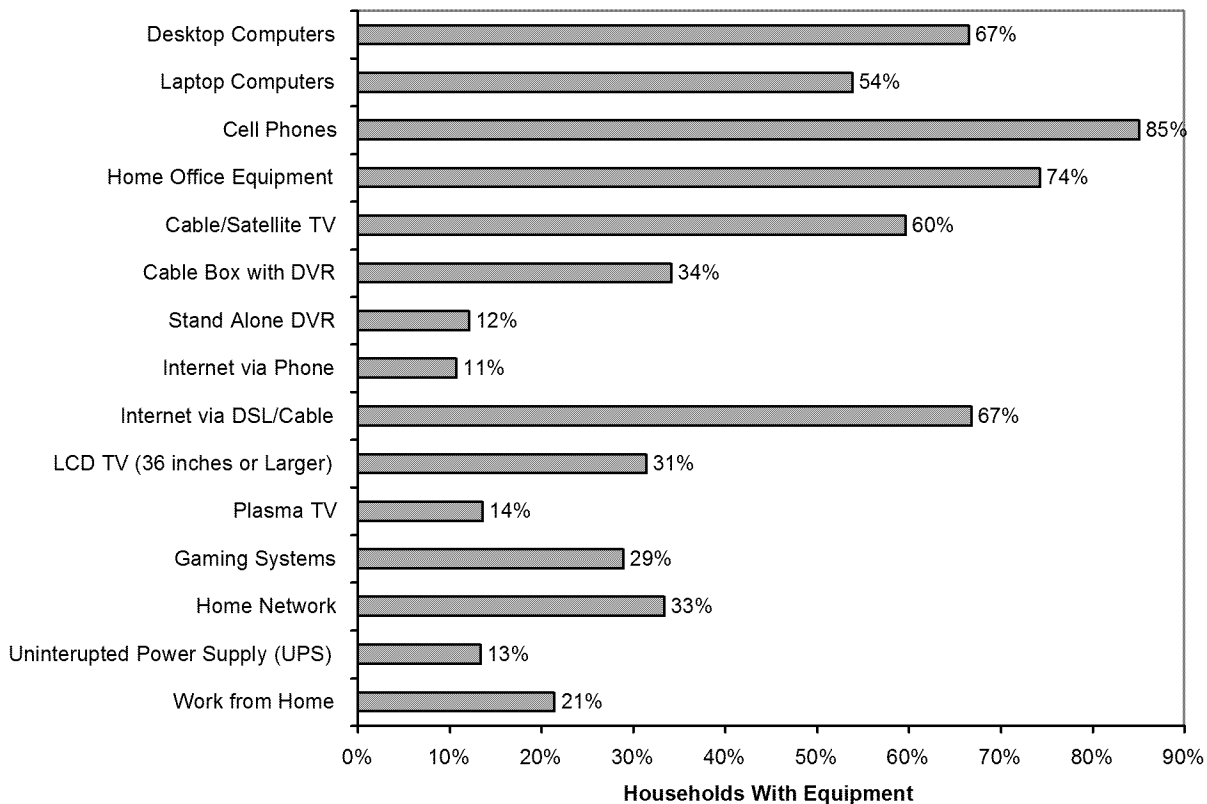
Source: 2010 California Residential Appliance Saturation Survey

Technology

Households are quickly becoming infused with various technologies. Figure ES-45 shows the penetration of a number of entertainment and home office equipment and services. In general, all of the technologies listed increased in popularity compared to the 2003 RASS, except for internet service via a telephone connection.

Cellular phones are most popular, with 85 percent of households having at least one compared to 67 percent of households in 2003. Large screen televisions are also much more prevalent, with 59 percent of households having at least one. Eighty-five percent of households have a computer, with 67 percent having a desktop and 54 percent having a laptop. Sixty-seven percent of households have Internet service via digital subscriber line (DSL) or cable.

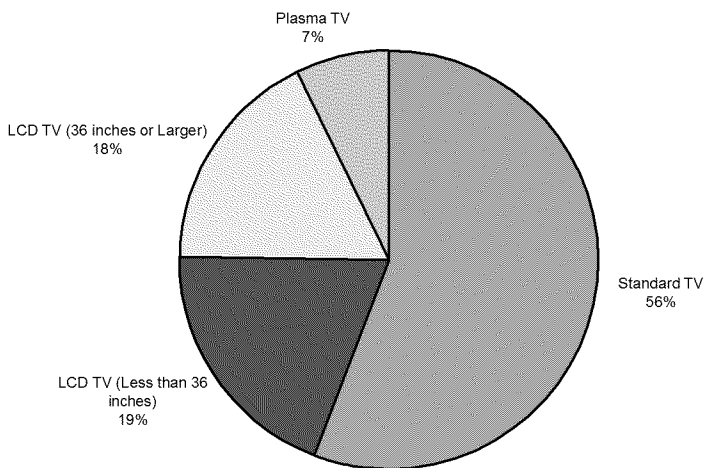
Figure ES-45: Penetration of Technology Equipment



Source: 2010 California Residential Appliance Saturation Survey

Figure ES-46 shows the distribution of the various types of televisions.

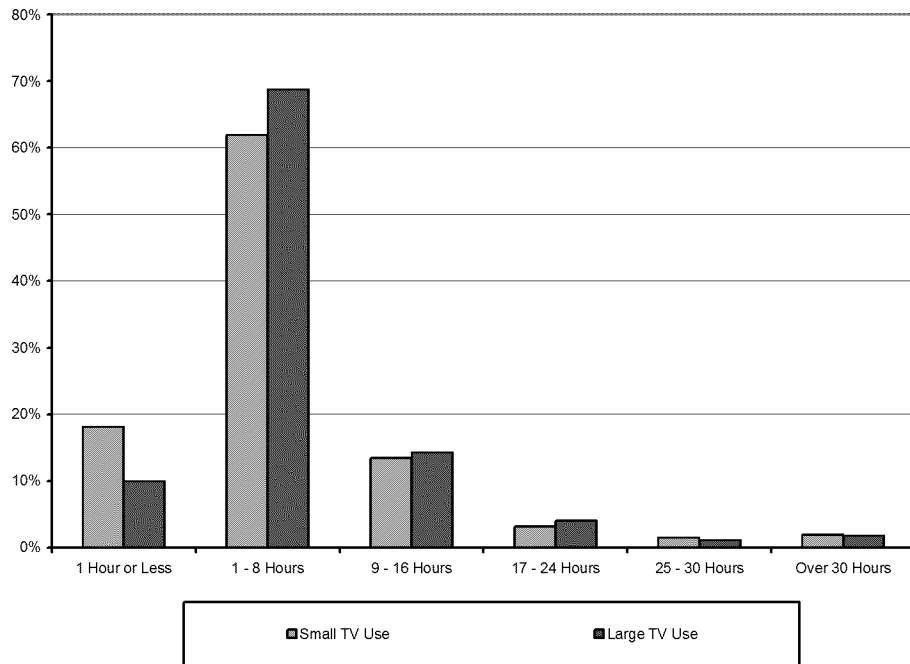
Figure ES-46: Types of Televisions



Source: 2010 California Residential Appliance Saturation Survey

Figure ES-47 shows the number of hours of television use by size of television.

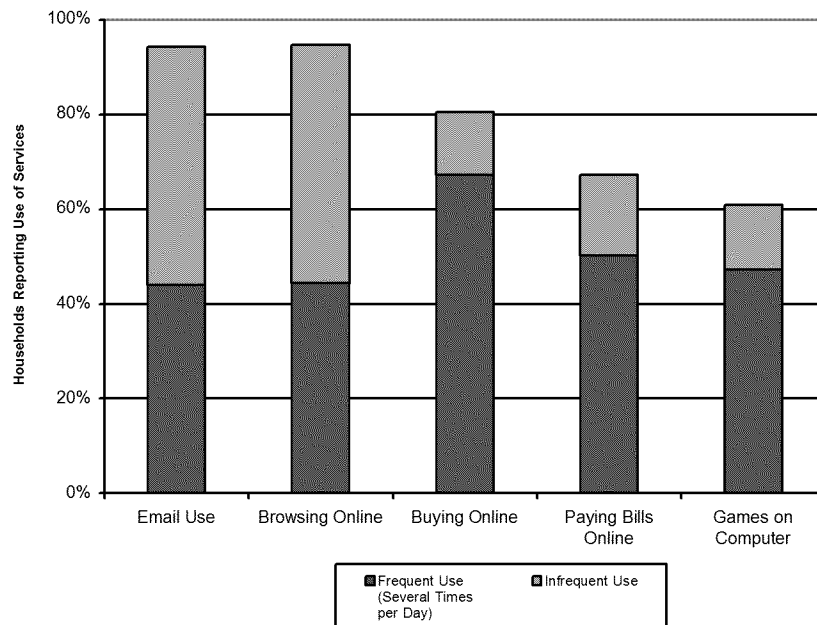
Figure ES-47: Hours of Television Use by Size of Television



Source: 2010 California Residential Appliance Saturation Survey

Respondents report using their computers for a variety of tasks, as shown in Figure ES-48.

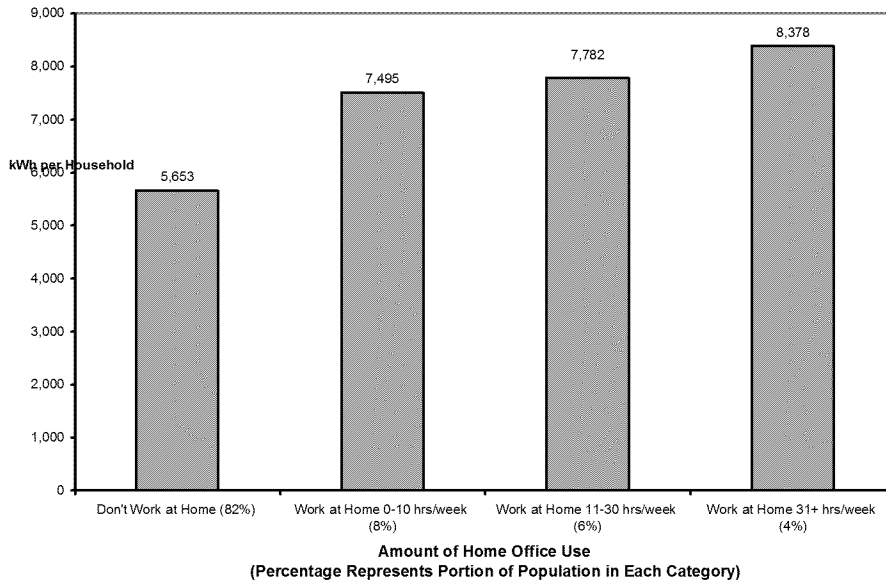
Figure ES-48: Use of Computer



Source: 2010 California Residential Appliance Saturation Survey

Eighteen percent of households have a home office. Figure ES-49 shows that as home office use increases, household electric consumption increases.

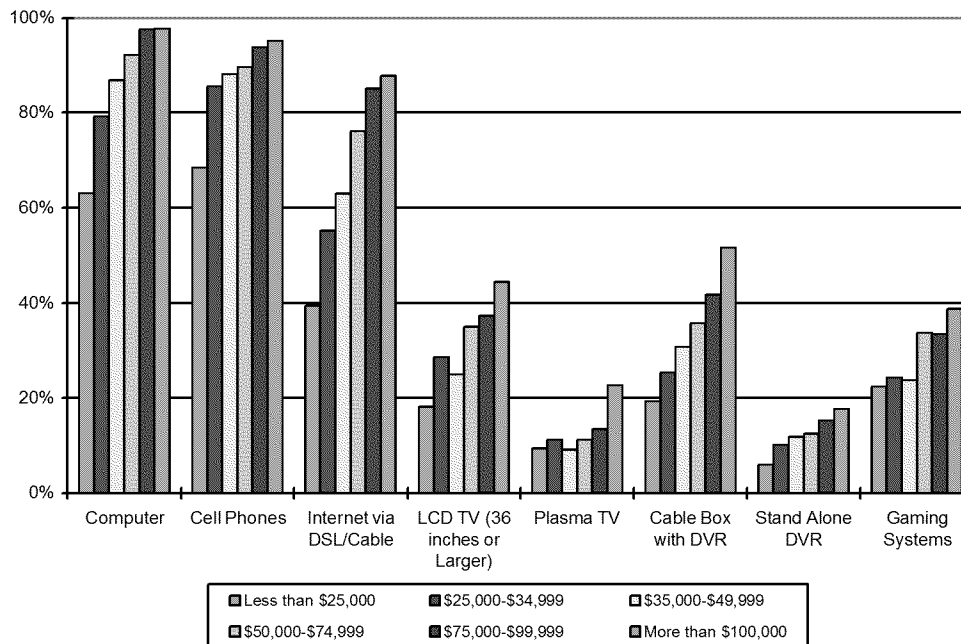
Figure ES-49: Electricity Consumption by Amount of Home Office Use



Source: 2010 California Residential Appliance Saturation Survey

As many new technologies mature, the accessibility of the technology typically increases across all income levels. Figure ES-50 illustrates technology by income. The lowest income category lags in ownership of all technologies, most notably computers and cell phones.

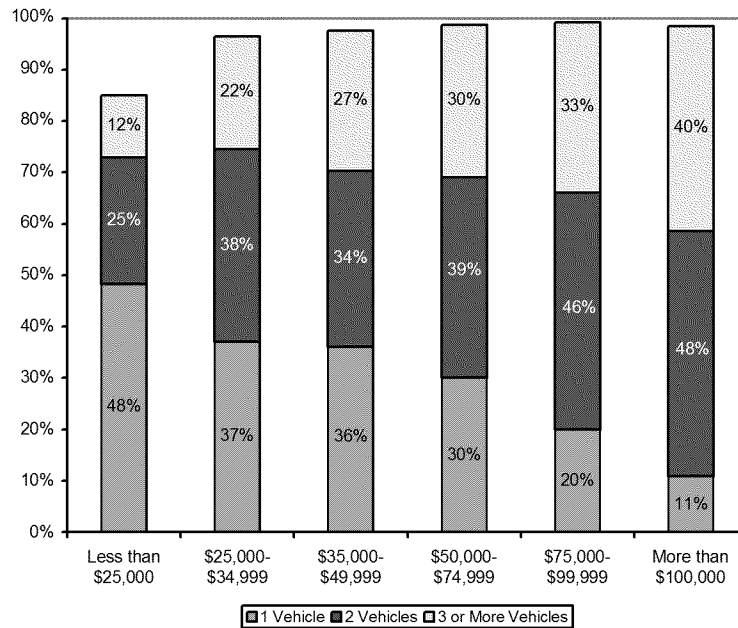
Figure ES-50: Technology by Income



Source: 2010 California Residential Appliance Saturation Survey

As with other technologies previously discussed, the number of vehicles increases with income, as shown in Figure ES-51.

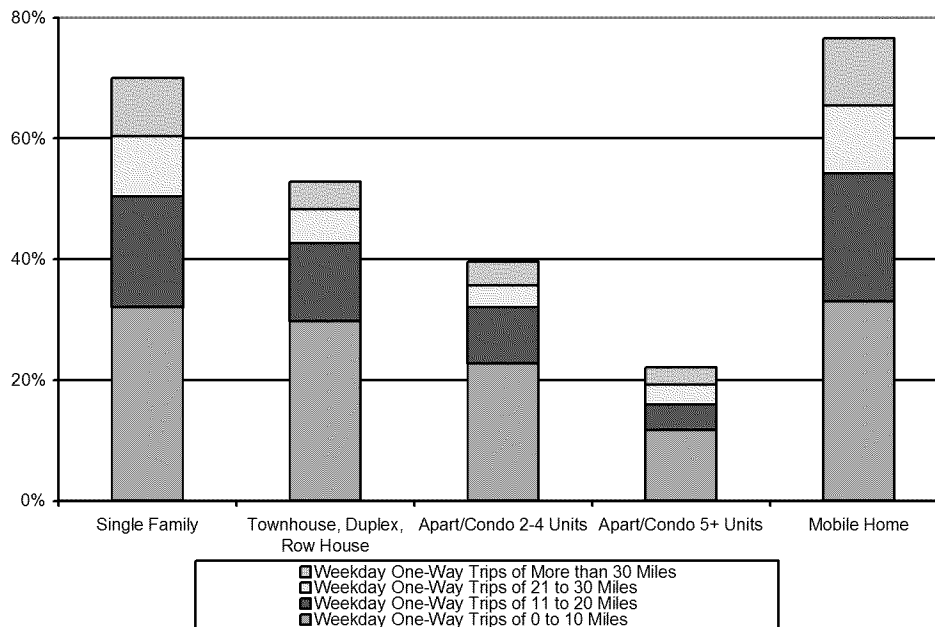
Figure ES-51: Number of Vehicles by Income



Source: 2010 California Residential Appliance Saturation Survey

Overall, 60 percent of vehicles are parked near a power outlet and 46 percent of vehicles are driven on weekday trips with one-way mileage of 10 miles or less. Figure ES-52 shows percentage of households with a power outlet near a vehicle’s parking area by home type.

Figure ES-52: Availability of Power Outlet Near Vehicle Parking by Home Type



Source: 2010 California Residential Appliance Saturation Survey

Data Comparisons

Effect of Combining the Main Sample and Non-Response Follow-Up Sample

To combine the non-response results with the results from the initial mailing, the study created case weights that represented the number of households that each respondent represented. The approach for calculating the weights for the individually metered sample for the 2009 RASS followed the same approach as the weighting scheme used for the 2003 RASS. This approach weighted the non-response follow-up sample less heavily by assuming the follow-up sample represents only the follow-up population and not the entire set of non-responders to the initial mailing. In effect, the responding sample represents only the people who responded to the initial mailings or to the follow-up effort.

A non-response follow-up effort can effectively reach segments of the population that do not respond to the initial mailings. Table ES-8 presents a comparison of the households that completed their surveys in response to the initial mailings to the households responding to the non-response follow-up effort. The non-response households had similar major equipment and energy consumption in their households to the initial mail responders. Key differences of non-response follow-up households include:

- Less likely to own their residence.
- Likely to have fewer seniors in the household.
- Less likely to use English as their primary language.
- More likely to have a head of household that is Hispanic.

Table ES-8: Comparison of Results by Surveying Method and Dwelling Type

| | Single Family | | Multi-Family (2-4 Units) | | Multi-Family (5+ Units) | | Mobile Homes | |
|-------------------------------------|---------------|--------------|-----------------------------|--------------|----------------------------|--------------|--------------|--------------|
| | Initial Mail | Non-Response | Initial Mail | Non-Response | Initial Mail | Non-Response | Initial Mail | Non-Response |
| Completed Surveys | 13,968 | 1,389 | 3,599 | 412 | 3,758 | 480 | 816 | 42 |
| Weighted to Population | 2,716,013 | 4,333,328 | 562,229 | 1,243,344 | 589,620 | 1,443,735 | 103,337 | 102,191 |
| Average Electric Consumption | 7,568 | 7,628 | 4,249 | 4,146 | 3,577 | 3,763 | 5,563 | 5,597 |
| Average Gas Consumption | 427 | 418 | 240 | 236 | 155 | 147 | 334 | 345 |
| Average Dwelling Size | 1,911 | 1,864 | 1,203 | 1,131 | 954.84515 | 927.2109 | 1,277 | 1,353 |
| Average Dwelling Age | 37.8 | 37.0 | 34.6 | 34.6 | 31.9 | 32.0 | 28.1 | 28.2 |
| Average Number of People | 2.82 | 3.39 | 2.54 | 2.79 | 2.09 | 2.43 | 2.13 | 2.63 |
| Average Number of Seniors | 0.61 | 0.35 | 0.42 | 0.21 | 0.40 | 0.20 | 0.79 | 0.37 |
| Average Income | 79,062 | 80,001 | 58,253 | 56,341 | 50,859 | 55,686 | 32,970 | 46,373 |
| Owners | 91% | 86% | 49% | 33% | 28% | 22% | 86% | 84% |
| Central Cooling | 59% | 60% | 46% | 41% | 43% | 42% | 70% | 73% |
| Gas Space Heating | 83% | 86% | 77% | 74% | 60% | 62% | 62% | 51% |
| All Exterior Walls Insulated | 57% | 56% | 45% | 41% | 43% | 45% | 60% | 53% |
| CFL Penetration | 87% | 84% | 85% | 83% | 84% | 80% | 88% | 74% |
| Primary Language English | 91% | 84% | 82% | 74% | 85% | 76% | 94% | 95% |
| Head of Household Hispanic | 17% | 27% | 23% | 32% | 18% | 26% | 11% | 17% |
| College Grad or Higher | 56% | 54% | 50% | 47% | 53% | 52% | 22% | 20% |

Source: 2010 California Residential Appliance Saturation Survey

List of Acronyms

| | |
|-------------------|---|
| CAC | central air conditioning |
| CDA | conditional demand analysis |
| CFL | compact fluorescent lamp |
| DDN | degree-day normalization |
| Energy Commission | California Energy Commission |
| F | Fahrenheit |
| IOU | investor-owned utilities |
| LADWP | Los Angeles Department of Water and Power |
| LCD | liquid crystal display |
| NAC | normalized annual consumption |
| PC | personal computer |
| PG&E | Pacific Gas and Electric Company |
| RAC | room air conditioning |
| RASS | Residential Appliance Saturation Survey |
| SAE | statistically adjusted engineering |
| SAS | statistical analysis system |
| SCE | Southern California Edison Company |
| SDG&E | San Diego Gas & Electric Company |
| SoCal Gas | Southern California Gas Company |
| UEC | unit energy consumption |