CALIFORNIA ENERGY COMMISSION

California Energy Commission

CONSULTANT REPORT

2019 California Residential Appliance Saturation Study (RASS)

Project Overview Prepared for**: California Energy Commission**

Prepared by: **DNV GL Energy Insights USA, Inc.**

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ABSTRACT

From 2018 to 2020, the California Energy Commission funded and administered a Residential Appliance Saturation Study that updates the *2009 Residential Appliance Saturation Study*, with the following utilities participating: Pacific Gas and Electric Company, Southern California Edison, Sacramento Municipal Utility District, San Diego Gas & Electric Company, Southern California Gas Company, and Los Angeles Department of Water and Power. DNV GL Energy Insights (formerly KEMA, Inc.) was the prime consultant for this study and the 2009 and 2003 studies.

The research team implemented the study using online and mailed paper surveys. The surveys requested households to provide information on appliances, equipment, and general consumption patterns, including electric vehicle charging and the presence of renewable energy technology such as a solar photovoltaic system. The research team completed data collection in early 2020, just before the full impact of COVID-19 events.

The study yielded energy consumption estimates for 28 electric and 9 natural gas residential end uses and appliance saturations for households. The team developed these consumption estimates 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 *2019 Residential Appliance Saturation Study* resulted in end-use saturations for 39,682 individually metered and 303 master-metered households. The team weighted the survey and conditional demand analysis results to provide population-level estimates, representative of the participating utilities that allow comparison across utility service territories, forecasting climate zones, and other variables of interest including dwelling type, dwelling age group, and income.

Keywords: California Energy Commission, conditional demand analysis, CDA, unit energy consumption, UEC, residential, energy survey, online survey, appliance, saturations, degree-day normalization, AMI data, hourly load shapes, electric vehicles, EVs.

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CHAPTER 1:
RASS Project Overview

This project overview presents key findings from the *2019 California Residential Appliance Saturation Study* (*2019 RASS*) that was sponsored by the California Energy Commission (CEC). The study yielded unit energy consumption (UEC) estimates, the amount of energy a single appliance is estimated to use in a year, for 28 electric and 9 natural gas residential end uses and appliance saturations for households within the California territories of the participating utilities.

The project overview is a companion document to a thorough methods and results report that includes detailed energy consumption tables from the conditional demand analysis along with a series of tables that display the survey results in a comprehensive format.

The sections of this project overview include:

- Study overview.
- UEC and appliance saturation summaries. Presents electric and natural gas results from the conditional demand analysis 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.
- Electric vehicles and renewable energy.
- Data comparisons.
- Hourly electric load profiles and daily gas loads summary.

Study Overview

From 2018 to 2020, the CEC funded and administered a Residential Appliance Saturation Study (RASS) that was implemented across the territories of the large investor-owned utilities (IOUs) and two of the largest municipal utilities. The 2019 study served as an update to the *2009 RASS*. Participating utilities included Pacific Gas and Electric Company (PG&E), Southern California Edison Company (SCE), San Diego Gas & Electric Company (SDG&E), Southern California Gas Company (SoCalGas), Sacramento Municipal Utility District (SMUD), and Los Angeles Department of Water and Power (LADWP). DNV GL was the prime consultant.

The research team initiated the study at the end of 2018 with the sampling plans and implementation beginning in the fall of 2019. The team collected data using online and direct mail approaches to a representative sample of Californian households. The survey asked households to provide information on appliances, equipment, and general usage patterns. The

2019 RASS questionnaire used the 2009 survey as a starting point with updates to reflect changes in available energy-consuming and generation-storage technologies in households, including new questions about electric vehicles, miscellaneous electronic appliances, photovoltaic (PV) systems, and battery storage systems. The team implemented a smaller and more focused nonresponse follow-up recruitment effort to a sample of the nonrespondents after the initial contact methods were exhausted. The nonresponse effort consisted of telephone calls and in-person assistance with completing the survey. The team completed data collection in early 2020 just before the full impact of COVID-19 events.

The study yielded UEC estimates for 28 electric and 9 natural gas residential end uses and appliance saturations for households. A UEC represents the amount of energy an appliance is estimated to use in a year. The team developed the UEC estimates 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 method are presented in Volume One.

The *2019 RASS* resulted in end-use saturations for 39,682 individually metered and 303 master-metered households. UEC estimates were provided for individually metered households only, while end-use saturations reflected individually and master-metered households. Survey and CDA results were weighted to provide population-level estimates representative of the participating utilities that allow comparison across utility service territories, forecasting climate zones, and other variables of interest such as dwelling type, dwelling age group, and income.

By using a statewide survey instrument, the research team provided the CEC and other parties with a consistent set of questions and study results to use for statewide planning and cross-utility comparisons. 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 selected for the sample. The research team provided anonymity to survey participants 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 the utilities to link survey respondents to a specific account.

Unit Energy Consumption and Appliance Saturation Summaries

The conditional demand analysis used normalized annual consumption based on interval data from October 2018 through September 2019 to produce UEC estimates for electric and natural gas end uses in households. UECs were calculated for the 39,682 individually metered households in the study. This section presents key results for electric and natural gas end uses.

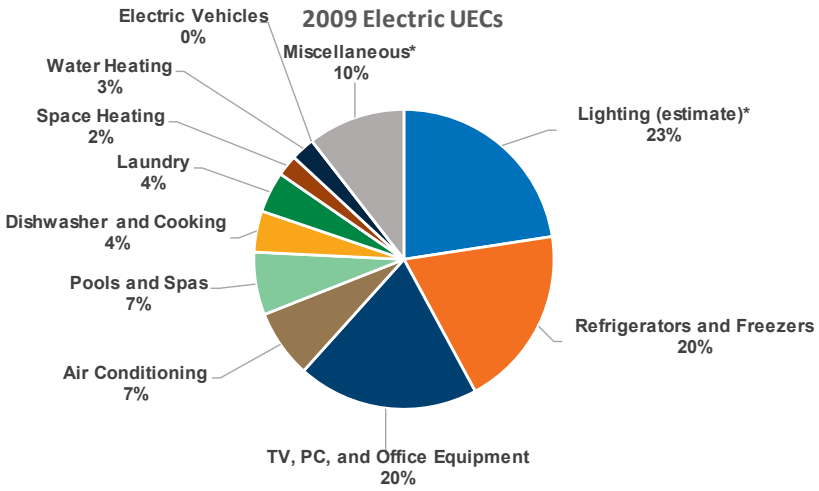
Electricity Consumption and Unit Energy Consumptions

The average annual electricity consumption in California was 6,174 kilowatt-hours (kWh) per household, based on the *2019 RASS* normalized interval data. This amount was a decrease of nearly 2 percent compared to the 6,296 kWh per household reported in the *2009 RASS*.

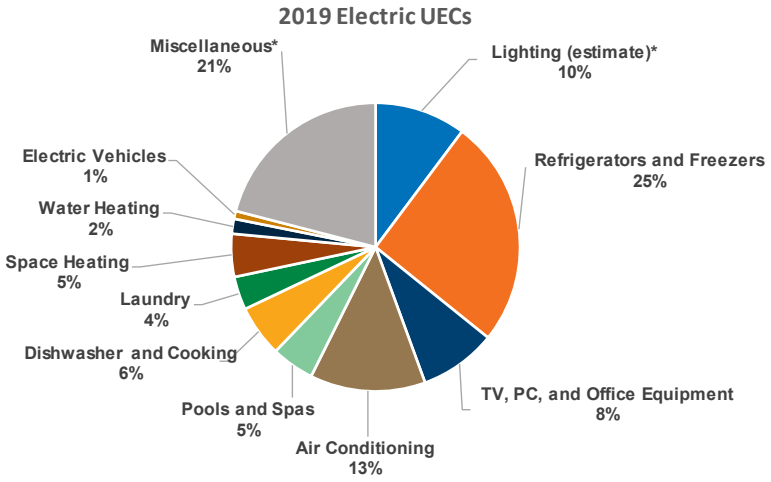
Figure 1 breaks down the 2019 annual household electricity consumption by end use and compares it to the 2009 consumption by end use.

Figure 1: Statewide Electricity Consumption per Household

***2009 RASS*: 6,296 kWh per Household**



2019 RASS: 6,174 kWh per Household



*Note: An estimate of 489 kWh per household (8 percent of the total consumption) was designated as interior lighting and was combined with exterior lighting consumption for the lighting category. This number comes from other lighting studies[1] that are better able to pinpoint this estimate than a conditional demand model as was used for the RASS. This approach is the same as used in *2009 RASS*, but the estimate in 2009 was 1,200 kWh for interior lighting. Since estimated energy used for the combination of lighting and miscellaneous was relatively stable over the two RASS studies, the estimates in 2019 indicate a shift in consumption from lighting to other end uses in the miscellaneous category.

Source: 2019 Residential Appliance Saturation Survey

1 Interior lighting UEC estimated from *2019 RASS* lamp type results, DNV GL California lighting studies, and *2012 California Lighting and Appliance Saturation Study (CLASS 2012)*, November 24, 2014.

Table 1 and **Table 2** present electric UECs with saturation estimates by electric utility and by dwelling type, respectively. **Table 1** shows the following changes by utility for household UECs: PG&E decreased by 3 percent, relative to the *2009 RASS*, SDG&E 12 percent, LADWP 8 percent, and SCE less than 1 percent. SMUD was not included in the *2009 RASS* and has the highest overall household UEC but is also the only utility with no coastal customers.

Table 2 shows the following changes by dwelling type for household UECs with mobile homes increasing 4 percent, multifamily (townhomes, 2–4 unit apartments, and 5+unit apartments) increasing about 2 percent, and single-family dwellings decreasing less than 1 percent compared to *2009 RASS* results.

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

	PG&E UEC	PG&E Saturation	SCE UEC	SCE Saturation	SDG&E UEC	SDG&E Saturation	SMUD UEC	SMUD Saturation	LADWP UEC	LADWP Saturation
Household Total UEC	6,266	15,967 homes	6,424	13,381 homes	5,230	5,172 homes	8,246	2,366 homes	5,112	2,796 homes
Primary Conventional Space Heating	1,302	16%	635	13%	541	19%	1,329	18%	452	14%
Primary Heat Pump Space Heating	1,163	3%	565	4%	433	5%	1,160	10%	542	6%
Auxiliary Space Heating	655	9%	123	6%	90	6%	776	8%	.	.
Furnace Fan	171	65%	101	67%	90	61%	201	79%	73	46%
Attic Fan	133	2%	171	2%	145	2%	159	2%	136	1%
Central Air Conditioning	1,132	51%	1,344	68%	599	54%	1,194	89%	1,021	52%
Room Air Conditioning	682	13%	665	18%	374	15%	849	7%	529	29%
Evaporative Cooling	809	10%	1,109	12%	525	8%	801	13%	587	9%
Water Heating	2,071	7%	1,443	4%	1,290	6%	2,677	8%	1,538	5%
Solar Water Heating	1,325	0%	916	0%	1,392	0%	1,396	0%	1,301	0%
Dryer	511	46%	491	20%	420	24%	602	59%	438	17%
Clothes Washer	82	81%	95	79%	83	78%	112	81%	89	62%
Dishwasher	81	69%	89	67%	79	72%	92	76%	80	51%
First Refrigerator	1,121	100%	1,145	100%	1,044	100%	1,398	99%	1,083	100%
Additional Refrigerator	1,080	27%	1,093	30%	922	26%	1,442	24%	1,062	20%
Freezer	858	20%	836	16%	722	14%	950	22%	798	10%
Pool Pump	2,775	8%	2,939	11%	2,723	8%	3,468	14%	2,898	7%
Spa	319	7%	314	10%	332	11%	305	9%	243	4%
Outdoor Lighting	214	62%	229	61%	225	62%	275	67%	219	46%
Range/Oven	344	58%	359	37%	335	52%	433	58%	328	36%
Television	442	63%	508	64%	397	64%	543	66%	404	65%
Spa Electric Heat	1,102	5%	911	3%	985	5%	1,023	5%	822	2%
Microwave	145	87%	155	87%	139	90%	174	91%	146	82%
Home Office Equipment	47	16%	50	15%	55	19%	59	17%	54	19%
Personal Computer	274	81%	269	83%	268	86%	308	79%	268	80%
Well Pump	1,321	7%	1,418	2%	1,101	2%	1,776	1%	1,828	1%
Electric Vehicle	929	6%	1,142	6%	772	6%	1,632	2%	719	6%
Miscellaneous	1,772	100%	1,804	100%	1,700	100%	2,097	100%	1,582	100%
Utility Averages	***PG&E***		***SCE***		***SDG&E***		***SMUD***		***LADWP***	
Average Dwelling Size	*1,586*		*1,595*		*1,620*		*1,559*		*1,363*	
Average Number of Residents	*2.8*		*3.0*		*2.8*		*3.3*		*2.7*	
Percent Single-Family	*64.5%*		*62.7%*		*54.7%*		*70.5%*		*36.1%*	
Percent of Population	*38.3%*		*36.0%*		*10.2%*		*4.3%*		*11.2%*	

Source: 2019 California Residential Appliance Saturation Survey

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

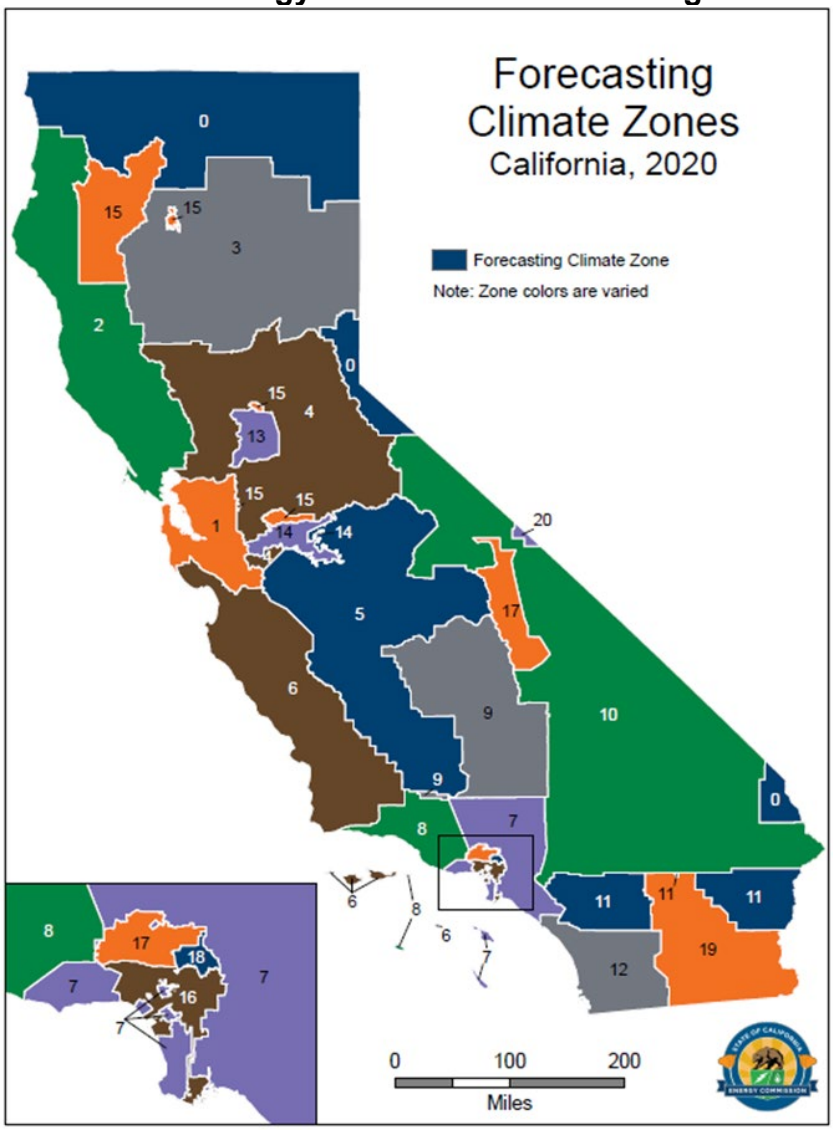
	All UEC	All Saturation	Single-Family UEC	Single-Family Saturation	Multifamily UEC	Multifamily Saturation	Mobile Home UEC	Mobile Home Saturation
Household Total UEC	6,174	39,682 homes	7,553	26,263 homes	4,022	12,583 homes	5,798	836 homes
Primary Conventional Space Heating	953	15%	1,509	10%	622	23%	1,193	6%
Primary Heat Pump Space Heating	768	4%	1,221	3%	493	7%	980	1%
Auxiliary Space Heating	489	7%	825	8%	117	7%	528	6%
Furnace Fan	130	64%	159	76%	55	45%	116	63%
Attic Fan	152	2%	133	3%	182	1%	442	3%
Central Air Conditioning	1,163	59%	1,372	66%	698	48%	1,246	53%
Room Air Conditioning	620	17%	828	14%	354	20%	1,026	29%
Evaporative Cooling	890	10%	1,001	12%	497	7%	1,488	27%
Water Heating	1,792	6%	2,539	4%	1,168	8%	2,107	5%
Solar Water Heating	1,295	0%	1,297	0%	1,258	0%	.	.
Dryer	502	32%	552	35%	396	25%	478	40%
Clothes Washer	89	78%	94	94%	74	51%	73	92%
Dishwasher	84	67%	93	74%	69	56%	51	53%
First Refrigerator	1,130	100%	1,209	100%	1,010	100%	1,034	100%
Additional Refrigerator	1,081	27%	1,161	38%	604	10%	1,110	20%
Freezer	840	17%	853	23%	781	7%	818	30%
Pool Pump	2,895	9%	2,895	15%	.	0%	.	0%
Spa	314	8%	322	13%	129	1%	106	4%
Outdoor Lighting	224	60%	251	76%	138	36%	164	53%
Range/Oven	350	47%	404	43%	285	54%	269	31%
Television	462	64%	483	66%	418	61%	571	68%
Spa Electric Heat	1,015	4%	1,032	6%	683	0%	679	3%
Microwave	150	87%	157	90%	137	82%	136	91%
Home Office Equipment	51	16%	53	19%	47	13%	24	6%
Personal Computer	272	82%	298	86%	230	76%	180	68%
Well Pump	1,346	4%	1,358	5%	1,371	1%	1,121	10%
Electric Vehicle	971	6%	1,062	6%	686	4%	901	1%
Miscellaneous	1,769	100%	2,099	100%	1,264	100%	1,473	100%
Dwelling Type Averages	***All Types***		***Single Family***		***Multifamily***		***Mobile Homes***	
Average Dwelling Size	*1,567*		*1,888*		*1,074*		*1,308*	
Average Number of Residents	*2.9*		*3.1*		*2.6*		*2.3*	
Percent of Population	*100.0%*		*59.9%*		*38.1%*		*2.0%*	

Source: 2019 California Residential Appliance Saturation Survey

Figure 2 is a map of the CEC's Forecasting Climate Zones. These zones were used to expand the conditional demand analysis modeling results and provide regional summaries by climate. Comparisons to the *2009 RASS* are difficult given the changes in geography covered by the forecasting climate zones and moving from 16 to 20 zones.

- Zones 1 through 6 are served by PG&E with some SoCalGas overlap.
- Zones 7 through 11 are served by SCE/SoCalGas.
- Zone 12 is served by SDG&E with some SoCalGas overlap.
- Zone 13 is served by Sacramento Municipal Utility District.
- Zones 16 and 17 are served by LADWP/SoCalGas.
- Zones 14, 15, and 18 through 20 are served by electric utilities not included in the RASS.

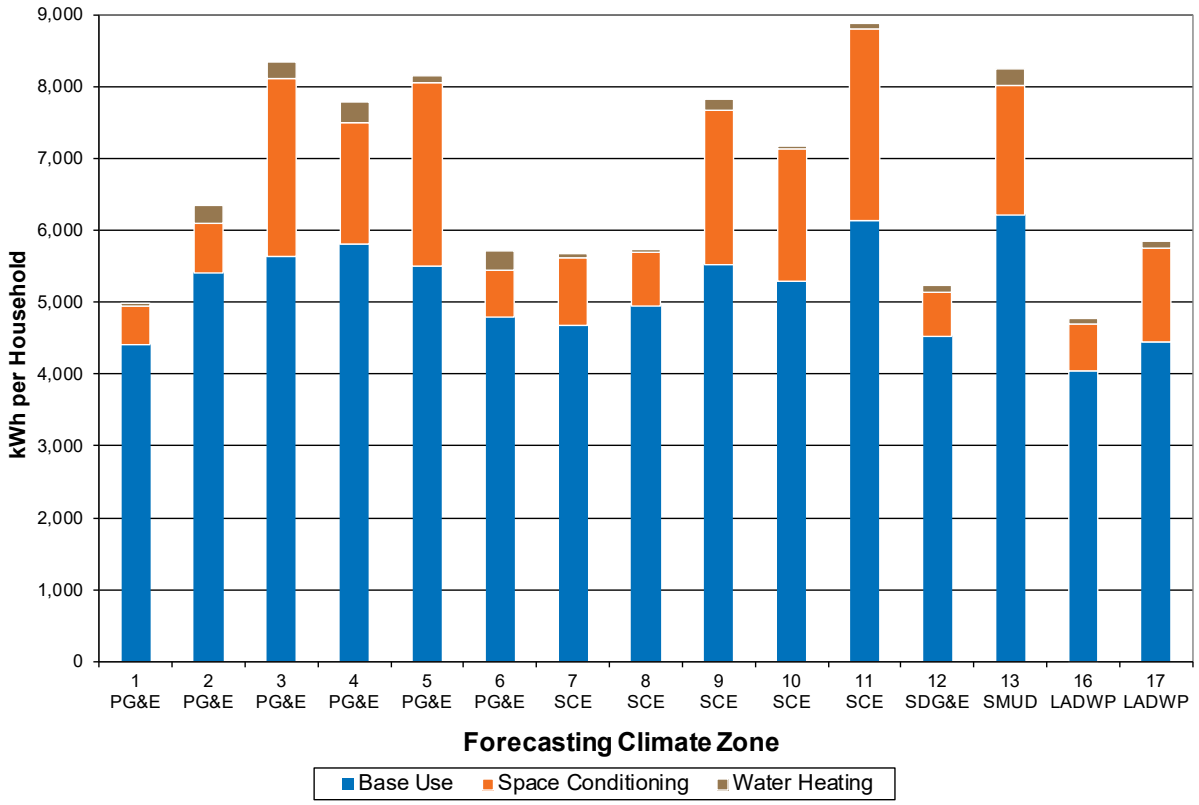
Figure 2: California Energy Commission Forecasting Climate Zones



Source: CEC

Figure 3 shows that base electricity consumption and space conditioning vary by CEC forecasting climate zone. The important 2019 trends are that base usage is the majority of consumption in all forecasting climate zones and logically the zones in the hotter central valley (3,4,5,9,13) and desert (10,11) have higher annual electric UECs driven by space conditioning.

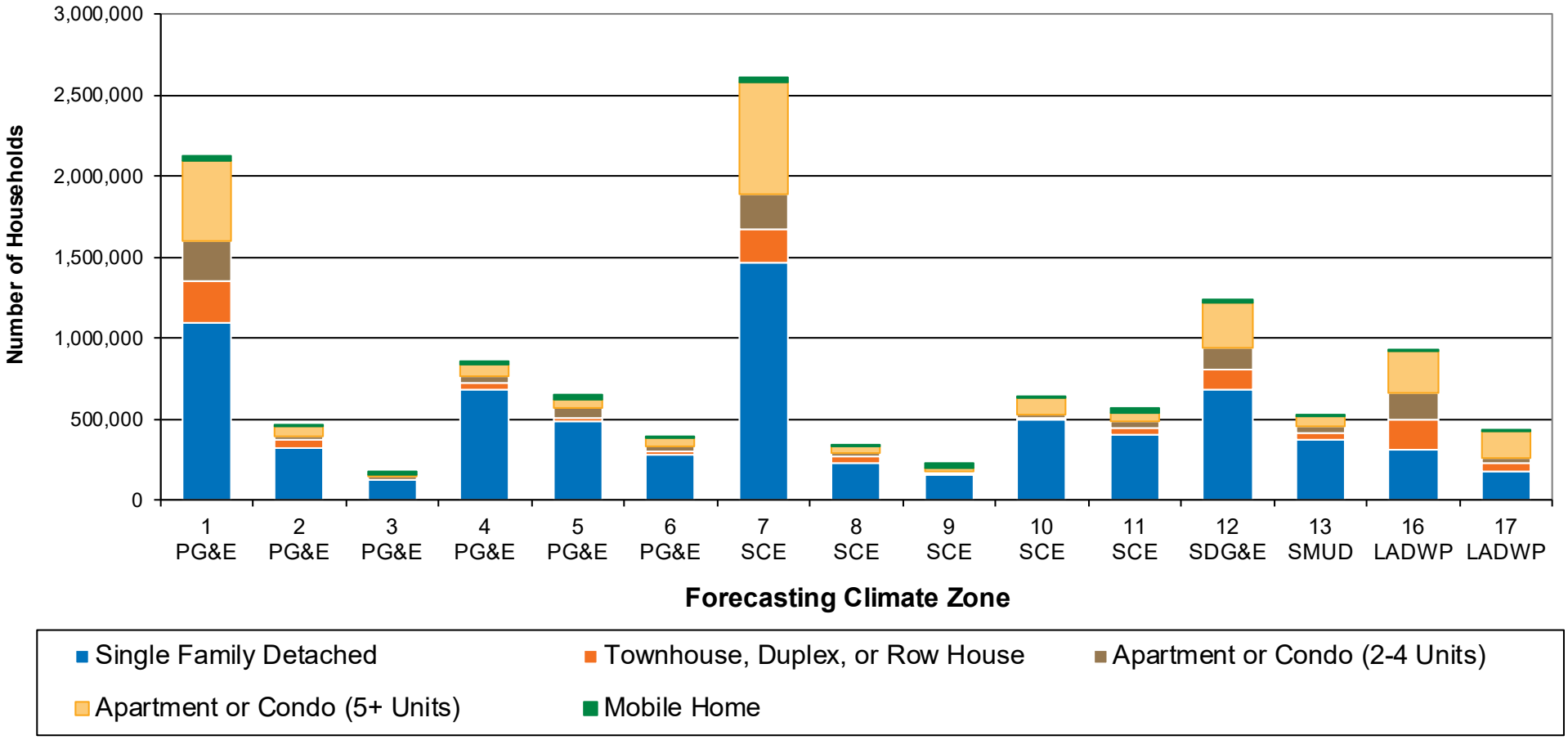
Figure 3: Electric UECs by Forecasting Climate Zone



Source: 2019 California Residential Appliance Saturation Survey

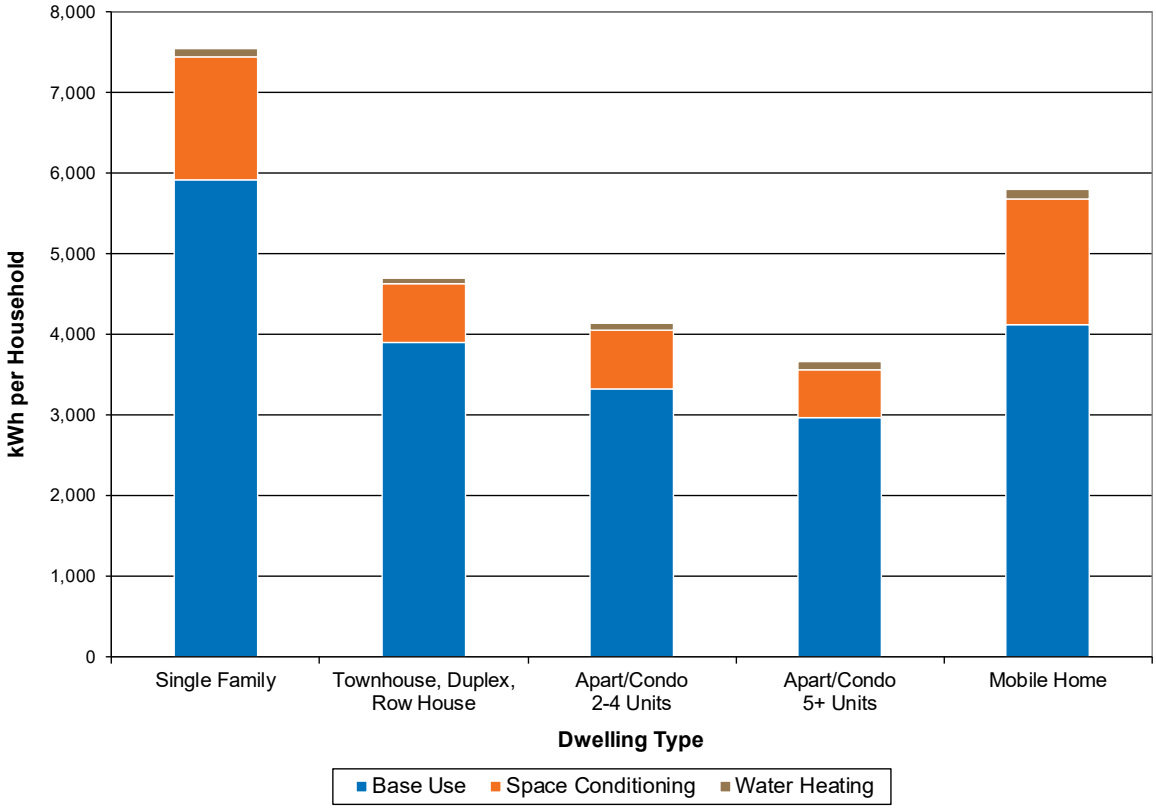
Although households in all forecasting climate zones are predominantly single-family homes, **Figure 4** shows how the proportions of housing type vary by forecasting climate zone, which helps explain the differences in the base consumption shown in **Figure 3**. Annual electric consumption is highest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

Figure 4:Dwelling Types by Forecasting Climate Zone



Source: 2019 California Residential Appliance Saturation Survey

Figure 5:Electric UECs by Dwelling Type



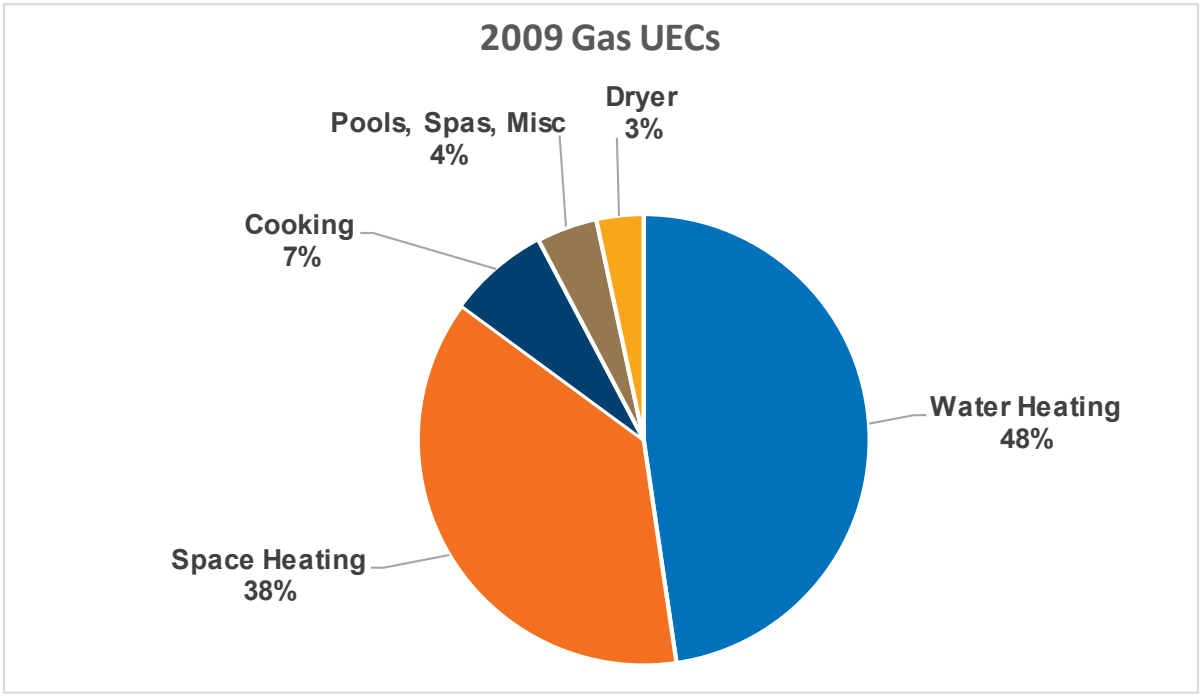
Source: 2019 California Residential Appliance Saturation Survey

Natural Gas Consumption and UECs

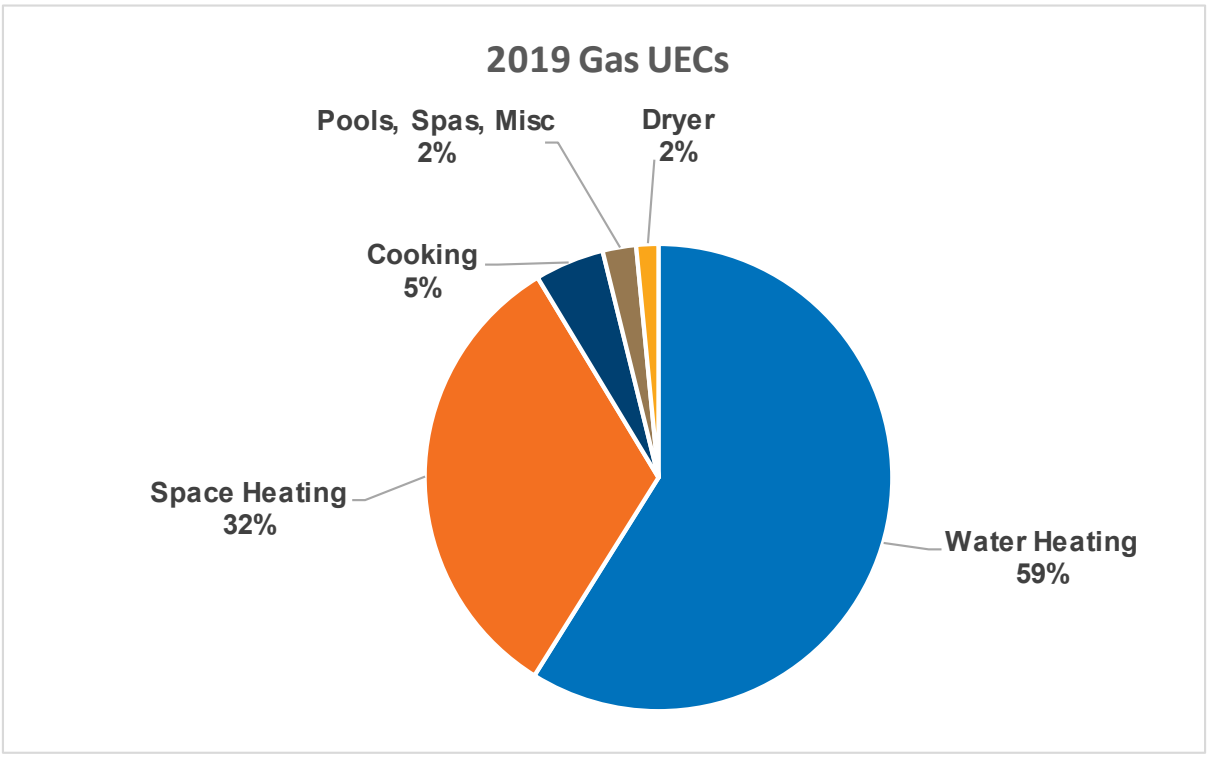
The average annual natural gas consumption in California households for which interval data was available (72 percent of the study population) was 360 therms per household, as calculated from *2019 RASS* interval data. The research team obtained gas interval data from PG&E, SDG&E, and SoCalGas. Natural gas UECs were calculated for 85 percent of the study population, as the estimates were made for all households identified as having a natural gas line to their home. The household natural gas UEC of 360 therms was relatively close to 354 therms per household reported in the *2009 RASS*. **Figure 6** breaks down the 2019 annual household natural gas consumption by end use and compares it to the 2009 consumption by end use. Compared to the *2009 RASS*, consumption for water heating increased by 11 percent to 59 percent, whereas space heating decreased by 6 percent to 32 percent.

Figure 6: Statewide Natural Gas Consumption per Household

RASS 2009: 354 therms per household



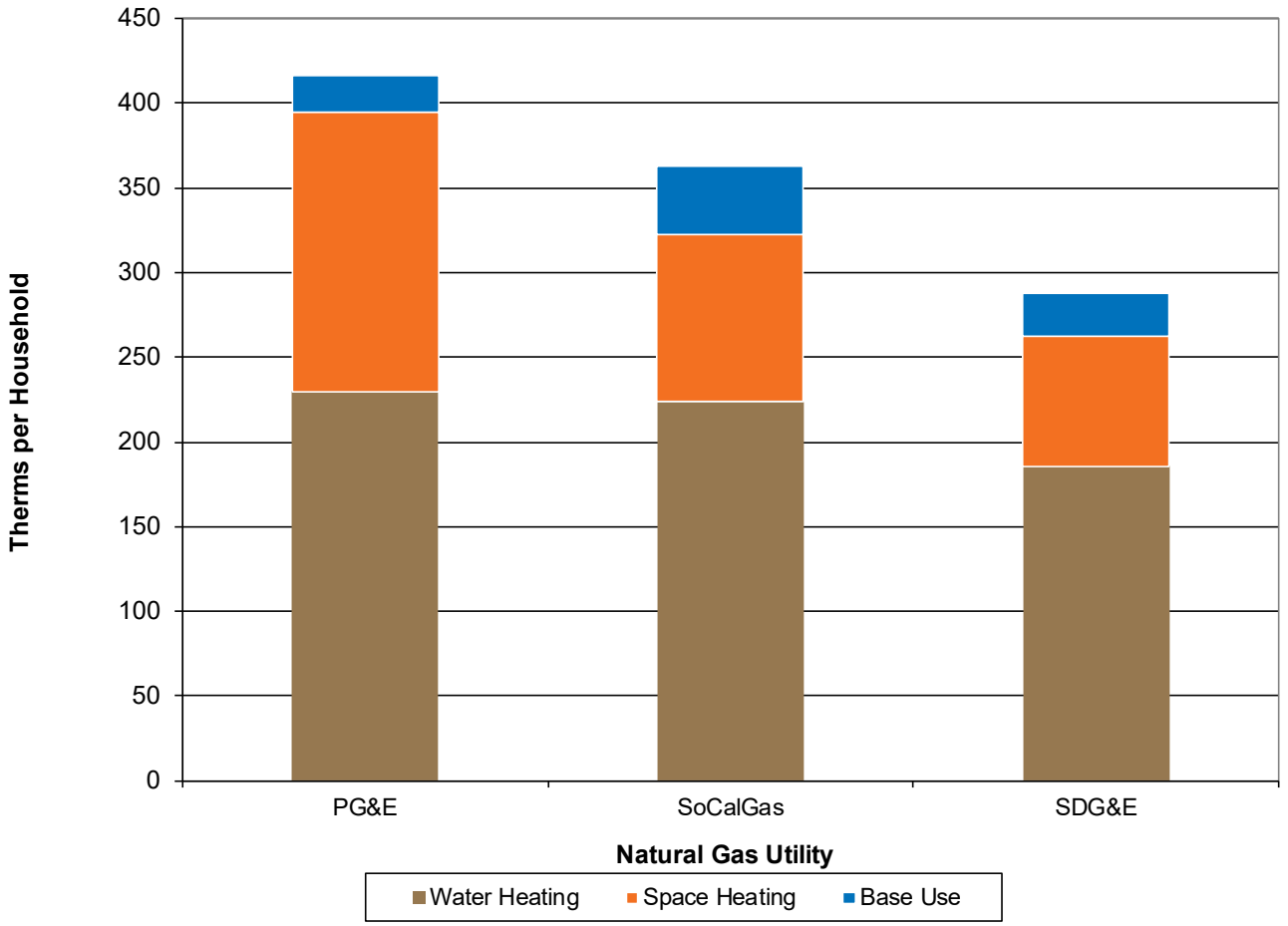
RASS 2019: 360 therms per household



Source: 2019 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 7**.

Figure 7: Natural Gas UECs by Gas Utility



Source: 2019 California Residential Appliance Saturation Survey

Table 3 and **Table 4** present natural gas UECs with saturation estimates for households for which interval data were available, by gas utility and dwelling type, respectively. The bottom 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 do not fully represent statewide gas consumption.

Table 3 depicts an increase of 11 percent in the household natural gas UEC of 363 therms for households served by SoCalGas from the 328 therms reported in the *2009 RASS*. The other two gas utilities had less dramatic changes for household natural gas UECs, with SDG&E having a decrease of 4 percent and PG&E having an increase of 3 percent.

Table 4 presents natural gas UECs by dwelling type. The household natural gas UEC for multifamily homes increased by 22 percent from the results from the *2009 RASS*. Household gas consumption for mobile homes dropped by 15 percent, and for single-family homes, consumption increased by 4 percent.

Table 3: Natural Gas UECs and Appliance Saturation Summaries by Gas Utility

	All UEC	All Saturation of Homes with Gas Data	PG&E UEC	PG&E Saturation of Homes with Gas Data	SDG&E UEC	SDG&E Saturation of Homes with Gas Data	SoCalGas UEC	SoCalGas Saturation of Homes with Gas Data
Household Total UEC	377	23,606 homes	416	10,338 homes	287	2,765 homes	363	10,503 homes
Primary Heat	158	77%	207	79%	101	75%	128	76%
Auxiliary Heat	53	2%	77	2%	30	2%	40	3%
Water Heating	258	86%	259	89%	208	88%	267	84%
Solar Water Heat	183	<1%	218	<1%	164	1%	196	<1%
Dryer	13	45%	13	30%	10	57%	13	54%
Range/Oven	24	75%	22	63%	18	77%	26	84%
Pool Heating	164	4%	139	3%	134	4%	180	5%
Spa Heating	37	5%	34	3%	37	8%	39	7%
Miscellaneous	17	10%	17	8%	14	16%	18	11%
	All Homes		*PG&E*		*SDG&E*		*SoCalGas*	
Household Total UEC for All Homes with Gas Service	*360*		*402*		*280*		*358*	

Source: 2019 California Residential Appliance Saturation Survey

Table 4: Natural Gas UECs and Appliance Saturation by Dwelling Type

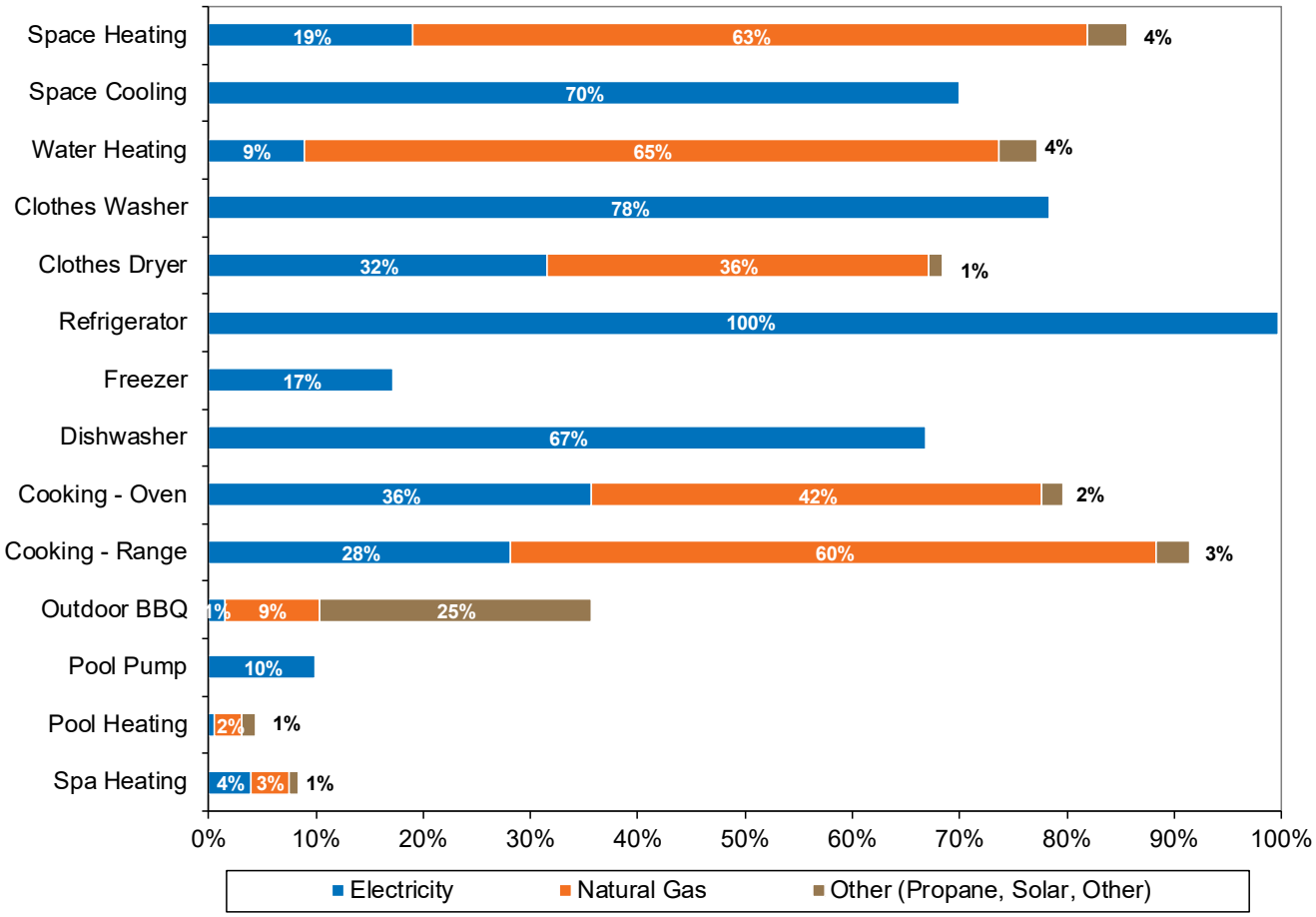
	Single-Family UEC	Single-Family Saturation of Homes with Gas Data	Multifamily UEC	Multifamily Saturation of Homes with Gas Data	Mobile Home UEC	Mobile Home Saturation of Homes with Gas Data
Household Total UEC	443	17,269 homes	241	5,999 homes	300	338 homes
Primary Heat	191	83%	67	63%	136	73%
Auxiliary Heat	59	2%	43	3%	37	<1%
Water Heating	260	94%	252	69%	257	85%
Solar Water Heat	184	<1%	166	0%	174	<1%
Dryer	12	53%	18	28%	17	35%
Range/Oven	25	77%	23	71%	20	82%
Pool Heating	163	5%	178	1%	181	1%
Spa Heating	38	8%	28	1%	38	<1%
Miscellaneous	17	12%	18	6%	27	5%
	Single Family		**Multifamily**		**Mobile Home**	
Household Total UEC for All Homes with Gas Service	434		226		324	

Source: 2019 California Residential Appliance Saturation Survey

Fuel Shares of End Uses

The saturations of fuel type by major household end uses are presented in **Figure 8** for all individually metered households in the study sample. Several changes are noted when compared to the results from the *2009 RASS*. There was an increase in electric space heating by 14 percent, while natural gas and other fuels decreased. Water heating and cooking remain majority gas with slight increases of electric systems. Additional figures follow looking at the fuel shares for specific end uses.

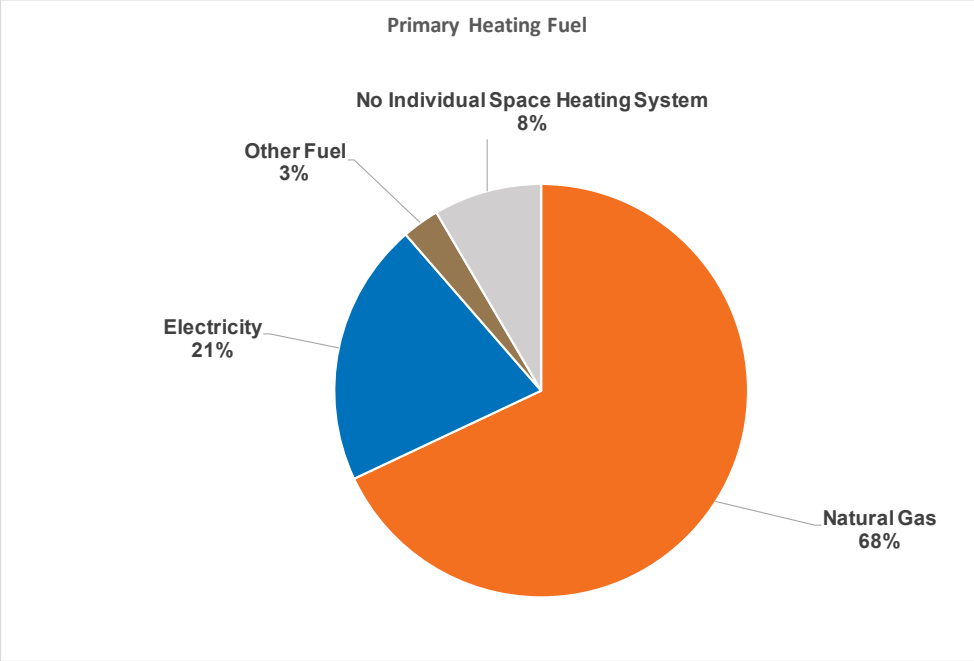
Figure 8: Combined Electric, Natural Gas, and Other Fuel Saturations



Source: 2019 California Residential Appliance Saturation Survey

Space heating systems are fueled primarily by natural gas for households in the study, as shown in **Figure 9**. 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 *2009 RASS*, the proportion of electric space heating systems has increased by 16 percent, and natural gas decreased by 10 percent with other fuels decreasing as well, and the same proportion not having a space heating system. The Other fuel category includes mostly propane with a small amount of wood or something else, as reported by the respondent.

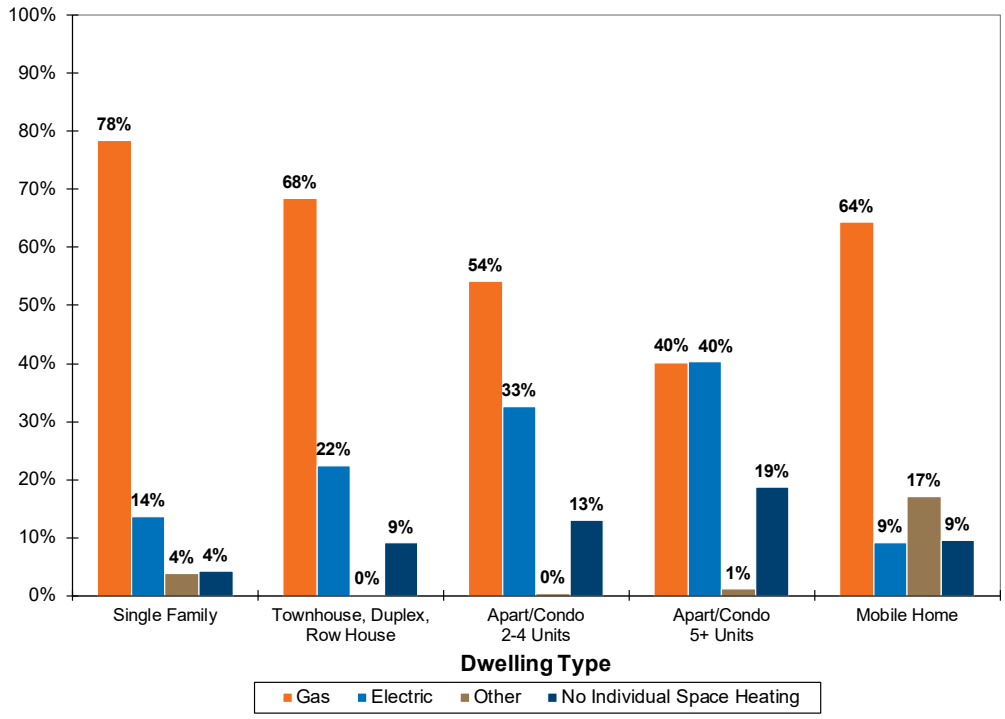
Figure 9: Primary Space Heating Fuel



Source: 2019 California Residential Appliance Saturation Survey

Figure 10 shows that electric space heating is more common in apartments and condominiums than in single-family homes. There was a significant increase in electric space heating across all dwelling types compared to the *2009 RASS*. The largest increase of electric space heating is among multifamily homes, which saw an increase of about 27 percent for all apartment buildings.

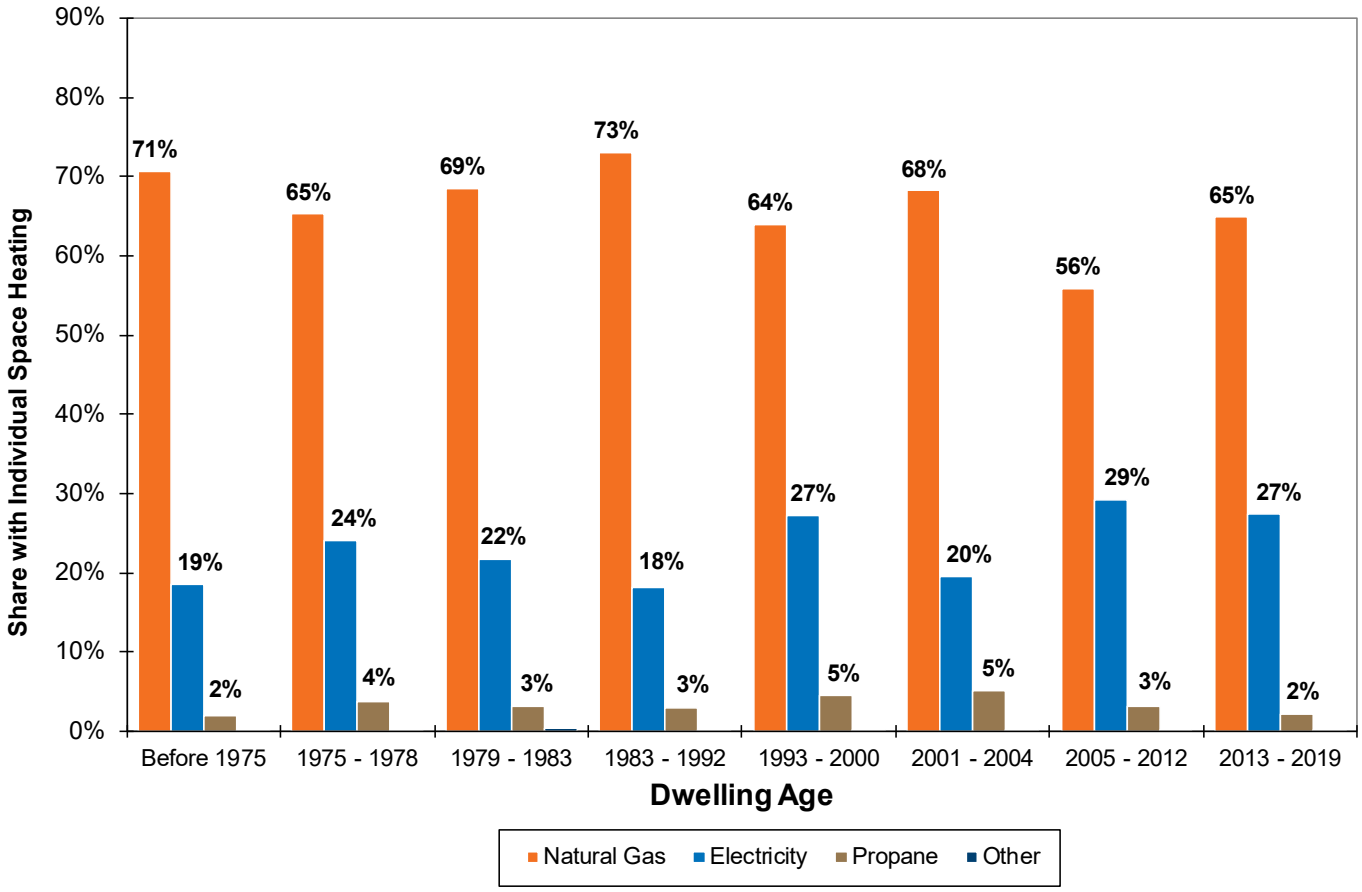
Figure 10: Space Heating Fuel by Dwelling Type



Source: 2019 California Residential Appliance Saturation Survey

Electric space heating increased across all ages of dwellings, and natural gas, propane, and other fuel went down compared to the *2009 RASS*, as shown in **Figure 11**. Only heating systems for individual households are included; systems that heat multiple households are excluded.

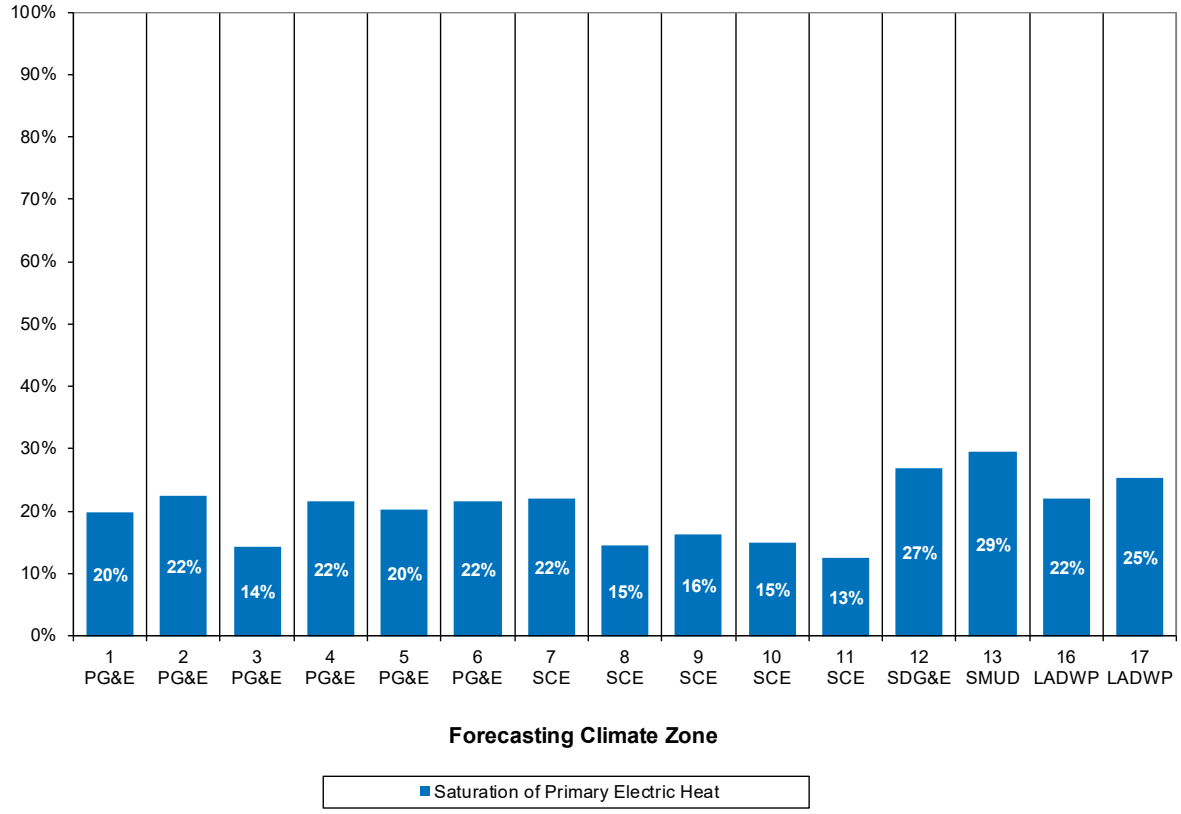
Figure 11: Space Heating Fuel by Dwelling Age



Source: 2019 California Residential Appliance Saturation Survey

Figure 12 presents shares of electric space heating by forecasting climate zones. Zone 13 (SMUD) with 29 percent has the highest proportion, followed by Zone 12 (SDG&E) at 27 percent and Zone 17 (LADWP) at 25 percent.

Figure 12: Saturation of Electric Space Heating by Forecasting Climate Zone

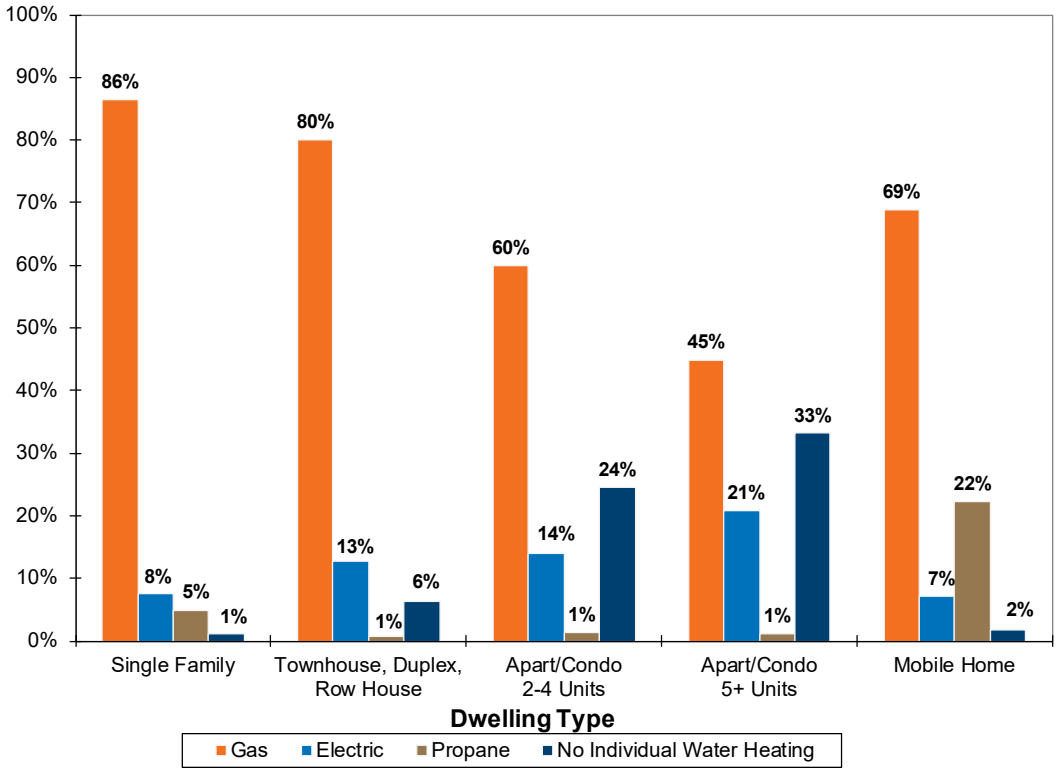


Source: 2019 California Residential Appliance Saturation Survey

Figure 13 shows that electric water heating is more common in townhomes and multifamily dwellings than in single-family homes. The *2019 RASS* results show that more dwellings have individual water heating. Gas water heating increased for all multifamily dwellings and decreased for single-family dwellings.

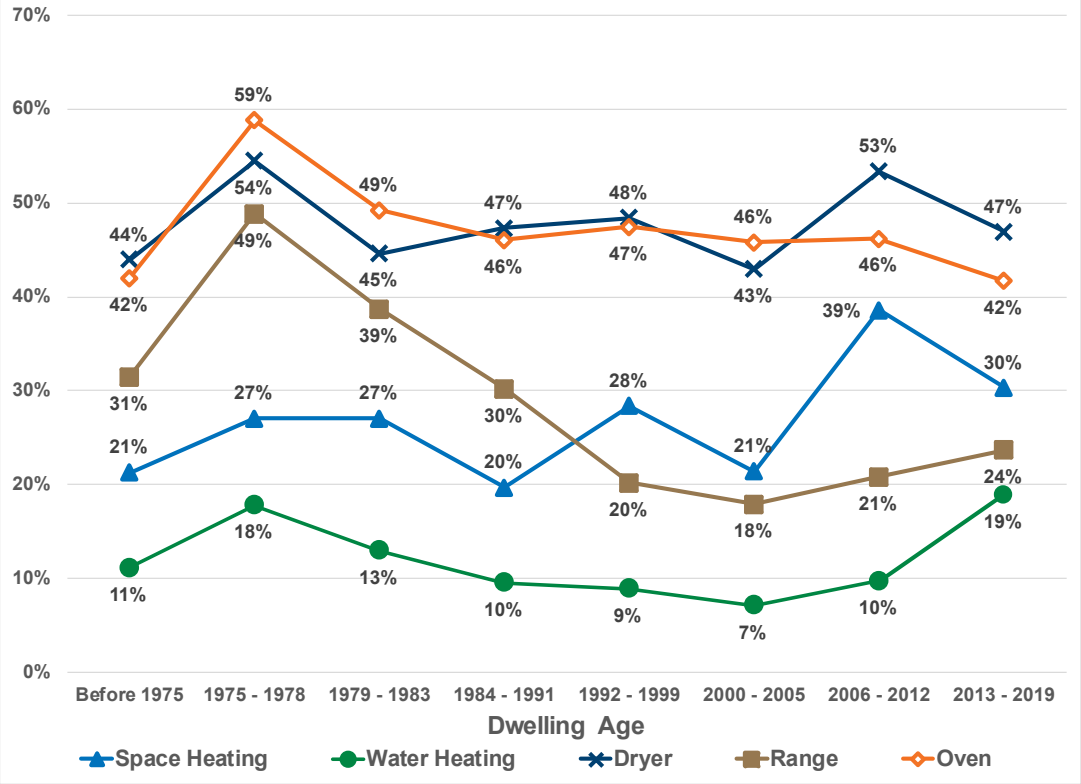
Across all dwelling ages, electric appliances are increasing in saturation for space heating, ovens, and dryers, while electric saturation is decreasing for water heating and ranges relative to the *2009 RASS*. **Figure 14** shows the saturation of electric appliances by dwelling age.

Figure 13: Water Heating Fuel by Dwelling Type



Source: 2019 California Residential Appliance Saturation Survey

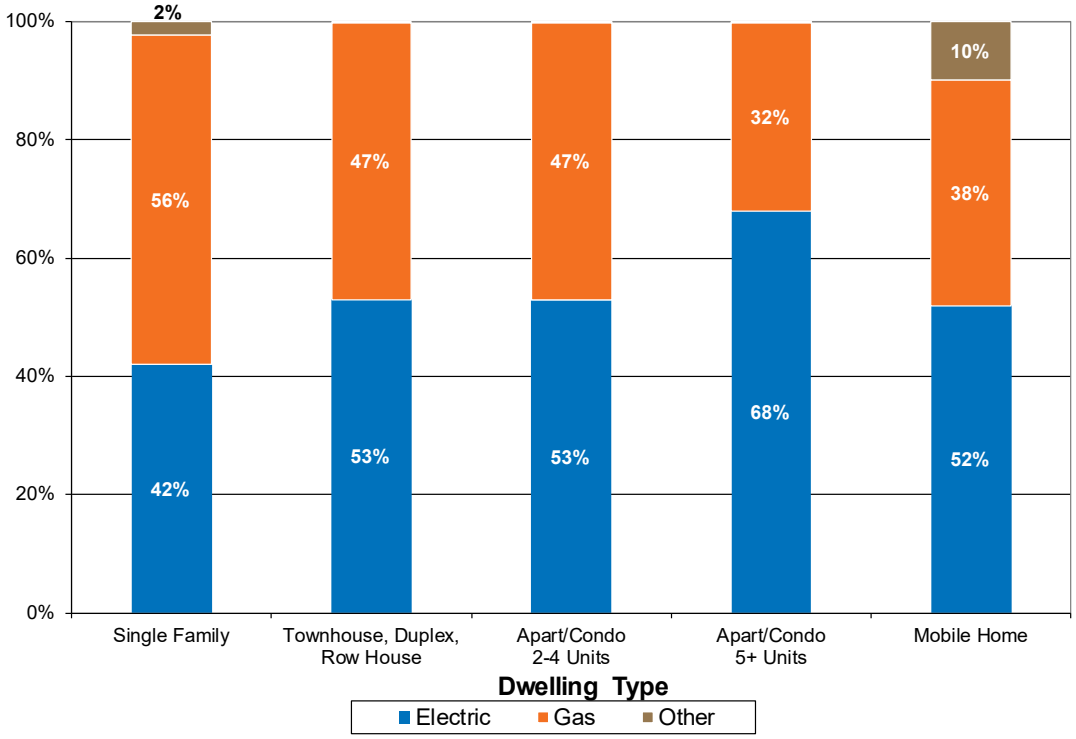
Figure 14: Electric Appliances Share by Dwelling Age



Source: 2019 California Residential Appliance Saturation Survey

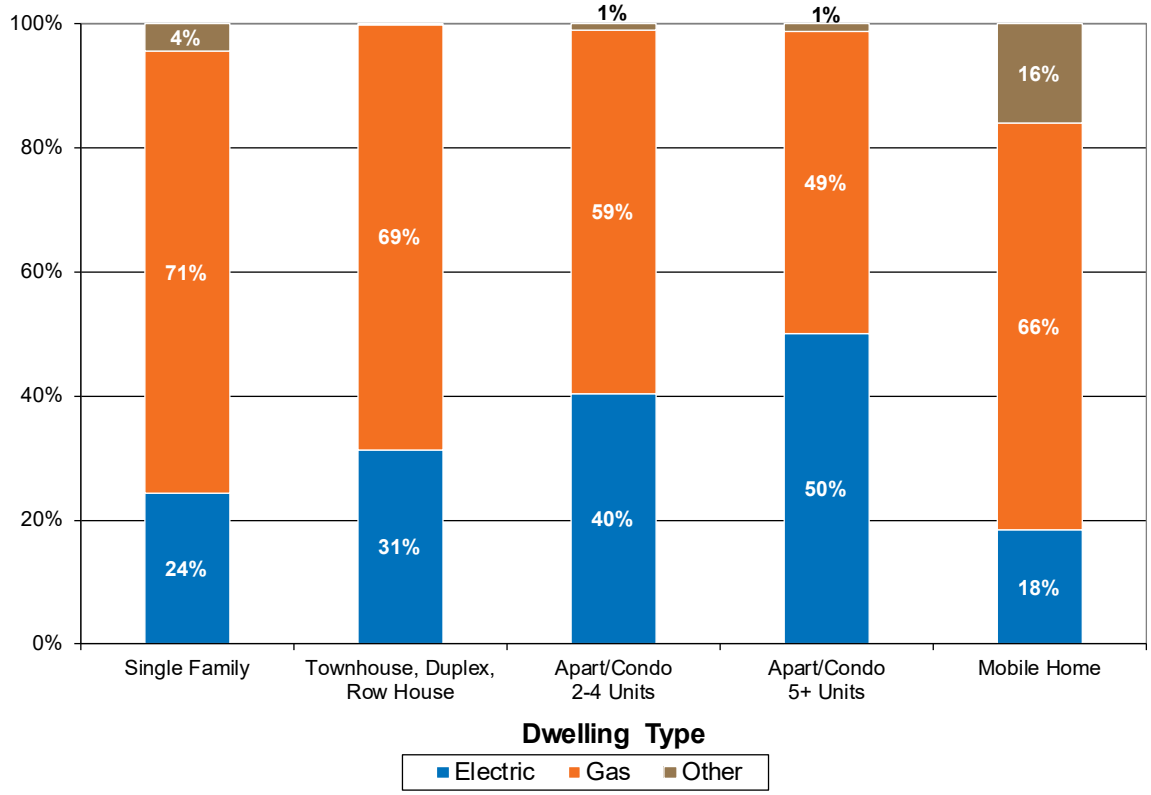
Figure 15, **Figure 16**, and **Figure 17** show fuel shares by dwelling type for clothes dryers, cooking ranges, and ovens, respectively. Across the three figures, electric fuel shares are higher in multifamily buildings than in single-family homes or mobile homes. Overall, the fuel shares have remained relatively stable compared with the *2009 RASS*. The only categories to shift more than 5 percent from the *2009 RASS* are ranges for apartments in buildings with 5 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 15: Fuel Shares for Clothes Dryers by Dwelling Type



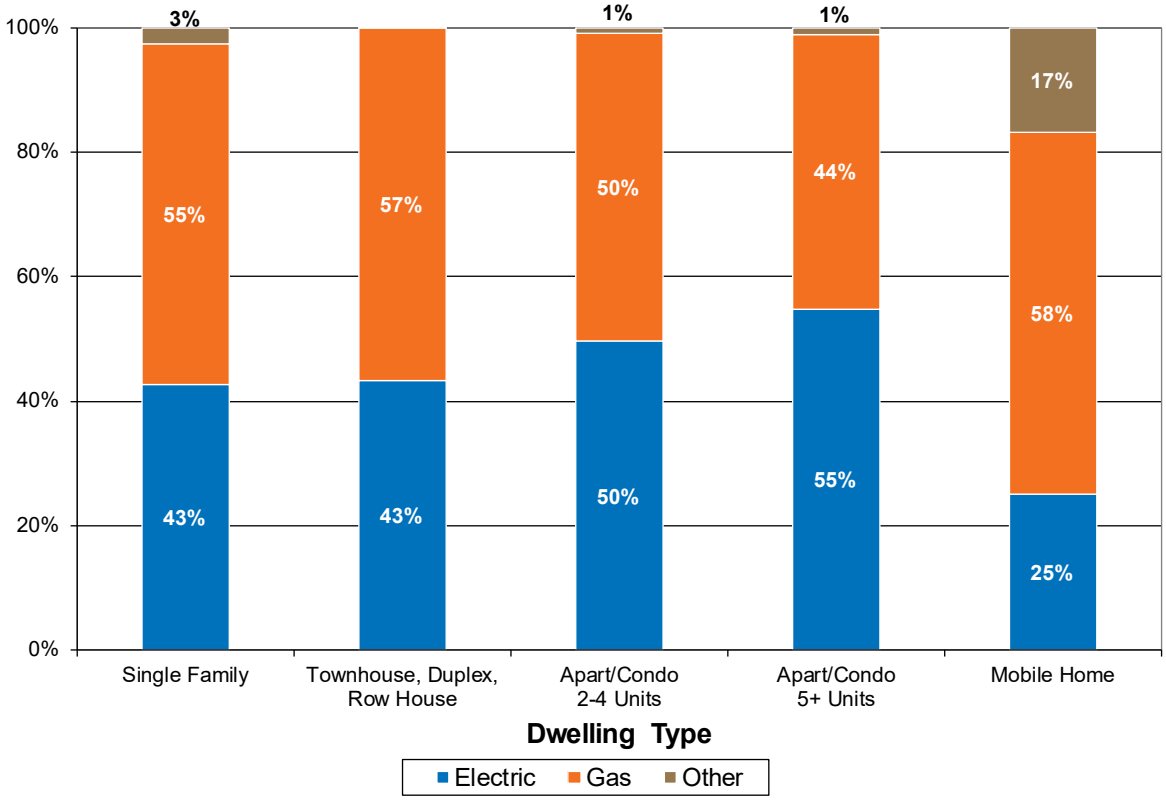
Source: 2019 California Residential Appliance Saturation Survey

Figure 16: Fuel Shares for Cooking Ranges by Dwelling Type



Source: 2019 California Residential Appliance Saturation Survey

Figure 17: Fuel Shares for Ovens by Dwelling Type

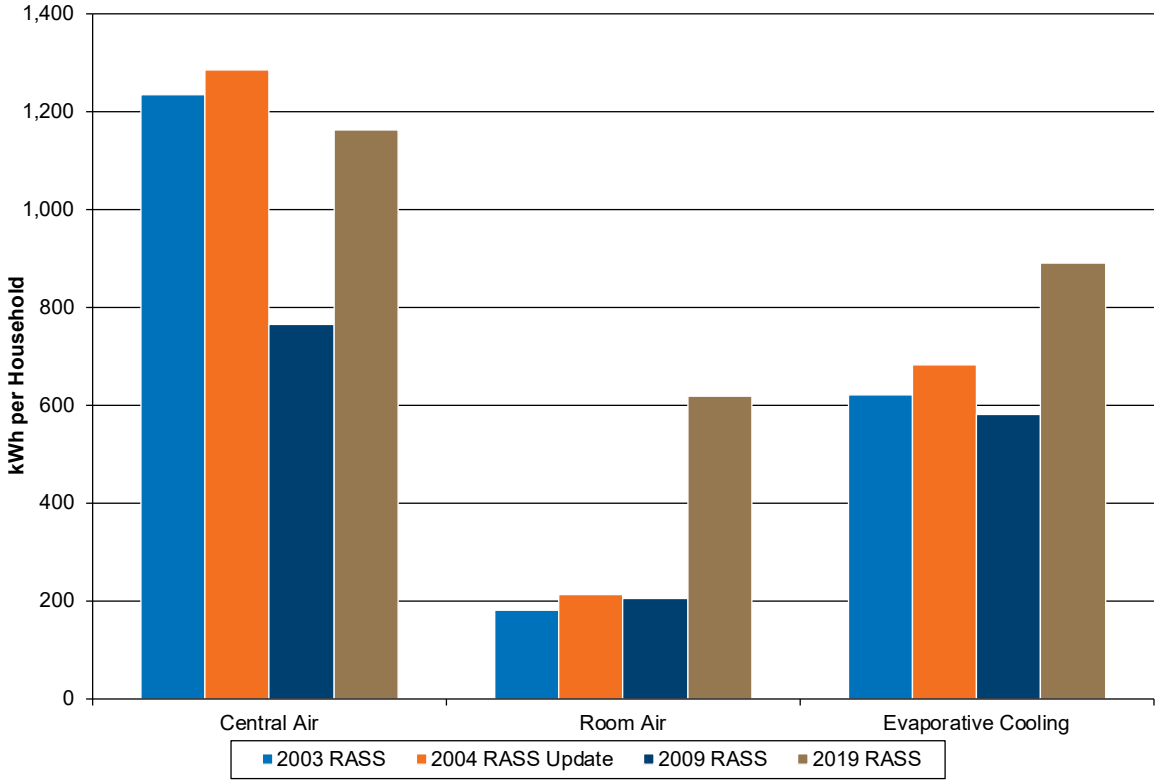


Source: 2019 California Residential Appliance Saturation Survey

Air Conditioning

Although space cooling consumes only 13 percent of annual residential electricity consumption, it is the main driver of residential peak load. The overall UEC for central air conditioning is 1,163 kWh, with the UEC for evaporative systems at 890 kWh and room air conditioning at 620 kWh per household, as shown in **Figure 18**. The UEC for all cooling types went up compared to the *2009 RASS*. The central air conditioner UEC is more comparable to 2003–2004 estimates, while room air conditioner use tripled, and evaporative cooler use increased by more than 50 percent compared to both previous RASS studies.

Figure 18: Air Conditioning UECs by AC Type for RASS Studies



Source: 2019 California Residential Appliance Saturation Survey

Table 5 presents central air conditioning UECs along with cooling degree days by CEC forecasting climate zones. UECs for central air conditioning vary significantly by forecasting climate zone. All cooling degree days represent normalized weather. UECs throughout this report are based on normalized weather.

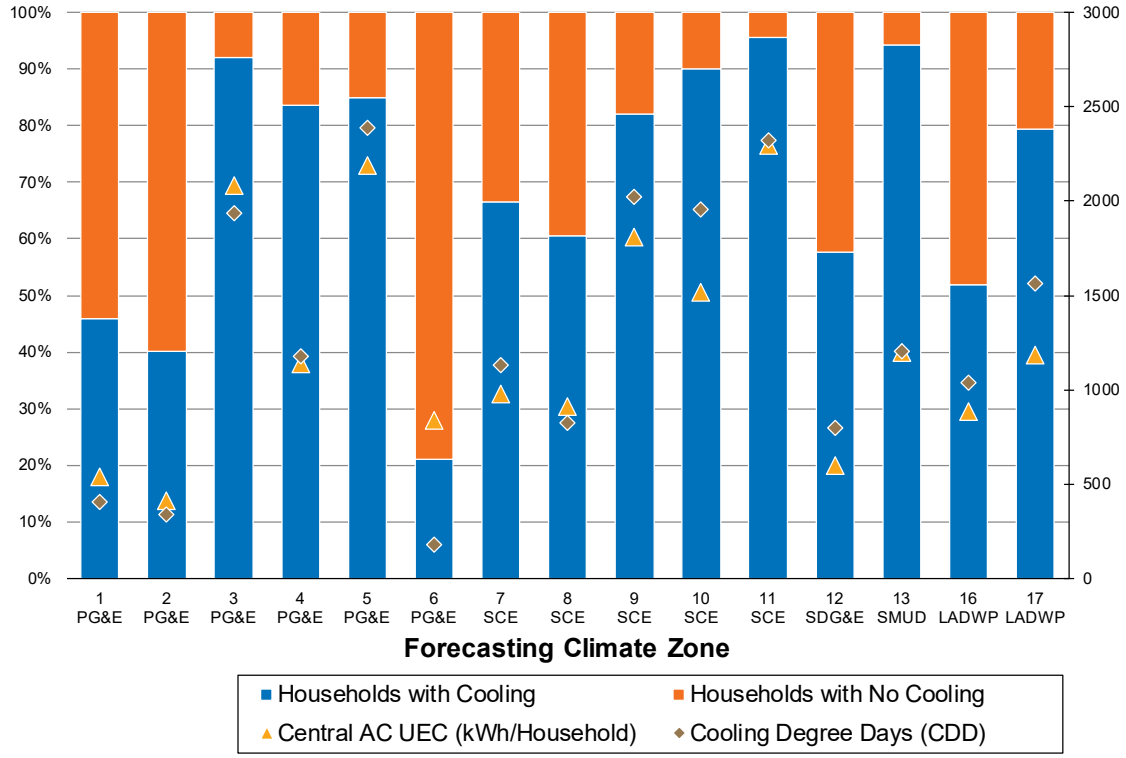
Table 5: Central Air Conditioning UECs by Forecasting Climate Zone with Cooling Degree Days

Energy Commission Forecasting Climate Zone	Central AC UEC (kWh/Household)	CDD
Zone 1 (PG&E)	539	402
Zone 2 (PG&E)	412	340
Zone 3 (PG&E)	2,083	1,935
Zone 4 (PG&E)	1,134	1,176
Zone 5 (PG&E)	2,186	2,387
Zone 6 (PG&E)	836	177
Zone 7 (SCE)	979	1,132
Zone 8 (SCE)	914	827
Zone 9 (SCE)	1,807	2,020
Zone 10 (SCE)	1,519	1,953
Zone 11 (SCE)	2,296	2,321
Zone 12 (SDG&E)	599	799
Zone 13 (SMUD)	1,194	1,203
Zone 16 (LADWP)	887	1,039
Zone 17 (LADWP)	1,183	1,562

Source: 2019 California Residential Appliance Saturation Survey

Figure 19 shows the saturations of air conditioning along with the cooling degree days and unit energy consumption by forecasting climate zone for the *2019 RASS*.

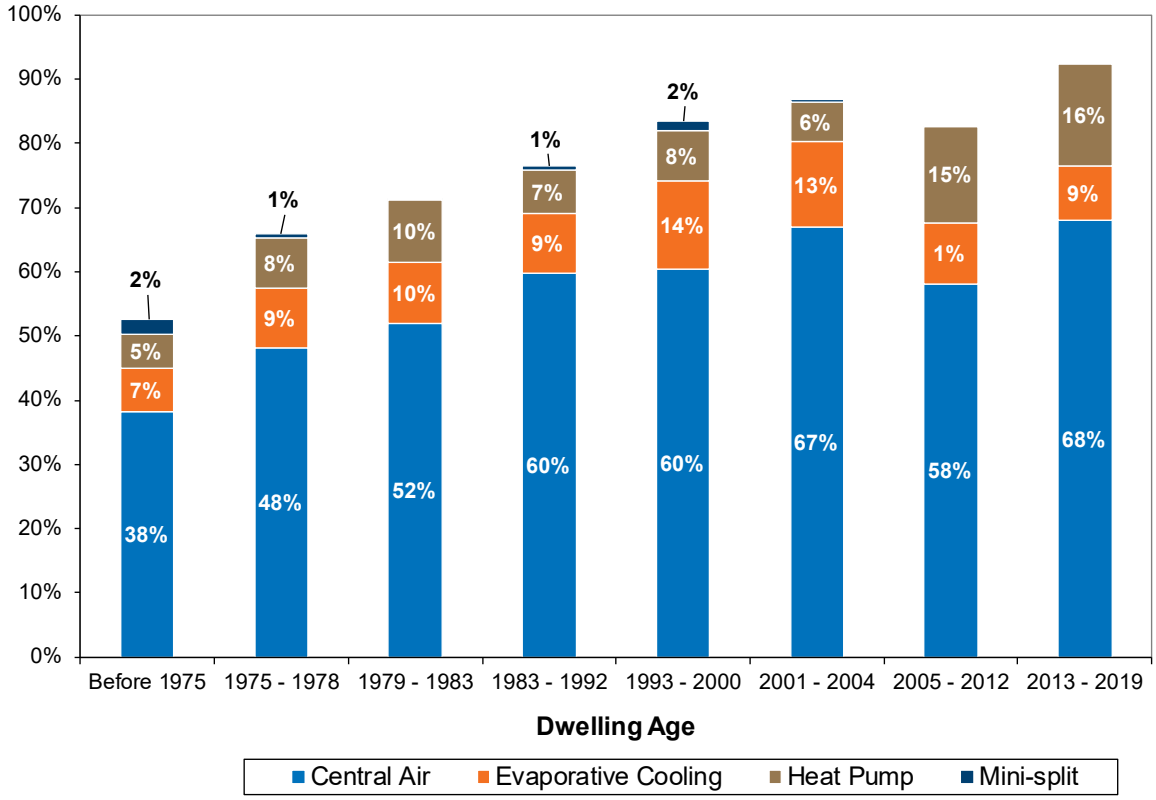
Figure 19: Saturation of Air Conditioning by Forecasting Climate Zone



Source: 2019 California Residential Appliance Saturation Survey

Figure 20 shows the type of air conditioning and saturation 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 20: Air Conditioning Type by Dwelling Age

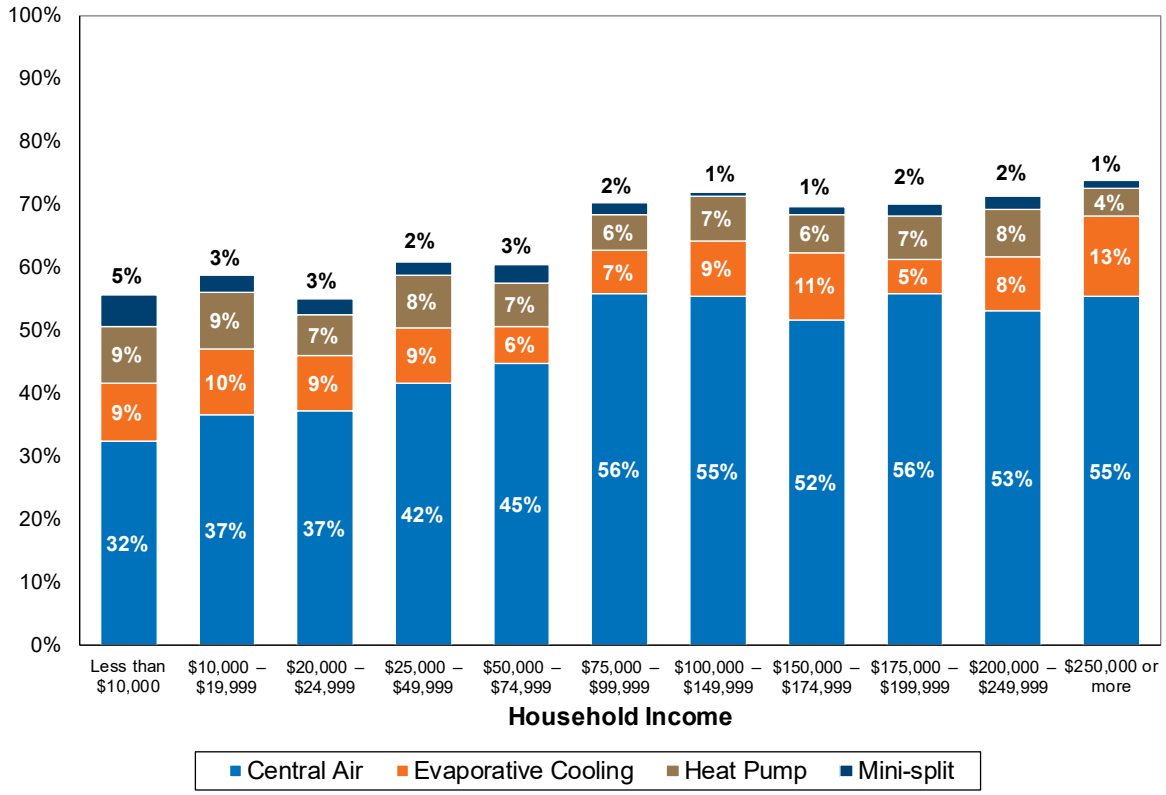


Source: 2019 California Residential Appliance Saturation Survey

Although income is correlated both with having air conditioning and the type of air conditioning, as shown in **Figure 21**, it is not as big of a driver as dwelling age.

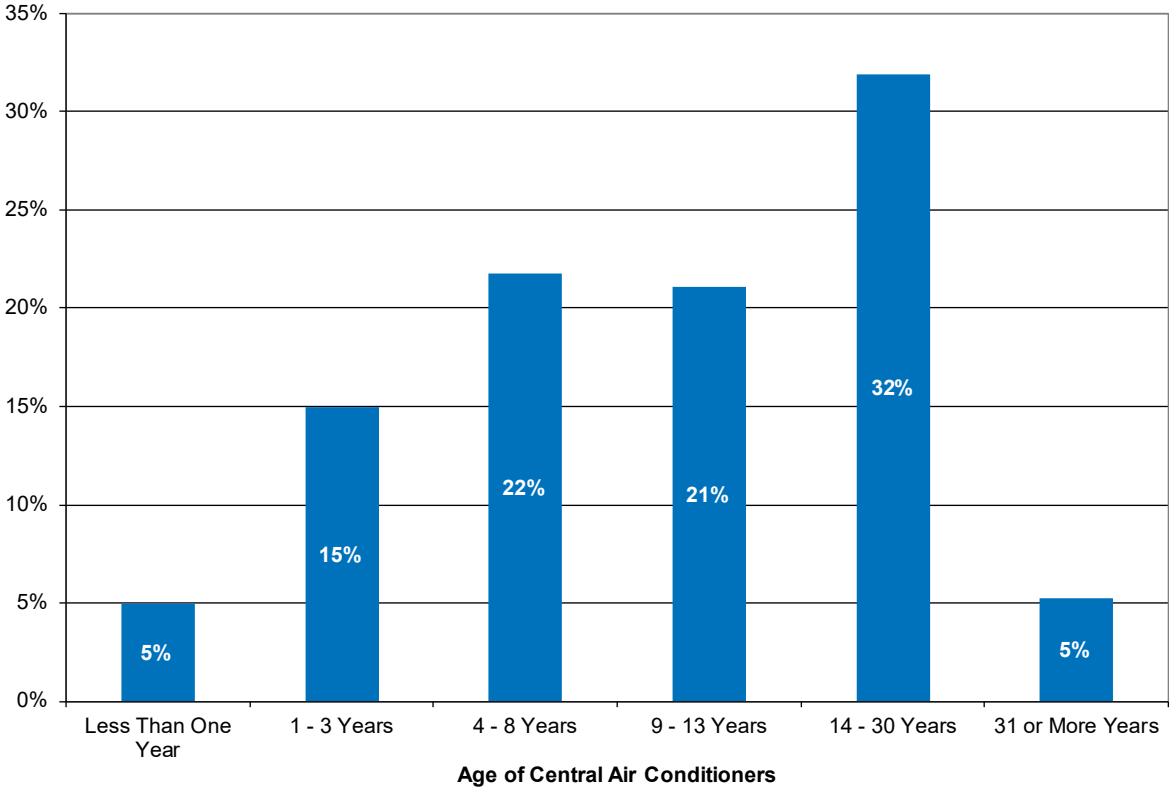
Figure 22 shows the age distribution of central air conditioners, with a 9 percent higher proportion than *2009 RASS* of air conditioners 14 years old or older.

Figure 21: Air Conditioning Type by Income



Source: 2019 California Residential Appliance Saturation Survey

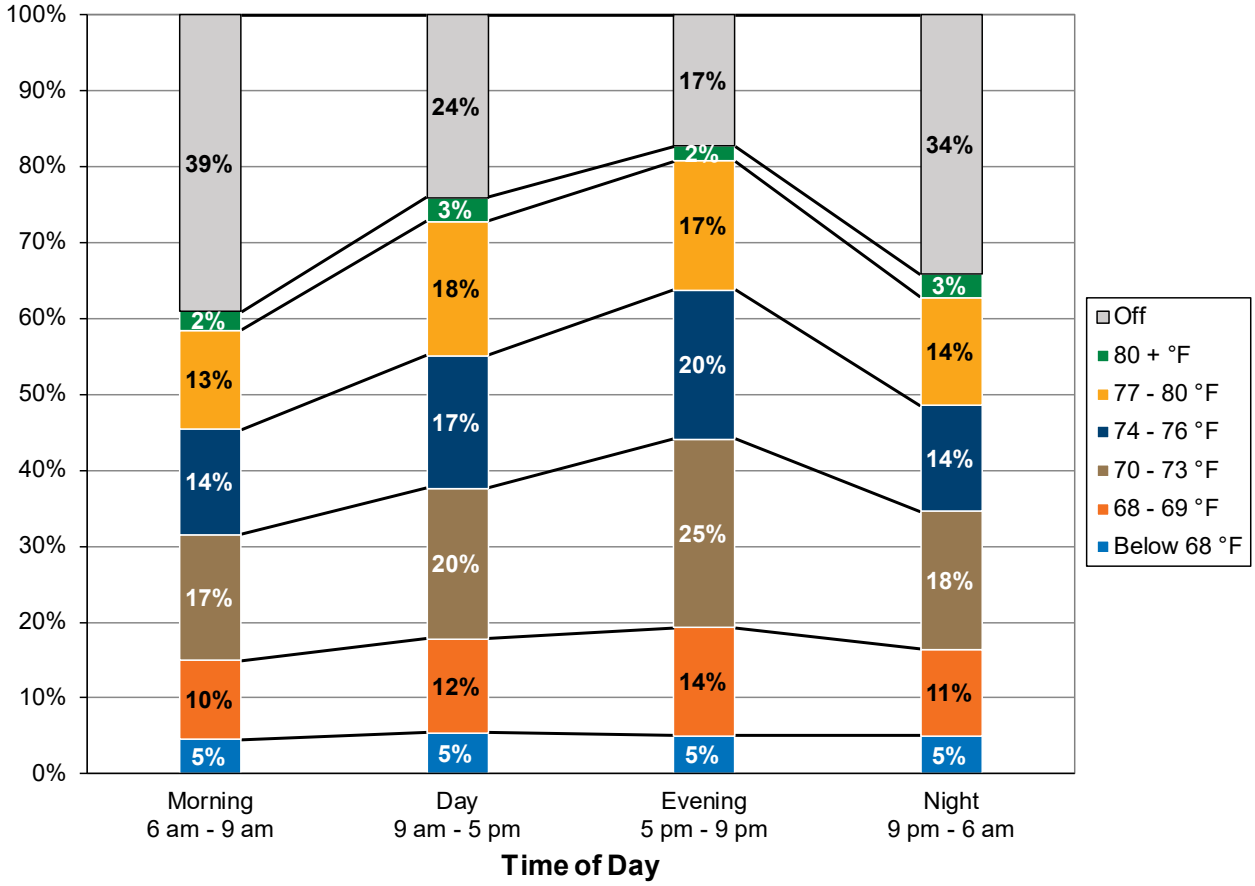
Figure 22: Age Distribution of Central Air Conditioners



Source: 2019 California Residential Appliance Saturation Survey

Figure 23 breaks down how households with central air conditioning set the temperature on their thermostats. *2019 RASS* improved the data collection to provide seven temperature setpoints for four time-of-day periods. Many units are at the coldest setpoints in the evening, which coincides with the new system peak electric demand and the times of highest grid emissions and costs as solar generation drops. "Smart" communicating thermostats were 15 percent of heating thermostats and 20 percent of cooling thermostats.

Figure 23: Air Conditioning Thermostat Temperature Setting Habits

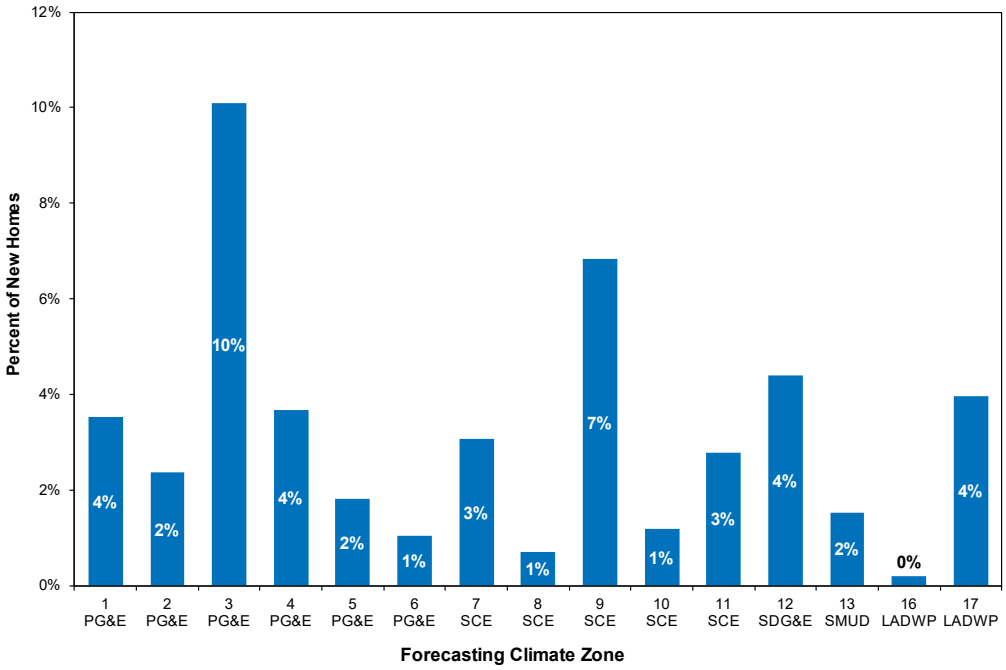


Source: 2019 California Residential Appliance Saturation Survey

New Dwellings

Dwellings built from 2013 onward are considered new dwellings in the *2019 RASS*. **Figure 2**, near the beginning of this report, shows a map of the forecasting climate zones. **Figure 24** shows the housing growth rate by climate zone as the percentage of new dwellings within the total housing population in each climate zone.

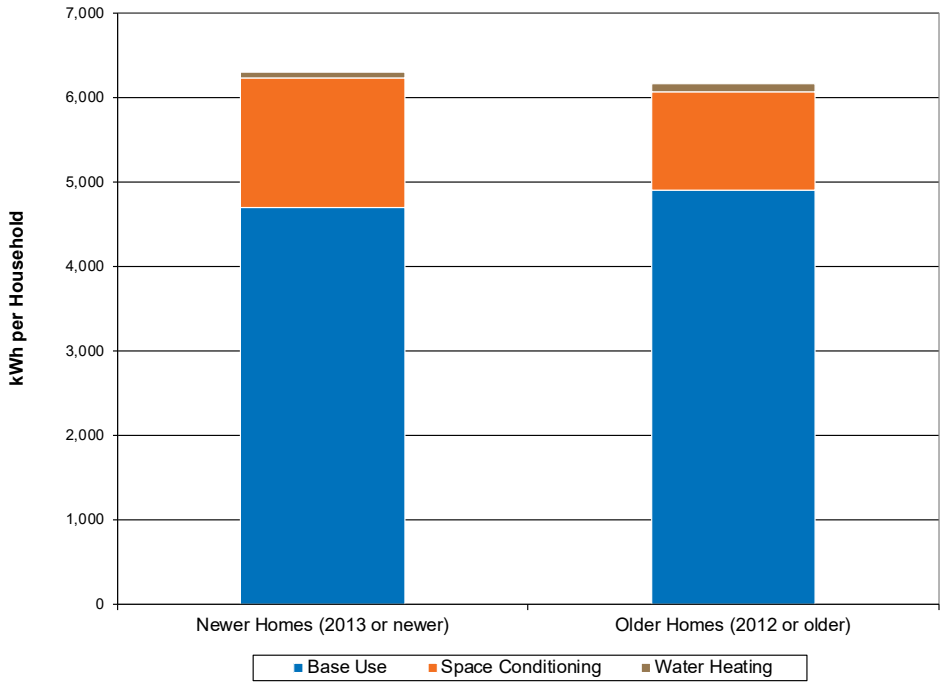
Figure 24: Housing Growth Rate by Forecasting Climate Zone



Source: 2019 California Residential Appliance Saturation Survey

Household average electric consumption in newer dwellings is 6,292 kWh per year (a 5 percent decrease from *2009 RASS*) compared to 6,166 kWh in older dwellings (a 1.5 percent decrease from *2009 RASS*), as shown in **Figure 25**. Consumption for space conditioning is the largest difference between the two age categories.

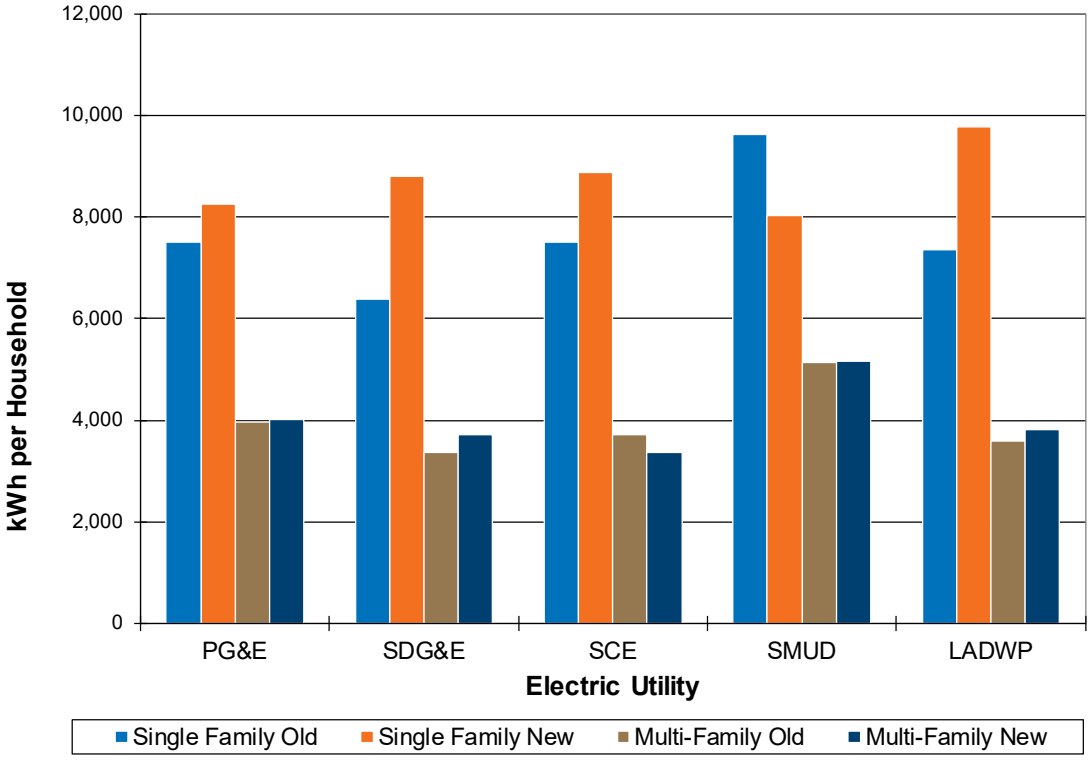
Figure 25: Electric UECs for Newer and Older Dwellings



Source: 2019 California Residential Appliance Saturation Survey

The overall average electric consumption is higher in newer dwellings, but the increase is predominantly within single-family homes, as shown in **Figure 26**. Newer multifamily dwellings have similar or slightly higher consumption than older homes, except within SCE territory, where consumption decreased for newer multifamily dwellings.

Figure 26: Electric UECs by Dwelling Age, Dwelling Type, and Utility

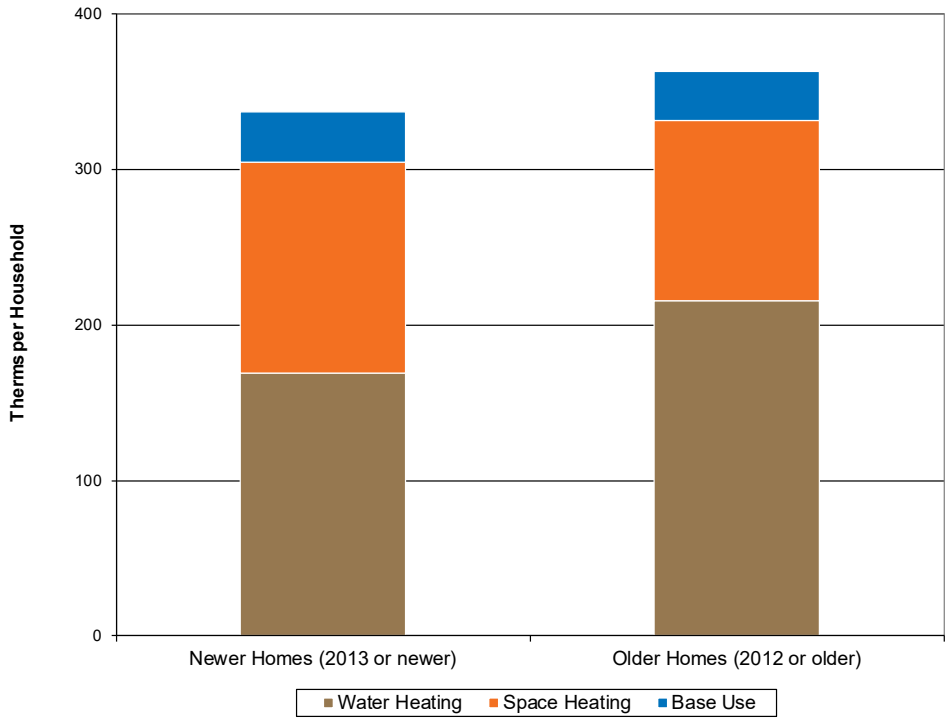


Source: 2019 California Residential Appliance Saturation Survey

Total household natural gas consumption is higher for older homes, but space heating consumes a higher proportion, and water heating consumes a lower proportion of the total for newer homes than for older homes, as shown in **Figure 27**.

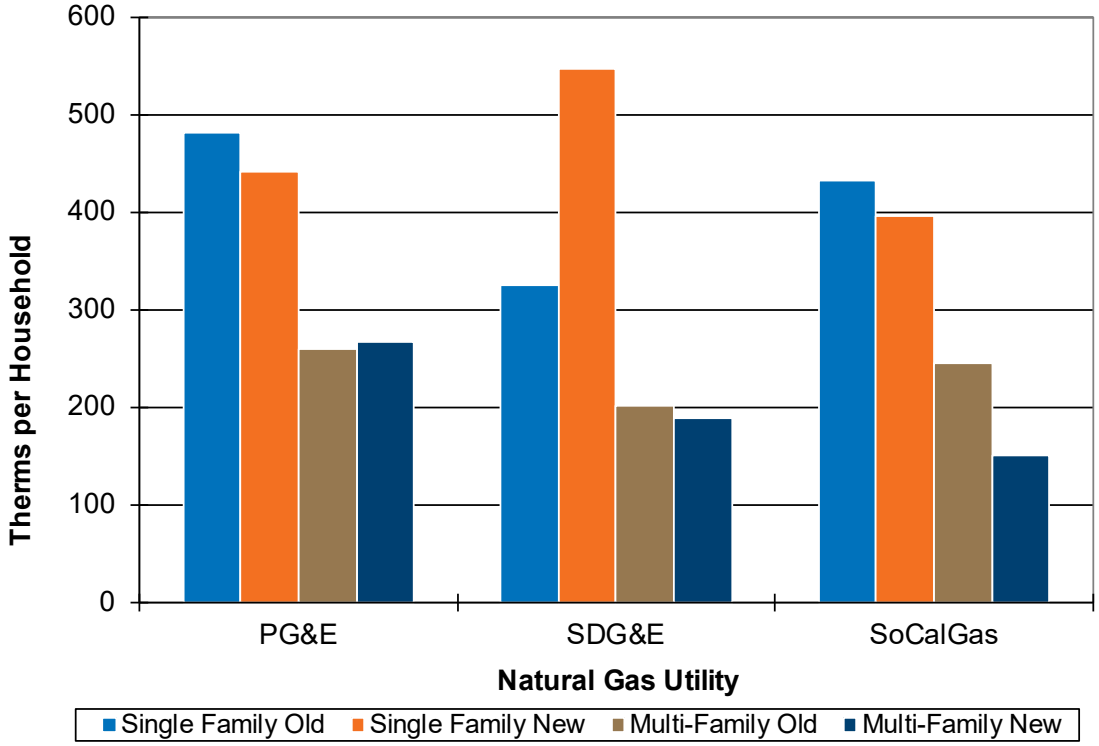
The overall average natural gas consumption is typically lower for newer than older dwellings, as shown in **Figure 28**. The notable exception is higher gas consumption for newer single-family homes in the SDG&E service area.

Figure 27: Natural Gas UECs for Newer and Older Dwellings



Source: 2019 California Residential Appliance Saturation Survey

Figure 28: Natural Gas UECs by Dwelling Age, Dwelling Type, and Utility

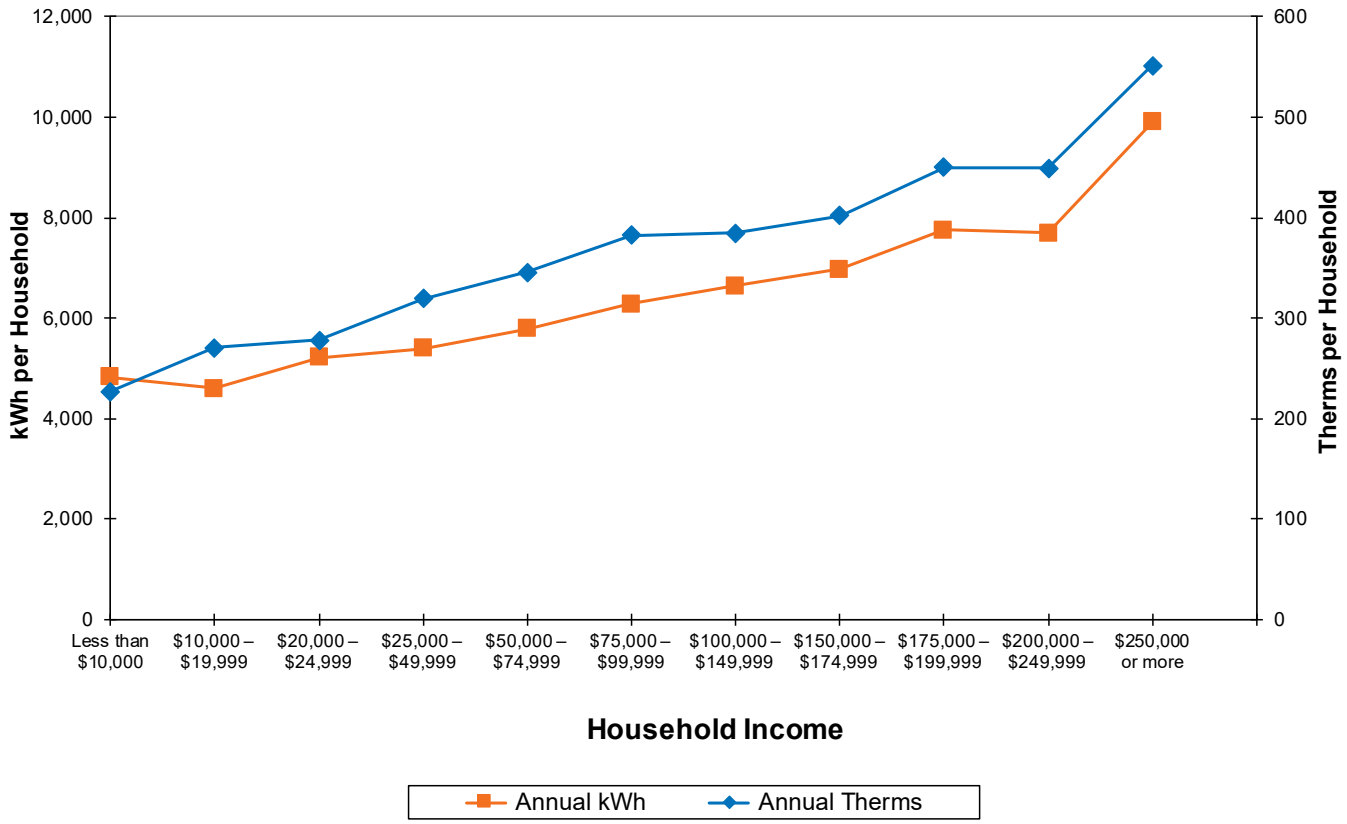


Source: 2019 California Residential Appliance Saturation Survey

Income Effects

Both overall average household electric and natural gas consumption increase as income increases, as shown in **Figure 29**. The larger income brackets in the *2019 RASS* also show higher consumption in the new largest categories.

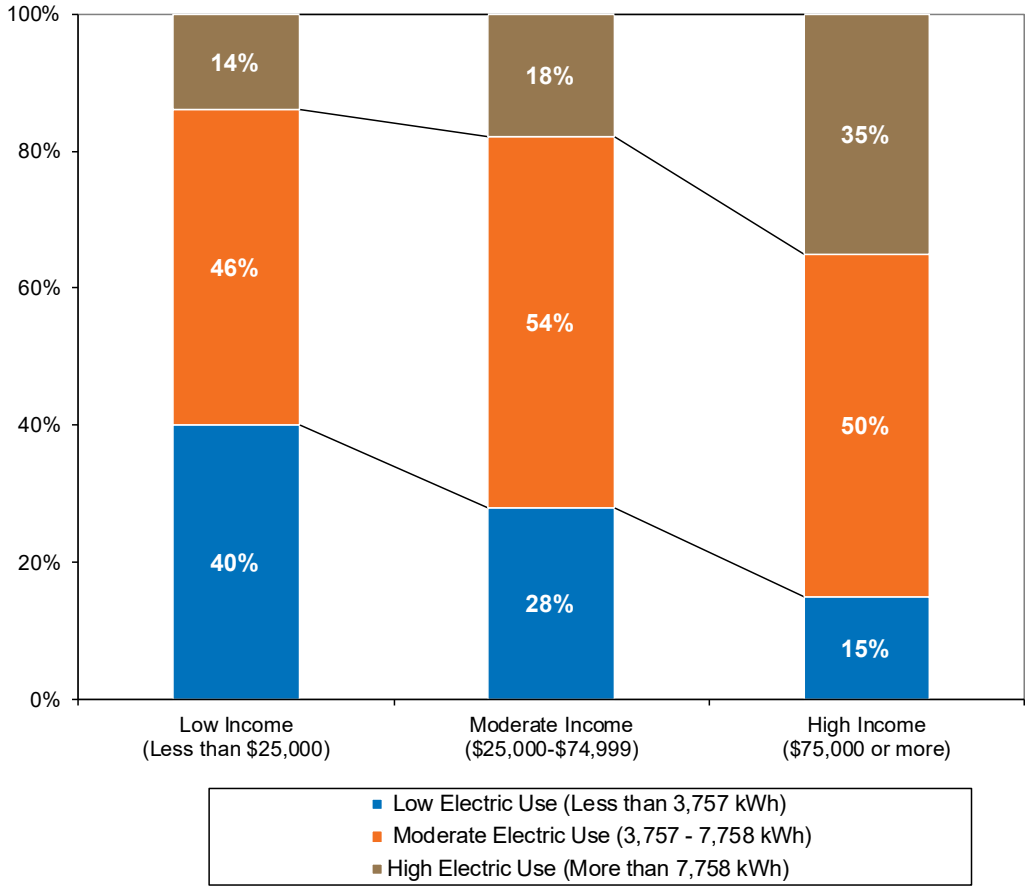
Figure 29: Average Electricity and Natural Gas Consumption by Income



Source: 2019 California Residential Appliance Saturation Survey

Although income is correlated with energy consumption, **Figure 30** shows that all levels of electric consumption are present in all income categories, but the proportions vary. The electric consumption is broken down into quartiles (four equal parts), with the two middle quartiles comprising the moderate consumption category. 14 percent of households in the low-income category have electric consumption at the highest quartile (use more than 7,758 kWh per year). Conversely, 15 percent of households in the high-income category have electric consumption in the lowest quartile (use less than 3,757 kWh per year).

Figure 30: Electricity Consumption Compared with Income

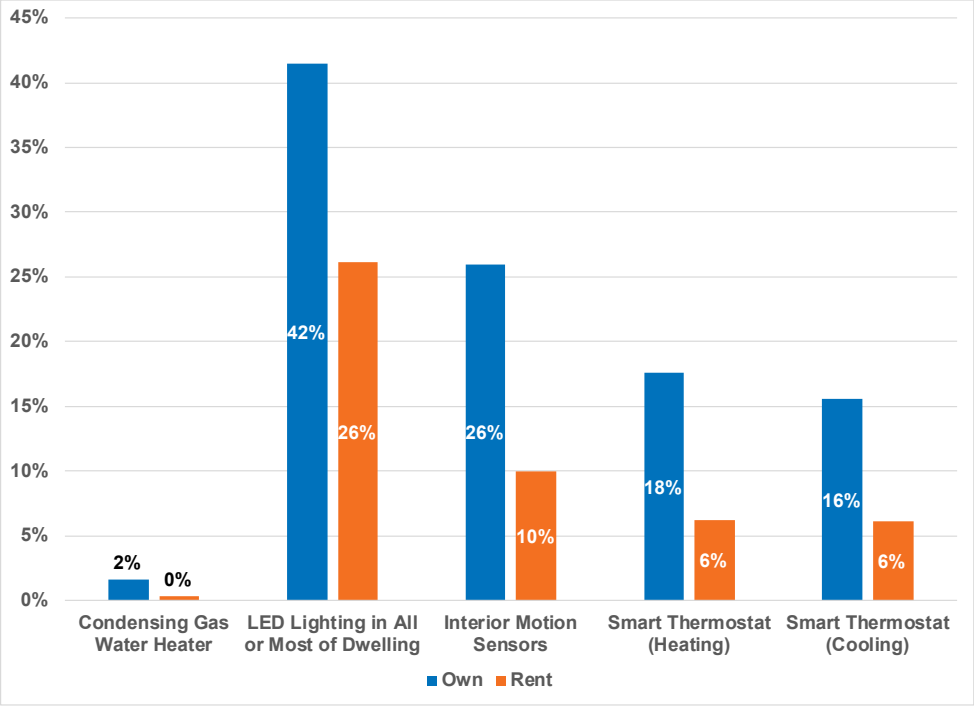


Source: 2019 California Residential Appliance Saturation Survey

Adoption of Energy-Efficient Measures

Often the adoption of energy efficiency measures rests with the homeowner, either by choice or 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 31** shows that households in which the dwellings are owned are more likely to have energy-efficient measures in place. Light-emitting diode (LED) lighting and smart thermostats are the notable new energy-efficient measures present in the *2019 RASS* that were not present in 2009. Smart thermostats can be used with home automation systems and may sense when you are home.

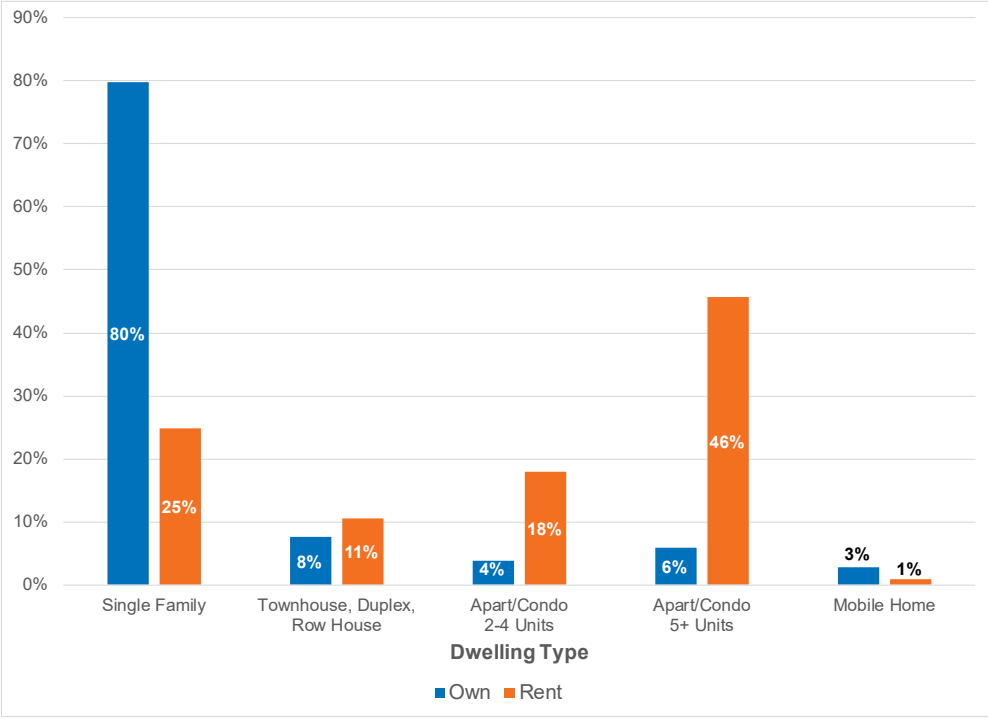
Figure 31: Energy Efficiency Measures by Home Ownership



Source: 2019 California Residential Appliance Saturation Survey

Owners comprise 65 percent of the study population, with the remaining 35 percent being renters. **Figure 32** shows home ownership by dwelling type. Eighty percent of owners live in single-family homes, while 46 percent of renters live in apartments or condominiums in buildings with five or more units.

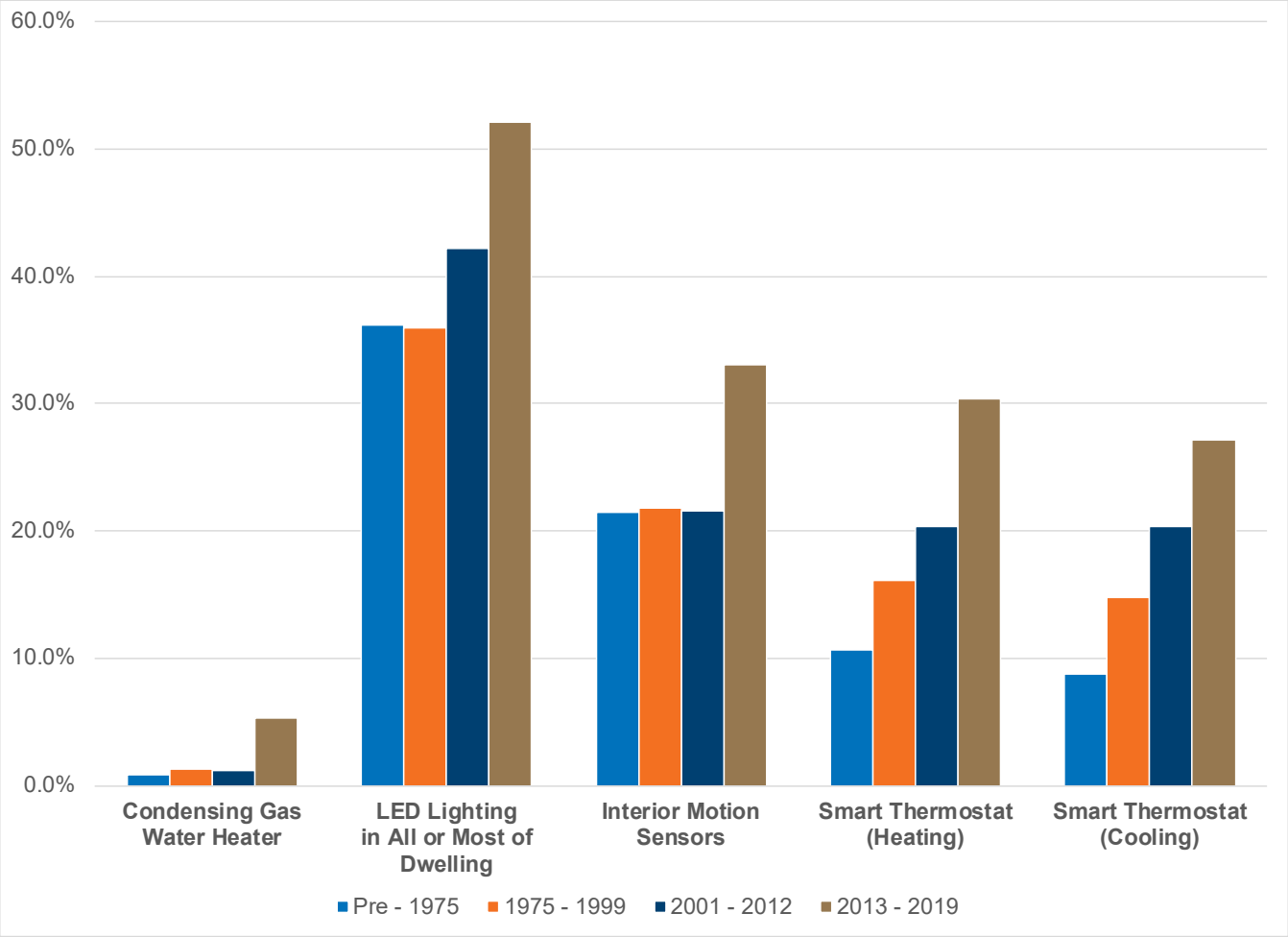
Figure 32: Home Ownership by Dwelling Type



Source: 2019 California Residential Appliance Saturation Survey

Figure 33 compares the same energy efficiency measures as listed above across newer and older homes. Notably, a greater portion of newer homes have energy-efficient measures installed. LED lights and smart thermostats are installed in older and newer homes.

Figure 33: Energy Efficiency Measures by Dwelling Age



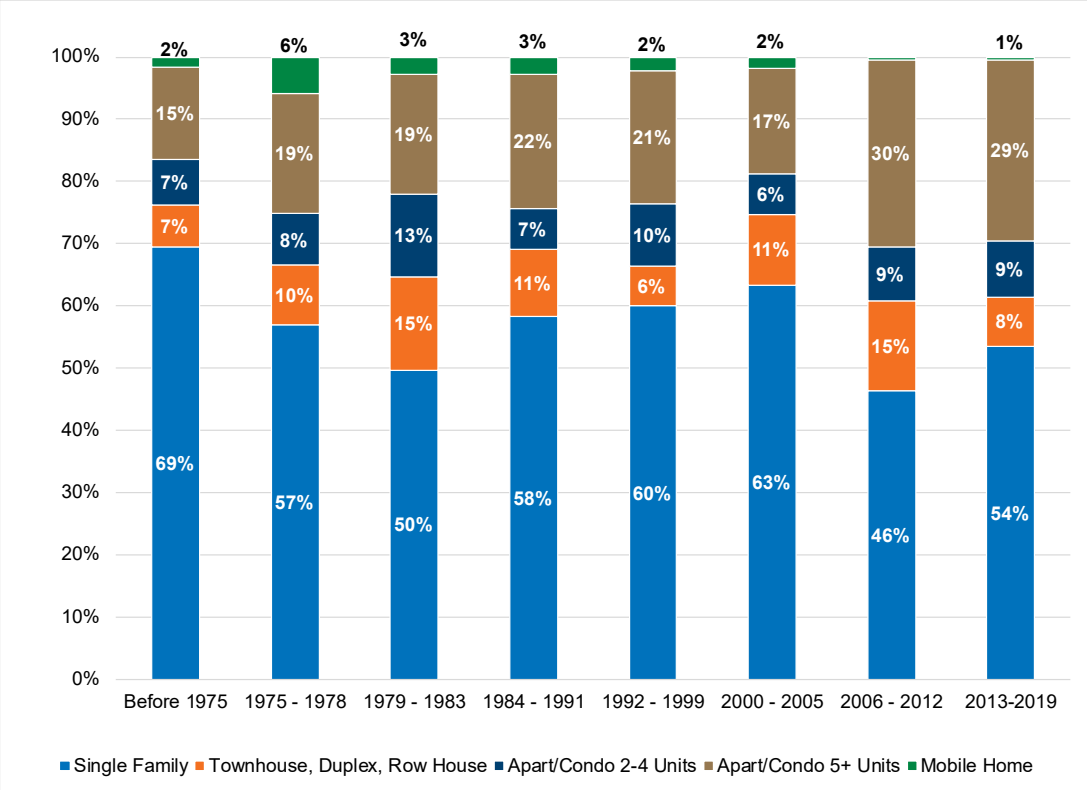
Source: 2019 California Residential Appliance Saturation Survey

Ninety-three percent of the dwellings in the study population were built in 2005 or earlier. **Figure 34** shows the distribution of dwelling age group across dwelling types.

LED bulbs have been heavily marketed through various program initiatives throughout the state since RASS 2009, following years of compact fluorescent (CFL) bulb programs.

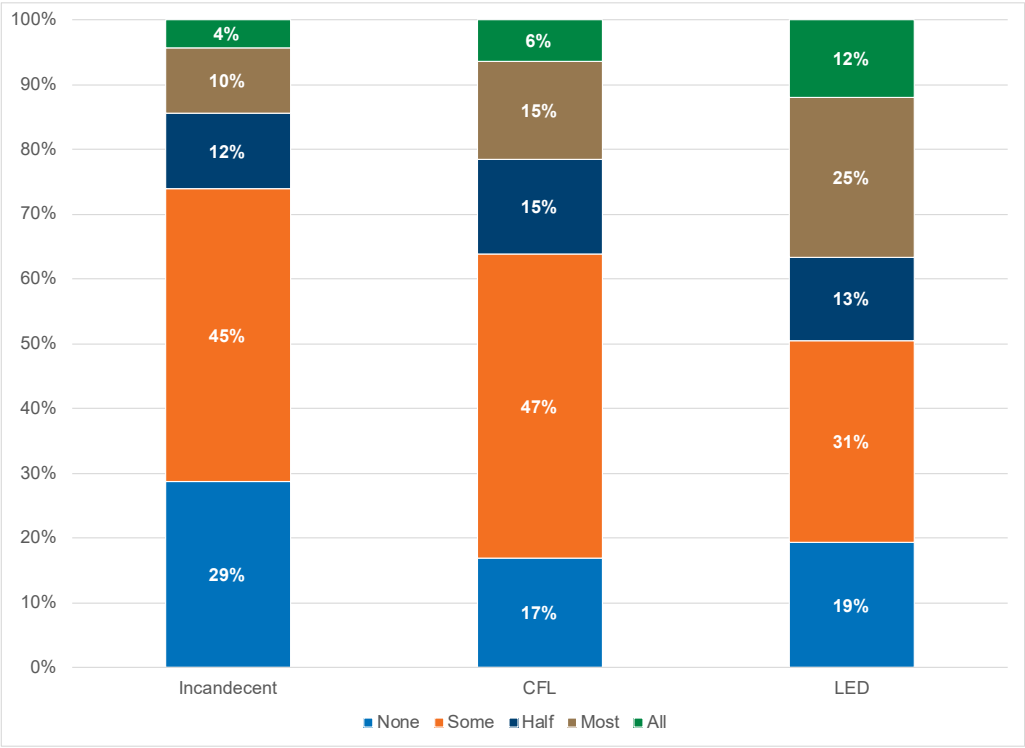
Figure 35 shows the penetration of incandescent, CFL, and LED bulbs. The survey asked for the proportion of each technology and many reported having some of all three technologies. Notably, 12 percent of homes reported being all LED, and only 4 percent reported being all incandescent, while 29 percent of homes reported not having any incandescent bulbs.

Figure 34: Dwelling Age by Dwelling Type



Source: 2019 California Residential Appliance Saturation Survey

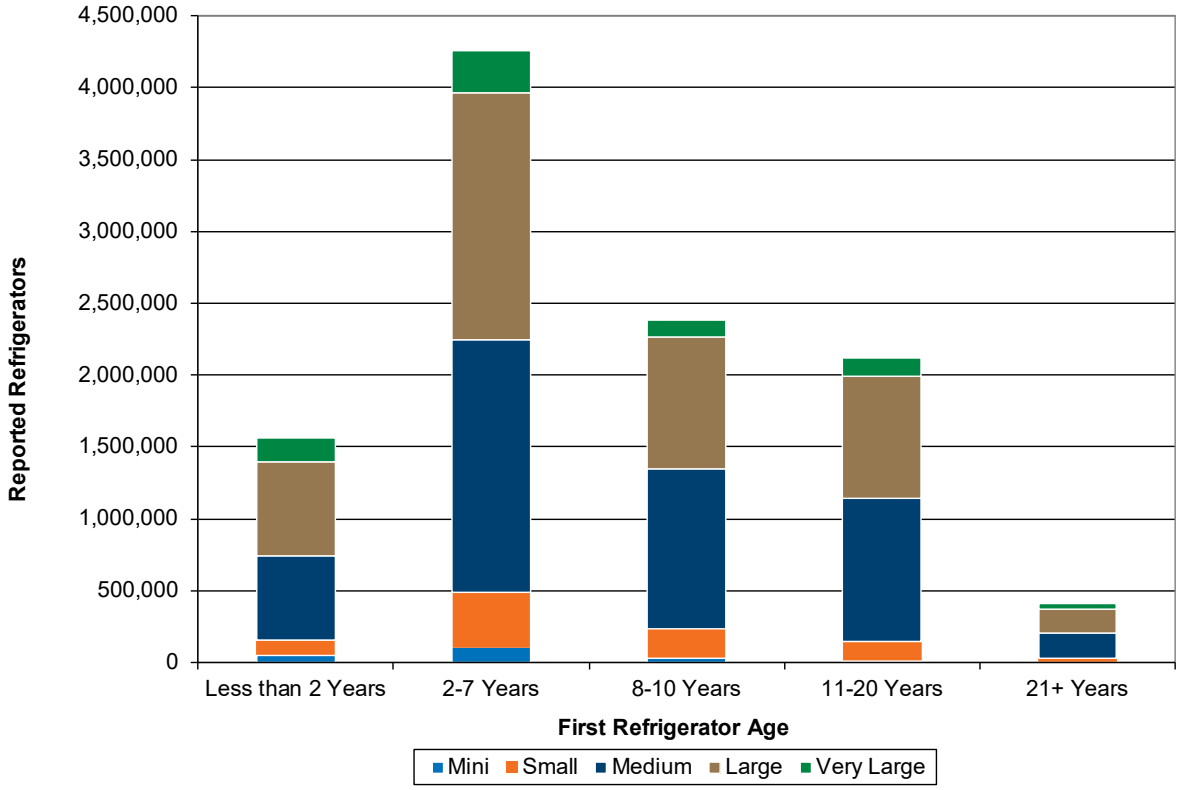
Figure 35: Penetration of Lighting Technologies



Source: 2019 California Residential Appliance Saturation Survey

The UEC for first refrigerators is 1,130 kWh per household, a significant increase from the *2009 RASS* estimate, which was 772 kWh per household. **Figure 36** shows a similar age distribution as *2009 RASS* but with more refrigerators in the age category of 11–20 years.

Figure 36: First Refrigerators by Size and Age



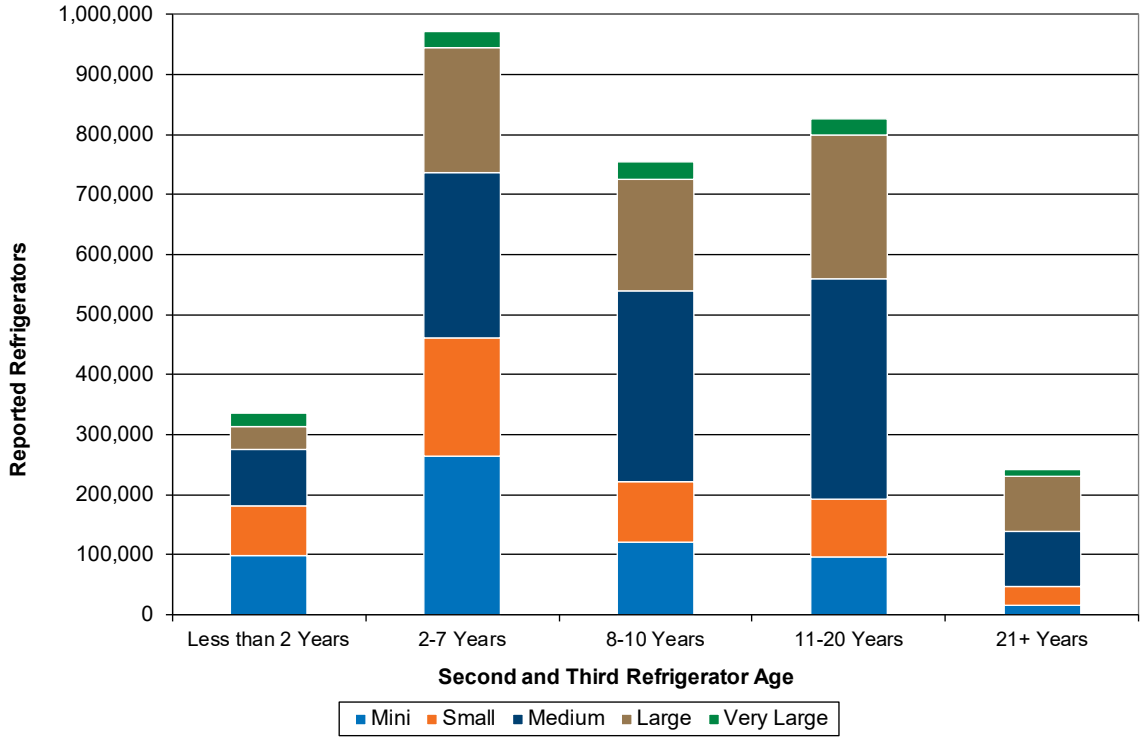
Source: 2019 California Residential Appliance Saturation Survey

Twenty-seven percent of households report having at least one additional refrigerator. Second and third refrigerators use an average of 1,081 kWh per unit, a decrease from the 1,212 kWh per household in the *2009 RASS* despite having a higher proportion of units over 10 years old, as shown in **Figure 37**.

Technology

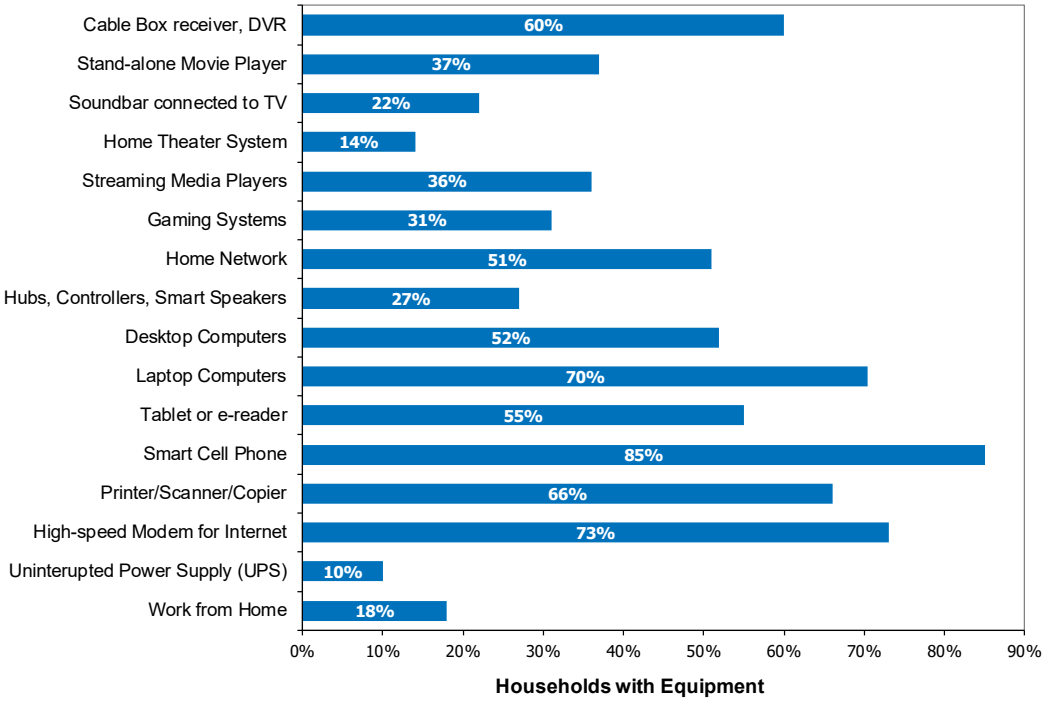
Households are quickly becoming infused with various technologies. **Figure 38** shows the penetration of several entertainment and home office equipment and services. Smart cell phones are most popular, with 85 percent of households having at least one. Laptops are more prevalent, with 70 percent of households having at least one, compared to 54 percent of households in 2009. Desktop computers correspondingly decreased to 52 percent of households compared to 67 percent of households in 2009. Fifty-five percent of households have a tablet or e-reader. Home networks are also more common, as they are in 51 percent of households, compared to 33 percent of households in 2009.

Figure 37: Second and Third Refrigerators by Size and Age



Source: 2019 California Residential Appliance Saturation Survey

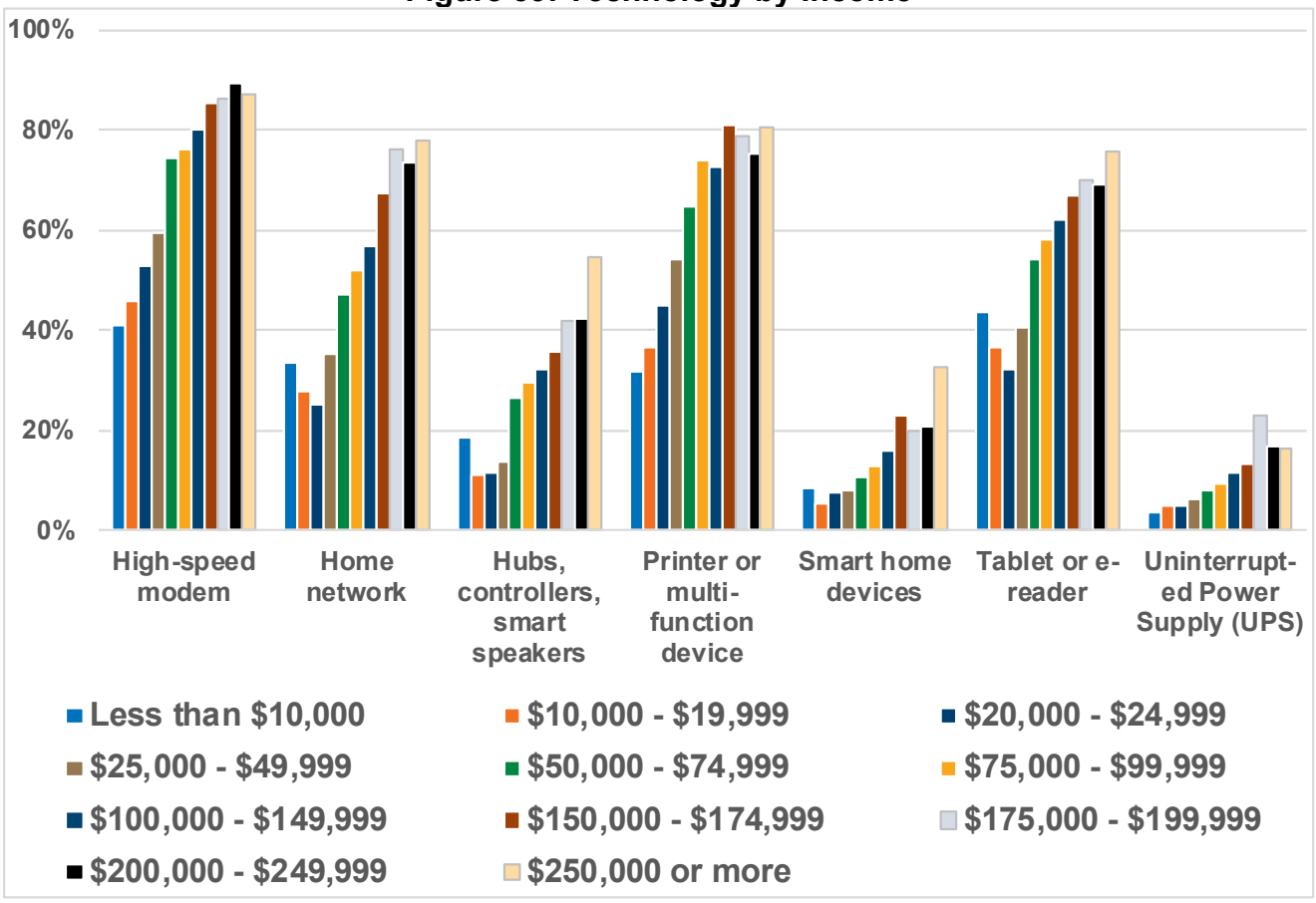
Figure 38: Penetration of Technology Equipment



Source: 2019 California Residential Appliance Saturation Survey

As many new technologies mature, the accessibility of the technology typically increases across all income levels. **Figure 39** illustrates technology by income. The income levels are increasing from left to right for each technology.

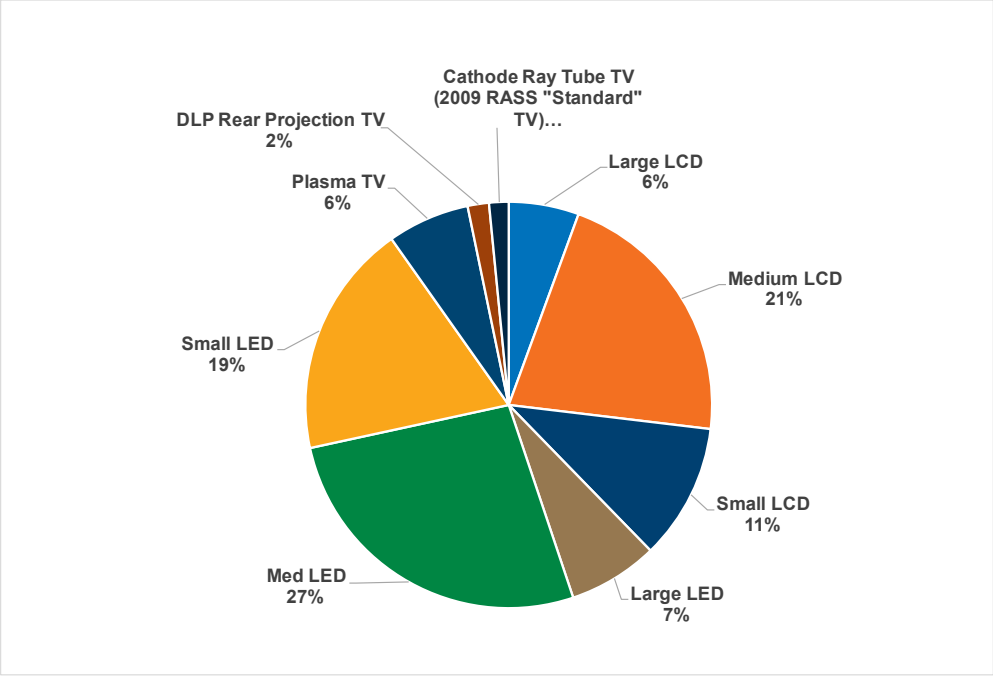
Figure 39: Technology by Income



Source: 2019 California Residential Appliance Saturation Survey

Figure 40 shows the distribution of the various types of televisions. The number of types increased greatly since the *2009 RASS*, and "standard" cathode-ray tube televisions decreased from 56 percent in 2009 to 1 percent in 2019. More than half (53 percent) of all TVs are LED, which was not a category in the *2009 RASS*.

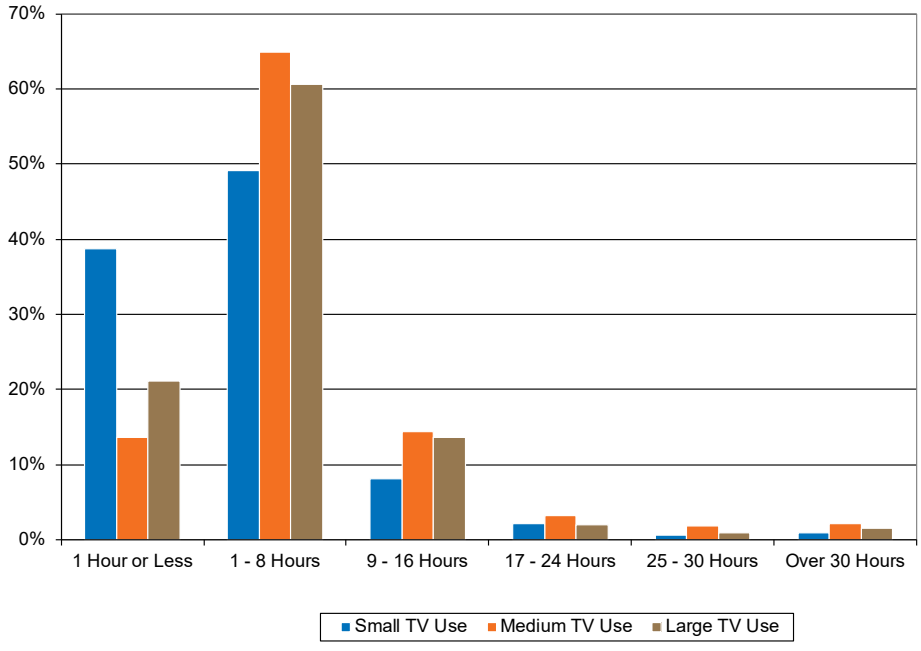
Figure 40: Types of Televisions



Source: 2019 California Residential Appliance Saturation Survey

Figure 41 shows the total number of hours of television use by size of television for households that have televisions in the size categories. The number of hours represents the total combined hours of use for all televisions in a size category in the household. Compared to the *2009 RASS*, small televisions are still used for fewer hours than medium or large televisions. Medium and large televisions are used for more hours than reported in the *2009 RASS*.

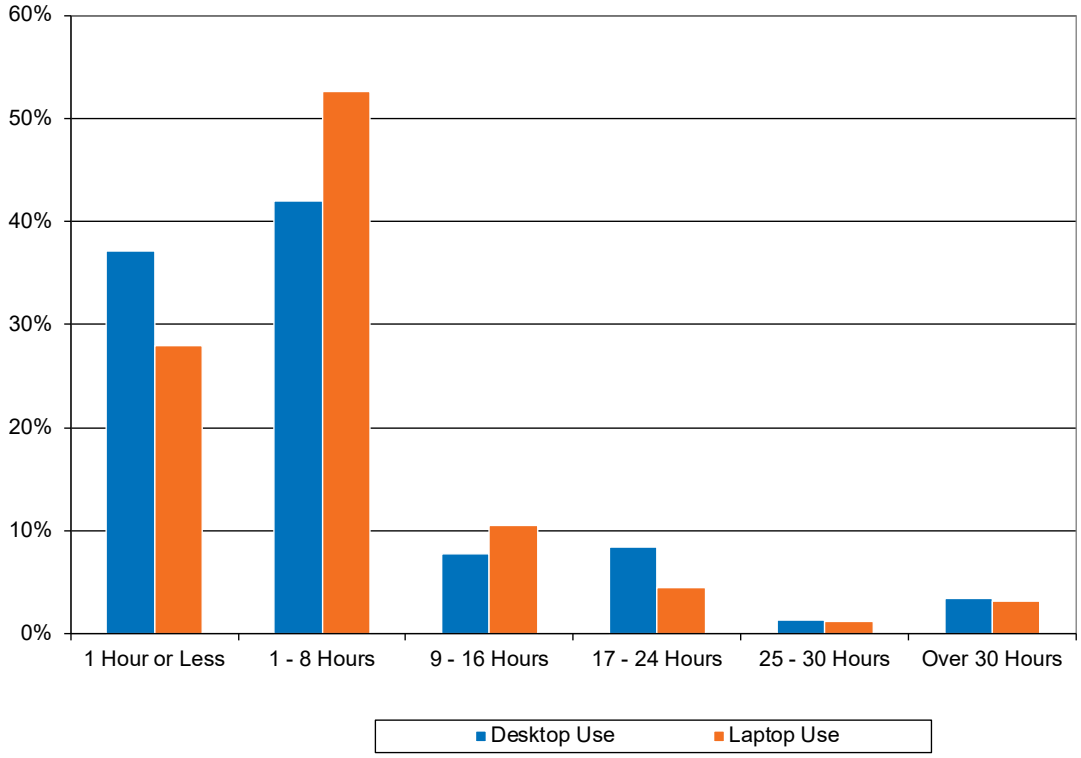
Figure 41: Total Hours of Television Use by Size of Television



Source: 2019 California Residential Appliance Saturation Survey

Respondents report using their desktop computers for one to eight hours in a higher proportion than in the *2009 RASS*, as shown in **Figure 42**. Hours of use of laptop computers are about the same as reported in 2009.

Figure 42: Total Hours of Computer Use by Type

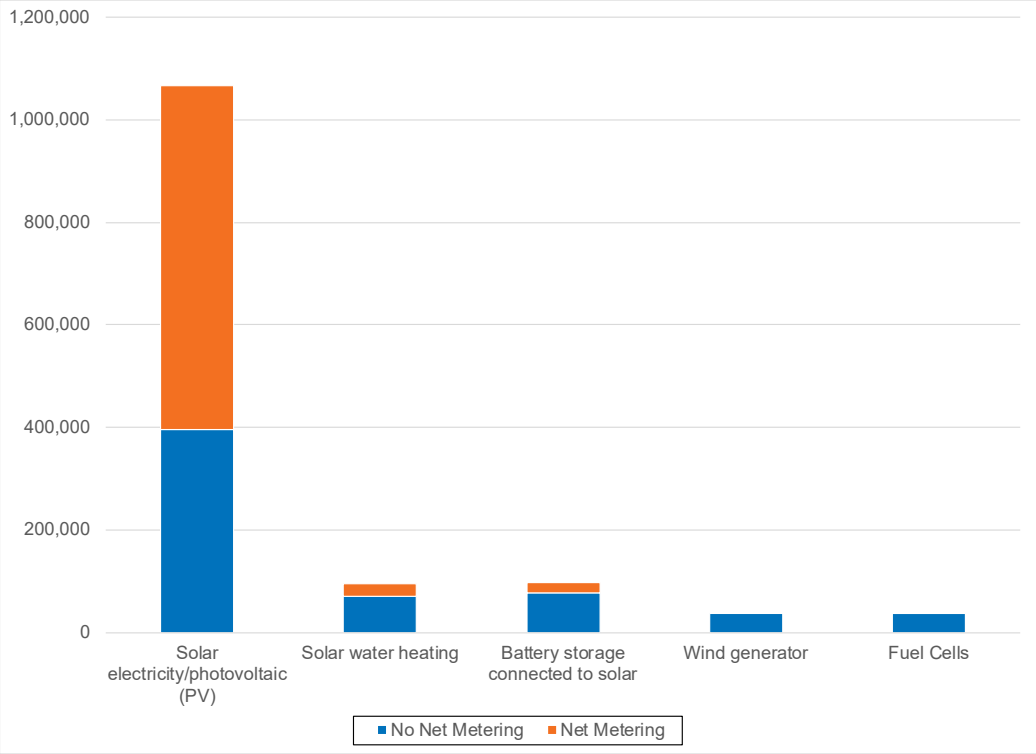


Source: 2019 California Residential Appliance Saturation Survey

Renewable Energy Technologies

New to *2019 RASS* are survey questions on renewable energy technologies. Based on households reporting using solar, the results show California achieving the 1 million solar roofs goal as shown in **Figure 43**.

Figure 43: Renewable Energy Technologies Statewide

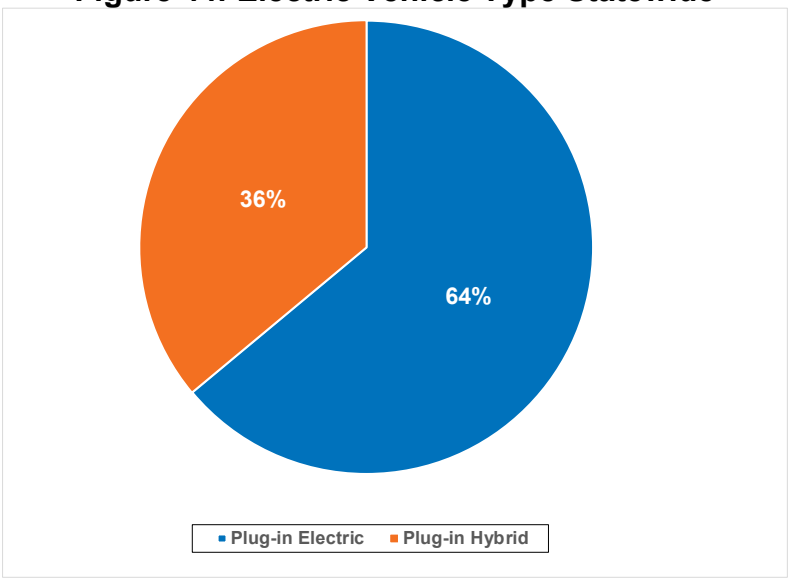


Source: 2019 California Residential Appliance Saturation Survey

Electric Vehicles

New to *2019 RASS* are survey questions on electric vehicles. Notably, the results show about 675,000 households have personal electric vehicles, which is about 6 percent saturation. Most (64 percent) are all-electric plug-in vehicles compared to plug-in gasoline-electric hybrid vehicles, as shown in **Figure 44**.

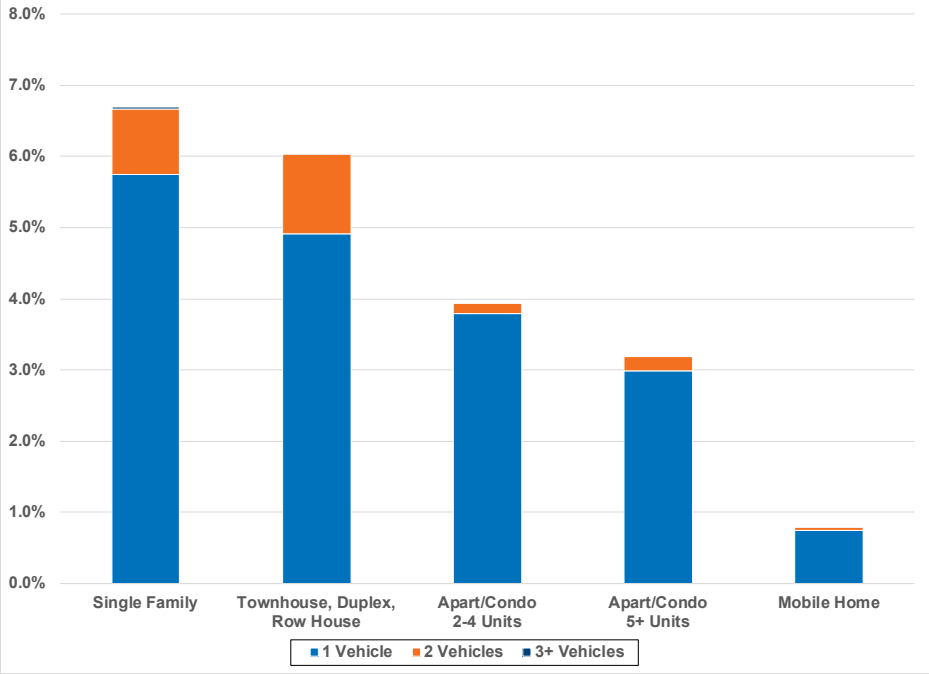
Figure 44: Electric Vehicle Type Statewide



Source: 2019 California Residential Appliance Saturation Survey

Figure 45 shows the penetration of electric vehicles by home type.

Figure 45: Number of Electric Vehicles by Dwelling Type



Source: 2019 California Residential Appliance Saturation Survey

Data Comparisons

Effect of Combining the Main Sample and Nonresponse Follow-Up Sample

To combine the nonresponse results with those from the initial recruitment efforts, the study created case weights that describe the number of households that each respondent represented. The general approach for calculating the weights for the individually metered sample for the *2019 RASS* followed the same general approach as the weighting scheme used for the *2009 RASS*. This approach weighted the nonresponse follow-up sample less heavily by assuming the follow-up sample represents only the follow-up population and not the entire set of nonresponses to the initial survey recruitment efforts. In effect, the responding sample represents only the people who responded to the initial recruitment effort or the follow-up effort.

A nonresponse follow-up effort can effectively reach segments of the population that do not respond to the initial recruitment effort. **Table 6** compares households that completed their surveys in response to the initial recruitment efforts to those responding to the nonresponse follow-up effort. The nonresponse households had similar major equipment and energy consumption in their households to the initial recruitment effort responders. Key differences of nonresponse follow-up households include that they are:

- Less likely to own their home.
- Likely to have a higher number of people but fewer seniors in the household.
- Likely to have a lower average income.
- More likely to have a head of household that is Hispanic.

Table 6: Comparison of Results by Recruitment Effort and Dwelling Type

	Single-Family Initial Effort	Single-Family Non-Response Effort	Multi-family (2-4 Units) Initial Effort	Multi-family (2-4 Units) Non-Response Effort	Multi-family (5+ Units) Initial Effort	Multi-family (5+ Units) Non-Response Effort	Mobile Homes Initial Effort	Mobile Homes Non-Response Effort
Completed Surveys	24,942	1,321	5,592	428	6,083	480	802	34
Weighted to Population	2,383,860	4,916,557	578,286	1,599,575	668,606	1,789,568	83,897	159,074
Average Electric Consumption	7,257	7,268	4,565	4,475	3,810	3,880	6,632	6,775
Average Gas Consumption	438	439	270	257	180	208	337	410
Average Dwelling Size	1,968	1,848	1,228	1,212	969	942	1,295	1,316
Average Dwelling Age	47	47	45	42	41	39	38	40
Average Number of People	2.8	3.2	2.4	2.8	2.2	2.5	2.2	2.4
Average Number of Seniors	0.51	0.35	0.39	0.21	0.36	0.21	0.64	0.38
Average Income	118,723	116,664	89,255	85,259	76,982	74,091	45,181	38,704
Owners	89%	82%	49%	39%	28%	16%	87%	82%
Central Cooling	59%	61%	40%	38%	33%	33%	54%	36%
Gas Space Heating	75%	74%	61%	53%	37%	35%	58%	52%
Primary Language English	82%	81%	76%	68%	73%	74%	85%	89%
Head of Household Latino	16%	26%	20%	34%	19%	28%	18%	30%
College Grad or Higher	59%	58%	54%	50%	53%	47%	27%	22%

Source: 2019 California Residential Appliance Saturation Survey

Electric Load Profiles

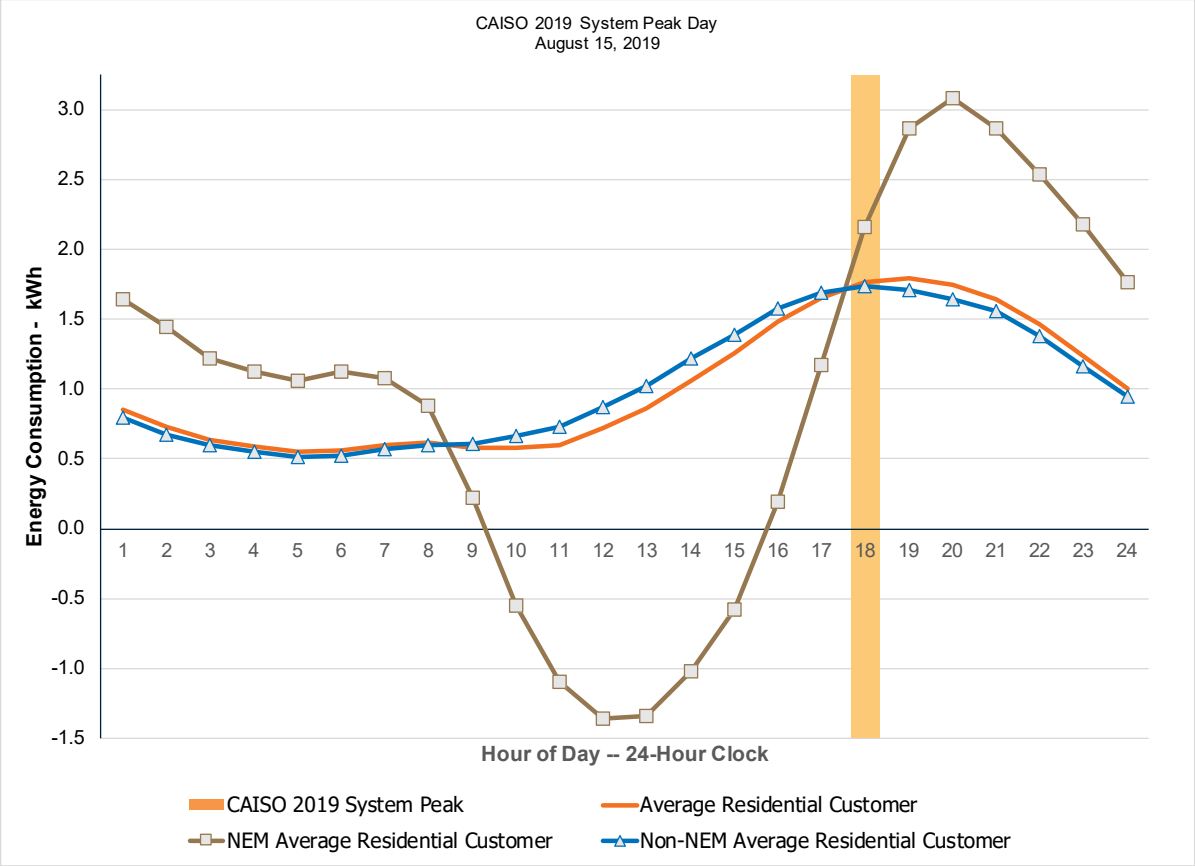
Load profiles are estimates of customers' electric usage at the hour level. Four utilities provided electric interval data for the *2019 RASS*: PG&E, SCE, SDG&E, and SMUD. The load profiling sample size for these four utilities combined is roughly 27,800 households (actual sample sizes vary from day-to-day), which represents about 11 million residential customers.

The linear graphs in this section illustrate energy use on the day of the 2019 California Independent System Operator (California ISO) system peak (August 15, 2019, a Thursday).

While utilities do not necessarily peak on the same day or at the same time as the California ISO, this day of the year is when the state's infrastructure and energy resources are most strained due to high energy use. In these graphs, the orange line represents average residential energy use from the grid, the vertical band highlights the peak hour, and these are the same from one graph to the next. The hours of the day are presented in the 24-hour clock format.

Figure 46 illustrates the difference in energy consumption from the grid between net-metered (brown line with the squares) and non-net-metered (blue line with the triangles) residential customers on the day of the California ISO system peak. The orange line represents the average of all residential customers.

Figure 46: Net-Metered and Non-Net-Metered Electric Load Profiles (August 15, 2019)



Source: 2019 California Residential Appliance Saturation Survey

Earlier in the day, from midnight to about 8 in the morning, *Net-Energy Metering* (*NEM*) customers have higher energy use than average residential customers. This finding indicates that on average, NEM customers use more energy (perhaps from larger houses, EVs, electric water heaters, swimming pools, and so forth), but a substantial portion of this energy is produced onsite rather than provided by the grid. At around 9 in the morning, solar production starts to ramp up, resulting in a pronounced drop in energy use from the grid. In **Figure 46**, negative values represent exports to the grid from NEM households. These exports are maximized at noon, when NEM households exported an average of 1.4 kWh to the grid. As solar production declines later in the day and energy use increases for **all** households (kids

return from school, air conditioning is turned on), NEM households' electric use from the grid increases and returns to a higher level of energy use than non-NEM households. About 6 p.m. (Hour 18 in **Figure 46**), the time of the California ISO system peak, the grid energy use of NEM households is, on average, 0.4 kWh higher than for the non-NEM counterparts. This difference is greatest at 8 p.m. (Hour 20 in **Figure 46**),when NEM households have an average use of 3.1 kWh per household, compared to 1.6 kWh per non-NEM household.

DNV GL estimated that NEM households used an average of 22.6 kWh of energy from the grid on August 15, 2019, compared to an average of 24.7 kWh for non-NEM households. While the total energy use of NEM households is larger, their energy use from the grid is, on average, lower than that of non-NEM households.

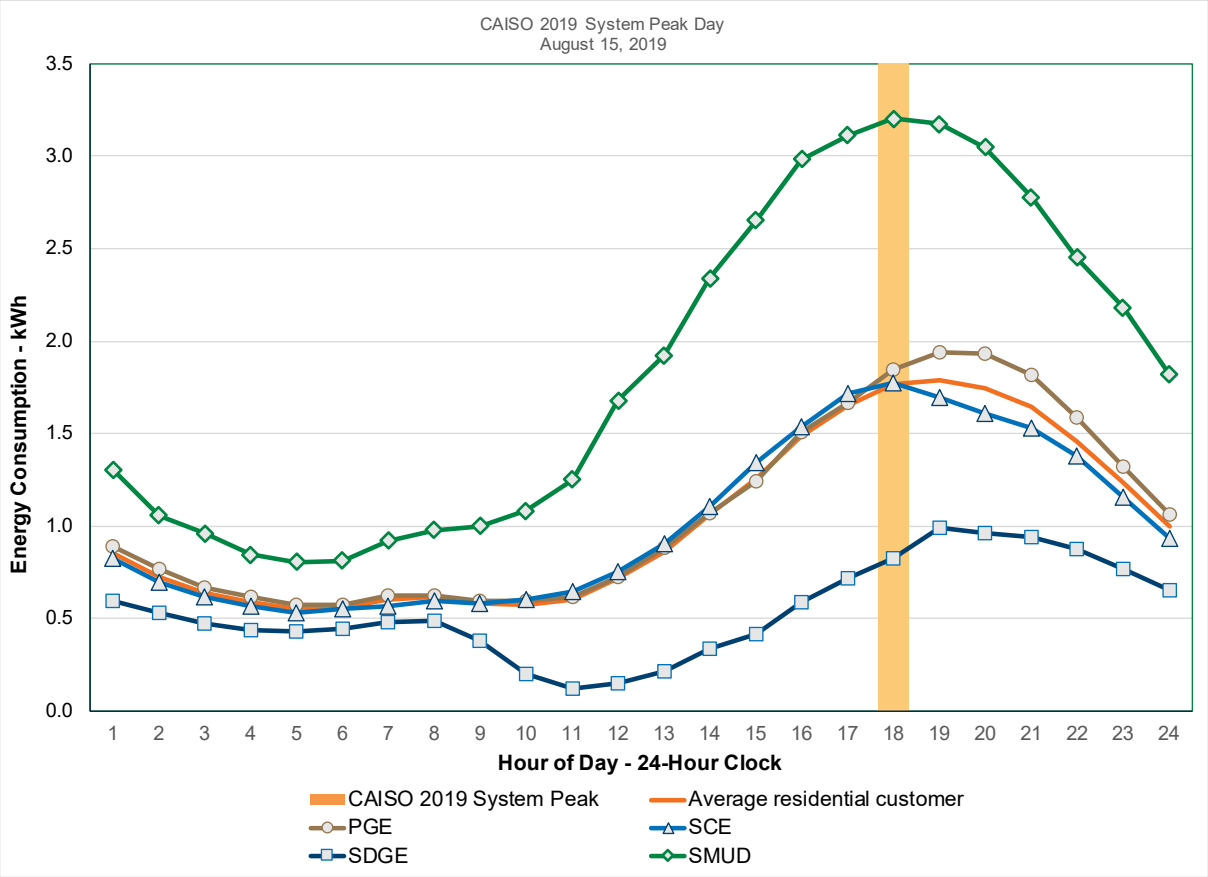
Figure 47 illustrates the difference, in average energy consumption, from the grid between households for each of the four electric utilities that provided hourly electric consumption data for the RASS study. The orange line represents the average profile of all households.

PG&E and SCE's load profiles are similar. These two utilities are the largest in the state and account for 83 percent of the customers represented in the overall average profile. As such, they drive this average.

SDG&E's load profile clearly shows the effect of the highest solar penetration of the four utilities represented in these load profiles. SDG&E accounts for 12 percent of the customers represented in the overall average profile.

SMUD's load profile shows that, on average, SMUD customers have higher energy use from the grid than the other three utilities. SMUD accounts for 5 percent of the customers represented in the overall average profile.

Figure 47: Electric Load Profiles by Utility (August 15, 2019)



Source: 2019 California Residential Appliance Saturation Survey

Gas Daily Use

Unlike electricity, for which hourly analysis is common, gas use is often tracked and analyzed at the daily level. This level of tracking is appropriate because gas does not experience extreme hourly price changes the way electricity does, and because in many instances, gas meters are set to record intervals that are defined by volume and not by time.

Analogous to electricity, gas does have peak days. While in California electricity peak use is driven by hot weather in most areas, gas experiences winter peaks driven by cold weather and summer peaks driven by hot weather that translate into increased gas demand for electric generation. For this section, the research team used the daily estimates produced by the gas RASS analysis to select the week of February 18–24, 2019, as the cold-driven average peak gas use in the study period.

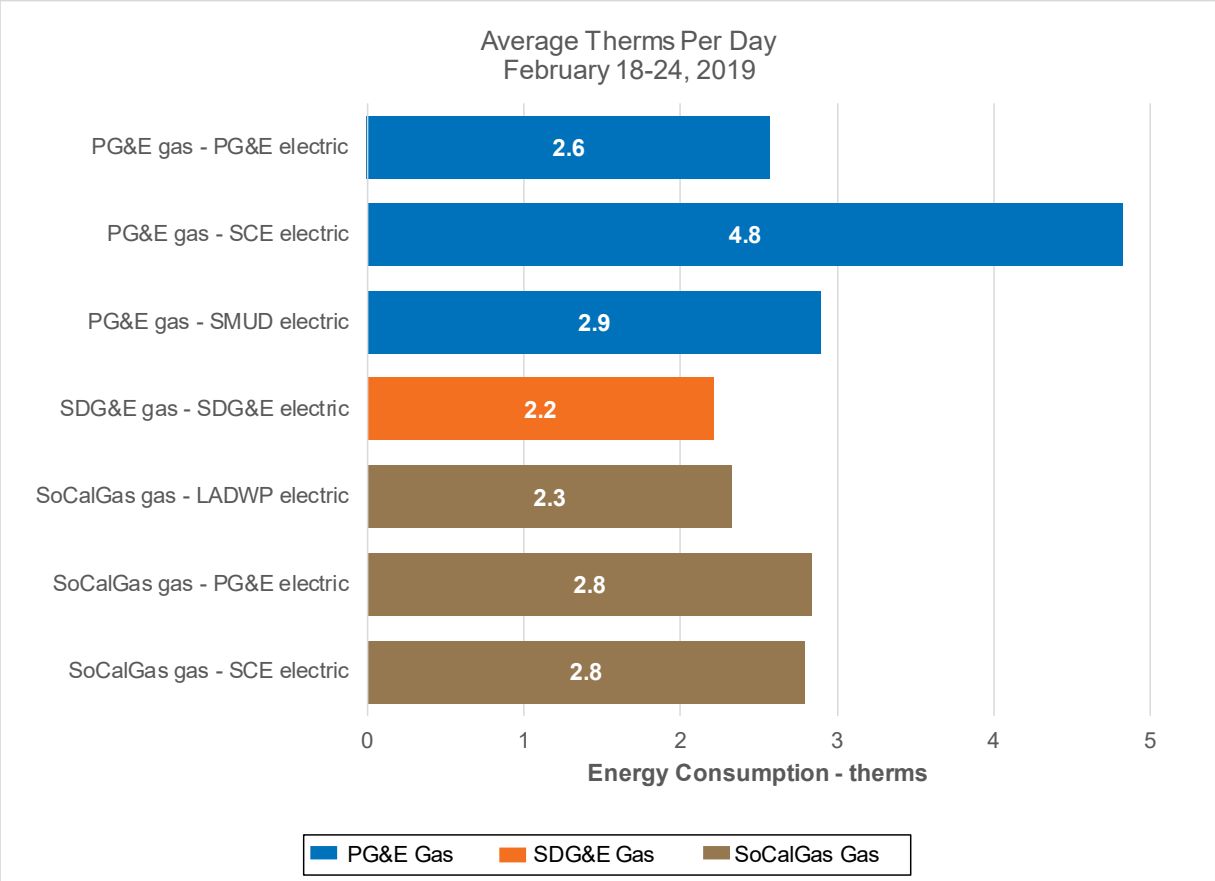
Three utilities provided gas interval data for the *2019 RASS*: PG&E, SDG&E, and SoCalGas. The gas daily use sample size for these three utilities combined is nearly 24,600 households (actual sample sizes vary from day to day), representing about 10 million homes in the five electric service territories included in the RASS.

Figure 48 shows the average daily therms used the week of February 18–24 for the combinations of gas and electric utilities represented in the RASS. SDG&E (gas and electric) and the combination of SoCalGas with LADWP electric have the lowest use (2.2 therms per

day and 2.3 therms per day, respectively). The highest average gas use is for the combination of PG&E gas with SCE electric (4.8 therms per day).

Cold weather drives gas use, which is why it is expected that households in milder weather use less gas. During the peak week, the average SDG&E gas customer used 76 percent of the gas used by the average household that has PG&E gas with SMUD electric and less than half of the average household that has PG&E gas with SCE electric.

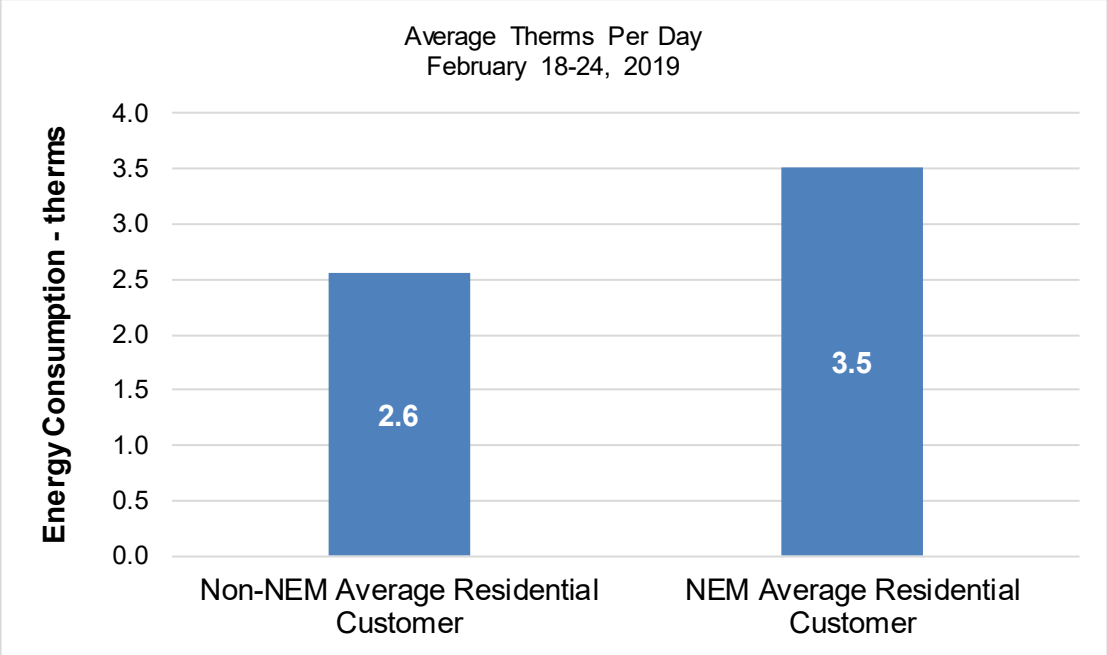
Figure 48: Peak Week Average Daily Gas Use by Combinations of Gas and Electric Utility (February 18-24, 2019)



Source: 2019 California Residential Appliance Saturation Survey

Figure 49 illustrates the difference in gas use among NEM and non-NEM households. While gas use does not directly depend on electricity use, there is a strong correlation between the use of both fuels. Electric interval data show that net-metered households use more electricity than their non-net-metered counterparts. This usage pattern is true of gas too. NEM households used 37 percent more gas this peak week than the average non-NEM household.

Figure 49: Peak Week Average Daily Gas Use for NEM and Non-NEM Customers (February 18-24, 2019)



Source: 2019 California Residential Appliance Saturation Survey

LIST OF ACRONYMNS AND RELATED DEFINITIONS

Acronym	Definition
AC	Air conditioning — cooling system to control the humidity, ventilation, and temperature in a building.
ACS	American Community Survey — a survey conducted by the U.S. Census Bureau.
AMI	Advanced metering infrastructure — an integrated system of smart meters and other equipment that support two-way communication between the utility and the customer. Smart meters can record energy usage in short intervals throughout the day.
CAC	Central air conditioning — a system where air is cooled at a central location and distributed to and from rooms by one or more fans and ductwork.
California ISO	California Independent System Operator — entity that oversees the operation of California's bulk electric power system, transmission lines, and electricity market generated and transmitted by its member utilities in California.
CARE	California Alternative Rates for Energy — is a program that provides discounts on electric and natural gas bills to low-income households.
CDA	Conditional demand analysis — a statistical technique that combines utility consumption data with weather information and household survey data to produce energy consumption estimates by end use or equipment.
CDD	Cooling degree days — are a measure of how much (in degrees) and for how long (in days) the air temperature was above a certain reference temperature (for example, 65°F). CDD are used in calculations of energy consumption for cooling a building.
CEC	California Energy Commission — established in 1975 and based in Sacramento, the CEC is primary energy policy and planning agency for California. It is committed to reducing energy costs, curtailing greenhouse gas emissions, and ensuring a safe, resilient, and reliable supply of energy.
CFL	Compact fluorescent lamp — a fluorescent bulb designed to fit into a standard household light fixture. CFLs use less energy than the predecessors, incandescent bulbs.
DDN	Degree-day normalization — statistical method of estimating annual energy consumption for normal weather conditions.

Acronym	Definition
DEER	Database for Energy Efficient Resources — database that provides information on the incremental energy savings associated with installing energy-efficient measures or equipment compared to what equipment is commonly installed.
DLP	Digital light processing — the use of micromirrors to reflect light and color onto a screen. These micromirrors are positioned in a semiconductor chip and are very small.
DVR	Digital video recorder — a consumer electronics device designed for recording video in a digital format within a mass storage device such as USB flash drive, hard disk drive, or any other storage device.
End Use	A category of equipment or appliance that uses energy and provides a benefit or a service to the user (for example, space heating, space cooling, and refrigerators).
EV	Electric vehicle — a vehicle, often an automobile, that uses one or more electric motors to create movement.
F	Fahrenheit — a temperature scale based on 32 degrees for the freezing point of water and 212 degrees for the boiling point of water.
FCZ	Forecasting climate zones — geographic areas defined by the CEC to assist energy forecasting and planning and sometimes are also called electricity demand forecast zones. The FCZs are specific to electricity providers.
FERA	Family Electric Rate Assistance Program —– provides discounts on energy bills to income qualified households. FERA income allowances are slightly higher than CARE allowances.
HDD	Heating degree days — are a measure of how much (in degrees) and for how long (in days) the air temperature was below a certain reference temperature (for example, 65°F). HDD are used in calculations of energy consumption for heating a building.
IOU	investor-owned utilities — private electricity and natural gas providers whose stock is publicly traded. IOU energy rates are regulated, usually by the state's utility commission.
LADWP	Los Angeles Department of Water and Power — a publicly owned electric and water utility serving residential and commercial customers in Los Angeles and surrounding communities.
LCD	Liquid crystal display — a type of electrically generated image shown on a thin, flat panel. LCD screens are found in consumer electronics like laptops, tablets, and smartphones.

Acronym	Definition
LED	Light-emitting diode — an electronic device that glows when a voltage is applied. Energy-saving LED bulbs are often used instead of CFLs or other light fixtures.
NAC	Normalized annual consumption — an estimate of yearly energy consumption that has variations in weather effects removed.
NEM	Net-Energy Metering — billing mechanism that allows customers to generate energy onsite to meet their energy needs and receive a financial benefit for any excess energy sent to their utility.
OLED	Organic light-emitting display — a display technology based on the use of an organic substance to produce light. OLED screens are found in consumer electronics like TVs, smartphones, tablets, and watches.
PC	Personal computer — a multipurpose computer whose size, capabilities, and price make it feasible for individual use.
PG&E	Pacific Gas and Electric Company — an investor-owned electric and natural gas utility serving residential and commercial customers in Northern and Central California.
POU	Publicly owned utility — are publicly-run electric and natural gas providers. POUs include government-run (federal, state, or municipal) and public utility districts that operate independently of city or county government. Unlike IOUs, publicly owned utilities do not issue stock or have shareholders.
PV	Photovoltaic — PV devices, like those found in solar power panels, generate electricity directly from sunlight via an electronic process that occurs naturally in certain types of materials.
RAC	Room air conditioning — cooling provided to rooms rather than the entire home or business.
RASS	Residential Appliance Saturation Study — a comprehensive survey of California residents to collect information about characteristics of their homes, their appliances and heating and cooling equipment, use of solar or electric vehicles, and general energy use.
SAE	Statistically adjusted engineering — a method of analyzing energy savings that uses statistical modeling and engineering estimates of energy savings.
SAS	Statistical analysis system — a software suite that can manipulate, manage, and retrieve data from a variety of sources and perform statistical analysis on it.

Acronym	Definition
SCE	Southern California Edison Company — an investor-owned electric utility serving residential and commercial customers in Southern California.
SDG&E or SDGE	San Diego Gas & Electric Company — an investor-owned electric and natural gas utility serving residential and commercial customers in San Diego and surrounding areas.
SMUD	Sacramento Municipal Utility District — a community-owned electric utility serving Sacramento County and parts of Placer County.
SoCalGas	Southern California Gas Company — an investor-owned natural gas utility based in Los Angeles serving residential and commercial customers. SoCalGas is a subsidiary of Sempra Energy, based in San Diego.
T24	Title 24 — California building standards code, a set of standards for new construction and existing buildings.
UEC	Unit energy consumption — the amount of energy a single appliance is estimated to use in a year.
USPS	United States Postal Service
VEE	Validation, editing, and estimation — processing information to assess the quality, edit information, and estimate missing values.