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CHARACTERISTICS OF RANGE HOODS IN CALIFORNIA HOMES – DATA COLLECTED FROM A REAL ESTATE WEB SITE

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September 2011

Disclaimer

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Funding was provided by the U.S. Department of Energy under Contract No. DE-AC02-05CH11231 and by the California Energy Commission through Contracts 500-08-061 and 500-05-026.

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ABSTRACT

Venting range hoods are important residential ventilation components that remove pollutants generated by cooking activities and natural gas cooking burners. To address the lack of data on range hood installations in California, we conducted a survey by examining photographs of homes for sale or rent listed on a popular real estate web site. The survey was conducted in November 2010 and April–May 2011. Posted photos of the homes were reviewed to determine if a hood was installed, the type of hood, and two installation details that can impact performance, namely the height above the cooktop and the degree to which the hood covers the cooktop burners. We additionally collected information about the homes, including asking price for purchase or rent, type of building (e.g. detached house, townhouse or apartment), building age, floor area, and cooktop fuel type. Listings were first sampled to focus on homes built since 2005, then randomly sampled to include varied prices and locations around the state. Data were obtained for 1002 homes built between 1865 and 2011 (median year built 1989). Homes for sale varied in asking price from $16,000 to $16,500,000 (median $353,000) and homes for rent varied from $500 to $25,000 (median $2125) per month. Approximately 74% of the sample had natural gas cooktops. In this sample, natural gas cooktops were more prevalent in more expensive homes than in less expensive homes. Across the entire sample, 7.4 % appeared to have no hood installed, 33% had a short hood, 13% had a deep hood and 47% had a microwave over the range. The percentage of these hoods that vent to the outdoors could not be determined. Hood type was related to coverage of the cooktop. For deep hoods, 76% appeared to cover most or all of the cooktop burners. For short hoods, 70% covered about three quarters of the cooktop. And for microwaves the vast majority (96%) covered the back burners but not the front burners. Hood type was also correlated with asking price or monthly rent, with deep hoods most common in the most expensive homes. Hood type was also correlated with home age, with microwave hoods more common in newer homes. Installation height was related to device type with microwaves installed lower (closer) to the cooktop (median 18 inches), and short hoods (median 28 inches) and deep hoods (median 30 inches) installed higher. Deep range hoods are more common with natural gas cooktops than with electric cooktops, and slightly fewer homes with natural gas cooktops lack a range hood (7%) than homes with electric cooktops (9%). This study provides limited but useful information about the characteristics of range hoods in California homes and demonstrates the potential value of non-traditional forms of data collection.

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IMPLICATIONS

There is a need to understand more about the potential exposures of households to cooking-generated pollutants that result from both the cooking of the food as well as the combustion from gas-fired cook stoves. The determining factors for human exposure include the type of cook stove, the duration of the cooking, the food cooked, as well as the type, location, size and use of the range hood used for ventilation. This study provides new information on the type of range hoods found in California homes. Because we could not collect information on either the type of venting from the hood (whether air is recirculated or vented to the outdoors) or the usage by the occupants, the results are limited to the characteristics related to the morphology and location of the vent hoods. This information can be used in simulation-based assessments to estimate the range of potential pollutant exposures from cook stoves in California. Since performance varies widely by basic equipment design (short, deep, and microwave hoods) and coverage, data on how these characteristics prevail across the housing stock will enable a more reality-based simulation of residual exposures to cooking related when hoods are used.

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INTRODUCTION

Removal of pollutants generated by cooking and, when present, natural gas fueled cooking burners is important to maintaining good indoor air quality in residences. Range hoods can effectively remove these pollutants at the source, before they mix into the home and degrade air quality. The potential effectiveness of range hoods can be characterized by the efficiency with which they capture pollutants emitted at the cooktop or in the oven. LBNL research has shown that capture efficiency depends on the airflow rate, on the physical geometry of the hood, and the degree to which the hood covers the burners (Singer et al. 2011a, 2011b). Since heated plumes entrain air as they rise, the height of the hood above the cooktop can also be important to capture efficiency. To our knowledge there is currently no reliable information about the prevalence and characteristics of range hoods in existing residences in California or throughout the U.S.

The objective of the study described in this report was to collect information about range hood prevalence and characteristics in California. With the limitations of a minimal budget, we sought to develop and implement a method that could advance our knowledge about cooking exhaust hoods and how they varied across California housing stock. A secondary goal was to explore a novel data collection approach that uses an existing online (web-based) database of information about the housing stock; the resource is a real-estate site listing homes for sale or rent.

METHODS

We obtained information from the real estate website www.Zillow.com. The website has listings for both homes for sale and homes for rent and allows for filtering by various parameters, including location, price, home type, and whether the home is for rent or for sale. The site also allows sorting by various parameters including price, year built, and the number of days the home has been listed on the website. The website provides a variety of information about the homes and many but not all home listings include photographs of the exterior and interior of the home. The key element of our data collection effort was to inspect available photographs to determine if a hood was present, the basic type (morphology) of hood, installation height, coverage of the cooktop and the type of cooktop (gas or electric). We also recorded information about the home that may be useful in predicting range hood prevalence and characteristics across the wider population.

The following method was used when acquiring data. We used the website's filtering function to limit searches to California. At the website's homepage, "Homes for Sale" was selected under the "Homes" category. Under the "Home Type" category, we selected "Single Family," "Condo/Apartment," Multi Family," and "Manufactured"; this excluded lots and foreclosures. In November 2010, we focused data collection on homes for sale that were built during or after 2005. We additionally focused on homes located in one of the thirteen highest-population Californian counties (Los Angeles, Orange, San Diego, Riverside, Santa Clara, Alameda, Sacramento, Contra Costa, Fresno, Ventura, Kern, San Francisco, and San Mateo) and specific price ranges of $100,000-$399,000, $400,000-$699,000, and $700,000-$999,000. We collected data for each county and price range combination in proportion to the number of homes listed for sale; to accomplish this we collected data for the number listed in each bin divided by 100. The option of "Days on Zillow" was chosen from the sort menu; this displayed the homes in the order of days they had been listed on the website instead of ascending/descending price or age of home and ensured that data from homes within the entire range of prices within each bin would be

recorded. This resulted in the collection of data for 124 homes, as indicated in Table 1. On April 22 and 23, 2011, we repeated this data collection approach. After data were collected for the target number of homes built during or after 2005 within each price range, we expanded our search to include all homes for sale in the highest-population Californian counties, with no stipulation on age or price. We divided the number of listings for each county by 1000 to set the sample size for each county. This method was followed on April 25 and 26, 2011 and again on April 28 and 29. During the latter two-day period, the added stipulation of selecting homes that had been listed for 2 days or less on the website was used to avoid recording data about homes twice. On May 18, 2011, we recorded data for homes for rent; data were recorded for 100 homes for rent with no stipulation on age, monthly rent, or location in California. Again, the option of "Days on Zillow" was chosen on the sort menu to ensure that houses from a range of prices would be included. After recording rental data, we returned to recording data about homes for sale, with no stipulation on age, monthly rent, or location in California. The intent of our data collection method was to obtain a broad range of homes for sale or rent in California.

Table 1. Data collection by date.

Date	Count
11/11/10	124
4/22/11	75
4/23/11	37
4/25/11	53
4/26/11	72
4/28/11	53
4/29/11	71
5/18/11	100
5/19/11	118
5/20/11	8
5/21/11	133
5/24/11	150
5/25/11	8
Total	1002

In each case, after scoping and sorting as noted above, we scanned listings for those containing larger numbers of photos (e.g. 5 or more), and scanned the thumbnails to see if there were suitable photos of the kitchen area that showed the cooktop and range hood with enough clarity and the right orientation to determine the installation parameters of interest. After we ascertained that the hood and cooktop information could be discerned, we recorded other info about the home. The full list of parameters collected is provided in Table 2.

Table 2. Data collected for all homes.

Parameters
Data Source[1]
Date
County
City
Zip Code
Year Built
Type[2]
Size (square feet)
Home Cost or Monthly Rent
Cooktop Fuel
Cooktop or Range
Wall or Island
Hood Location[3]
Hood Type[4]
Height (inches)
Coverage Percent[5]

[1] Zillow.com for all
[2] Options were: single family detached (sfd), single family attached (sfa), highrise (high), multifamily lowrise (mfl), manufactured/mobile (man)
[3] Options were: under cabinet, wall, island, downdraft, none
[4] Options were: microwave, short hood, deep hood, none
[5] Options were: 0, 50, 75, 100

Range hoods were characterized by morphology, as “short”, “deep” or “microwave”. The first two groupings broadly separate between those hoods with a small or no capture volume and those with a larger volume to capture the air rising from the cooking appliance. These two distinctions apply primarily to the height of the hood as it is relevant to hood volume. Also, deep hoods generally project farther out from the wall and are thus deeper in that respect as well. Limited experimental evidence reinforces the physical expectation that deep hoods with larger capture volumes have higher capture efficiencies. The degree of coverage was characterized as 50, 75, or 100 percent, based on the fraction of the four burners covered by the hood. The height above the cooktop was estimated by the researcher who reviewed the photos, using visual cues such as the height of cabinets, the width of the hood (almost always 30”), nearby refrigerators, and other nearby items. The same researcher reviewed all photos.

Checking Estimates by Reviewing Photos with Measured Height and Coverage

We checked the accuracy of the photograph-based estimation of hood height and coverage as follows. A researcher not directly involved in the review of photographs posted on the web site took photographs and measured the installation height and coverage percent of hoods in 23 homes. These photographs were posted on a photo-sharing website and the researcher revising photos for data collection was asked to record the hood installation data from the photographs as was done from the real estate website. This assessment was done without knowledge of the measurement results. The calibration photographs were of a similar quality to those on the real estate website and were taken as though they meant to display the entire kitchen to a prospective buyer or renter, not the range hood exclusively. The calibration photographs are provided in Appendix B. The reviewing researcher was allowed to dismiss any photographs that would have been deemed inacceptable for data collection due to an inability to properly estimate the height and coverage of the range hood or discern the characteristics of the cooktop or hood such as

cooktop fuel type or range hood type. By comparing their estimates to the measured data, we were able to assess accuracy of coverage percent and height estimates from the primary data collection approach.

Table 3 shows the comparison between the measured coverage percent and coverage percent estimated from photos. Three homes were omitted because their photos were deemed unacceptable for data collection because of the difficulty in estimating coverage percent of the range hood; homes with photos in which it is difficult to discern the range hood coverage percent would not have been chosen for data collection. Coverage percent estimates were shown to be very accurate; in only one of the 20 homes assessed for coverage percent did the estimated coverage percent differ from the actual coverage percent.

Table 3. Estimated range hood coverage percent compared to measured range hood coverage percent.
Note: Houses 8, 15 and 23 were deemed unacceptable for data collection because of the difficulty in estimating the coverage percent of the range hood.

House Number	Hood Type	Measured Coverage Percent	Estimated Coverage Percent
1	Deep	100	100
2	Short	100	75
3	Short	75	75
4	Microwave	50	50
5	Microwave	50	50
6	Short	75	75
7	Microwave	50	50
9	Short	50	50
10	Short	100	100
11	Short	75	75
12	Microwave	50	50
13	Short	75	75
14	Microwave	50	50
16	Short	50	50
17	Microwave	50	50
18	Short	75	75
19	Short	75	75
20	Microwave	50	50
21	Short	75	75
22	Microwave	50	50

Table 4 shows the comparison between the measured installation height and installation height estimated from photos for the twenty-three homes used for calibration. One photograph was deemed unacceptable for data collection by the researcher reviewing the photos because the installation height could not be estimated. The estimates for installation height tended to be lower than the actual measured height; the average difference between the estimate and the actual height for the 22 homes assessed was approximately 2.25 inches. The accuracy of estimates did vary slightly depending on range hood type; the average difference between measured height and estimated height for the 8 microwave hoods included in the calibration was

2.16 inches, for the 3 deep hoods included in the calibration the was 3.17 inches, and for the 11 short hoods included in the calibration was 2.09 inches.

Table 4. Estimated range hood installation height compared to installation height measured in person.
House 15 was omitted from the calculation of average difference because its photo was deemed unacceptable for data collection based on the height estimate.

House Number	Hood Type	Measured Height (in.)	Estimated Height (in.)	Difference (in.)
1	Deep	28	24	-4
2	Short	23	22	-1
3	Short	27	24	-3
4	Microwave	15.75	16	0.25
5	Microwave	16.5	14	-2.5
6	Short	18.5	16	-2.5
7	Microwave	20	16	-4
8	Deep	32	30	-2
9	Short	27	22	-5
10	Short	18.5	22	3.5
11	Short	29	28	-1
12	Microwave	17.5	14	-3.5
13	Short	22	20	-2
14	Microwave	19.5	16	-3.5
16	Short	26.5	22	-4.5
17	Microwave	13	14	1
18	Short	23	22	-1
19	Short	27.5	26	-1.5
20	Microwave	18	16	-2
21	Short	29	24	-5
22	Microwave	19	16	-3
23	Deep	27.5	24	-3.5
			Average Difference	-2.3

RESULTS AND DISCUSSION

Data were collected from 1002 homes throughout California. Of the 1002 homes, 902 were homes for sale and 100 were homes for rent. When comparing range hood characteristics to the year the home was built or home cost or rent, the data were divided into bins for year built and for cost/rent in order to display relationships in a more clear and concise manner.

Home Demographics

Table 5 through Table 10 show the statistics for important housing characteristics from the collected data: home type, year built, home cost, and home monthly rent.

Table 5 displays the number of homes from each home building type. Homes in multifamily buildings are individual units, not entire buildings.

Table 5. Home building type.

Home Building Type	Count
Single Family Detached	699
Multifamily Lowrise	173
Single Family Attached/Townhouse	99
Multifamily Highrise	20
Manufactured/Mobile	11
Total	1002

Table 6. Home year built (range).

Year Built Range	Count
Before 1950	82
1950-1979	281
1980-1994	195
1995-2005	233
2006-2011	211
Total	1002

Table 7 and Table 8 show how home year built varies with home building type. Data is divided into two separate tables in order to show differences in home year built and home building type depending on whether the home is for sale or for rent.

Table 7. Home building type by year built range—homes for sale.

Year Built Range	Single Family Detached	Multifamily Lowrise	Single Family Attached	Multifamily Highrise	Manufactured/ Mobile	Total
Before 1950	67	7	6	0	0	80
1950-1979	203	23	16	0	2	244
1980-1994	104	30	19	0	5	158
1995-2005	180	19	15	1	2	217
2006-2011	145	12	36	8	2	203
Total	699	91	92	9	11	902

Table 8. Home building type by year built range—homes for rent.

Year Built Range	Single Family Detached	Multifamily Lowrise	Single Family Attached	Multifamily Highrise	Manufactured/ Mobile	Total
Before 1950	0	0	0	2	0	2
1950-1979	0	35	0	2	0	37
1980-1994	0	30	3	4	0	37
1995-2005	0	12	2	2	0	16
2006-2011	0	5	2	1	0	8
Total	0	82	7	11	0	100

Table 9. Home cost range.

Home Cost Range	Count
Less than $100,000	34
$100,000-$199,000	169
$200,000-$299,000	159
$300,000-$399,000	141
$400,000-$599,000	177
$600,000-$799,000	76
$800,000-$1,000,000	76
More than $1,000,000	70
Total	902

Table 10. Monthly rent range.

Monthly Rent Range	Count
Less than $1000	6
$1000-$1999	40
$2000-$2999	25
$3000-$5000	17
More than $5000	12
Total	100

Table 11 shows the distribution of home cost by home year built. This provides context for later analysis of range hood type by home cost and home year built.

Table 11. Mean, standard deviation, and median of home cost by home year built.

Year Built Range	Mean ($1000s)	Median ($1000s)
Before 1950	829	677
1950-1979	540	395
1980-1994	406	305
1995-2005	616	335
2006-2011	475	325

Cooktop Fuel Type by Home Characteristics

This section shows how cooktop fuel type varies by various home characteristics and sets the context for analysis of range hood type by home characteristics. Our data can be compared to data from the California Energy Commission's 2009 Residential Appliance Saturation Survey (RASS) for some analyses. The RASS asks several cooking-related and demographic questions similar to the data gathered in our study and thus allows for comparison between our data and a more representative survey. RASS percentages calculated are based on the non-weighted sample data from the 2009 RASS.

Figure 1 shows variance in cooktop fuel type by the year the home was built. Natural gas cooktops are shown to be more common than electric cooktops in all year built ranges, but the fraction of electric cooktops/stoves was higher (approximately 40%) prior to 1979 than in homes built in later years. The increase in natural gas cooktops after 1979 may be at least partially

attributable to the California Code of Regulations Title 24, which updated energy efficiency standards for residential and nonresidential homes.

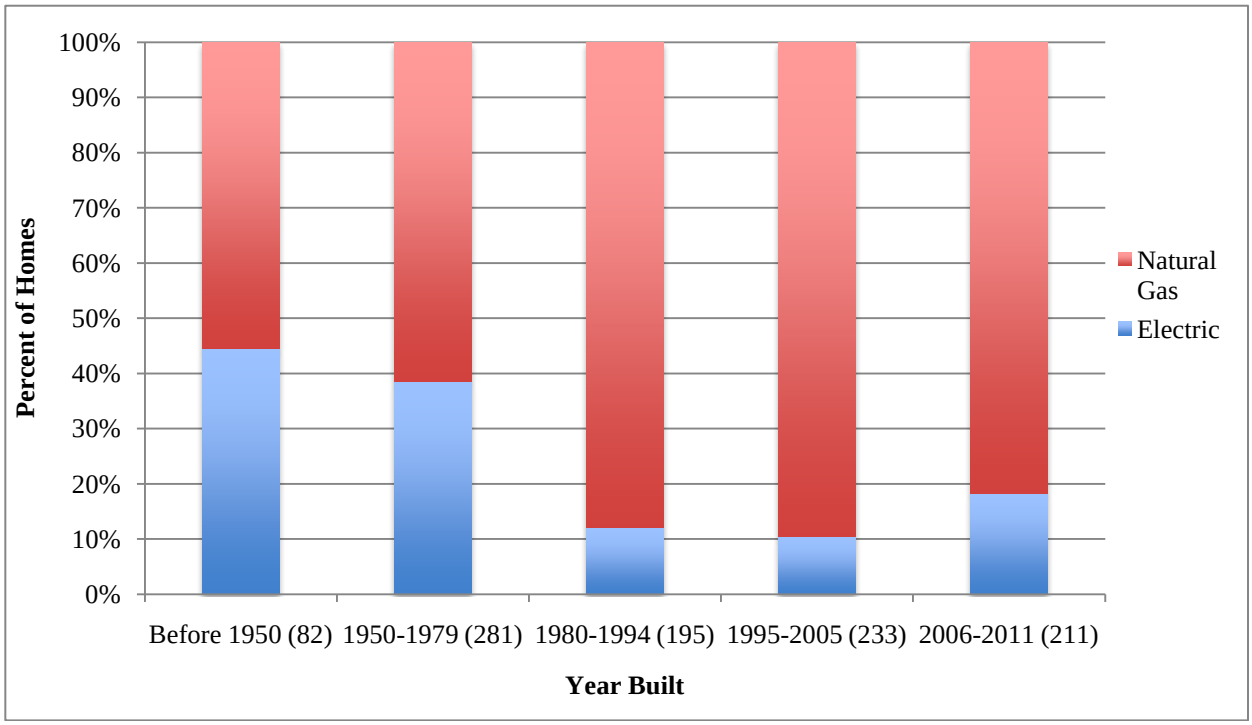

Figure 1. Cooktop fuel type by home year built.
Number of homes in each set of stacked columns shown in parentheses.

Table 12 is provided to show how data collected in this study compares to the raw data collected in the 2009 RASS data for cooktop fuel type by home year built. To aid comparison, we have in this table divided our data into the same bins used in RASS.

Table 12. Cooktop fuel type by home year built compared to the 2009 RASS.

	Zillow		RASS 2009		
Year Built	**Electric**	**Natural Gas**	**Electric**	**Natural Gas**	**Other**
Before 1975	33.2%	66.8%	32.5%	65.5%	2.0%
1975-1977	65.5%	34.5%	44.9%	50.6%	4.5%
1978-1982	54.5%	45.5%	48.1%	48.0%	3.9%
1983-1992	37.3%	62.7%	40.9%	55.8%	3.2%
1993-1997	11.1%	88.9%	24.5%	67.1%	8.4%
1998-2000	25.6%	74.4%	21.3%	73.3%	5.4%
2001-2008	9.5%	90.5%	18.4%	74.7%	6.9%
2009-2011	17.4%	82.6%	--	--	--

Figure 2 displays how the percent of homes with each cooktop fuel varies with home cost. As home cost increases, a higher percent of homes have natural gas cooktops.

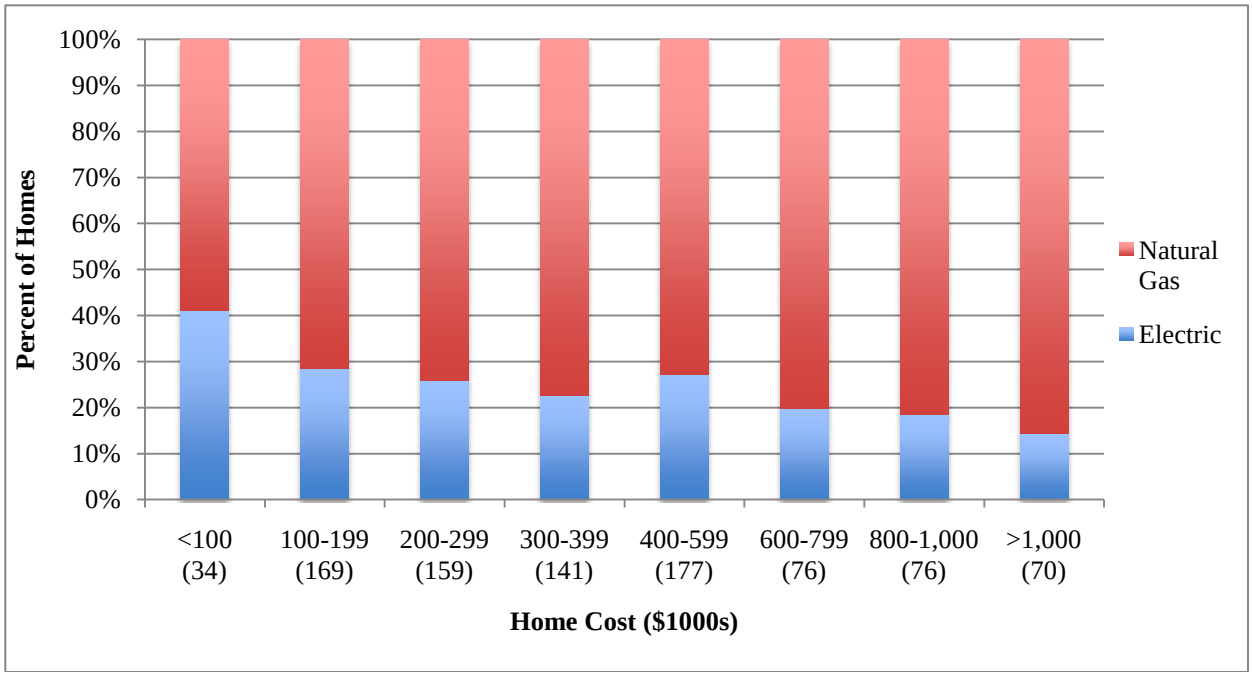

Figure 2. Cooktop fuel type by home cost.

Number of homes in each set of stacked columns shown in parentheses.

Figure 3 shows that as the floor area of the house increases the fraction of homes with natural gas cooktops also increases. This is similar to the increase in natural gas cooktops with home cost.

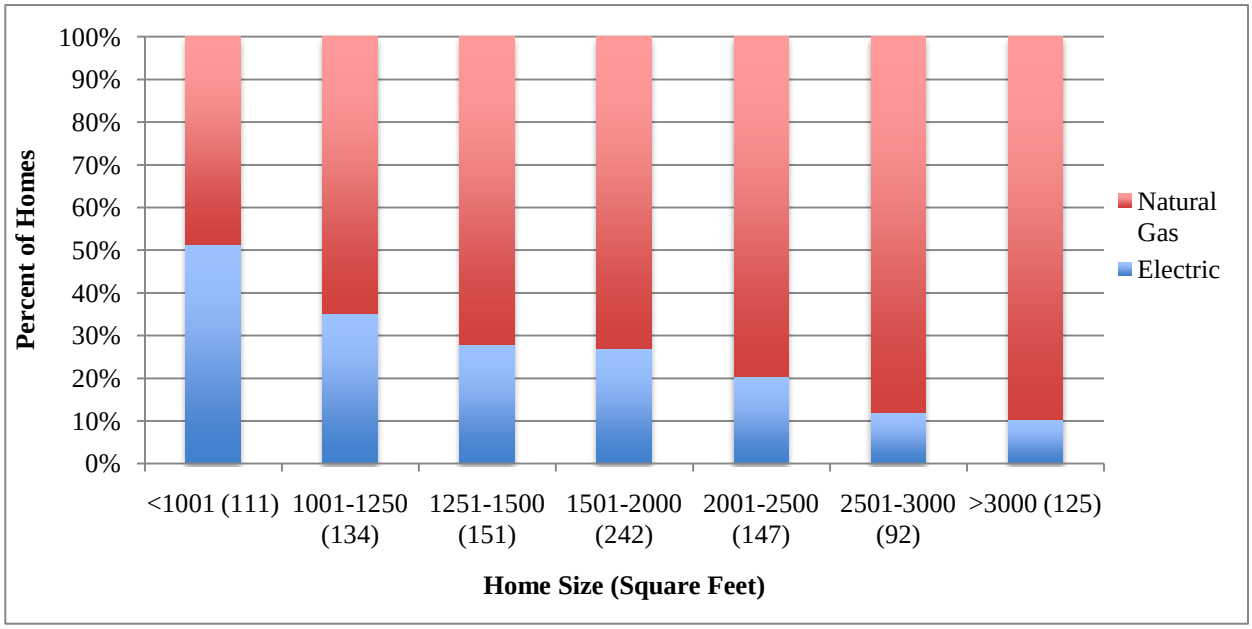

Figure 3. Cooktop fuel type by home size.

Number of homes in each set of stacked columns shown in parentheses.

Table 13 is provided to allow comparison between data gathered in this study and RASS data for cooktop fuel type by home size.

Table 13. Cooktop fuel type by home size compared to the 2009 RASS.

	Zillow Data		RASS 2009		
Listed floor area (ft^2)	**Electric**	**Natural Gas**	**Electric**	**Natural Gas**	**Other**
<1001	51.4%	48.6%	41.9%	56.3%	1.8%
1001-1250	35.1%	64.9%	35.2%	61.7%	3.1%
1251-1500	27.8%	72.2%	33.4%	63.9%	2.7%
1501-2000	26.9%	73.1%	31.4%	64.7%	3.9%
2001-2500	20.4%	79.6%	29.1%	66.2%	4.7%
2501-3000	12.0%	88.0%	28.4%	65.0%	6.6%
>3000	10.4%	89.6%	21.0%	73.1%	5.9%

Figure 4 shows how cooktop fuel type varies by home building type.

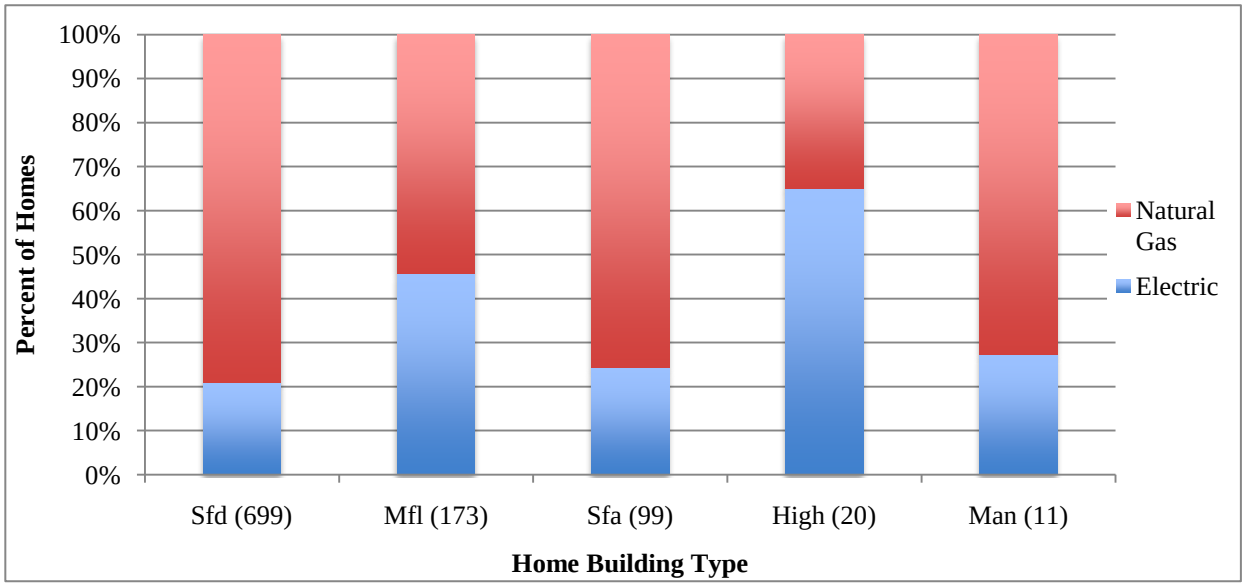

Figure 4. Cooktop fuel type by home building type.

Number of homes in each set of stacked columns shown in parentheses. Sfd=single family detached, Mfl=multifamily lowrise, Sfa=single family attached/townhouse, High=highrise, and Man=manufactured/mobile

Table 14 is provided to allow comparison between data gathered in this study and RASS data for cooktop fuel type by home building type.

Table 14. Cooktop fuel type by home building type compared to the 2009 RASS.

	Zillow Data		RASS 2009		
Home Building Type	**Electric**	**Natural Gas**	**Electric**	**Natural Gas**	**Other**
Sfd[1]	20.9%	79.1%	26.7%	69.4%	3.9%
Mfl[2]	45.7%	54.3%	41.8%	56.9%	1.3%
Sfa[3]	24.2%	75.8%	38.8%	60.3%	0.9%
High[4]	65.0%	35.0%	54.3%	45.4%	0.3%
Man[5]	27.3%	72.7%	20.3%	65.5%	14.1%
Other[6]	--	--	35.0%	58.0%	7.1%

[1] Sfd represents "Single Family Detached" for Zillow data and "Single Family" for RASS.
[2] Mfl represents "Multifamily Lowrise" for Zillow data and "Apt Condo 2-4 Units" for RASS.
[3] Sfa represents "Single Family Attached/Townhouse" for Zillow data and "Townhouse, Duplex, Row House" for RASS.
[4] High represents "Highrise" for Zillow data and "Apt Condo 5+ Units" for RASS.
[5] Man represents "Manufactured/Mobile" for Zillow data and "Mobile Home" for RASS.
[6] Other was not an option for home building type for our data.

Range Hood Univariate Statistics

Figure 5, Figure 6, and Figure 7 display statistics for the range hood characteristics for the homes assessed in this study: hood type, range hood coverage percent, and range hood installation height for all homes. Despite the importance of this parameter to effectiveness, it was not possible to obtain via the photographs information about venting (whether air is recirculated or vented to the outdoors) of the observed hoods.

As shown in Figure 5, microwave range hoods are the most common (present in 47% of homes), followed by short hoods (present in 33% of homes). Homes lacking hoods make up the smallest portion of the data set (7% of homes).

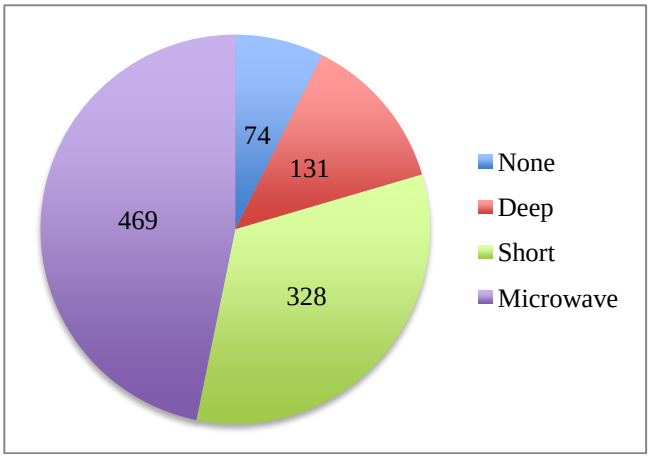

Figure 5. Range hood type for all homes.

Shown in Figure 6, the majority of homes (52%) have range hoods that cover approximately half of their cooktop, followed by homes with hoods that cover approximately 75% of the cooktop.

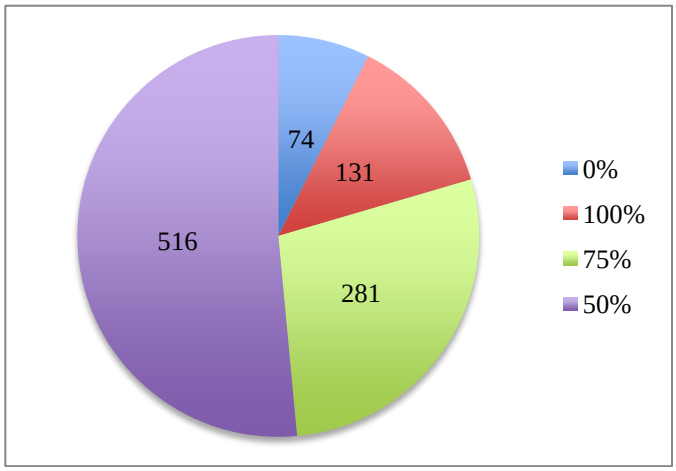

Figure 6. Range hood coverage percent for all homes.

Figure 7 shows the count of homes with each estimated range hood installation height. The lowest installation height was 14 inches above the cooktop, and the highest was 48 inches. Installation height is later shown to correlate with range hood type.

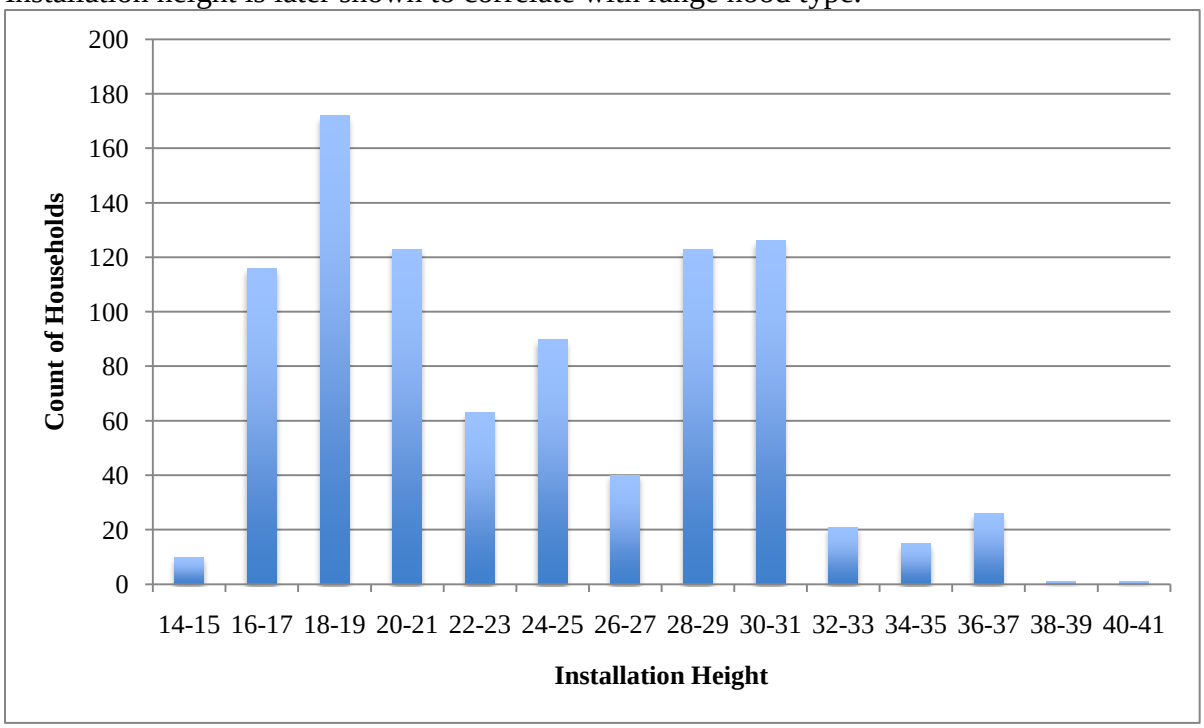

Figure 7. Range hood installation height for all homes.

One home had an estimated range hood installation height of 48" but this height was not included in the figure.

Range Hood Characteristics by Home and Cooktop Characteristics

The following tables and figures show how range hood type, coverage percent, and installation height vary by home characteristics, such as year built, cost, and cooktop fuel type. Also

presented is range hood coverage percent by range hood type and range hood type by cooktop fuel type.

The relationship between range hood type and year the home was built is presented in Figure 8. The percent of homes with microwave hoods increases as home age decreases while percent of homes with short hoods and without hoods decreases as home age decreases. The percent of homes with deep hoods varies with home age, decreasing from the "Before 1950" range until the "1980-1994" range and then increasing through the range of homes built most recently, "2006-2011."

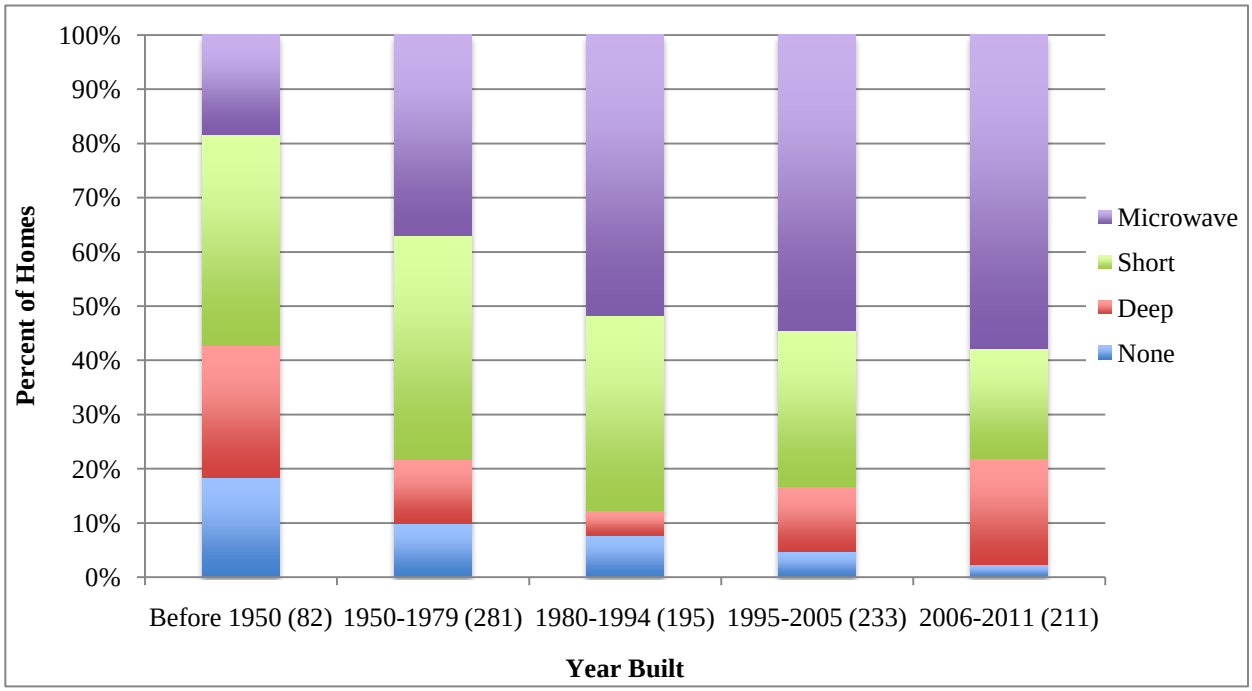

Figure 8. Hood type by home year built range.
Number of homes in each set of stacked columns shown in parentheses.

Figure 9 shows that deep hoods become more common as home cost increases while microwave hoods become less common. 65% of the least expensive homes (less than $100,000) have short hoods and none have deep hoods. It should be noted that we were unable to discern if downdraft kitchen exhaust systems were present in homes; these are generally more expensive devices that are more common in more expensive homes. This could explain why there is a rise in percent of homes without a hood (above) in the most expensive category of homes.

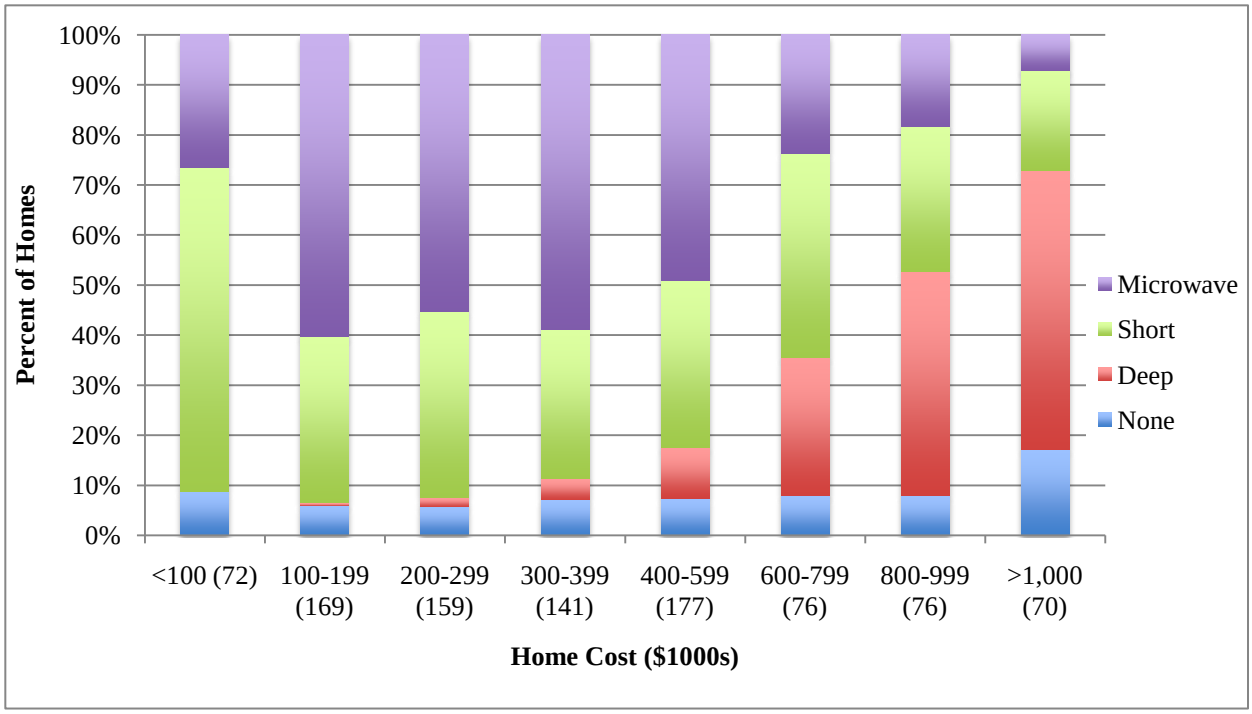

Figure 9. Range hood type by home cost.

Number of homes in each set of stacked columns shown in parentheses.

Although the sample size for homes for rent was small (exactly 100 homes) similar trends to those in the homes for sale data can be seen in the homes for rent in our data set. See Figure 10.

Figure 10. Range hood type by monthly home rent.

Number of homes in each set of stacked columns shown in parentheses.

Figure 11 shows how range hood type varies by home size. Similar trends to those comparing range hood type and home cost are revealed; deep hoods are more common in larger homes,

while microwave homes are more common in smaller homes. This correlation is important because smaller homes have less area for unventilated cooking-related pollutants to be diluted, and poorly performing range hoods could exacerbate indoor air quality problems related to cooking.

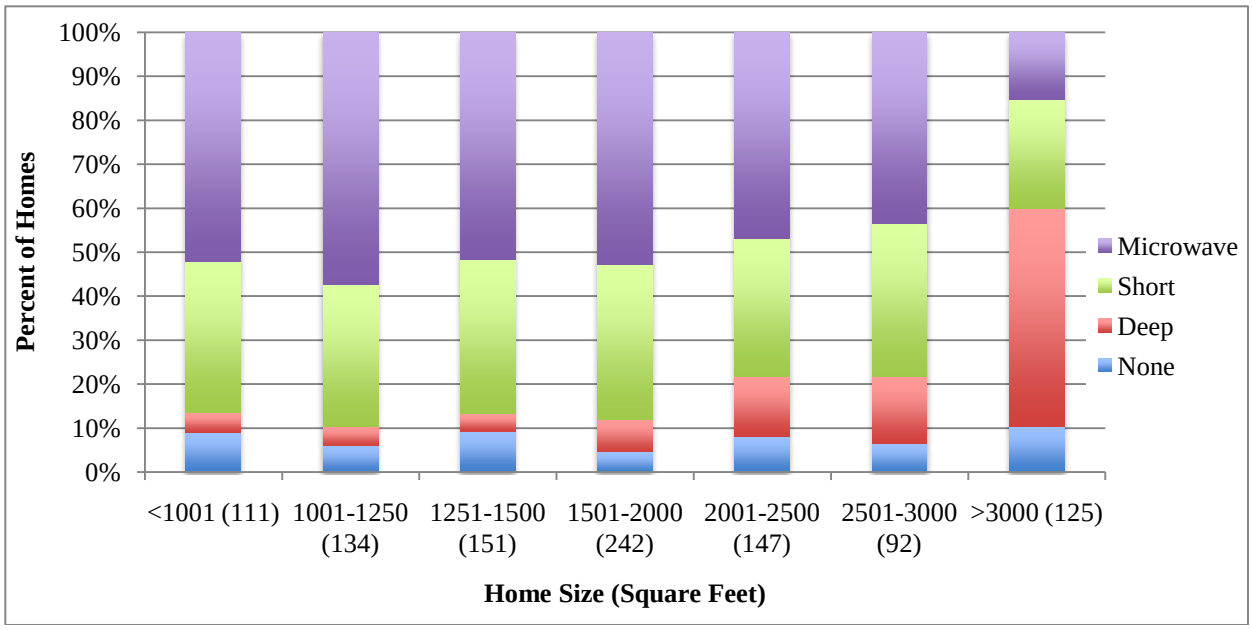

Figure 11. Range hood type by home size.

Number of homes in each set of stacked columns shown in parentheses.

Figure 12 shows how range hood type varies by home building type. Although microwave hoods are still the most common hood type in single-family detached homes, it is interesting to note that the prevalence of microwave hoods in single-family detached homes is substantially less than that of homes in the categories of multifamily lowrise or single family attached houses.

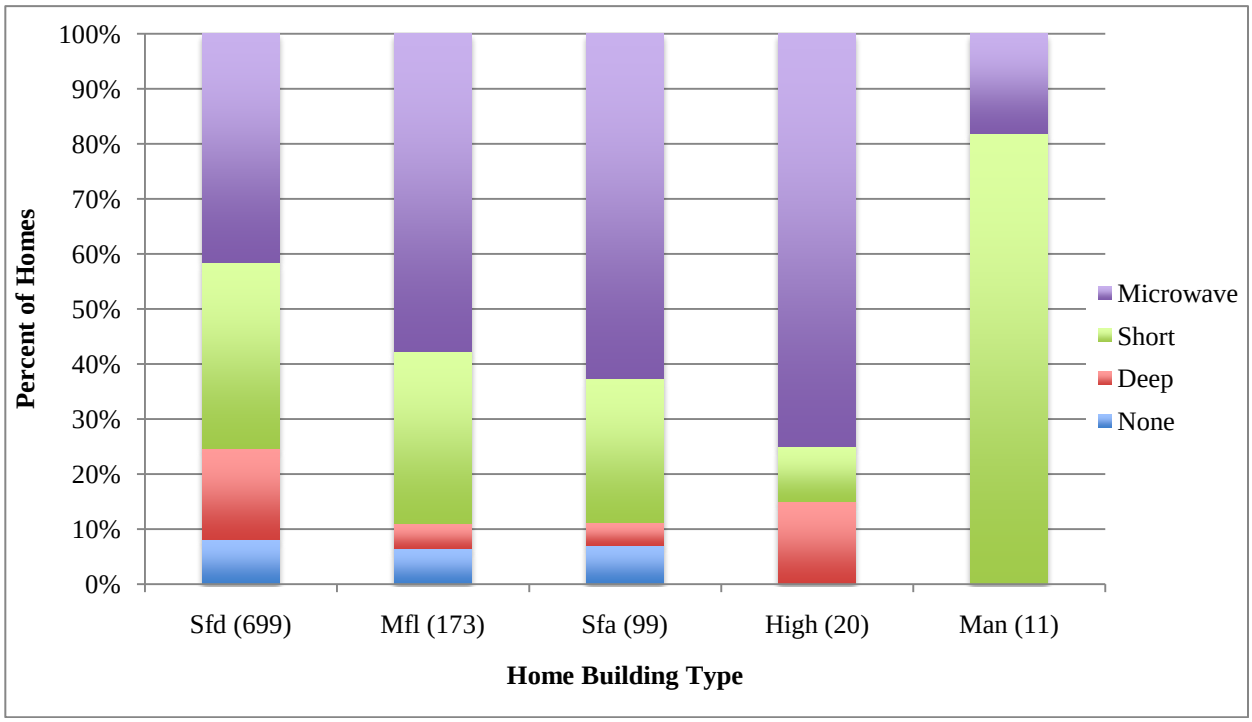

Figure 12. Range hood type by home building type.

Number of homes in each set of stacked columns shown in parentheses. Sfd=single family detached, Mfl=multifamily lowrise, Sfa=single family attached/townhouse, High=highrise, and Man=manufactured/mobile.

An important characteristic of range hoods is the percent of the cooktop that it covers; the greater the coverage percent, the greater the capture efficiency of the range hood for cooking done on the front burners. Range hood type and coverage percent are closely related; most (about 76%) of deep hoods cover the entire or almost the entire cooktop, almost all (about 96%) of microwave hoods cover approximately half of the cooktop, and a significant majority (about 69%) of short hoods cover three-fourths of the cooktop. This can be seen in Figure 13. Note that the legend shows the three possible coverage percentages while the percentages shown on the pie charts shows the percentage of range hoods with that coverage percentage.

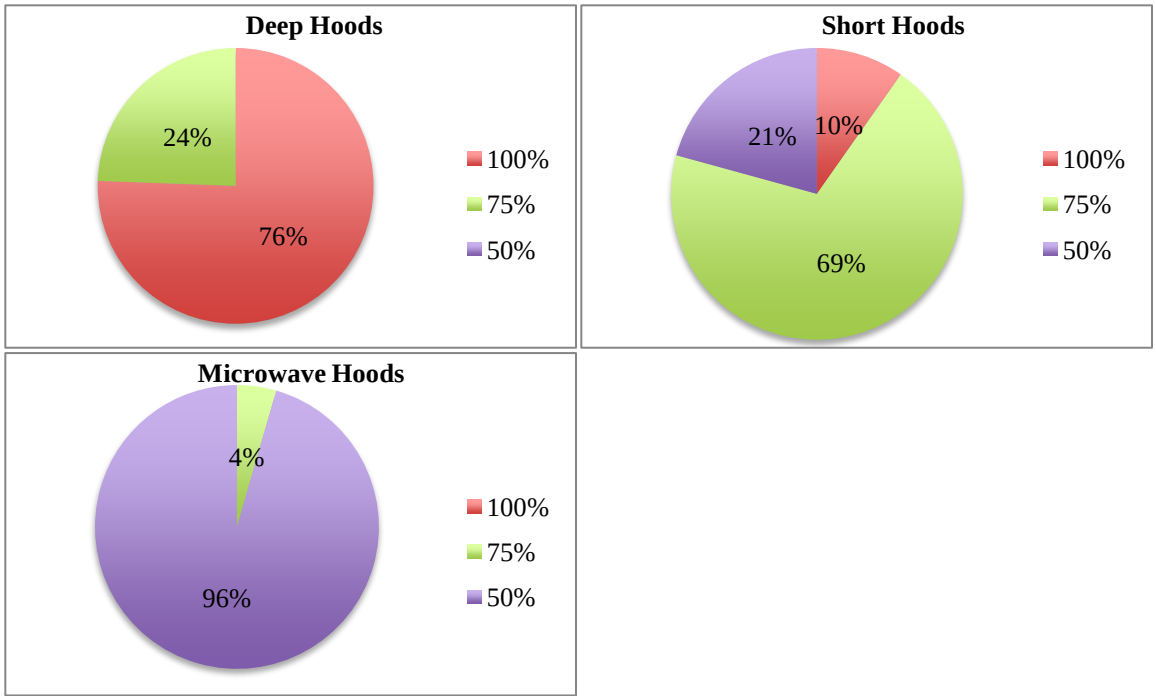

Figure 13. Range hood coverage percent by range hood type.

Since there is a strong relationship between hood type and coverage percent, the distribution of range hood coverage by home cost is similar to the distribution of range hood type by home cost. These trends can be seen in Figure 14.

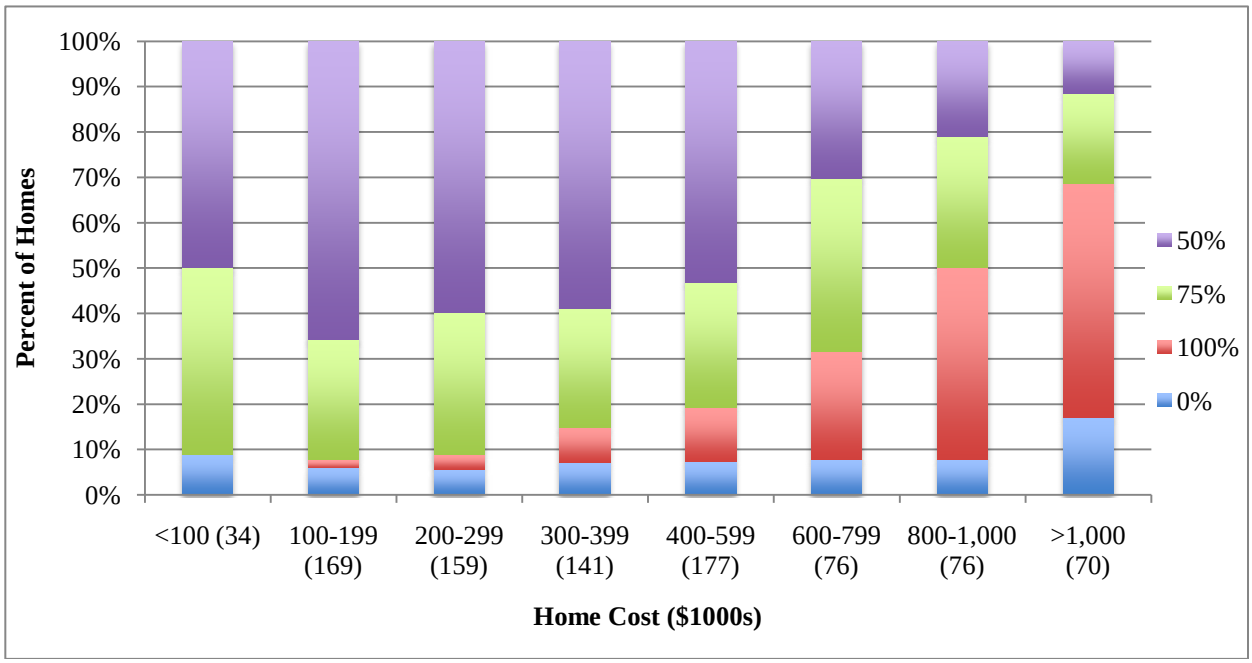

Figure 14. Range hood coverage percent by home cost.

Number of homes in each set of stacked columns shown in parentheses.

Table 14 shows the mean, standard deviation, median, and mode for the installation height for each type of range hood. Figure 15 shows range hood installation height by range hood type. Refer back to Table 13 for estimated installation height calibration data. It should be noted that a microwave installed under a cabinet extends further down than a short hood and that microwaves need to be within reach of shorter people; this influences microwave hood installation height, which is lower than that of deep or short hoods.

Table 15. Installation height statistics by range hood type (inches).

Hood Type	Mean	Standard Deviation	Median	Mode
Deep	30.1	4.3	30	30
Short	27.2	3.7	28	28
Microwave	18.7	2.4	18	18

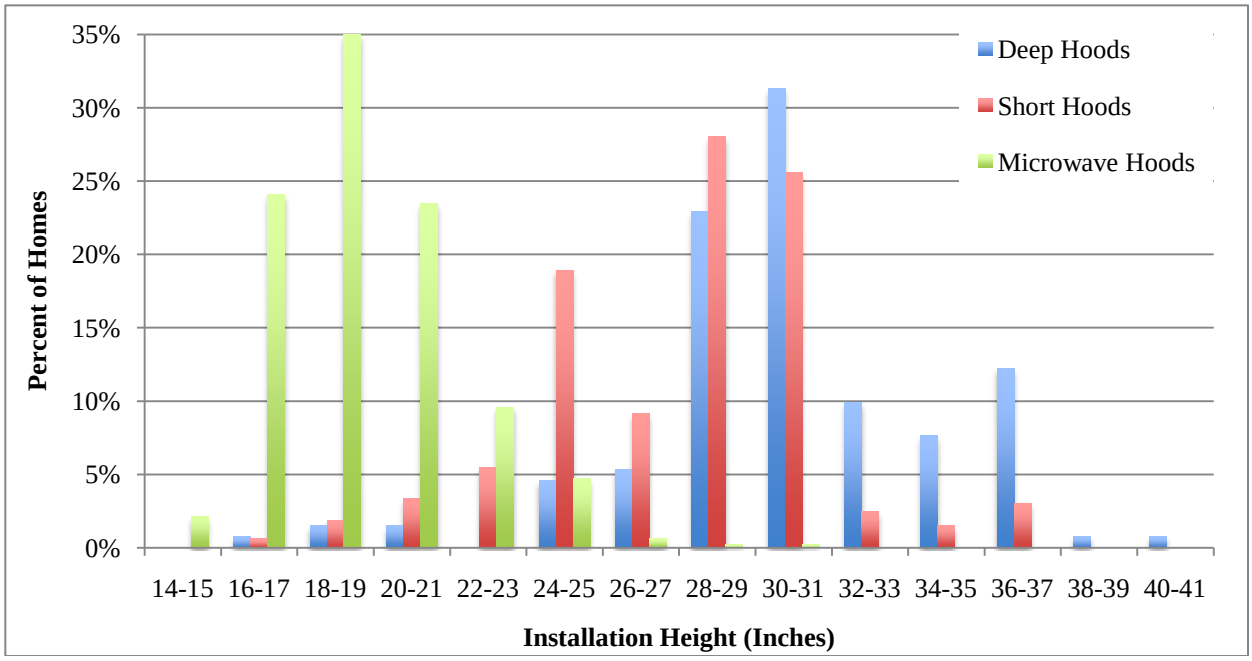

Figure 15. Installation height by type of range hood.

One deep range hood had an estimated installation height of 48" but was omitted from the figure.

Figure 16 shows the percent of the cooktop fuel type with each range hood type. Since hood type is a main factor in determining how effectively a range hood can remove cooking activity emissions from the home, the relationship between range hood type and cooktop fuel type in our data set is important. Homes with natural gas cooktops tend to have deep hoods more often than homes with electric cooktops, and homes with electric cooktops tend to have microwave hoods more often than homes with natural gas cooktops.

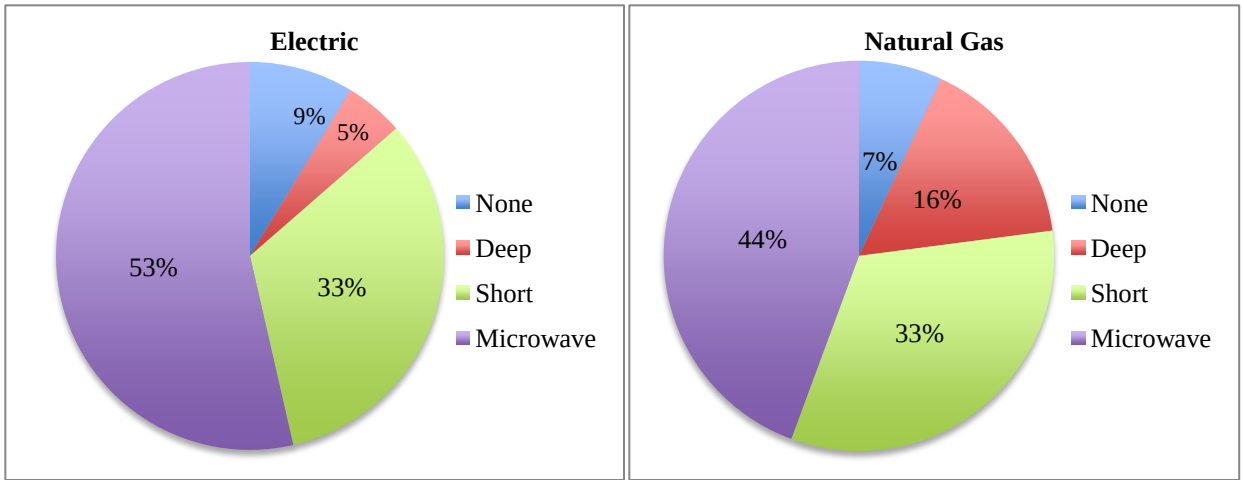

Figure 16. Range hood type by cooktop fuel type.

Figure 17 shows the percent of range hood coverage percent by cooktop fuel type. It is arranged to allow for easy visual comparison to Figure 16. Substantially fewer households that have a natural gas cooktop have a range hood that covers only 50% of the cooktop than those with electric cooktops, and substantially more households that have a natural gas cooktop than houses with an electric cooktop have a range hood that covers 100% of the range hood. Again, it should be noted that the legend shows the three possible coverage percentages while the percentages shown on the pie charts shows the percentage of range hoods with that coverage percentage.

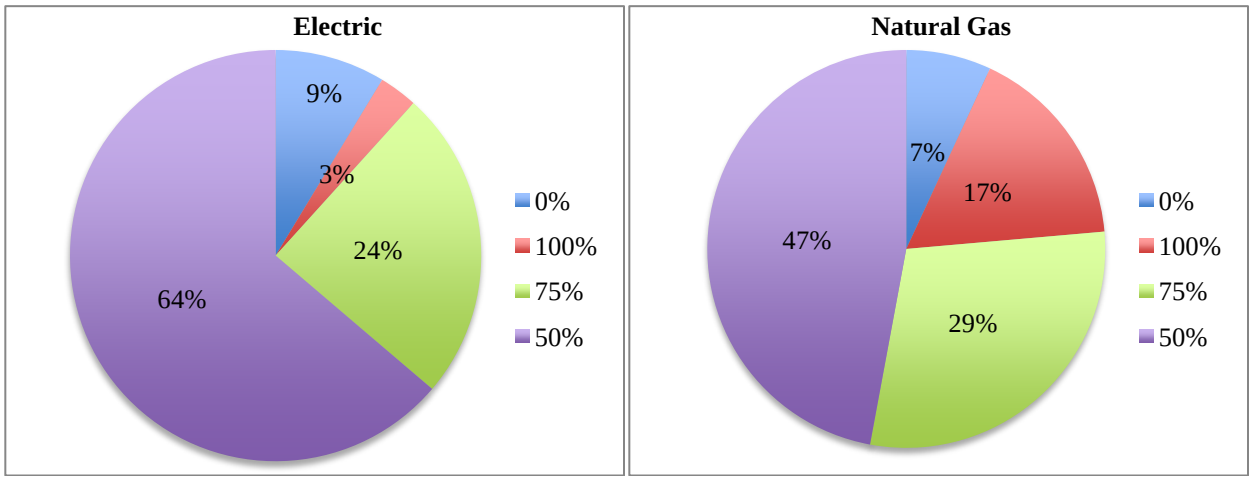

Figure 17. Range hood coverage percent by cooktop fuel type.

CONCLUSIONS

This report presents information on relationships between home, cooktop, and range hood characteristics that will allow us to begin to assess the potential for controlling indoor air quality with existing equipment. Our results can be paired with information about the emissions of cooking activities and information about how effectively different range hoods can remove cooking-related pollutants from the home. This paired information can be used to demonstrate the indoor air quality of homes throughout California and guide efforts to improve cooking-related effects on indoor air quality. One critical limitation of this study is that we were unable to

determine whether hoods recirculated air through the hood into the kitchen or vented to the outdoors, which would be valuable to assess their ability to remove cooking related pollutants and thus improve indoor air quality. Overall, this was an inexpensive way to gather basic information about range hoods in California homes.

Microwave range hoods are the most common type of range hood, present in 47% of households in our sample. Only 7% of households lack a range hood. The majority (52%) of homes have range hoods that cover approximately half of their cooktop. Homes with natural gas cooktops tend to have less microwave range hoods and more deep range hoods than homes with electric range hoods. Range hoods in homes with natural gas cooktops tend have a greater coverage percent than homes with electric cooktops.

Newer homes more often have microwave range hoods than older homes, and more expensive homes less often have microwave hoods than less expensive homes. Deep hoods and hoods with a greater coverage percent are shown to be more common in more expensive homes and the percent of homes with natural gas cooktops is shown to increase with increasing home cost and with increasing home size.

The majority (76%) of deep hoods cover the entire or almost the entire the cooktop, the majority (69%) of short hoods cover three-fourths of the cooktop, and the majority (96%) of microwave hoods cover only approximately half of the cooktop. Deep hoods tend to be installed highest (median 30 inches) above the cooktop, short hoods slightly lower (median 28 inches), and microwave hoods the closest to the cooktop (median 18 inches). Of all the homes in our data set with hoods, the median installation height was 22 inches.

ACKNOWLEDGEMENTS

Funding was provided by the U.S. Department of Energy under Contract No. DE-AC02-05CH11231 and by the California Energy Commission through Contracts 500-08-061 and 500-05-026. The authors thank Richard Diamond, Jennifer Logue and Richard Sextro for reviewing this document prior to publication.

REFERENCES

CEC (2010). *California Statewide Residential Appliance Saturation Study. Final Report. Prepared by KEMA, Inc.* October 2010. 200-2010-004. Available at: http://www.energy.ca.gov/2010publications/CEC-200-2010-004/CEC-200-2010-004-V1.PDF

Singer BC, Delp WW, Apte MG. 2011. Natural Gas Variability in California: Environmental Impacts and Device Performance: Experimental Evaluation of Installed Cooking Exhaust Fan Performance. California Energy Commission, PIER Energy-Related Environmental Research, Interim Report. Contract CEC-500-05-026. Submitted to CEC November 2010. CEC Report number pending. LBNL-4183E.

Singer BC, Sherman AD, Hotchi T, Sullivan DP. Pollutant removal efficiency of residential cooking exhaust hoods. *Proceedings of Indoor Air 2011, The 11th International Conference on Indoor Air Quality and Climate,* Austin TX. International Academy of Indoor Air Sciences. LBNL-4902E

Appendix. Calibration Photographs

Photographs used for coverage percent and installation height calibration are provided here, in order of house number. These photographs were meant to be of a similar quality of those listed on the real estate website used for data collection.