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COOKING APPLIANCE USE IN CALIFORNIA HOMES—DATA COLLECTED FROM A WEB-BASED SURVEY

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Environmental Energy Technologies Division

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ABSTRACT

Cooking of food and use of natural gas cooking burners generate pollutants that can have substantial impacts on residential indoor air quality. The extent of these impacts depends on cooking frequency, duration and specific food preparation activities in addition to the extent to which exhaust fans or other ventilation measures (e.g. windows) are used during cooking. With the intent of improving our understanding of indoor air quality impacts of cooking-related pollutants, we created, posted and advertised a web-based survey about cooking activities in residences. The survey included questions similar to those in California's Residential Appliance Saturation Survey (RASS), relating to home, household and cooking appliance characteristics and weekly patterns of meals cooked. Other questions targeted the following information not captured in the RASS: (1) oven vs. cooktop use, the number of cooktop burners used and the duration of burner use when cooking occurs, (2) specific cooking activities, (3) the use of range hood or window to increase ventilation during cooking, and (4) occupancy during cooking. Specific cooking activity questions were asked about the prior 24 hours with the assumption that most people are able to recollect activities over this time period. We examined inter-relationships among cooking activities and patterns and relationships of cooking activities to household demographics. We did not seek to obtain a sample of respondents that is demographically representative of the California population but rather to inexpensively gather information from homes spanning ranges of relevant characteristics including the number of residents and presence or absence of children. This report presents the survey, the responses obtained, and limited analysis of the results.

IMPLICATIONS

Results from this survey provide data on the details of residential cooking activities when they occur. Data were obtained for the relative frequency of oven and cooktop use, the number of cooktop burners used, the duration of burner use, and specific cooking activities (e.g. frying, baking, sautéing), all by meal. Information was also obtained about range hood use by meal. Results also provide information about the concurrence of activities and the relationships of activities to household characteristics. These data are valuable to modeling the indoor air quality impacts of cooking. Results also demonstrate the potential to obtain valuable data through the low-cost method of a web-based survey. While statistically representative data would better advance the objective of modeling population impacts, the data obtained by this study provide values for specific parameters that were not previously available.

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INTRODUCTION

Cooking of food and use of natural gas cooking burners generate pollutants that can have substantial impacts on residential indoor air quality. The extent of these impacts depends on cooking frequency, duration and specific food preparation activities in addition to the extent to which exhaust fans or other ventilation measures (e.g. windows) are used during cooking. With the intent of improving our understanding of indoor air quality impacts of cooking-related pollutants, we created, posted and advertised a web-based survey about cooking activities in residences. This report presents the survey, the responses obtained, and analysis of the results.

The survey was intended to begin to fill a huge gap in the available information about cooking and cooking appliance use in homes. Recruitment for the survey focused on California residents, but it was not distributed in a way that produced a representative sample of the population. While it therefore cannot be assumed to describe food preparation activities for all demographic groups or in proportion to the full population of California, survey results nevertheless provide valuable data to advance understanding of cooking and related activities that impact residential indoor air quality.

METHODS

The cooking survey was created using SurveyMonkey.com, a web site that allows users to create and post online surveys. The survey was distributed through emails to personal contacts with requests to forward, announcements in Lawrence Berkeley National Lab (LBNL) lab-wide and Environmental Energy Technologies Division division-wide newsletters and through at least one University of California, Berkeley health-related listserv. The survey was approved and deemed exempt from annual review by the Human Subjects Committee of LBNL.

Distribution was limited and targeted to fill an urgent need for data to support a modeling study of pollutant exposures from unvented natural gas cooking burners (Lobscheid et al. 2011; Singer et al. 2011). As a result, we did not attempt to capture a sample of respondents representative of the population of California. The objective instead was to obtain preliminary data on specific cooking activities when cooking occurs.

Survey questions were focused on obtaining information related to the following two categories:

1. Questions about building and household characteristics, cooking equipment, and weekly cooking patterns that were asked in the California Energy Commission's Residential Appliance Saturation Survey (RASS). These questions allow us to compare the demographics of our sample and responses to similar questions to those of the RASS study, which, unlike our study, was targeted to a representative sample of California residential customers.
2. Questions not covered in the RASS, focusing on specific cooking activities and cooking-related ventilation activities over the past 24 hours. The rationale is that people can recall relatively accurately over this period of time. These questions were designed to gather information about the total amount of cooking burner use (from number of burners and minutes), specific type of cooking activity and the use of ventilation during cooking.

Survey respondents provided information about the age and fuel of their conventional oven and cooktop, frequency with which they use each appliance for each meal (breakfast, lunch, dinner,

and "Other—snacks or other food preparation"), oven and cooktop use for each meal over the past 24 hours, type of cooking and related activities done over the past 24 hours, and household characteristics. The complete survey is provided as Appendix A.

RESULTS AND DISCUSSION

This section presents responses, analysis and discussion for the cooking survey and includes comparisons to RASS data where appropriate. RASS percentages calculated are based on the non-weighted sample data from the 2003 or 2009 RASS. In most cases, comparison is to the 2009 RASS. The 2003 RASS data is used for weekly cooking patterns by meal because the 2009 survey did not include the same level of resolution.

We do not present any formal error analysis. The largest uncertainty is the degree to which the respondents to this survey are or are not representative of the general population.

There were a total of 372 respondents to the cooking survey. Two respondents chose the option "stop survey and do not use my responses" at the end of the survey; they are not included in this total or in any of our data presented in this report.

The survey was posted on March 8, 2010, and the data presented in this report were downloaded on June 13, 2011. Table 1 shows the number of respondents completing the survey during each month. The majority of the respondents took the survey during the first month, and only 8 people complete the survey after April 2010.

Table 1. Respondents that submitted the survey during each month.

Month	Number	Percent
Mar-2010	213	57.3%
Apr-2010	151	40.6%
May-2010	5	1.3%
Jun-2010	1	0.3%
Nov-2010	1	0.3%
Apr-2011	1	0.3%
Total	372	100.0%

Respondent household demographics

The reported home locations of survey respondents are shown in Table 2. Most respondents reported living within California; about 12% indicated other U.S. locations and a few were from outside the United States. We chose to retain non-California respondents and respondents who did not provide information about their location; these are included in comparisons with RASS results and all analyses.

Table 2. Location of respondent homes.

Location	Number	Percent	Non-Blank Responses
California	280	75.3%	87.2%
Outside of CA	38	10.2%	11.8%
Outside United States[1]	3	0.8%	0.9%
Blank/Decline to State	51	13.7%	--
Total	372	100.0%	100.0%

[1] Three respondents noting specific locations households outside of the United States listed their locations as Canada, Switzerland, and "Oz."

Responses to the question "What type of building does your household reside in?" are shown in Table 3. The cooking survey included single-family homes and apartments in large buildings in proportions similar to 2009 RASS. The survey included no mobile homes, though the latter comprised 7% of the RASS sample.

Table 3. Type of building in which the respondent resides, compared to RASS 2009.

Type of Home	Survey Number	Survey Percent	Survey Non-Blank	RASS 2009 Percent	RASS Non-Blank
Single-family detached	200	53.8%	61.3%	55.5%	59.3%
Apartment/condo with more than 5 units	51	13.7%	15.6%	15.8%	16.9%
Townhome/Duplex	40	10.8%	12.3%	7.1%	7.6%
2-4 unit condo or apartment	34	9.1%	10.4%	7.4%	7.9%
Mobile home	0	0.0%	0.0%	6.6%	7.1%
Other (not an option on our survey)	0	0.0%	0.0%	1.2%	1.2%
Decline to State/Blank	47	12.6%	--	6.5%	--
Total	372	100.0%	99.7%	100.0%	100.0%

Responses to the question "How many people, including yourself, currently reside in your household?" are shown below alongside RASS 2009 results. The cooking survey sample includes a smaller percentage of single-person households and a higher percentage of households with 3-4 residents, relative to RASS. The total number of residents represented by the 325 respondents to this question is 872. Forty-six respondents left the question about number of residents blank and one respondent selected "decline to state".

Table 4. Number of residents in the household, compared to RASS 2009.

Number of Residents	Survey Numbers	Survey Percent	Survey Non-Blank	RASS 2009 Percent	RASS Non-Blank
0[1]	0	0.0%	0.0%	0.1%	0.1%
1	47	12.6%	14.5%	24.1%	24.6%
2	126	33.9%	38.8%	36.6%	37.3%
3	66	17.7%	20.3%	13.7%	13.9%
4	55	14.8%	16.9%	12.6%	12.8%
5 or more	31	8.3%	9.5%	11.0%	11.3%
decline to state/blank	47	12.6%	--	1.9%	--
Total	372	100.0%	100.0%	100.0%	100.0%

[1] Not an option on our survey

Responses to the questions about number of household residents in each age category are shown in the three tables below. It should be noted that totals by column do not equal values in Table 4 because many homes have individuals from more than one age group. We assumed that blank responses represent a "0" response for an age group when the same respondent provided a number for how many residents of another age group reside in the household.

The number of residents represented in the responses to these questions is 876, just a few more than the 872 represented by the question about total residents in each household. This is at least partially due to the fact that the highest value option for responses to the question about total number of residents living in the house is "5+" which can represent any number of residents in the house above 4. In the case in which there are actually 6 or more residents in the house from different age groups, responses to the question about number of residents in each age group would add up to more than the number of total residents reported to live in a household. Using 876 as the divisor, the breakdown by age is 23.4% aged 0-17 years (n=205), 72.5% aged 18-65 (n=635), and 4.1% (n=36) 65 or older.

Table 5. Number of residents 0-17 years old (0-18 in the RASS) in the household.

Number of Residents	Survey Responses	Survey Percent	Survey Non-Blank	RASS 2009	RASS Non-Blank
0[1]	210	56.5%	64.6%	68.3%	69.2%
1	45	12.1%	13.8%	12.4%	12.6%
2	53	14.2%	16.3%	10.9%	11.1%
3	14	3.8%	4.3%	4.1%	4.1%
4	3	0.8%	0.9%	1.8%	1.8%
5 or more	0	0.0%	0.0%	1.3%	1.3%
Decline to state/blank[2]	47	12.6%	--	1.2%	--
Total	372	100%	100%	100%	100%

[1] Number (percent) of respondents selecting "0" residents 0-17 years old: 72 (19.4%)
[2] Number (percent) of respondents not providing a response (blank) or declining to state: 185 (49.7%)

Table 6 and Table 7 show that relative to the RASS, the cooking survey includes a much lower percentage of households without a non-senior adult, and a higher percentage of households with no seniors. In other words, the response sample for the cooking survey substantially under-represents senior-only and senior led households.

Table 6. Number of residents 18-65 years old (19-64 in the RASS) in the household.

Number of Residents	Survey Responses	Survey Percent	Survey Non-Blank	RASS 2009	RASS Non-Blank
0[1]	10	3.0%	3.4%	30.0%	30.4%
1	63	16.9%	19.3%	20.8%	21.0%
2	210	56.5%	64.4%	34.1%	34.5%
3	24	6.5%	7.4%	8.3%	8.4%
4	10	2.7%	3.1%	3.7%	3.8%
5 or more	8	2.2%	2.5%	1.9%	1.9%
Decline to state/blank[2]	47	12.6%	--	1.2%	--
Total	372	100%	100%	100%	100%

[1] Number (percent) of respondents selecting "0" residents 18-65 years old: 3 (0.8%)
[2] Number (percent) of respondents not providing a response (blank) or declining to state: 54 (14.5%)

Table 7. Number of residents over 65 years old (65 or older in the RASS) in the household.

Number of Residents	Survey Responses	Survey Percent	Survey Non-Blank	RASS 2009	RASS Non-Blank
0[1]	299	80.6%	92.0%	61.3%	62.1%
1	16	4.3%	4.9%	21.5%	21.7%
2	10	2.7%	3.1%	15.4%	15.5%
3	0	0.0%	0.0%	0.4%	0.4%
4	0	0.0%	0.0%	0.0%	0.0%
5 or more	0	0.0%	0.0%	0.2%	0.2%
Decline to state/blank[2]	47	12.6%	--	1.2%	--
Total	372	100%	100%	100%	100%

[1] Number (percent) of respondents selecting "0" residents over 65 years old: 102 (27.4%)
[2] Number (percent) of respondents not providing a response (blank) or declining to state: 244 (65.6%)

Table 8 presents the number of respondent households that fit into the age group categories used for analysis later in the report. The number of households does not sum to 372 since many did not respond to the questions regarding age of residents. The "Child(ren) Present" and "Senior(s) Present" categories are not mutually exclusive because there are households that have both senior and children residents that are counted in both categories. In the 2003 and 2009 RASS, age groups were separated into "Have Children, No Seniors," "No Seniors, No Children," "Have Seniors, No Children," and "Seniors and Children." As noted above, the cooking survey did not receive a large fraction of responses from Senior-only or Senior-led households; we therefore chose to combine the two senior related categories to a "Senior(s) Present" group.

Table 8. Age group represented in the household.

Age Group	Survey Responses	Survey Percent	Survey Non-Blank Percent	RASS 2009 Percent
Non-Senior Adult(s) Only	189	50.8%	58.0%	35.6%
Child(ren) Present	116	31.2%	35.6%	30.5%
Senior(s) Present	27	7.3%	8.3%	37.5%

Responses to the question about ethnicities represented in each household are shown in Table 9. The sum exceeds 100% because some respondents reported more than one ethnicity in the household; however, many respondents did not provide information about the ethnicities represented in their households. We provide RASS responses for comparison in Table 10. The

RASS asked only about the ethnicity of the head of the households, while we asked for all ethnicities represented in the household, preventing direct comparison between the two tables. With this caveat, we note that the cooking survey included more Asian or Pacific Islanders and the RASS included more Latinos.

Table 9. Distribution of ethnicities represented in households of survey respondents.

Ethnicity	Number of Households	Percent of Households[1]
White, Caucasian	282	75.8%
Asian or Pacific Islander	57	15.3%
Hispanic/Latino	33	8.9%
Black, African American	14	3.8%
Other	7	1.9%
American Indian, Alaska Native	1	0.3%

[1] Sum of percentages exceeds 100% because some respondents reported more than one ethnicity in the household.

Table 10. Head of household ethnicity—RASS 2009.

Ethnicity	Percent of Households
White Caucasian	67.1%
Hispanic Latino	14.7%
Asian Pacific Islander	8.6%
Black African American	4.1%
Mixed	2.5%
Other	2.0%
American Indian AK Native	1.0%

Cooktop and Oven Characteristics

Responses to the questions about cooktop and oven fuel are shown below, compared to results from RASS 2009. The columns showing percentage of non-blank results are provided because of the larger percent of blank responses to the RASS 2009 question about oven fuel. Even though electricity is not technically a “fuel,” we use the term in our survey because it was used in the RASS. The cooking survey sample was similar to RASS 2009 in the breakdown of electric and gas appliances; the cooking survey did not ask explicitly about propane, but there were no responses for the “other” category.

Table 11. Cooktop fuel, compared to RASS 2009.

Cooktop Fuel	Survey Responses	Survey Percent	Survey Non-Blank Percent	RASS 2009 Percent	RASS 2009 Non-Blank
Electric	115	30.9%	32.1%	33.8%	34.1%
Natural Gas	243	65.3%	67.9%	61.4%	61.9%
Other[1]	0	0.0%	0.0%	3.9%	4.0%
Blank	14	3.8%	--	0.8%	--

[1] "Other" was an option on our survey, but none of our survey respondents reported having a cooktop fuel other than electricity or natural gas.

Table 12. Oven fuel, compared to RASS 2009.

Oven Fuel	Survey Responses	Survey Percent	Survey Non-Blank Percent	RASS 2009 Percent	RASS 2009 Non-Blank
Electric	167	44.9%	46.5%	38.4%	46.3%
Natural Gas	192	51.6%	53.5%	41.9%	50.5%
Other[1]	0	0.0%	0.0%	2.6%	3.2%
Blank	13	3.5%	--	17.0%	--

[1] "Other" was an option on our survey, but none of our survey respondents reported having a oven fuel other than electricity or natural gas.

Responses to the questions about cooktop and oven fuel were combined to explore combinations of fuel sources, as shown in Table 13. It should be noted that the row and column totals in Table 13 differ from the numbers presented in Table 11 and Table 12 because only respondents who provided information about both cooktop and oven fuel type are shown in Table 13. Only two households with an electric cooktop reported having a natural gas oven, while almost a quarter of households with natural gas cooktops reported having an electric oven.

Table 13. Combinations of cooktop and oven fuel.

Cooktop Fuel	Electric Oven	Natural Gas Oven
Electric	110	2
Natural Gas	53	180

Survey responses to questions about cooktop and oven age group are shown in Table 14. The two had similar age distributions; we assume this results from a large percentage of combined appliances (cooking ranges). The appliance age groupings in RASS differ slightly from the age groupings used in the cooking survey, as shown in Table 15. The cooking survey sample had more 10-14 year old devices and fewer new devices.

Table 14. Age of cooktop and oven—survey responses.

	Cooktop		Oven	
Age	Survey Responses	Survey Percent	Survey Responses	Survey Percent
0-4 years	97	27.8%	93	27.0%
5-9 years	96	27.5%	94	27.2%
10-14 years	67	19.2%	66	19.1%
15-19 years	32	9.2%	33	9.6%
20+ years	57	16.3%	59	17.1%
Blank	23	--	27	--
Total	372	100.0%	372	100.0%

Table 15. RASS 2009 age of cooktop and oven, percent of non-blank responses.

Age	Cooktop	Oven
0-5 years	38.9%	38.6%
6-10 years	27.7%	27.2%
11-15 years	13.5%	13.7%
16+ years	20.0%	20.5%

The fraction of households with cooktops powered by natural gas did not vary substantially with cooktop age among cooking survey respondents. The fraction of households with natural gas ovens varied more, from a low of 41% natural gas ovens in the 15-19 year old range to a high of 60% natural gas ovens in the 5-9 year old bin. Although the breakdown of fuel type varied depending on appliance age, there is no general increase in percent of households with electricity or natural gas powering either appliance.

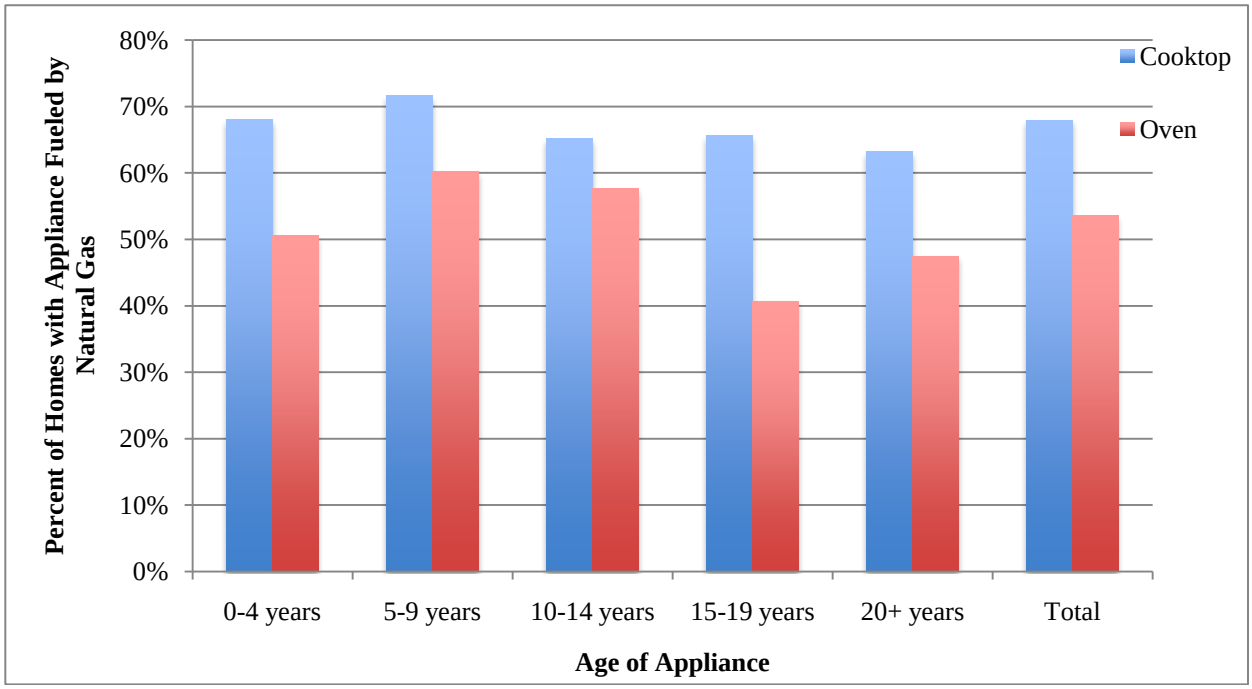

Figure 1. Appliance fuel type by appliance age.

Cooking Activities

Table 16 and Table 17 present results for weekly cooktop and oven use patterns reported by cooking survey respondents and Table 18 shows similar data from RASS 2003. RASS 2003 results were used instead of RASS 2009 results because the question regarding cooking frequency included in RASS 2009 was not specific to the meal during which cooking occurred. We chose to have separate questions for cooktop and oven use as opposed to the original RASS question about weekly cooking frequency in order to explore the relative rates of cooktop and oven use. We found that oven use occurs much less frequently than cooktop use.

Table 16. Weekly cooktop use frequency (number of days per week).

Meal	Never	1-2 days	3-4 days	5-6 days	Every day	Blank	**Total**
Breakfast	19.1%	40.1%	14.8%	9.1%	15.1%	1.9%	100%
Lunch	27.7%	50.0%	13.2%	2.4%	4.0%	2.7%	100%
Dinner	0.8%	8.6%	26.1%	39.0%	24.5%	1.1%	100%
Other	24.7%	44.1%	10.5%	4.0%	5.4%	11.3%	100%

Table 17. Weekly oven use frequency (number of days per week).

Meal	Never	1-2 days	3-4 days	5-6 days	Every day	Blank	**Total**
Breakfast	75.5%	19.4%	0.5%	0.3%	0.8%	3.5%	100%
Lunch	68.0%	26.3%	1.3%	0.0%	0.3%	4.0%	100%
Dinner	8.9%	53.0%	28.5%	7.5%	0.8%	1.3%	100%
Other	37.6%	43.0%	6.7%	0.3%	0.3%	12.1%	100%

Table 18. Weekly cooktop and oven use frequency from the RASS 2003 (number of times per week)

Meal	Never	Rarely (<1 time)	Occasionally (1-2 times)	Sometimes (3-4 times)	Often (5-7 times)	Blank	**Total**
Breakfast	21.8%	20.9%	20.8%	12.0%	17.9%	6.7%	100%
Lunch	27.8%	24.8%	17.9%	9.5%	10.2%	9.8%	100%
Dinner	3.1%	8.5%	14.7%	26.8%	43.7%	3.1%	100%
Other	25.8%	13.9%	9.0%	3.2%	2.3%	45.6%	100%

Table 19 and Figure 2 show the web survey responses about the duration (how many minutes) of cooktop use for each meal over the past 24 hours. In Figure 2, “0” responses are not shown so as to see patterns when cooktop cooking does in fact occur. “Don’t Know” responses were treated as blank responses and subtracted from the total responses for the particular meal. There were two “Don’t know” responses for lunch and three for other cooking. The most common non-zero response for breakfast and lunch was 6-10 minutes, the most common non-zero response for dinner was 16-30 minutes, and the most common non-zero response for “other” cooking was 1-5 minutes. This table provides valuable information about the duration of cooking when it occurs.

Table 19. Cooktop use duration (minutes) for each meal within the past 24 hours.

Duration (Minutes)	**Breakfast**	**Lunch**	**Dinner**	**Other**
0	155	231	56	159
1-5	45	13	8	26
6-10	58	26	35	20
11-15	36	16	42	13
16-30	20	12	86	10
31-45	2	5	46	2
46-60	1	2	23	2
61-90	0	0	14	1
91-120	1	3	2	0
>120	0	0	1	0
Don't know	0	2	0	3
Blank	54	62	59	136
Total	372	372	372	372

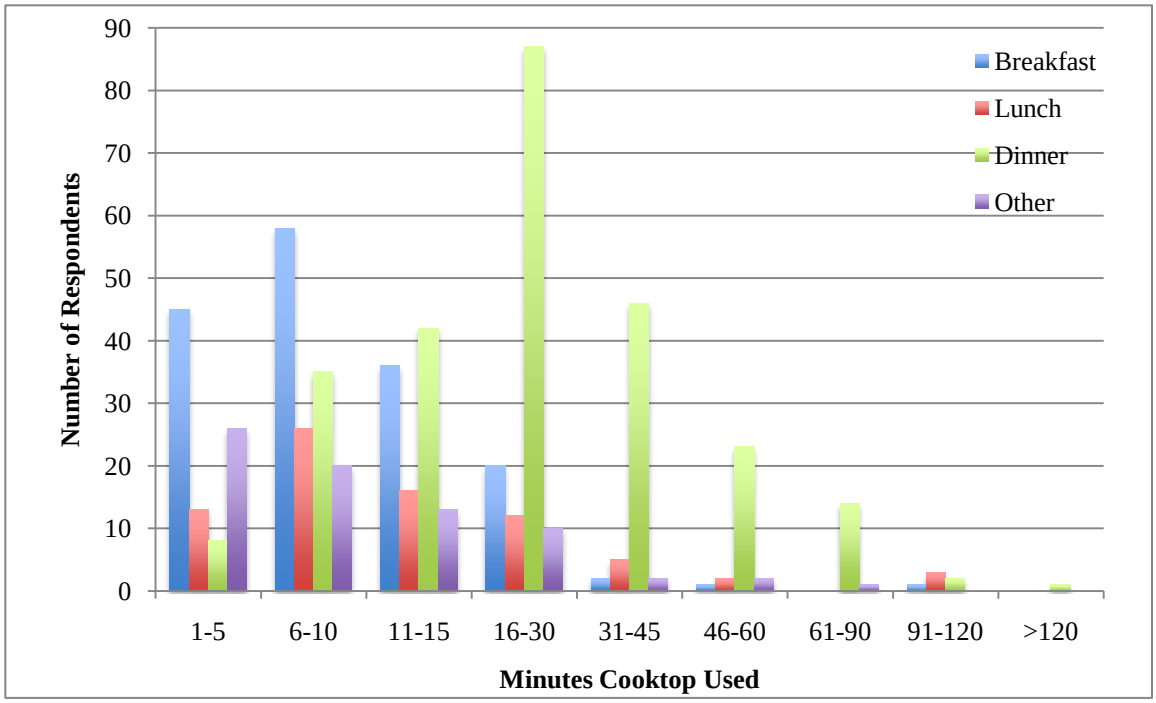

Figure 2. Duration (minutes) of cooktop use for each meal within the past 24 hours.

Table 20 and Figure 3 show cooking survey responses to the questions about the number of cooktop burners used for each meal over the past 24 hours. In Figure 3, "0" responses are not shown to clarify patterns when cooktop cooking does in fact occur. "Don't Know" responses were treated as blank responses and subtracted from the total responses for the particular meal. There were 2 "don't know" responses for lunch and 4 "don't know" responses for other cooking. Except for dinner cooking, the most common non-zero response for cooktop burners used is one. For dinner, most respondents who perform cooking used two burners and one burner was the second most common non-zero response. When cooking occurred, one burner was most common for Breakfast and Lunch.

Table 20. Cooktop number of burners used for each meal within the past 24 hours.

Cooktop Burners Used	Breakfast	Lunch	Dinner	Other
0	141	210	50	149
1	116	53	92	60
2	37	16	113	9
3	1	1	31	2
4	3	1	7	0
More than 4	1	2	6	1
Don't know	0	2	0	4
Blank	73	87	73	147

The cooktop activity results (number of burners and number of minutes) already have been used to support modeling of indoor exposures to pollutants from natural gas cooking burners (Lobscheid et al. 2011; Singer et al. 2011).

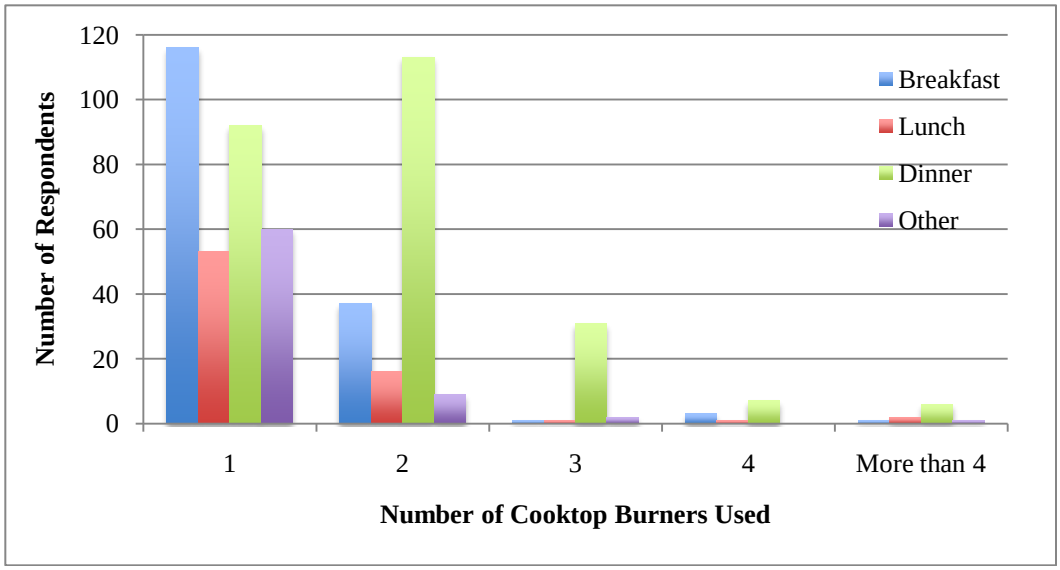

Figure 3. Cooktop number of burners used for each meal within the past 24 hours.

Table 21 shows how often the cooktop was also used when the oven was used over the past 24 hours; the percent is shown to be highest during dinner, likely because dinner is the meal when the most cooking and the most paired cooking occurs. Overall, this table shows that oven cooking infrequently occurs without cooktop cooking occurring as well.

Table 21. Frequency of cooktop use accompanying oven use.

	Breakfast	Lunch	Dinner	Other
Cooktop Also Used	76.0%	62.5%	84.1%	43.3%
Cooktop Not Used	24.0%	37.5%	13.0%	53.3%
No Response About Cooktop Use	0.0%	0.0%	2.9%	3.3%

Table 22 and Figure 4 show the responses to the questions asking about duration of oven use for each meal (how many minutes) over the past 24 hours. “0” responses are not shown in Figure 4 so that patterns when oven cooking does in fact occur can be seen. “Don’t Know” responses were treated as blank responses and subtracted from the total responses for the particular meal. There were two “don’t know” responses for lunch and one “don’t know” response for “other” cooking. The duration (minutes) reported is the total time the oven was turned on.
However, since the oven burner is only on approximately half of the time that the oven is on, the time reported by respondents includes time when the burner is not on; energy is consumed and pollutants emitted only when the burner is on. Dinner is the meal associated with the highest proportion of non-zero responses for oven use and 16-30 minutes is the most common non-zero response for duration of dinner cooking.

Table 22. Duration (minutes) of oven use for each meal within the past 24 hours.

Duration (Minutes)	Breakfast	Lunch	Dinner	Other
0	272	274	167	198
1-5	5	4	4	3
6-10	6	1	9	2
11-15	5	6	12	2
16-30	6	4	38	10
31-45	1	0	25	5
46-60	2	1	25	4
61-90	0	0	18	2
91-120	0	0	3	1
>120	0	0	4	0
Don't know	0	2	0	1
Blank	75	80	67	144
Total	372	372	372	372

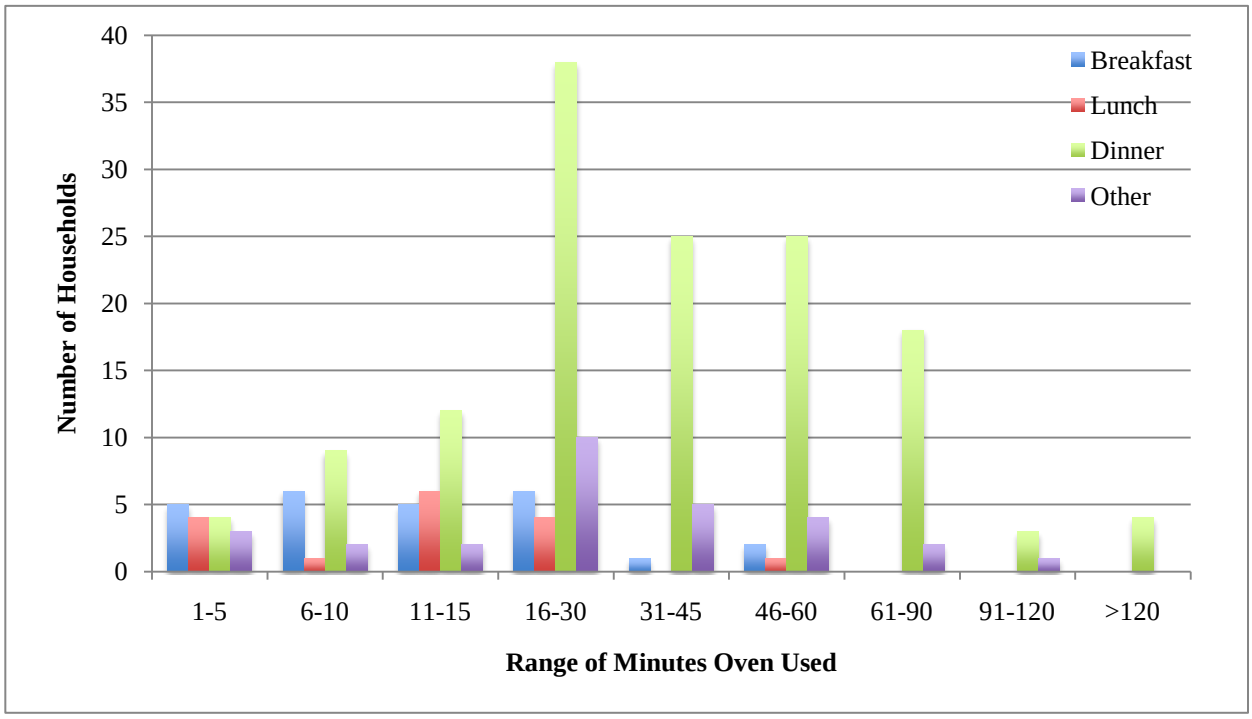

Figure 4. Duration (minutes) of oven use for each meal within the past 24 hours.

Consistency of Cooking Survey Responses

We compared the responses to several questions in order to compare how consistent the respondents to our survey reported their cooking activities. Responses to duration of cooktop use and about number of cooktop burners used were compared as were responses about weekly cooking frequency and about cooking within the past 24 hours.

To compare the consistency of responses to the two questions pertaining to cooktop use, the percent of those who reported cooking based on each question were calculated and the results are presented in Table 23. The divisor by which the percentages are calculated is the total number of respondents instead of omitting blank or "don't know" responses. This allows us to see how

consistently the responses to the questions about cooktop burners and minutes align. The responses of the two questions are generally consistent.

Table 23. Comparison of duration of cooktop use and number of burners used responses.

	Percent that reported some cooking			
	Breakfast	**Lunch**	**Dinner**	**Other**
Reported minutes of cooktop use	43.8%	20.7%	69.1%	19.9%
Reported number of cooktop burners used	42.5%	19.6%	66.9%	19.4%

Table 24 shows that people provide estimates of weekly cooktop cooking frequency consistent with the frequency with which they cooked in the past 24 hours. It is interesting to note that some respondents said they used their cooktop every day of the week for a particular meal but did not cook for that meal yesterday; also, some respondents said that they never cook for a particular meal but reported cooking that meal yesterday. These nominally inconsistent responses may result from the fact that we did not include a “rarely” option for those who use their cooktop less than once a week but more often than never or an ”frequently” option for those who use their cooktop more than 5-6 times a week on average but not every single day. Also, among respondents reporting dinner cooking only 1-2 times per week, 56% also reported cooking dinner yesterday.

Table 24. Reported cooktop cooking frequencies in past 24 hours compared to frequency expected based on response to weekly cooking patterns question.

“ND” represents “not enough data” in cells for the meal cooking frequencies that had less than 20 responses.

	1-2	**3-4**	**5-6**	**Every day**	**Never**
Percent that should have cooked using cooktop yesterday based on weekly cooking frequency	21.4%	50.0%	78.6%	100.0%	0.0%
		Percent that actually cooked			
Breakfast	33.6%	68.0%	85.7%	94.3%	1.6%
Lunch	20.6%	52.6%	ND	ND	3.5%
Dinner	56.0%	66.3%	82.2%	85.7%	0.0%
Other	19.3%	64.0%	ND	ND	7.9%

Cooking Within the Past 24 Hours Related to Household Characteristics

Responses related to cooktop and oven use within the past 24 hours were combined to calculate the number of respondents that performed any cooking task for each meal within the past 24 hours. The following figures show how cooking occurrence varies depending on age groups represented, ethnicities represented, and number of residents in the household.

Figure 5 shows the percent of households in each age group that reported any cooking activity for each meal over the past 24 hours. The presence of one or more children or seniors is shown to correlate with a slightly higher percent of respondents cooking for breakfast, lunch, and dinner.

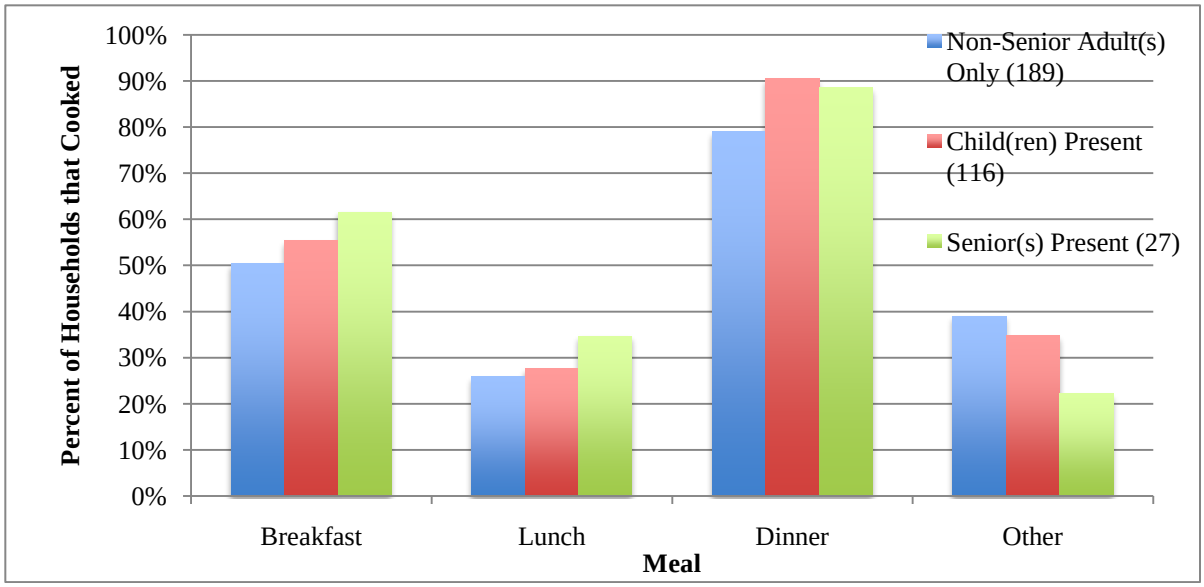

Figure 5. Cooktop and/or oven use for each meal within the past 24 hours by age groups represented in the household.

Figure 6 shows that the pattern of cooking across meals is roughly consistent across ethnicities represented in the survey. (The category "American Indian, Alaska Native" is omitted in the figure because this ethnicity was represented in only one household.)

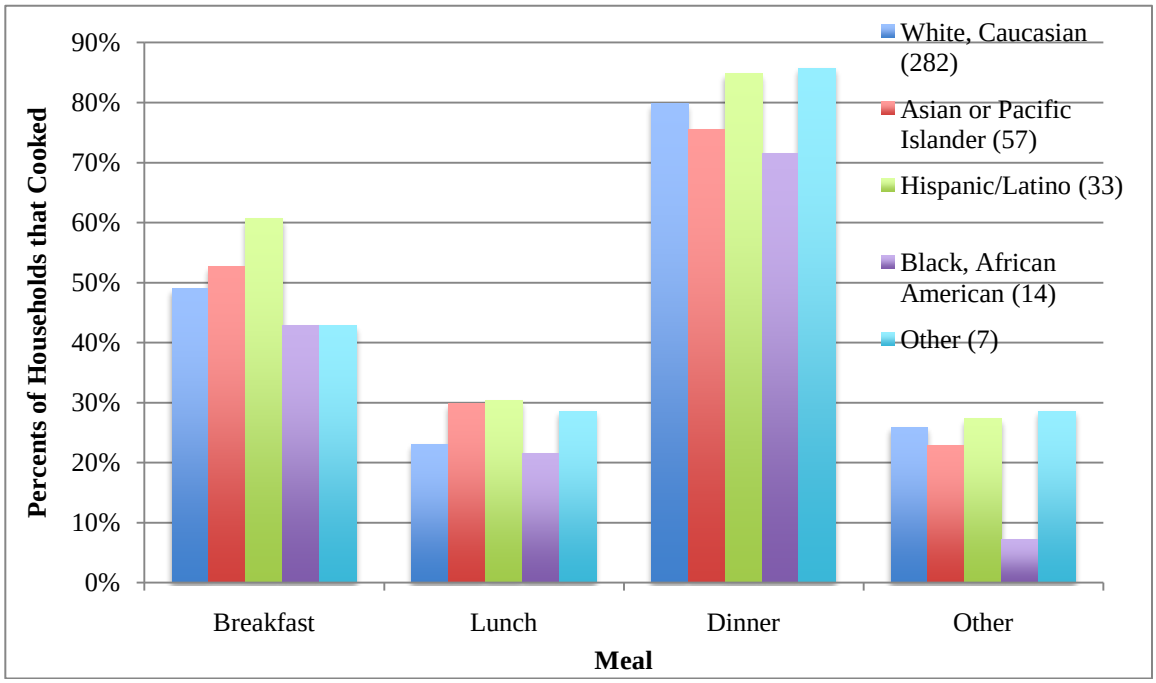

Figure 6. Cooktop and/or oven use for each meal within the past 24 hours by ethnicities represented in the household.

Figure 7 shows the percent of households with each number of residents that reported cooking during each meal over the past 24 hours. Frequency of cooking generally increases with

increasing number of residents. The increase in number of respondents who cooked with increased number of residents is more substantial than the increase with the presence of a child or a senior (Figure 5).

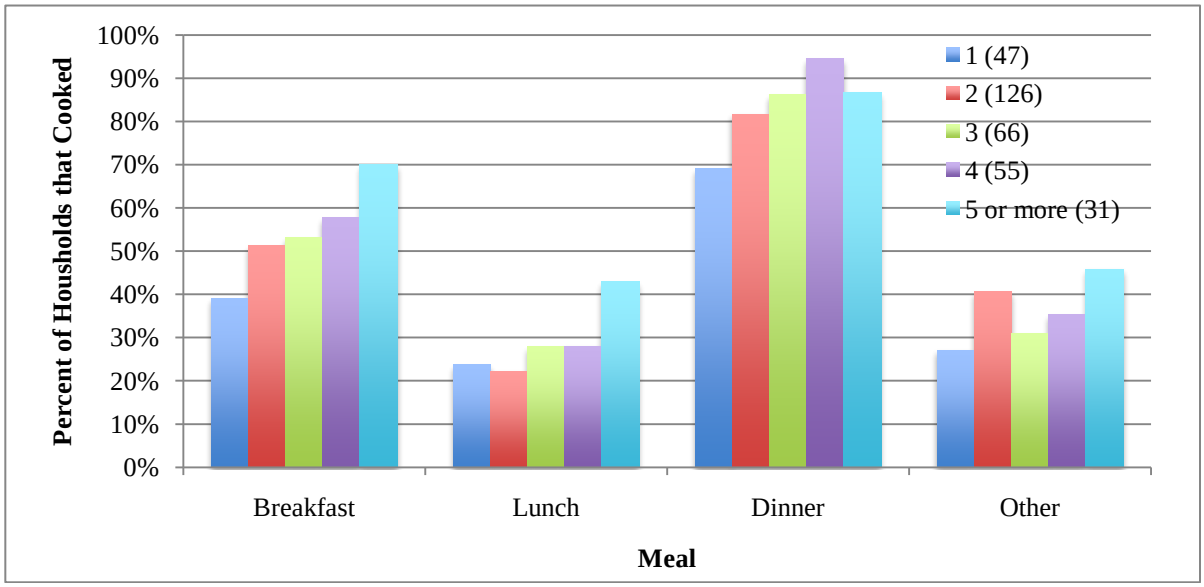

Figure 7. Cooktop and/or oven use for each meal within the past 24 hours by number of residents in the household.

Type of Cooking Activity

The survey asked respondents to report specific cooking activities when breakfast, lunch, or dinner was cooked within the past 24 hours. Table 25 shows how frequently each specific cooking activity was reported among respondents reporting any cooking for the meal. Boiling is the most common type of cooking activity for all meals, simmering is the second most common for lunch and dinner, and pan-frying is the second most common for dinner.

Table 25. Positive responses for each cooking activity for each meal.

Divisor is the number of respondents who reported at least one type of cooking activity for a particular meal, shown in parentheses in the column heading for each meal.

Cooking Activity	Breakfast (163)	Lunch (78)	Dinner (262)
Stir-frying	6.7%	16.7%	26.3%
Pan-frying	44.2%	35.9%	40.1%
Boiling	68.1%	69.2%	76.0%
Simmering	22.7%	50.0%	67.9%
Baking	13.5%	16.7%	48.9%
Broiling	3.1%	1.3%	12.2%

Table 26, Table 27, and Table 28 show how the type of cooking activity varies for each meal depending on ethnicity. Occurrence of most types of cooking are shown to not vary significantly by ethnicity, although it is interesting to note that the percent of households with Asian or Pacific Islander residents in which food was stir-fried during lunch (52.9%) is over 40 percentage points greater than in households without Asian or Pacific Islander residents.

Table 26. Type of cooking depending on ethnicity—breakfast.

Divisor is the number of households in which the ethnicity is represented that cooked for breakfast, shown in parentheses in each column heading.

	Breakfast			
Cooking Type	**White, Caucasian (138)**	**Asian or Pacific Islander (30)**	**Hispanic/Latino (20)**	**Black, African American (6)**
Stir-Fried	5.1%	10.0%	15.0%	16.7%
Pan-Fried	45.7%	43.3%	40.0%	83.3%
Boiled	64.5%	73.3%	70.0%	83.3%
Simmered	20.3%	20.0%	35.0%	0.0%
Baked	10.1%	10.0%	10.0%	33.3%
Broiled	2.9%	6.7%	0.0%	0.0%

Table 27. Type of cooking depending on ethnicity—lunch.

Divisor is the number of households in which the ethnicity is represented that cooked for lunch, shown in parentheses in each column heading.

	Lunch			
Cooking Type	**White, Caucasian (65)**	**Asian or Pacific Islander (17)**	**Hispanic/Latino (10)**	**Black, African American (3)**
Stir-Fried	9.2%	52.9%	10.0%	0.0%
Pan-Fried	32.3%	52.9%	60.0%	66.7%
Boiled	69.2%	76.5%	70.0%	33.3%
Simmered	41.5%	64.7%	50.0%	33.3%
Baked	12.3%	11.8%	10.0%	33.3%
Broiled	1.5%	0.0%	0.0%	0.0%

Table 28. Type of cooking depending on ethnicity—dinner.

Divisor is the number of households in which the ethnicity is represented that cooked for dinner, shown in parentheses in each column heading.

	Dinner			
Cooking Type	**White, Caucasian (225)**	**Asian or Pacific Islander (43)**	**Hispanic/Latino (28)**	**Black, African American (10)**
Stir-Fried	23.1%	44.2%	39.3%	40.0%
Pan-Fried	39.6%	58.1%	50.0%	30.0%
Boiled	76.9%	83.7%	89.3%	90.0%
Simmered	68.0%	76.7%	71.4%	90.0%
Baked	52.0%	41.9%	67.9%	30.0%
Broiled	11.6%	20.9%	14.3%	0.0%

Table 29, Table 30, and Table 31 show how the type of cooking activity varies for each meal depending on age groups represented in the household. Occurrence of type of cooking activity is shown not to vary greatly for each meal by the age groups represented in the household.

Table 29. Type of cooking depending on age group represented—breakfast.

Numbers shown in parentheses in the column headings for each age group are the number of households in which the age group is represented that reported cooking for breakfast.

	Breakfast		
Cooking Type	**Non-Senior Adult(s) Only (88)**	**Child(ren) Present (62)**	**Senior(s) Present (16)**
Stir-Fried	9.1%	4.8%	0.0%
Pan-Fried	47.7%	41.9%	25.0%
Boiled	67.0%	71.0%	68.8%
Simmered	26.1%	17.7%	18.8%
Baked	12.5%	14.5%	18.8%
Broiled	4.5%	0.0%	6.3%

Table 30. Type of cooking depending on age group represented—lunch.

Numbers shown in parentheses in the column headings for each age group are the number of households in which the age group is represented that reported cooking for lunch.

	Lunch		
Cooking Type	**Non-Senior Adult(s) Only (44)**	**Child(ren) Present (29)**	**Senior(s) Present (9)**
Stir-Fried	22.7%	10.3%	11.1%
Pan-Fried	45.5%	24.1%	22.2%
Boiled	63.6%	75.9%	77.8%
Simmered	61.4%	31.0%	44.4%
Baked	20.5%	10.3%	11.1%
Broiled	0.0%	0.0%	11.1%

Table 31. Type of cooking depending on age group represented—dinner.

Numbers shown in parentheses in the column headings for each age group are the number of households in which the age group is represented that reported cooking for dinner.

	Dinner		
Cooking Type	**Non-Senior Adult(s) Only (140)**	**Child(ren) Present (104)**	**Senior(s) Present (23)**
Stir-Fried	28.6%	19.2%	43.5%
Pan-Fried	45.0%	31.7%	52.2%
Boiled	78.6%	72.1%	87.0%
Simmered	68.6%	65.4%	69.6%
Baked	45.0%	52.9%	56.5%
Broiled	12.1%	11.5%	13.0%

Table 32, Table 33, and Table 34 show correlations between types of cooking activities—that is, how often each type of cooking activity occurs with the other—for each meal. In each table, the percent of respondents who performed the cooking task in the leftmost column who also performed the cooking task across the top row are displayed in each cell. Since the number of respondents who performed a certain cooking task varies and the values in each column relate to this number, results are not symmetrical about the diagonal.

Boiling, as the most common cooking activity overall, is also most frequently paired with another activity, occurring for example, about 80% of the time that simmering occurs for all meals. Pan-frying and boiling are also often paired.

Table 32. Cooking task patterns—breakfast.

Percent of those reporting cooking task in left column who also did task in column heading						
	Stir-fried	**Pan-fried**	**Boiled**	**Simmered**	**Baked**	**Broiled**
Stir-fried (11)	100.0%	36.4%	63.6%	36.4%	18.2%	0.0%
Pan-fried (72)	5.6%	100.0%	47.8%	13.9%	13.9%	2.8%
Boiled (111)	6.3%	28.8%	100.0%	25.2%	15.3%	2.7%
Simmered (37)	10.8%	27.0%	77.8%	100.0%	18.9%	2.7%
Baked (22)	9.1%	45.5%	85.0%	31.8%	100.0%	4.5%
Broiled (5)	0.0%	40.0%	60.0%	20.0%	20.0%	100.0%

Table 33. Cooking task patterns—lunch.

Percent of those reporting cooking task in left column who also did task in column heading						
	Stir-fried	**Pan-fried**	**Boiled**	**Simmered**	**Baked**	**Broiled**
Stir-fried (13)	100.0%	23.1%	38.5%	38.5%	23.1%	0.0%
Pan-fried (28)	10.7%	100.0%	57.1%	46.4%	10.7%	0.0%
Boiled (54)	9.3%	29.6%	100.0%	57.4%	13.0%	0.0%
Simmered (39)	12.8%	33.3%	79.5%	100.0%	20.5%	0.0%
Baked (13)	23.1%	23.1%	53.8%	61.5%	100.0%	0.0%
Broiled (1)	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%

Table 34. Cooking task patterns—dinner.

Percent of those reporting cooking task in left column who also did task in column heading						
	Stir-fried	**Pan-fried**	**Boiled**	**Simmered**	**Baked**	**Broiled**
Stir-fried (69)	100.0%	46.4%	80.6%	76.9%	46.4%	10.1%
Pan-fried (102)	31.4%	100.0%	70.2%	71.8%	47.6%	14.3%
Boiled (199)	27.1%	36.7%	100.0%	71.4%	46.2%	11.1%
Simmered (178)	28.1%	41.6%	81.1%	100.0%	28.1%	12.9%
Baked (122)	26.2%	41.3%	74.2%	65.0%	100.0%	17.2%
Broiled (28)	25.0%	51.7%	73.3%	76.7%	71.0%	100.0%

Aggregate Burner-Minutes

To explore the relationship between total cooking activity and variables such as meal, age of household residents, ethnicity of household residents, and type of cooking, a “burner-minute” metric was calculated. The respondents indicated how many minutes the cooktop was used, how many cooktop burners were used, and how many minutes the oven was used for each meal over the past 24 hours. Although cooking emissions are likely to be influenced by the energy use rate of the burner, we did not include a question about cooktop burner size or setting to avoid lengthening the survey. Due to the lack of key questions relating to energy use rate and the imprecision of the burner-minutes model, it should be used only as an approximation of overall cooking burner use.

In order to approximate how much use of the burners (both cooktop and oven) these responses represented, the number of cooktop burners used was multiplied by the minutes of cooktop use. Since it is logical to assume that a respondent who indicated having used several cooktop burners and using the cooktop for a long time did not use all of the cooktop burners for that amount of time, we set a maximum of 250 “burner-minutes” for the total cooktop use of a single respondent for each meal. This is not sufficient to entirely correct for the likelihood that not all burners were on for the entire time cooking was reported, but it does help to ensure that inaccurately high individual reports of burner use do not greatly bias the total aggregate burner-minutes for a group.

In order to approximate oven burner-minutes, we considered that oven burners are comparable to two cooktop burners, but that oven burners are on for approximately one-half of the reported oven use duration. See Appendix B for data illustrating how oven use times translate to oven burner operation times. Since the oven burner is considered to be two cooktop burners but on for half the time, the reported oven duration is the same as the burner-minutes representing oven use.

This model, although imprecise, allows us to represent the extent of cooking as a single value, facilitating the investigation of several questions we set out to answer. These include seeing if burner-minutes correlate with activities meant to mitigate the effects of cooking on air quality, like kitchen exhaust fan use or window opening and if certain household characteristics correlate with more cooking activity, as indicated by burner-minutes.

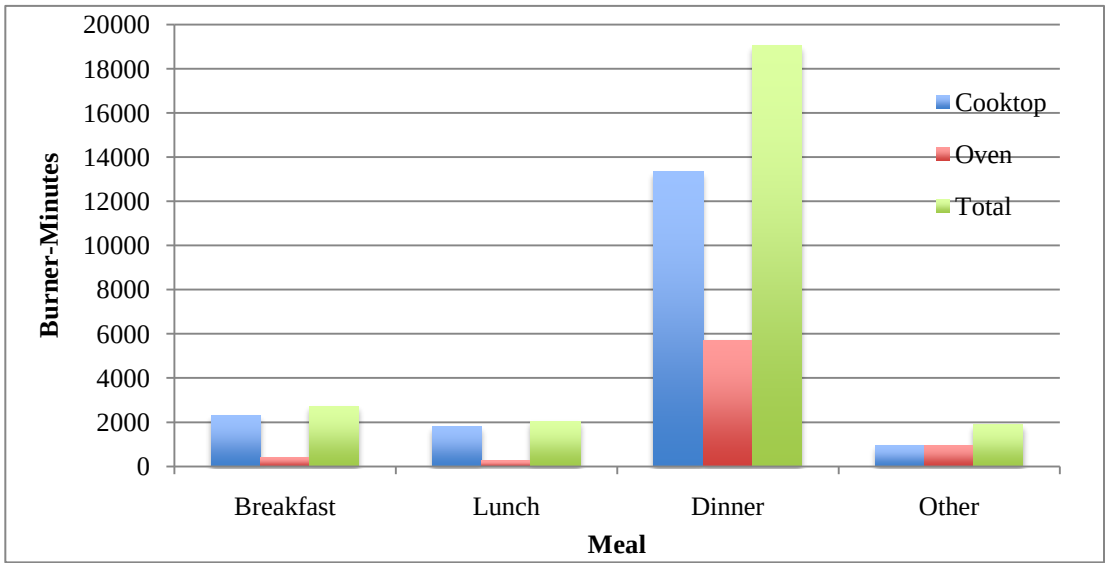

Figure 8. Cooktop, oven, and total burner-minutes for each meal.

For breakfast, total burner-minutes amounted to about 2700, with nearly 85% coming from cooktop use and 15% coming from oven use. For lunch, total burner-minutes amounted to about 2050, with 88% coming from cooktop use and 12% coming from oven use. For dinner, the total burner-minutes amounted to 19,000, with 70% coming from cooktop use and 30% coming from oven use. For all "other" cooking, total burner-minutes amounted to about 1900, with 50% coming from cooktop use and 50% coming from oven use. These numbers allow us to see how significantly dinner burner use dominates all other use. Breakfast, lunch and other cooking all have similar totals for estimated burner minutes, each individually about a tenth of those used during dinner. It should again be noted that the burner-minutes metric is imprecise, and these numbers are meant only to explore how cooking varies by meal and other factors.

Table 35 shows the average burner-minutes by reported frequency of cooktop use during a typical week, relating reported amount of burner use in past 24 hours to the reported frequency of cooking over a week. Numbers in parentheses in each cell are the number of respondents that reported each weekly cooktop cooking frequency for that particular meal and also reported cooking yesterday—that is, the divisor used to calculate the average aggregate cooktop burner-minutes. The general increase in average aggregate burner-minutes with an increase in weekly

cooking frequency indicates that people who cook more frequently also tend to cook more when they cook. Average aggregate burner-minutes values are not "0" for respondents who reported to "never" perform cooking for a particular meal because of inconsistency between reporting weekly cooking frequency and cooking performed yesterday, as shown previously in Table 24.

Table 35. Average aggregate cooktop burner-minutes by frequency of cooktop use reported for each meal during typical week.

Numbers in parentheses in each cell are the numbers of respondents reporting the weekly cooking frequency for the meal.

	Average aggregate cooktop burner-minutes by meal			
Reported weekly cooking frequency	**Breakfast**	**Lunch**	**Dinner**	**Other**
Never	3.0 (1)	5.7 (3)	0 (0)	9.1 (5)
1-2	11.3 (42)	20.8 (33)	40.7 (14)	10.5 (21)
3-4	14.1 (34)	21.0 (20)	44.9 (53)	18.3 (16)
5-6	19.4 (24)	25.7 (6)	52.3 (106)	4.3 (8)
Every day	17.2 (50)	58.1 (9)	70.6 (66)	20.2 (12)

Table 36 displays the calculated aggregate burner minutes by meal for respondents reporting whether cooking a given meal occurred on a weekday. All households responding "Yes" to the question "Cooking occurred on a weekday?" were placed in the weekday category; those responding "No" were placed into the weekend group. Blank responses to this question were excluded from this calculation. Respondents not reporting the number of burners used or the duration of burner use also were excluded. The total (sum of) burner-minutes for each group (weekend or weekday, resolved by meal) was divided by the number of respondents in each group to calculate average burner minutes for the meal. The numbers of respondents for each meal group are shown in the table in parentheses. The data suggest that breakfast cooking may be more extensive on weekends, lunch cooking may be more extensive during the week, and extent of cooking for dinner is similar on weekdays and weekends.

Table 36. Average Aggregate Total Burner-Minutes Depending on Whether Cooking Occurred on a Weekday or a Weekend.

Parentheses show number of responses from which the mean burner-minutes were calculated.

	Breakfast	**Lunch**	**Dinner**
Weekday	15.2 (126)	29.4 (49)	73.5 (200)
Weekend	22.0 (33)	20.7 (25)	75.4 (54)

Household Occupancy During the Use of Oven and/or Cooktop

To assess the fraction of household occupants that may be impacted by pollutant emissions associated with cooking activities, we calculated a "meal occupancy ratio" which is the number of people in the home at the time that a meal was cooked divided by the number of residents of the household. This is important to the modeling of indoor air quality and exposure impacts related to cooking; when more people are at home during cooking, exposure impacts are greater. When asked how many people were present during cooking for each meal, respondents had the options of 1, 2, 3, 4, 5, or more than 5; when asked how many residents live in the household, respondents had the options of 1, 2, 3, 4, or 5+. "More than 5" responses were treated as 6 and 5+ responses were treated as 5 when calculating the ratio, although some respondents may have

meant for 5+ to represent more than 5 residents in the home. Also, respondents that did not report any cooking for a particular meal were not included in the average ratio calculation.

Table 37, Table 38, and Table 39 show active responses (decline to state, don't know, and blank responses omitted) for how many people were home during the cooking of each meal depending on the number of residents in the household. It is notable that the mode for people home during cooking for breakfast and dinner is the number of residents. For lunch, fewer people tend to be home during cooking than the number of residents in the household. In many cases, the respondents reported a larger number of occupants present during cooking than reside in the home. The meal occupancy ratio is used to condense the results presented in the following three tables and compare occupancy during cooking by meal, weekday/weekend, and age of residents.

Table 37. People home during cooking by number of residents in household—breakfast.

	Breakfast				
	Number of residents in household				
People home during cooking	**1**	**2**	**3**	**4**	**5**
1	31	19	4	1	
2	4	67	18	1	3
3		4	25	8	2
4			3	29	4
5				4	8
More than 5					7

Table 38. People home during cooking by number of residents in household—lunch.

	Lunch				
	Number of residents in household				
People home during cooking	**1**	**2**	**3**	**4**	**5**
1	28	33	8	9	1
2	2	31	14	7	2
3		1	10	5	3
4			1	11	5
5				4	4
More than 5			1		2

Table 39. People home during cooking by number of residents in household—dinner.

	Dinner				
	Number of residents in household				
People home during cooking	**1**	**2**	**3**	**4**	**5**
1	33	11	1		
2	7	91	7	3	
3		2	45	10	2
4		1	4	33	6
5		1	1	2	11
More than 5		1	1	3	10

Table 40 shows the meal occupancy ratio for each meal and also separates data into weekday vs. weekend cooking occurrence. The number of respondents noted in weekend and weekday entries is less than the number for all days because some respondents did not answer the question about whether the given meal occurred on a weekday. Overall, Table 39 shows that occupancy ratios are close to one on average. The largest weekday-weekend difference was seen for lunch. It must

be noted however that this analysis does not distinguish by household size; households of one person should always have a ratio of at least one and with one guest those households would have a ratio of 2. The analysis nevertheless provides solid support for using the number of occupants for initial estimates of exposures.

Table 40. Average meal occupancy ratio during each meal and separated by weekday and weekend.

"Number of households" is the number of households that cooked during the particular meal that reported how many people were home during the cooking for the meal, how many people live in the house, and, for weekday and weekend cooking, that reported that cooking occurred during that time of week.

		Breakfast	Lunch	Dinner
All days	Meal occupancy ratio	0.95	0.80	1.02
	Number of households	160	75	251
Weekday	Meal occupancy ratio	0.93	0.72	1.02
	Number of households	123	46	191
Weekend	Meal occupancy ratio	1.01	0.98	1.02
	Number of households	33	25	53

Table 41 shows that the meal occupancy ratio does not vary substantially when children or seniors are present in the home.

Table 41. Average meal occupancy ratio for each meal depending on age groups represented in the household.

"Number of households" is the number of households that cooked during the particular meal that reported how many people were home during the cooking for the meal, how many people live in the house, and fit into the age group in the leftmost column.

		Breakfast	Lunch	Dinner	Other
Non-Senior Adults Only	Meal occupancy ratio	0.95	0.82	1.01	0.96
	Number of households	86	42	137	52
Child or Children Present	Meal occupancy ratio	0.96	0.81	1.01	0.93
	Number of households	62	29	98	21
Senior(s) Present	Meal occupancy ratio	0.89	0.73	1.12	0.95
	Number of households	16	8	21	4

Ventilation Patterns

One important aspect of cooking activity that our survey addresses is ventilation that relates to cooking. This section presents the frequency with which the range hood was used, the frequency with which window(s) were open during cooking, the frequency with which the two occurred together, and how range hood use varies depending on a variety of factors.

Table 42 shows the frequency (percent) with which respondents that reported some cooking for a meal used the range hood during cooking. The range hood was used most often during dinner and least often during breakfast.

Table 42. Range hood use for each meal.

Range Hood On	Breakfast (163)	Lunch (78)	Dinner (262)	Total For All Meals
Yes	21.5%	33.3%	42.4%	34.2%
No	74.2%	57.7%	54.2%	61.2%
Don't Know	1.2%	6.4%	1.1%	2.0%
Blank	3.1%	2.6%	2.3%	2.6%
	100%	100%	100%	100%

Table 43 shows the frequency (percent) with which respondents who reported some cooking for a meal also had at least one window was open during cooking. It should be noted that window opening follows seasonal and daily patterns and the survey did not ask if windows were opened specifically for the purpose of ventilation during cooking or whether the window was open in the kitchen or in another part of the house. The fact that windows were open substantially more during lunch and dinner may just reflect springtime ventilation behaviors rather than have any link to cooking.

Table 43. Window(s) open for each meal.

Window(s) Open	Breakfast (163)	Lunch (78)	Dinner (262)	Total For All Meals
Yes	19.0%	37.2%	35.1%	30.2%
No	74.2%	57.7%	59.9%	64.2%
Don't Know	1.8%	2.6%	1.9%	2.0%
Blank	4.9%	2.6%	3.1%	3.6%
	100%	100%	100%	100%

Table 44 shows the correlation between range hood use and window(s) being open. This analysis shows that 40-60% of the respondents did not use their range hood even though they didn't have windows open.

Table 44. Paired range hood use and window(s) being open for each meal.

Adding the percentages for the four possible combinations for each meal yields 100%. "Don't know" and blank responses to either question—range hood use or window(s) being open—were omitted for simplicity.

	Window(s) Opened					
	Breakfast		Lunch		Dinner	
Range Hood On	No	Yes	No	Yes	No	Yes
No	63.3%	14.7%	40.8%	22.5%	38.4%	19.6%
Yes	16.0%	6.0%	21.1%	15.5%	24.9%	17.1%

Table 45 through Table 47 show how range hood use varied depending on cooking task, age group of residents, and aggregate burner-minutes range. Each of these tables presents the number and percent of respondents in each particular category that used their range hood for that meal. The percent is calculated by dividing the number in the "Number" column by the number of respondents in that particular category for the meal. Since the question about range hood use for the particular meal is included in the same section of the survey as the questions about whether cooking occurred for each meal, we assumed that blank responses to the range hood question indicate a negative response instead of simply skipping over sections of questions. See Appendix A to see the location of these questions in the survey. For all three of the comparisons presented, blank and "don't know" responses to the question about range hood use are considered negative responses and included in the divisor.

Table 45 shows how range hood use varies depending on cooking task. The number of respondents who completed each cooking activity during breakfast and lunch may be too small to make any significant observations about range hood use depending on cooking activity. Higher numbers of respondents cooking during dinner allow us to see that range hood use varies only slightly depending on cooking task.

Table 45. Range hood use by cooking task.

"Number" is the number of respondents who reported using the range hood during the meal listed above that performed the cooking task at left; the divisor used to calculate percent is the number of respondents that performed the cooking task at left for the particular meal. Blank and "don't know" responses to the question about range hood use are considered negative responses and included in the divisor.

	Breakfast		Lunch		Dinner	
Cooking Task	**Number**	**Percent**	**Number**	**Percent**	**Number**	**Percent**
Stir-Fried	2	18.2%	8	61.5%	36	52.9%
Pan-Fried	20	27.8%	14	50.0%	52	49.5%
Boiled	19	17.1%	21	38.9%	88	44.2%
Simmered	7	18.9%	18	46.2%	81	45.5%
Baked	7	31.8%	3	23.1%	61	47.7%
Broiled	1	20.0%	0	0.0%	19	59.4%

Table 46 shows how range hood use varies depending on age groups of residents. The presence of children appears to be associated with slightly higher rates of range hood use. For homes with seniors, the only meal with a non-negligible number of respondents was dinner, and for this meal homes with seniors present were more likely to use their hoods.

Table 46. Range hood use by age group for each meal.

"Number" is the number of respondents who reported using the range hood during the meal listed above that fit into the age group at left; the divisor used to calculate percent is the number of respondents that fit into the age group at left for the particular meal. Blank and "don't know" responses to the question about range hood use are considered negative responses and included in the divisor.

	Breakfast		Lunch		Dinner	
Age Group	**Number**	**Percent**	**Number**	**Percent**	**Number**	**Percent**
Non-Senior Adult(s) Only	16	18.2%	15	34.1%	50	35.7%
Child(ren) Present	15	24.2%	11	37.9%	49	47.1%
Senior(s) Present	5	31.3%	1	11.1%	16	69.6%

Table 47 shows how range hood use varies depending on total aggregate burner-minutes. During dinner, the percent of respondents using their range hood evidently increases as the overall amount of cooking (as represented by burner-minutes) increases.

Table 47. Range hood use by aggregate burner-minutes range for each meal.

"Number" is the number of respondents who reported using the range hood during the meal listed above whose cooking activities fit into the burner-minutes range at left; the divisor used to calculate percent is the number of respondents whose cooking activities fit into the burner-minutes range at left for the particular meal. Blank and "don't know" responses to the question about range hood use are considered negative responses and included in the divisor.

	Breakfast		Lunch		Dinner	
Burner-Minutes Range	**Number**	**Percent**	**Number**	**Percent**	**Number**	**Percent**
1-10 Minutes	10	13.2%	10	31.3%	7	23.3%
11-20 Minutes	13	31.0%	5	31.3%	6	26.1%
21-30 Minutes	7	35.0%	5	33.3%	21	42.9%
More than 30 minutes	3	15.0%	5	35.7%	68	48.6%

CONCLUSIONS

The survey responses and analyses included in this report provide insight to important relationships between household characteristics and cooking-related activities that impact indoor

air quality. This report is intended to demonstrate that valuable data can be obtained via relatively inexpensive web-based sampling, even when the final respondent cohort is not statistically representative of the population.

Cooktop use was shown to occur much more frequently than oven use. Cooktop and/or oven cooking was shown to occur more often when a child or senior is a resident of the household and when there are more residents in the household. Extent of cooking during dinner dominates the extent of cooking during any other meal. People who cook more frequently during a typical week also tend to cook more (for a longer period of time or using more burners) when they cook. Occupancy during cooking is most commonly equal to the number of residents and is sometimes even larger. The mean ratio of number present during cooking to number residing suggests some differences in weekday vs. weekend occupancy for breakfast and lunch, but not for dinner.

Boiling is the most popular type of cooking activity for all meals and is shown to be the type of cooking activity most frequently paired with another activity—that is, when boiling occurs, it is very likely that another type of cooking activity occurs as well.

Range hood use was shown to occur most often during dinner (42%) and least often during breakfast. Between 38% (dinner) and 63% (breakfast) of households do not use their range hood even if there are no windows open during cooking. The presence of children and/or senior residents is shown to correlate with increased range hood use. Range hood use was also shown to increase with increased extent of cooking.

FUTURE WORK

Lessons learned from this study will be incorporated into future efforts to collect data on activities that impact indoor air quality. The intent is that future surveys will include questions about a wider variety of indoor source and ventilation issues.

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REFERENCES

CEC (2004). *California Statewide Residential Appliance Saturation Study. Final Report. Prepared by KEMA-XENERGY,* Itron, RoperASW. June 2004. 400-04-009. Available at: http://www.energy.ca.gov/reports/400-04-009/2004-08-17_400-04-009ALL.PDF.

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

Lobscheid AB, Klepeis NE, Singer BC. Modeling population exposures to pollutants emitted from natural gas cooking burners. *Proceedings of Indoor Air 2011, The 11th International Conference on Indoor Air Quality and Climate,* Austin TX. International Academy of Indoor Air Sciences. Lawrence Berkeley National Laboratory Report LBNL-4885E.

Singer BC, Lobscheid AB, Klepeis NE. Natural Gas Variability in California: Environmental Impacts and Device Performance: Simulation-Based Estimates of Indoor Exposures to Pollutants from Natural Gas Cooking Burners. California Energy Commission, PIER Energy-Related Environmental Research, Interim Report. Contract CEC-500-05-026. This report should be completed in September 2011 with LBNL and CEC report numbers to be assigned.

Singer BC, MG Apte, DR Black, T Hotchi, D Lucas, MM Lunden, AG Mirer , M Spears, and DP Sullivan (2009). *Natural Gas Variability in California: Environmental Impacts and Device Performance: Experimental Evaluation of Pollutant Emissions from Residential Appliances.* California Energy Commission Report CEC□500□2009□099. December 2009. LBNL-2897E.

Appendix A. Cooking Survey

Household Cooking Patterns

1. Consent to Participate in Household Cooking Activity Survey

*** 1. The purpose of this survey is to collect data on household cooking activity. Your responses will be used to characterize cooking-related pollutant exposures and to relate these exposures to household characteristics. This research is being conducted by Lawrence Berkeley National Laboratory and is funded by the California Energy Commission.**

Participation in this research survey is voluntary. No incentive is being offered and there is no penalty for choosing not to participate or to stop participating at any time. You will have the option at the end of the survey of whether to 1) submit your responses, or 2) stop the survey and your responses will not be used.

Participation involves completing an online survey that will take 5-10 minutes.

The survey tool was designed to be anonymous and confidential. Data will be stored in a password protected electronic format and the survey does not request personally identifiable information. IP addresses of responders will be retained solely for the purpose of screening out replicates. The results of this study will be used for scientific research purposes only.

If you have any questions about the research study, please contact Agnes Lobscheid at 510-486-6945, or ablobscheid@lbl.gov. This research has been reviewed according to the Lawrence Berkeley National Laboratory Institutional Review Board procedures for research involving human subjects.

ELECTRONIC CONSENT: Please select your choice below.
Clicking on the "agree" button below indicates that:
- **you have read the above information**
- **you voluntarily agree to participate**
- **you are at least 18 years of age**

If you do not wish to participate in the research study, please decline participation by clicking on the "disagree" button.

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Household Cooking Patterns

- agree
- disagree

2. Stove/Cooktop and Conventional Oven (not microwave oven) Characteristics

This survey will ask questions about your COOKTOP and OVEN. The COOKTOP, sometimes called a stove top, refers to the gas burners or electric heating elements at counter level. OVEN questions refer only to gas or electric conventional (standard) ovens; they do NOT include microwaves.

This Section asks about the type of COOKTOP and OVEN in your residence. If you have both gas and electric conventional ovens, provide information for the one that is used most often.

1. What is the fuel for your Cooktop and Conventional Oven?

	natural gas	electric	other
COOKTOP	○	○	○
OVEN	○	○	○

2. How old is your Cooktop and Conventional Oven?

	0-4 years	5-9 years	10-14 years	15-19 years	20+ years
COOKTOP	○	○	○	○	○
OVEN	○	○	○	○	○

3. TYPICAL WEEK'S COOKING ACTIVITY

1. In a typical week, on how many days do you or anyone in your household, use your COOKTOP for the following cooking events?

	Never	1-2	3-4	5-6	every day
Breakfast	○	○	○	○	○
Lunch	○	○	○	○	○
Dinner	○	○	○	○	○
Other- snacks or other food preparation	○	○	○	○	○

2. In a typical week, on how many days do you and/or anyone in your household, use your CONVENTIONAL OVEN for the following cooking events?

	Never	1-2	3-4	5-6	every day
Breakfast	○	○	○	○	○
Lunch	○	○	○	○	○
Dinner	○	○	○	○	○
Other- snacks or other food preparation	○	○	○	○	○

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Household Cooking Patterns

4. Cooking Activity OVER THE PAST 24 HOURS

The next two questions refer to ALL cooking activity in your home OVER THE PAST 24 HOURS. For cooking times, please provide the best estimate in the pull-down menus, of the number of minutes YOU OR ANYONE in your household spent using the Cooktop and/or Oven.

1. Thinking about Breakfast, Lunch, Dinner, and Other Cooking OVER THE PAST 24 HOURS, how many

	minutes was COOKTOP used?	COOKTOP burners were used?	minutes was OVEN used?	people at home (including you) when cooking occurred?
Breakfast				
Lunch				
Dinner				
Other (snacks and other food preparation)				

2. Please select whether or not the following statements apply to the Breakfast, Lunch and Dinner cooking activities in your home OVER the PAST 24 HOURS.

	Breakfast	Lunch	Dinner
Cooking Activity was on a weekday			
Kitchen exhaust fan was on			
Window(s) opened during cooking			
Food was stir-fried			
Food was pan-fried			
Liquid was boiled			
Food was simmered			
Oven used on BAKE setting			
Oven used on BROIL setting			

5. Household characteristics.

The information you provide to us on the next four questions will allow us to assess cooking-related exposures based on household characteristics.

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Household Cooking Patterns

1. How many people, including yourself, currently reside in your household?

- 1
- 2
- 3
- 4
- 5+
- decline to state

2. Please indicate the number of household residents that are in the following age categories.

	0	1	2	3	4	5+	decline to state
0-17 years old							
18-65 years old							
over 65 years old							

3. Which of the following ethnicities are represented by member(s) of your household?

- [ ] American Indian, Alaksa Native
- [ ] Asian or Pacific Islander
- [ ] Black, African American
- [ ] Hispanic/Latino
- [ ] White, Caucasian
- [ ] Other
- [ ] decline to state

4. What type of building does your household reside in?

- single-family detached
- townhome/duplex
- 2-4 unit condo or apartment
- apartment/condo with more than 5 units
- mobile home
- decline to state

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Household Cooking Patterns

6. Submit your response

1. Please select one of the following.

- ○ Submit my responses
- ○ Stop survey and do not use my responses

7. Your responses have been submitted!

Thank you for your participation!

If you have any questions about this study, please contact

Agnes Lobscheid at 510-486-6945 or ablobscheid@lbl.gov
or
Brett Singer at 510-486-4779 or BCSinger@lbl.gov

8. Stop Survey

The survey has ended. If you provided any responses, they will not be used.

If you have any questions about the survey, please contact

Agnes Lobscheid at 510 486 6945 or ablobscheid@lbl.gov
or
Brett Singer at 510 486 4779 or BCSinger@lbl.gov

9.

The survey has ended. Please exit the browser.

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Appendix B. Oven Burner Time Algorithm

This appendix presents discussion from Singer et al. (2011) and data from Singer et al. (2009) to support our assertion about the translation from oven use times to oven burner operation times.

In order to capture the total oven burner "on" time, we extracted on/off cycling patterns from the 10-second resolved experimental data from Singer et al. (2009) to determine a burner firing algorithm for each oven used in our simulation. These oven-specific algorithms were used to translate the reported oven use durations (from web-based survey) to burner operation times. The oven burner algorithms are specified using the following parameters:

- Oven ramp time (initial burner "on time").
- Fraction of time burner is operating after initial firing to first reach temperature set point.
- Total oven use duration; this is provided by the oven cooking duration reported by the web-based cooking survey respondents.

The oven burner time algorithm, and firing rate [kBtu/h] for each of the twelve ovens is summarized in Table B-1.

Table B-1. Equations used to translate reported oven use times to oven burner operation times.[1]

Oven ID	Measured firing rate [kBtu/hr]	Nominal firing rate [kBtu/hr]	Oven Burner Operation Time
OV01	15.7	15.5	5.8 + 0.33 * (Oven use - 5.8)
OV02	16	18	6.0 + 0.25 * (Oven use- 6.0)
OV03	18.5	18	7.2 + 0.17 * (Oven use -7.2)
OV05	18	18	7.8 + 0.43 * (Oven use - 7.8)
OV06	16	16	7.5 + 0.20 * (Oven use -7.5)
OV07	18	18	10.3 + 0.39 * (Oven use -10.3)
OV08	18	18	5. + 0.18 * (Oven use - 5.2)
OV09	18	18[2]	7.0 + 0.23 * (Oven use -7.0)
OV10	15	18	11.0 + 0.5 * (Oven use - 11.0)
OV11	8.6[3]	16	Same as oven use.[3]
OV12	16	16	7.9 + 0.13 * (Oven use - 7.9)
OV13	17	18	7.3 + 0.17 * (Oven use - 7.3)

[1] "Oven use" is the total duration of use (in minutes), assigned in simulations from a lognormal distribution based on web-based cooking survey responses (Table 11). Burner operation time depends on firing rate, insulation and other device specific parameters. These equations based on oven experiments reported in Singer et al. (2009).

[2] Nominal firing rate of OV09 was not legible on the label on the appliance. Value determined from product information.

[3] OV11 burner operated at lower firing rate and did not regularly cycle. This improperly functioning burner was retained in data set to represent marginal appliances that are known to exist in the population. The results in this report were produced with the measured firing rates show in Table 10. Nominal firing rates were inadvertently used in the quality assurance run.