UNITED STATES OF AMERICA
BEFORE THE
DEPARTMENT OF ENERGY

Energy Conservation Program: Energy Conservation Standards for Consumer Conventional Cooking Products	**)))**	**EERE–2014–BT–STD–0005 RIN 1904–AD15**

ATTACHMENT B
TO THE
COMMENTS OF
THE AMERICAN GAS ASSOCIATION

Energy Information Administration State Appliance Data, March 2023

Dated: April 17, 2023

ENERGY CONSERVATION PROGRAM:
NOTIFICATION OF PETITION FOR RULEMAKING
EERE–2023–BT–TP–0006

ATTACHMENT A
TO THE COMMENTS OF
AMERICAN GAS ASSOCIATION, AMERICAN PUBLIC GAS ASSOCIATION,
NATIONAL PROPANE GAS ASSOCIATION,
SPIRE INC., SPIRE MISSOURI INC., AND SPIRE ALABAMA INC.

COMMENTS OF THE AMERICAN GAS ASSOCIATION IN
EERE–2014–BT–STD–0005 (APRIL 17, 2023) (DOC ID EERE-2014-BT-STD-0005-2279)

PART 3
(Submitted in three parts due to the size of the files)

Preliminary data release date: June 2022
Final data release date: March 2023

Highlights for appliances in U.S. homes by state, 2020

	Number (million) and percentage of housing units										
		Household has…									
	Total[a]	Electric cooking appliance[b]		Natural gas cooking appliance[c]		Two or more refrigerators		Separate freezer		Clothes washer	
All homes	123.53	83.94	68%	47.10	38%	42.53	34%	41.14	33%	103.96	84%
Alabama	1.90	1.53	81%	0.35	18%	0.69	36%	0.79	41%	1.75	92%
Alaska	0.26	0.17	66%	0.10	38%	0.07	27%	0.15	60%	0.21	84%
Arizona	2.68	1.99	74%	0.80	30%	0.98	37%	0.70	26%	2.43	91%
Arkansas	1.14	0.87	76%	0.34	30%	0.30	26%	0.55	48%	1.06	92%
California	13.18	5.98	45%	9.22	70%	4.18	32%	2.55	19%	10.10	77%
Colorado	2.26	1.70	75%	0.71	31%	0.83	37%	0.72	32%	1.94	86%
Connecticut	1.38	1.00	72%	0.37	27%	0.40	29%	0.35	26%	1.07	77%
Delaware	0.38	0.27	70%	0.10	27%	0.15	39%	0.13	35%	0.34	90%
District of Columbia	0.32	0.16	49%	0.20	62%	0.05	15%	0.04	14%	0.18	58%
Florida	8.06	7.44	92%	0.64	8%	2.62	33%	1.75	22%	7.11	88%
Georgia	3.88	2.87	74%	1.35	35%	1.45	37%	1.36	35%	3.53	91%
Hawaii	0.47	0.40	85%	0.05	11%	0.18	39%	0.15	31%	0.39	83%
Idaho	0.66	0.52	79%	0.18	28%	0.31	47%	0.34	52%	0.61	93%
Illinois	4.90	1.99	41%	3.28	67%	1.65	34%	1.57	32%	3.89	79%
Indiana	2.60	1.58	61%	1.05	40%	1.04	40%	1.15	44%	2.37	91%
Iowa	1.28	0.81	63%	0.42	33%	0.54	42%	0.66	51%	1.17	91%
Kansas	1.13	0.90	80%	0.26	23%	0.43	38%	0.50	44%	0.98	87%
Kentucky	1.74	1.47	84%	0.34	20%	0.62	35%	0.71	41%	1.59	91%
Louisiana	1.73	1.30	75%	0.57	33%	0.61	35%	0.81	47%	1.56	91%
Maine	0.56	0.42	74%	0.04	7%	0.14	25%	0.19	34%	0.48	85%
Maryland	2.28	1.59	70%	0.91	40%	0.78	34%	0.81	36%	1.97	86%
Massachusetts	2.71	1.71	63%	1.20	44%	0.72	27%	0.59	22%	2.04	75%
Michigan	3.92	2.39	61%	1.77	45%	1.43	36%	1.63	42%	3.40	87%
Minnesota	2.23	1.63	73%	0.65	29%	0.86	39%	1.17	52%	1.90	85%
Mississippi	1.08	0.88	81%	0.18	17%	0.36	34%	0.52	48%	0.96	89%
Missouri	2.43	1.88	77%	0.65	27%	0.95	39%	1.17	48%	2.11	87%
Montana	0.43	0.33	77%	0.11	26%	0.15	34%	0.24	56%	0.40	91%
Nebraska	0.77	0.63	83%	0.17	23%	0.30	40%	0.38	50%	0.63	83%
Nevada	1.14	0.55	48%	0.69	60%	0.38	33%	0.25	22%	1.00	88%
New Hampshire	0.54	0.37	69%	0.08	14%	0.19	35%	0.18	34%	0.44	83%
New Jersey	3.39	1.38	41%	2.36	69%	1.32	39%	0.73	22%	2.55	75%
New Mexico	0.79	0.44	55%	0.39	50%	0.25	31%	0.33	42%	0.69	88%
New York	7.52	3.30	44%	4.68	62%	1.94	26%	1.71	23%	4.66	62%
North Carolina	4.01	3.62	90%	0.56	14%	1.32	33%	1.26	31%	3.67	92%
North Dakota	0.32	0.28	89%	0.03	11%	0.13	42%	0.20	64%	0.26	83%

Preliminary data release date: June 2022
Final data release date: March 2023

Highlights for appliances in U.S. homes by state, 2020

	Number (million) and percentage of housing units										
		Household has…									
	Total[a]	Electric cooking appliance[b]		Natural gas cooking appliance[c]		Two or more refrigerators		Separate freezer		Clothes washer	
All homes	123.53	83.94	68%	47.10	38%	42.53	34%	41.14	33%	103.96	84%
Ohio	4.74	3.40	72%	1.63	34%	1.74	37%	1.91	40%	4.02	85%
Oklahoma	1.49	1.01	67%	0.55	37%	0.53	36%	0.66	44%	1.32	88%
Oregon	1.65	1.34	81%	0.41	25%	0.58	35%	0.73	44%	1.49	90%
Pennsylvania	5.13	3.35	65%	1.91	37%	2.02	39%	1.93	38%	4.43	86%
Rhode Island	0.42	0.27	65%	0.15	36%	0.14	33%	0.08	20%	0.32	77%
South Carolina	1.97	1.70	86%	0.35	18%	0.61	31%	0.67	34%	1.80	91%
South Dakota	0.35	0.30	86%	0.05	15%	0.14	41%	0.23	65%	0.30	87%
Tennessee	2.66	2.38	89%	0.38	14%	0.88	33%	1.02	38%	2.41	91%
Texas	10.26	7.58	74%	3.84	37%	3.51	34%	3.14	31%	9.03	88%
Utah	1.04	0.79	76%	0.37	35%	0.41	40%	0.49	48%	0.96	92%
Vermont	0.26	0.17	64%	0.03	11%	0.08	29%	0.12	46%	0.21	80%
Virginia	3.24	2.50	77%	0.88	27%	1.25	39%	1.08	33%	2.90	90%
Washington	2.94	2.48	84%	0.71	24%	1.02	35%	1.09	37%	2.49	85%
West Virginia	0.70	0.51	73%	0.17	25%	0.24	34%	0.29	42%	0.62	89%
Wisconsin	2.39	1.66	69%	0.80	34%	0.97	40%	1.20	50%	2.00	84%
Wyoming	0.23	0.18	79%	0.05	24%	0.09	39%	0.12	55%	0.19	86%

Data source: U.S. Energy Information Administration, Office of Energy Demand and Integrated Statistics, Form EIA-457A of the *2020 Residential Energy Consumption Survey*

Notes: Because of rounding, data may not sum to totals. Percentages are calculated on unrounded numbers. See RECS Terminology for the definitions of terms used in these tables. Differences in characteristics between states may not be statistically significant.

[a] *Total* includes all primary occupied housing units. Vacant housing units, seasonal units, second homes, military houses, and group quarters are excluded.

[b] This estimate includes electric ranges, cooktops, and ovens. Microwave ovens and small kitchen appliances are not included in this estimate.

[c] This estimate includes natural gas ranges, cooktops, and ovens. Natural gas outdoor grills are not included in this estimate.

Q = Data withheld because either the relative standard error (RSE) was greater than 50% or fewer than 10 households were in the reporting sample.

N = No households in reporting sample.

Preliminary data release date: June 2022
Final data release date: March 2023

Relative standards errors (RSEs) for Highlights for appliances in U.S. homes by state, 2020

	RSEs for number and percentage of housing units										
		Household has…									
	Total[a]	Electric cooking appliance[b]		Natural gas cooking appliance[c]		Two or more refrigerators		Separate freezer		Clothes washer	
All homes	0.00	0.51	0.51	0.92	0.92	0.80	0.80	1.18	1.18	0.30	0.30
Alabama	0.00	3.30	3.30	13.92	13.92	9.10	9.10	7.26	7.26	1.92	1.92
Alaska	0.00	3.73	3.73	7.52	7.52	9.98	9.98	5.29	5.29	2.99	2.99
Arizona	0.00	2.30	2.30	6.44	6.44	5.06	5.06	6.75	6.75	1.55	1.55
Arkansas	0.00	3.36	3.36	8.72	8.72	10.26	10.26	6.35	6.35	2.44	2.44
California	0.00	2.68	2.68	1.83	1.83	4.19	4.19	6.14	6.14	1.33	1.33
Colorado	0.00	2.92	2.92	7.69	7.69	6.26	6.26	7.38	7.38	2.17	2.17
Connecticut	0.00	4.26	4.26	11.72	11.72	8.69	8.69	10.61	10.61	3.89	3.89
Delaware	0.00	5.43	5.43	14.02	14.02	11.12	11.12	13.89	13.89	3.36	3.36
District of Columbia	0.00	6.42	6.42	5.55	5.55	15.29	15.29	17.42	17.42	6.18	6.18
Florida	0.00	1.13	1.13	13.13	13.13	5.24	5.24	6.85	6.85	1.69	1.69
Georgia	0.00	3.08	3.08	7.37	7.37	6.94	6.94	5.89	5.89	1.81	1.81
Hawaii	0.00	2.57	2.57	17.26	17.26	7.02	7.02	8.56	8.56	2.76	2.76
Idaho	0.00	2.81	2.81	10.32	10.32	7.26	7.26	5.68	5.68	2.26	2.26
Illinois	0.00	5.28	5.28	3.00	3.00	6.54	6.54	5.18	5.18	2.22	2.22
Indiana	0.00	4.52	4.52	6.29	6.29	6.83	6.83	6.54	6.54	1.82	1.82
Iowa	0.00	4.94	4.94	8.37	8.37	6.35	6.35	5.03	5.03	2.49	2.49
Kansas	0.00	3.71	3.71	13.25	13.25	8.97	8.97	6.92	6.92	2.94	2.94
Kentucky	0.00	2.28	2.28	9.35	9.35	7.16	7.16	6.45	6.45	1.70	1.70
Louisiana	0.00	3.32	3.32	8.60	8.60	8.04	8.04	6.38	6.38	1.84	1.84
Maine	0.00	3.87	3.87	23.92	23.92	11.94	11.94	9.63	9.63	3.28	3.28
Maryland	0.00	3.64	3.64	7.66	7.66	6.50	6.50	8.13	8.13	2.48	2.48
Massachusetts	0.00	3.06	3.06	4.94	4.94	6.32	6.32	7.23	7.23	2.85	2.85
Michigan	0.00	4.25	4.25	5.94	5.94	7.35	7.35	6.71	6.71	2.28	2.28
Minnesota	0.00	3.27	3.27	9.22	9.22	7.82	7.82	5.81	5.81	2.80	2.80
Mississippi	0.00	3.57	3.57	15.64	15.64	10.48	10.48	8.82	8.82	3.23	3.23
Missouri	0.00	3.12	3.12	9.79	9.79	7.14	7.14	6.29	6.29	2.55	2.55
Montana	0.00	4.25	4.25	13.39	13.39	11.26	11.26	7.70	7.70	3.53	3.53
Nebraska	0.00	3.25	3.25	14.25	14.25	8.62	8.62	7.24	7.24	4.10	4.10
Nevada	0.00	7.25	7.25	5.50	5.50	9.92	9.92	12.90	12.90	2.95	2.95
New Hampshire	0.00	5.02	5.02	19.24	19.24	9.46	9.46	10.74	10.74	4.17	4.17
New Jersey	0.00	5.85	5.85	3.08	3.08	5.38	5.38	8.67	8.67	2.85	2.85
New Mexico	0.00	7.40	7.40	8.37	8.37	12.13	12.13	10.01	10.01	3.31	3.31
New York	0.00	3.47	3.47	2.26	2.26	4.40	4.40	5.66	5.66	2.61	2.61
North Carolina	0.00	1.38	1.38	9.68	9.68	6.80	6.80	7.38	7.38	1.48	1.48
North Dakota	0.00	2.13	2.13	15.42	15.42	7.63	7.63	4.71	4.71	3.67	3.67

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	RSEs for number and percentage of housing units										
		Household has…									
	Total[a]	Electric cooking appliance[b]		Natural gas cooking appliance[c]		Two or more refrigerators		Separate freezer		Clothes washer	
All homes	0.00	0.51	0.51	0.92	0.92	0.80	0.80	1.18	1.18	0.30	0.30
Ohio	0.00	3.22	3.22	7.24	7.24	6.53	6.53	6.14	6.14	2.76	2.76
Oklahoma	0.00	5.21	5.21	9.75	9.75	9.66	9.66	9.10	9.10	2.94	2.94
Oregon	0.00	2.40	2.40	9.72	9.72	8.04	8.04	6.86	6.86	2.34	2.34
Pennsylvania	0.00	3.39	3.39	5.65	5.65	5.07	5.07	5.21	5.21	1.66	1.66
Rhode Island	0.00	5.75	5.75	11.57	11.57	11.44	11.44	16.83	16.83	5.27	5.27
South Carolina	0.00	2.01	2.01	12.51	12.51	8.62	8.62	7.75	7.75	1.53	1.53
South Dakota	0.00	2.94	2.94	18.20	18.20	9.04	9.04	5.52	5.52	3.40	3.40
Tennessee	0.00	1.44	1.44	10.27	10.27	6.43	6.43	5.82	5.82	1.63	1.63
Texas	0.00	1.75	1.75	3.98	3.98	3.87	3.87	4.99	4.99	1.17	1.17
Utah	0.00	4.17	4.17	9.52	9.52	9.97	9.97	7.47	7.47	2.73	2.73
Vermont	0.00	4.79	4.79	18.82	18.82	9.83	9.83	7.02	7.02	4.00	4.00
Virginia	0.00	2.50	2.50	8.56	8.56	5.77	5.77	7.16	7.16	1.65	1.65
Washington	0.00	1.77	1.77	7.48	7.48	5.00	5.00	5.80	5.80	2.57	2.57
West Virginia	0.00	4.97	4.97	14.51	14.51	10.43	10.43	9.80	9.80	2.98	2.98
Wisconsin	0.00	3.90	3.90	7.37	7.37	6.01	6.01	4.93	4.93	2.56	2.56
Wyoming	0.00	3.89	3.89	13.46	13.46	7.88	7.88	6.04	6.04	3.29	3.29

Data source: U.S. Energy Information Administration, Office of Energy Demand and Integrated Statistics, Form EIA-457A of the *2020 Residential Energy Consumption Survey*

Notes: See RECS Terminology for the definitions of terms used in these tables. Differences in characteristics between states may not be statistically significant.

[a] *Total* includes all primary occupied housing units. Vacant housing units, seasonal units, second homes, military houses, and group quarters are excluded.

[b] This estimate includes electric ranges, cooktops, and ovens. Microwave ovens and small kitchen appliances are not included in this estimate.

[c] This estimate includes natural gas ranges, cooktops, and ovens. Natural gas outdoor grills are not included in this estimate.

UNITED STATES OF AMERICA
BEFORE THE
DEPARTMENT OF ENERGY

Energy Conservation Program: Energy Conservation Standards for Consumer Conventional Cooking Products	**)))**	**EERE–2014–BT–STD–0005 RIN 1904–AD15**

ATTACHMENT C
TO THE
COMMENTS OF
THE AMERICAN GAS ASSOCIATION

E-mail from DOE's Appliance Standards Team to Joint Requesters, April 2023

Dated: April 17, 2023

Agen, Matthew

From: ApplianceStandardsQuestions <appliancestandardsquestions@ee.doe.gov>
Sent: Thursday, April 13, 2023 11:39 AM
To: bnussdorf@npga.org; Agen, Matthew; Stuart Saulters; Castor.Armesto@spireenergy.com
Subject: [EXTERNAL] Extension Request EERE-2014-BT-STD-0005

Dear Joint Requesters,

In your letter dated March 20, 2023, submitted via regulations.gov, you request that DOE release additional information related to the supplemental notice of proposed rulemaking ("SNOPR") published on February 1, 2023 and the notification of data availability ("NODA") published on February 28, 2023 for the energy conservation standards for consumer conventional cooking products. 88 FR 6818; 88 FR 12603. Additionally, you request that DOE extend the comment period by 15 days after the information is released. In particular, you ask that DOE provide the design changes used to determine this proposed minimum efficiency level for gas cooking tops, indicate the test procedure used to determine the levels for gas cooking tops, and specify by unit identification number which products are currently on the market and available to purchase.

Regarding the design changes considered for gas cooking tops in the SNOPR, DOE's testing showed that energy use was correlated to burner design and cooking top configuration (e.g., grate weight, flame angle, distance from burner ports to the cooking surface) and could be reduced by optimizing the design of the burner and grate system. DOE reviewed the test data for the gas cooking tops in its test sample and identified two efficiency levels associated with improving the burner and grate design that corresponded to different design criteria. 88 FR 6845. The full dataset for gas cooking tops may be found in Table 5.5.6 of the SNOPR Technical Support Document and Table 5.1 of the NODA attachment.

DOE's analysis in the SNOPR is based on testing in accordance with the test procedure for conventional cooking tops, at 10 CFR part 430, subpart B, appendix I1, ''Uniform Test Method for Measuring the Energy Consumption of Conventional Cooking Products.'' 87 FR 51492. As you note in your letter, the test procedure adopted the latest version of the relevant industry standard published by IEC, Standard 60350–2 (Edition 2.0 2017–08), ''Household electric cooking appliances—Part 2: Hobs—Methods for measuring performance'' (''IEC 60350–2:2017'') with modifications including adapting the test method to gas cooking tops. DOE notes that the test procedure used for testing cooking tops in the SNOPR analysis is fully described at 10 CFR part 430, subpart B, appendix I1, and a full discussion of the specific modifications made to IEC 60350-2:2017 can be found in the test procedure rulemaking. 87 FR 51492

In response to the request for additional data regarding which products are currently on the market, DOE stated in the NODA attachment that DOE's market survey indicates that 15 of the 24 gas cooking top models in its total cooking top sample and 10 of the 22 electric cooking top models in its total cooking top sample remain on the market at the time of the NODA. DOE further noted that model number changes that occur from year to year in most cases do not reflect technological changes that would impact the product's measured energy consumption. Furthermore, test results for models that are discontinued over the course of a DOE rulemaking timeline remain applicable in conducting the analysis in accordance with EPCA requirements because such models incorporate technologically feasible design options that manufacturers may use to achieve the corresponding efficiency levels in commercial products. (No. 343 at pg. 4)

Finally, regarding your request to extend the comment period, in a notice published on March 30, 2023, DOE extended the comment period for the SNOPR for an additional 14 days and will accept comments until April 17, 2023. 88 FR 19122

Regards,

Appliance Standards Team
U.S. Department of Energy

UNITED STATES OF AMERICA
BEFORE THE
DEPARTMENT OF ENERGY

Energy Conservation Program: Energy Conservation Standards for Consumer Conventional Cooking Products	**)** **)** **)**	**EERE–2014–BT–STD–0005** **RIN 1904–AD15**

ATTACHMENT D
TO THE
COMMENTS OF
THE AMERICAN GAS ASSOCIATION

AGA, Review and Comment on Composition, Emissions, and Air Quality Impacts of Hazardous Air Pollutants in Unburned Natural Gas from Residential Stoves in California, Environmental Science & Technology, October 2022

Dated: April 17, 2023

American Gas Association

Review and Comments "Composition, Emissions, and Air Quality Impacts of Hazardous Air Pollutants in Unburned Natural Gas from Residential Stoves in California," 2022

Rev 10.26.2022

In October 2022, the Environmental Science & Technology journal published "Composition, Emissions, and Air Quality Impacts of Hazardous Air Pollutants in Unburned Natural Gas from Residential Stoves in California" (Lebel et al., Oct. 2022).[1] The following Review and Comments present several points, observations, and issues for further scrutiny. The authors appear to have used an extreme, beyond "worst case" scenario to model potential exceedances of benzene in atypical circumstances. Furthermore, if these scenarios did occur, the odorants in the natural gas would alert the building occupants before the elevated benzene levels were encountered (based on the authors' own numbers in a prior study). Further investigation of the underlying methods, assumptions, and results is required to develop a full and fair exposition of the pertinent facts.

Overview of Study Conclusions

- The gas industry routinely tests natural gas to determine its constituents, including methane, ethane, propane, and butane content. Prior research has shown that natural gas contains only trace amounts of volatile organic compounds. The data from this new study is generally consistent with these earlier studies.

- The study measured samples of natural gas taken from end-use appliances and did not conduct direct measurements of fugitive natural gas emissions.

- The study then reported indoor ambient air concentrations that were *model*ed*, not measured,* and subject to underlying assumptions.

- Most of the model simulations, including *all* of the median-value simulations of indoor benzene concentrations attributable to natural gas stoves and ovens, were below the state 8-hour screening level (the California Environmental Protection Agency Office of Environmental Health Hazard Assessment 8-h reference exposure level [REL] of 0.94 ppbv) ("OEHHA guideline").

[1] Lebel, Eric D., et. al. "Composition, Emissions, and Air Quality Impacts of Hazardous Air Pollutants in Unburned Natural Gas from Residential Stoves in California" Environmental Science and Technology. October 20, 2022. https://pubs.acs.org/doi/10.1021/acs.est.2c02581

- The estimates of indoor air concentrations included contributions from other sources unrelated to indoor appliance use. The authors included an assumed 0.174 ppb of benzene from outdoor air. The outdoor air contributions represent nearly 20% of the conservative screening level used by the authors as a point of comparison.

- It is only when worst-case modeling inputs were stacked on top of one another (the highest regional 95th percentile benzene levels in natural gas combined with the 95th percentile natural gas leakage rate) that the authors found that "certain parameter combinations have the *potential*" to lead to modeled indoor air benzene concentrations exceeding the OEHHA guideline (emphasis added).

- All the modeled simulations were based on very conservative assumptions, including using air change rates (the frequency of the air replaced in a room) much lower than typical homes based on current U.S. Environmental Protection Agency (USEPA) literature.

- The assumptions used are so conservative that these scenarios would be very unlikely actually to occur in the real world. Furthermore, if these scenarios did occur, the odorants in the natural gas would alert the building occupants before the elevated benzene levels were encountered (based on the authors' own numbers in a prior study).[2]

- Moreover, it is uncertain how well the measured benzene concentrations in the natural gas samples represent long-term average trace gas concentrations. The authors acknowledge that their sampling design focused on capturing geographic rather than temporal variability.

- Findings are based on a limited one-time study and do not appear to be adequate to conclude that the volatile organic compound (VOC) "content in unburned [natural gas] observed in our study is representative of California's transmission and distribution segments of the supply chain." The sample sizes for each region were small, including some as low as eight samples.

- The study used natural gas leakage rates from an earlier 2022 Lebel study to *model* the benzene concentrations in indoor air.[3] An AGA review of that earlier study raised

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[2] Michanowicz, Drew R., et. al. "Home is Where the Pipeline Ends: Characterization of Volatile Organic Compounds Present in Natural Gas at the Point of the Residential End User" Environmental Science and Technology. June 28, 2022. https://pubs.acs.org/doi/full/10.1021/acs.est.1c08298

[3] AGA review of Lebel et. al. January 2022: https://www.aga.org/globalassets/research--insights/american-gas-association-review-and-comments-lebel-et.-al-2022-rev2022.4.14.pdf (reviewing Lebel, Eric D., et. al. "Methane

questions regarding the test methods, measuring instrumentation, emissions sampling, physical and operating conditions, and other issues. The data distribution for leakage rates from the earlier study was also highly skewed, and yet in the current study, the authors used the 95th percentile value from the skewed data set as an upper bound estimate. Reliance on that prior study, including the 95th percentile natural gas leakage rate, thus introduces additional uncertainty into these modeling scenarios.

Review of More Detailed Study Findings

- The study reported measurements of trace gas analyses and chemical composition from 159 natural gas samples collected directly from indoor distribution piping across seven geographic regions in California.
    - The study measured concentrations of different constituents of natural gas, including trace amounts of VOCs.
    - Measured benzene concentrations in these California natural gas samples were higher than reported concentrations in Massachusetts natural gas samples from a prior study.[4]
- This study conducted air modeling based on natural gas leakage data for stoves and ovens from the prior Lebel *et al*. (2022) paper to translate the observed benzene concentrations in natural gas samples into indoor air concentrations.
    - One hundred forty scenarios were modeled using different natural gas leakage rates, benzene concentrations (in unburned natural gas), and air exchange rates.
    - The modeling was based on very low air exchange rates, including the buildings' natural ventilation air change rate and the minimum recommended air change rate set by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE).
        - The range of values used for natural ventilation was 0.05 air changes per hour (ACH) (for apartments) to 0.11 ACH (for single-family homes). The authors indicate that these values have been empirically verified, but the supporting information fails to demonstrate any verification. These values appear consistent with the 5th percentile values for relatively new

and NOx Emissions from Natural Gas Stoves, Cooktops, and Ovens in Residential Homes" Environmental Science and Technology. January 27, 2022. https://pubs.acs.org/doi/10.1021/acs.est.1c04707).

[4] Michanowicz, Drew R., et. al. "Home is Where the Pipeline Ends: Characterization of Volatile Organic Compounds Present in Natural Gas at the Point of the Residential End User" Environmental Science and Technology. June 28, 2022. https://pubs.acs.org/doi/full/10.1021/acs.est.1c08298

AGA review of Michanowicz et. al. 2022: https://www.aga.org/globalassets/research--insights/policy/american-gas-association-review-and-comments-michanowicz-et-al.-2022-rev-220629.pdf construction in some cases.[5] For some scenarios, such as mobile homes, there does not appear to be any support for the ventilation value assumed in the study.

  - The highest assumed air change rate was the ASHRAE minimum recommendation of 0.35 ACH. It should be noted that this is a minimum recommendation, yet the authors chose to use this as a maximum value. The worst-case modeling assumptions used air change rates 86% lower than the minimum recommendation.
  - For comparison, the earlier Lebel study on leakage rates reported 1 to 3 ACH for the kitchens they tested (i.e., up to 60x higher than the assumed ventilation rate used in the modeling) even though they had attempted to seal off those spaces.
  - Based on the literature, USEPA data demonstrates that a typical residence has about 0.46 ACH.[6] Using 0.35 ACH as a *maximum* air change rate, when that is below the *average* (geometric mean) air change rate, is unrealistic and appears to assume a "worst-case" scenario.

- Despite using an unreasonably low air change rate, the study found that "*[m]ost model simulations– including all median value simulations– did not result in ambient benzene concentrations* attributable to emissions of NG [natural gas] from gas stoves that are off above *the California Office of Environmental Health Hazard Assessment [OEHHA] 8-hour REL* of 0.94 ppbv" (emphasis added).
- While the study modeled some exceedances of the California guideline, those appear to only be for "95th percentile model runs" where the 95th percentile natural gas leakage rate was paired with the 95th percentile benzene natural gas concentration for one or two regions.
  - Thus, the study concluded that: "*Based on model results, an elevated leakage rate of benzene and a low ventilation rate are both requisite for indoor concentrations to exceed the OEHHA 8-h REL for benzene*" (emphasis added). The use of a 95th percentile methane emission rate combined with a 95th percentile benzene NG concentration does not represent a condition that would occur 5% of the time. These two factors could be expected to co-occur in only 0.25% of cases. This is <u>before</u> accounting for the additional low building ventilation rates that would also be necessary for an exceedance to occur. Thus, the "95th percentile model runs" where a small number of exceedances were observed reflect atypical residential conditions and do not represent conditions in most homes. As

[5] See Environmental Protection Agency. "Update for Chapter 19 of the Exposure Factors Handbook, Building Characteristics," Table 19-1 (recommending a median central estimate of 0.45 ACH for residential buildings based on multiple studies), https://www.epa.gov/sites/default/files/2018-07/documents/efh_-_chapter_19_update.pdf.
[6] See *id.*, Table 19-25.

previously noted, occupants would be alerted by odors before the elevated benzene concentrations would occur.

- None of the modeled benzene concentrations exceed the equivalent national EPA guideline.

UNITED STATES OF AMERICA
BEFORE THE
DEPARTMENT OF ENERGY

Energy Conservation Program: Energy Conservation Standards for Consumer Conventional Cooking Products	**)))**	**EERE–2014–BT–STD–0005 RIN 1904–AD15**

ATTACHMENT E
TO THE
COMMENTS OF
THE AMERICAN GAS ASSOCIATION

AGA, Review and Comment on Methane and NOx Emissions from Natural Gas Stoves, Cooktops, and Ovens in Residential Homes, Environmental Science & Technology, January 2022

Dated: April 17, 2023

AGA
American Gas Association

Review and Comments
"Methane and NOx Emissions from Natural Gas Stoves, Cooktops, and Ovens in Residential Homes," Environmental Science & Technology, 2022

Rev 2022.4.14

In January 2022, the journal *Environmental Science & Technology* published "Methane and NOx Emissions from Natural Gas Stoves, Cooktops, and Ovens in Residential Homes" (Lebel et al. 2022). The following Review and Comments present several points, observations, and questions based on an AGA review of the study. A review of the study raises several issues and questions regarding the test methods, measuring instrumentation, emissions sampling of the natural gas cooking appliance types, physical and operating conditions, and other issues. Further investigation and analysis of testing and test results by individuals with the appropriate expertise are needed to sufficiently develop a full and fair exposition of the pertinent facts to enable the public to understand how the authors came to their conclusions or to form independent conclusions.

- The article claims "methane emissions from all gas stoves in U.S. homes have a climate impact comparable to the carbon dioxide emissions of 500,000 cars." The assumptions and calculations for this extrapolation are subject to question. Still, they would translate into only 0.09% of the annual methane emissions in the U.S. (Source: Inventory of U.S. Greenhouse Gas Emissions and Sinks | USEPA).
    - The U.S. Environmental Protection Agency (USEPA) estimates a typical passenger vehicle emits about 4.6 metric tons of carbon dioxide (CO2) per year (Source: Greenhouse Gas Emissions from a Typical Passenger Vehicle | USEPA); for 500,000 cars, that equates to 2.3 million metric tons of CO2 per year; which equates to 26,700 metric tons of methane per year using USEPA's Greenhouse Gas Equivalencies Calculator, which is 0.09% of annual methane emissions.

- The study states, "In addition to methane emissions, co-emitted health-damaging air pollutants such as nitrous oxides (NOx) are released into home air and can trigger respiratory diseases." However, the study did not measure representative nitrogen oxides (NOx) levels in room air. The rate of NOx emissions were measured rather than a direct measurement of NOx in the breathing zone under conditions representative of a normal kitchen.

- The article "found that ovens could produce enough NO_2 to exceed the 1-h ambient standard (100 ppb) within a few minutes." This claim improperly compares instantaneous peak concentrations during the first few minutes of stove usage to a threshold based on 1-hour time-averaged data and has no scientific basis. The shortest measurement time interval that should be used to evaluate against the outdoor air guideline is 1 hour.

- To make strong inferences about the nation, or even just California, requires a larger sample size of no less than 385 homes, preferably not all in the same region. This assumes a 95% confidence level, 5% margin of error, and at least 1.3 million gas stoves in use. Loosening the confidence level to 90% and a 10% margin of error would require 68 sites. (Both cases assume a 0.5 standard deviation.)

- The study did not include emissions from the cooking process, which is just as important, if not more so, than emissions from the burner or heat source operation. Indoor air quality studies have consistently found that emissions from the cooking process can be significant for various classes of pollutants such as particulate matter and volatile organic compounds.

- The Federal Interagency Committee on Indoor Air Quality (CIAQ), which is comprised of two dozen federal agencies led by the U.S. Environmental Protection Agency (EPA), routinely addresses indoor air quality issues of public importance. The CIAQ has not identified natural gas cooking emissions as an important issue concerning asthma or respiratory illness. Furthermore, the U.S. Consumer Product Safety Commission and EPA do not present gas ranges as a significant contributor to adverse air quality or health hazards in their technical or public information literature, guidance, or requirements.

- Federal agencies such as the Consumer Product Safety Commission (CPSC) and the Environmental Protection Agency (EPA) closely monitor and have evaluated homes with natural gas piping and natural gas appliances and have never taken action to limit their use on methane emissions as suggested in this study.

- The appliance manufacturers recommend the installation and use of gas piping and gas appliances in accordance with national consensus standards.

- Natural gas appliances are required to be design certified for safety to appropriate National American National Standards in order to be installed.

- The study does not isolate the methane leakage to the appliance, and the article could not confirm where the leaks originated.

    - The appliance was not isolated from the gas supply equipment as part of this investigation. Specific sources for the leaks were not identified.

- The tests were performed on gas-leaking appliances or where gas leaks existed in the home gas piping or at the connection of these two, making it impossible to determine which component contributed.
- There is no indication in the article that the appliances underwent periodic maintenance as specified by the appliance manufacturer.

- The study mentions ignitor issues, indicating the appliances were in disrepair.
  - Consequently, when a correctly functioning gas appliance is properly installed, there should not be any gas leaks.
  - Further, with a properly functioning gas appliance, there is no methane released into the atmosphere when the burner is operating. The combustion chemical reaction does not allow it, meaning that all of the gas being supplied to the burner, including the raw gas being released during the four seconds safety standards allowance during ignition, will burn during the combustion process, and nothing will be liberated as raw gas to the environment.

- There is no indication in the article that the building's gas distribution system, including connections in the piping and connections to the appliances, was verified as properly functioning and sealed before testing.

- The reported leak rates are skewed by a few possible outliers. Even so, the reported average leak rate when stoves are off is only 0.00005 cubic feet per minute.

- There are some potential methodological issues with the study. The measured methane and NOx results were adjusted for dilution caused by leak rates from the test enclosure reported to be 1 to 3 air changes per hour (ACH). That is about five to ten times more dilution than expected for a sealed-off test area.

- The authors may have been testing emissions from commercial appliances, which by code require that vent hoods be installed.
  - The authors noted in the article that the stoves' ages ranged between 3 and 30 years of age, with heat output for each burner ranging from 4500 to 25,000 Btu/h.
  - Commercial burners have higher heat output ranges (25,000 Btu/h), and the fuel gas codes (IFGC & NFGC) require that vent hoods be installed. Using both residential and commercial appliances in this study is inappropriate.
  - Commercial burners are designed, tested, and certified with a specified air exchange rate.

- No uncertainty analysis was conducted, and no independent tests of the method were presented.

Further observations and discussion points

- The scope of the study focused on gas stoves, cooktops, and ovens and includes measurements of these appliances in 53 California homes during all phases of appliance operations.
    - The study sampled a range of appliance brands (18) and ages (3 to 30 years), including appliances with pilot lights or electronic ignition.
    - No appliances in multi-family buildings were sampled.
    - The approach involved partitioning the kitchen with plastic sheets from the rest of the house.
    - This effectively formed a source enclosure where methane and NOx concentrations were sampled from within while the stove was in various states of operation.

- In the U.S., an organic foul-smelling non-toxic gas called mercaptan is added to natural gas to odorize it so that people can effectively detect any natural gas presence.
    - Humans can detect mercaptan at 1.6 ppb (0.0016 ppm) concentrations; therefore, in a typical home, gas leaks in appliances and their connecting gas lines/piping will be very easily detected by the home occupants. The reported concentrations in the study are well below levels that would likely be detected by smell. Nevertheless, it is unclear if the five ranges studied, or any range for that matter had detectable leaks that had not been remedied.

- All certified gas ranges are tested for leaks [with the Manufacturing and Productions Tests required by Section 6 of the ANSI Z21.1 · CSA 1.1 Standard, where subsections 6.1 b) and c)], and common multiple leak points are evaluated during factory manufacture.

- Fuel-fired appliances are designed and installed with the knowledge that there is air movement. The test area was sealed, preventing any normal air movement.

- The article does not indicate if the cavity ring-down spectrometer readings were corrected or adjusted for the presence of volatile organic compounds (VOCs) (due to the presence of common household items), hydrogen sulfide (present in trace amounts in gas), or other interferents

- Tested gas cooking appliances were not indicated as checked for proper operating rates.
    - The article indicates that nitrogen dioxide (NO_2) was measured directly. However, the instrumentation cited typically is used to measure NOx and nitric oxide (NO), with NO_2 calculated by difference rather than actually being directly measured.
    - The article does not state if the NOx results were corrected or adjusted for the presence of nitrous acid or other interferents. Correspondence with the authors indicates that they did not correct for the presence of HNO_2.

Statistical observations

Summary of mean CH4 emission rates of residential stoves, cooktops and ovens.

Source	**Number**	**Mean Emission Rate mg/hr**	**Lower Confidence Limit (5%)**	**Upper Confidence Limit (95%)**	**Comment**
steady state stove off	53	57.9	36.3	84	9% of stoves = 49% of emissions
single cooktop burner on	180	259	151	408	9% of burners = 51% of emissions
burner on/off	180	45.9	33.1	64.8	
burner on/off w pilot light	8	258	166	382	estimated ranges
burner on/off electronic	180	38	24	56	estimated ranges
oven pre heat	40	663	408	1030	
oven at temperature	40	759	435	1310	
broiler steady on	31	112	50	186	less on /off cycling

- As shown in the Table, the measured emission rates were characterized by highly skewed, fat-tailed distributions with relatively large confidence limits. Oven operations had the highest emission rates, while single burner emission pulses for pilot light burners were much higher than electronic ignition units. The data for steady-state-off measurements were long-tail skewed, with the top five stoves (9% of sampled units) emitting half (49%) of all steady-state-off emissions. Steady-state-on emission measurements were also long-tailed skewed. The top 5 stoves (9%) emitted 51% of all steady-state-on emissions.
    - The article does not indicate which stoves skewed the results.
    - Did the five appliances in the steady-state off measurements producing 49% of the emissions have standing pilots?
    - Were any of these appliances commercial-grade appliances and not residential?

- The extrapolation of the mean (58 mg/hr) test results to calculate an emission level for the entire country is problematic with the known skewness of the dataset. The median (24 mg/hr) leakage value from the dataset may have been a more representative value. Using the median result would not penalize the national emissions calculation based on a small number of ranges with potential special causes that were not fully investigated.

- It is noted in the report that bootstrapping was performed on the original data set.
    - There are several forms of bootstrapping. Which type was conducted is not indicated, nor were the number of replicate data sets generated in the bootstrapping process.

Regarding Figures

- 5S:
  - The data set appears to be exponential with severe right-sided skewness, yet the graph indicates mean & confidence intervals based on a normal data set.
  - In this, the average will be higher than the median in such a skewed data set. What is the median of this data set?

- S8, S9, S10:
  - The data set appears to be non-normal, yet the data presented assumes a normal distribution using the mean (average) and corresponding confidence intervals.
  - What distribution are the data sets and resulting medians?