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California Energy Commission
Docket Office, MS-4
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Re: Reply Comments to SoCalGas's August 24, 2020 Comments on Indoor Air Quality, Docket #19-BSTD-03 (2022 Energy Code Pre-Rulemaking)

Dear Commissioners and Staff:

In 2020, Californians are likely spending more time at home than ever. Before the COVID-19 pandemic, people generally spent nearly 90% of their time indoors.[1] With the COVID-19-related stay-at-home orders, as well as the widespread smoke from recent wildfires, many people are inside their homes even more, and the quality of our indoor air is becoming increasingly salient. For these reasons, Rocky Mountain Institute (RMI), Redwood Energy, Guttmann & Blaevoet Consulting Engineers, Mothers Out Front, Natural Resources Defense Council (NRDC), and Sierra Club feel compelled to respond to the Technical Comments[2] and Attachment[3] submitted by Southern California Gas Company (SoCalGas) to the California Energy Commission on August 24, 2020. Our response today focuses on the portions of SoCalGas's Technical Comments and Attachment that critique RMI and Redwood Energy's letter from April 10, 2020 (Joint Comments).[4]

In addition to detailed comments on six main criticisms,[5] SoCalGas lists eight bullet points on page 1 of their Attachment (hereinafter referred to as "SoCalGas Comments").[6] These

[1] Neil K. Klepis et al., "The National Human Activity Pattern Survey (NHAPS): A Resource for Assessing Exposure to Environmental Pollutants," Journal of Exposure Analysis and Environmental Epidemiology, 11(3). March 2001, https://www.ncbi.nlm.nih.gov/pubmed/11477521.
[2] SoCalGas, Technical Comments Regarding Pre-Rulemaking for the California 2022 Energy Code Compliance Metrics, Docket # 19-BSTD-03, TN#234420 (filed Aug. 24, 2020) **[hereinafter referred to as "SoCalGas Technical Comments"].**
[3] SoCalGas, Attachment A: Comments on Indoor Air Quality Arguments Presented in Written Comments in Response to the March 26, 2020 Pre-Rulemaking Workshop for the California 2022 Energy Standard, Title 24, Docket No. 2019-BSTD-03, TN#234419 (filed Aug.24, 2020) **[hereinafter referred to as "SoCalGas Comments"].**
[4] Rocky Mountain Institute & Redwood Energy, Comments on Docket No. 2019-BSTD-03 (2022 Energy Code Pre-Rulemaking), March 26, 2020 Workshop, TN#232712 (Apr. 10, 2020**) [hereinafter referred to as "Joint Comments"].** Note that RMI, jointly with other groups, also submitted two sets of comments to the Codes and Standards Enhancement (CASE) team, in response to the CASE report on Multifamily Indoor Air Quality. Those two sets of comments, addressing indoor air quality and ventilation, are attached as Appendix A and Appendix B to this letter.
[5] *See* SoCalGas Comments, p.2.
[6] *Id*, p.1.

bullet points pertain to the "research" and "conclusions" of an unidentified "report" or "study," and do not address the content of our Joint Comments.[7] Therefore, we focus here on the six main points that SoCalGas raises in response to our Joint Comments, which we group into four categories for clarity of response.

In particular, this letter responds to SoCalGas's comments by addressing the following points:

A. Ample scientific evidence shows that nitrogen dioxide (NO_2) and gas stoves as a source of NO_2, increase the risk of asthma, especially in children[8]
B. Research suggests that lower income communities and communities of color may be at higher risk of health impacts from indoor NO_2 pollution, due to higher asthma rates and building conditions that can result in higher NO_2 concentrations[9]
C. In applying its mandate to consider indoor air quality when developing building energy efficiency standards, the CEC should ensure that its ventilation standards reflect the latest science and protect public health, including for the most vulnerable communities[10]
D. Studies based on in-home and laboratory measurements show that gas cooking can generate pollutants at levels that would exceed outdoor standards[11]

A. The fact that gas stoves and nitrogen dioxide (NO_2) pollution can increase the risk of asthma is well-established, with the peer-reviewed science supporting this fact becoming clearer over time

SoCalGas asserts that the relationship between gas stove pollution and childhood asthma risk is not justified by cited literature.[12] Contrary to SoCalGas's claim, the relationship between gas cooking and childhood asthma is well-documented in peer-reviewed literature. In support of its assertion, SoCalGas criticizes a 1992 article by Hasselblad et al.[13] The Joint Comments did not cite the 1992 Hasselblad article. Instead, our comments relied upon the much more current and comprehensive Lin et al. meta-analysis, which was

[7] Two of the bullet points could potentially be read as applying more broadly than just the unidentified "report" or "study," so we will briefly address them. First, SoCalGas calls into question the relevance of 1- or 2-hour exposure studies, citing a survey that found that meal preparation times can be less than one hour. As described further in Section A below, there is substantial evidence that short-term NO_2 exposure (in the range of minutes) can result in respiratory health effects. Second, SoCalGas states that that electric cooking can generate particulate matter ($PM_{2.5}$). While the act of cooking food itself can produce particulate matter, it is important to note that gas stoves have been found to produce $PM_{2.5}$ levels twice as high as electric stoves *See* Tianchao Hu, Brett C Singer, Jennifer M Logue, Compilation of Published PM2.5 Emission Rates for Cooking, Candles and Incense for Use in Modeling Exposures in Residences, Ernest Orlando Lawrence Berkeley National Laboratory, 2012, p. 11, https://www.osti.gov/biblio/1172959 .
[8] Responding to SoCalGas's Claim 2.
[9] Responding to SoCalGas's Claim 3.
[10] Responding to SoCalGas's Claims 4–6.
[11] Responding to SoCalGas's Claim 1.
[12] *See* SoCalGas Comments, p.4–8.
[13] *See* SoCalGas comments, p. 4-5 (citing Hasselblad, V. I., D. M. Eddy, D. J. Kotchmar, "Synthesis of Environmental Evidence: Nitrogen Dioxide Epidemiology Studies," Journal of Air and Waste Management, 42(5), May 1992, pp. 662-71).

peer-reviewed and published in the *International Journal of Epidemiology* in 2013.[14] SoCalGas incorrectly claims that "No discernable differences are identified between the Weiwei, et. al. meta-analysis and that of Hasselblad", and yet, **twenty-one years** passed between the 1992 Hasselblad article and the 2013 Lin article, and during that time, the scientific evidence establishing a link between gas cooking and health effects has increased considerably. Even SoCalGas acknowledges in its own comments that the 1992 Hasselblad article considered only 58 studies, while the 2013 Lin article reviewed 1,064 studies—over **one thousand more** research sources than Hasselblad.[15]

The 2013 Lin study conducted a comprehensive analysis, reviewing all studies addressing gas cooking, indoor NO_2 and respiratory health effects in children published between 1977 and 2013. That study found that children living in homes with gas stoves are at a 42% higher risk of experiencing asthma symptoms compared to children living in homes with electric stoves, and having a gas stove increases the risk of being diagnosed with asthma by a doctor by 24%.[16] SoCalGas's attempt to cast doubt on these findings by relying on a 28-year-old article that the Joint Comments did not even cite is unfounded and misleading.[17]

SoCalGas's citation to the 1992 Hasselblad article is not the only example of its comments choosing to focus on outdated studies and ignore decades of scientific advancement. SoCalGas relies upon a year 2000 National Institute of Medicine report entitled *Clearing the Air*, which characterized NO_2's relationship to the development of asthma as "inadequate or insufficient evidence to determine whether or not an association exists."[18] Our scientific understanding of the causes and triggers of respiratory effects has developed considerably since 2000. The link between air quality and asthma has become clearer for many pollutants in the two decades since this report was released. For example, the 2000 report listed secondhand smoke in the same "insufficient evidence" category as NO_2.[19]

As for NO_2, in 2016, the EPA made the conclusive finding that short-term exposure to nitrogen dioxide has a causal relationship to respiratory effects, including the development

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[14] Weiwei Lin et al., *Meta-Analysis of the Effects of Indoor Nitrogen Dioxide and Gas Cooking on Asthma and Wheeze in Children*, 42 INT'L J. OF EPIDEMIOLOGY 1724 (2013), available at https://doi.org/10.1093/ije/dyt150.
[15] The 2013 Lin et al. study reviewed 171 of these 1,064 articles in depth and included 41 in the detailed meta-analysis, as compared to only 11 articles included in the 1992 Hasselblad study.
[16] *See* Lin, *supra* note 14.
[17] Even though the Joint Comments never mention the Hasselblad study, and So Cal Gas's critique is therefore irrelevant, So Cal Gas's assertions are also unfounded on their merits. SoCalGas asserts in its comments that the Hasselblad study was "largely dismissed in the 1990's;" however they offer no evidence of these reviews or dismissals. In actuality, the Hasselblad meta-analysis has been cited in over 100 publications, including favorable commentary by the World Health Organization (WHO) in its 2010 publication on indoor air quality guidelines. World Health Organization. 2010. "WHO Guidelines for Indoor Air Quality: Selected Pollutants."https://www.euro.who.int/__data/assets/pdf_file/0009/128169/e94535.pdf. p 229 at 29 ("This analysis is of considerable importance, as it provided the basis for outdoor air quality guideline setting by WHO in 1997 and its conclusions have, to date, not been seriously challenged by any new evidence.").
[18] *See* SoCalGas Comments at 5–6 (citing National Institute of Medicine, Clearing the Air: Asthma and Indoor Air Exposures, Washington, DC: National Academy Press, 2000, at 9 tbl.3).
[19] *See* National Institute of Medicine, Clearing the Air: Asthma and Indoor Air Exposures, Washington, DC: National Academy Press, 2000, at 9 tbl.3 (categorizing the relationship between "ETS [Environmental Tobacco Smoke] (in school-aged and older children, and in adults)" and the development of asthma as "inadequate or insufficient evidence to determine whether or not an association exists").

of asthma.[20] This finding reflects significant additional research not available at the time the 2000 *Clearing the Air Report* was released.

The table below from EPA's 2016 Integrated Science Assessment for nitrogen dioxide shows strengthening evidence of NO_2's effect on the body, including a causal relationship between short-term exposure to NO_2 and respiratory effects. Additionally, the EPA finds that long-term exposure to NO_2 is likely to have a causal relationship with respiratory effects.[21]

Table ES-1 Causal determinations for relationships between nitrogen dioxide exposure and health effects from the 2008 and 2016 Integrated Science Assessment for Oxides of Nitrogen.

Exposure Duration and Health Effects Category[a]	Causal Determination[b]	
	2008 Integrated Science Assessment	2016 Integrated Science Assessment
Short-Term Nitrogen Dioxide Exposure (minutes up to 1 month)		
Respiratory effects Section 5.2, Table 5-39	Sufficient to infer a likely causal relationship	Causal relationship
Cardiovascular effects Section 5.3, Table 5-52	Inadequate to infer the presence or absence of a causal relationship	Suggestive of, but not sufficient to infer, a causal relationship
Total mortality Section 5.4, Table 5-57	Suggestive of, but not sufficient to infer, a causal relationship	Suggestive of, but not sufficient to infer, a causal relationship
Long-Term Nitrogen Dioxide Exposure (more than 1 month to years)		
Respiratory effects Section 6.2, Table 6-5	Suggestive of, but not sufficient to infer, a causal relationship	Likely to be a causal relationship
Cardiovascular effects and diabetes[c] Section 6.3, Table 6-11	Inadequate to infer the presence or absence of a causal relationship	Suggestive of, but not sufficient to infer, a causal relationship
Reproductive and developmental effects[c] Sections 6.4.2, 6.4.3, and 6.4.4, Table 6-14	Inadequate to infer the presence or absence of a causal relationship	Fertility, reproduction, and pregnancy: Inadequate to infer a causal relationship
		Birth outcomes: Suggestive of, but not sufficient to infer, a causal relationship
		Postnatal development: Inadequate to infer a causal relationship
Total mortality Section 6.5, Table 6-18	Inadequate to infer the presence or absence of a causal relationship	Suggestive of, but not sufficient to infer, a causal relationship
Cancer Section 6.6, Table 6-20	Inadequate to infer the presence or absence of a causal relationship	Suggestive of, but not sufficient to infer, a causal relationship

More recently than EPA's 2016 Integrated Science Assessment, RMI and partners conducted an extensive literature review on the topic of the health effects from gas stove pollution, which was published in May 2020.[22] To provide the most current analysis, RMI's report on the health impacts of gas stove pollution focused on the most recent 20 years of research (2000 – 2020). That report contains extensive references to peer-reviewed literature detailing the strong and ever-growing scientific consensus on the respiratory harms from gas stove emissions, especially for children.

[20] U.S. EPA. Integrated Science Assessment (ISA) For Oxides of Nitrogen – Health Criteria (Final Report, 2016). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-15/068, 2016
[21] U.S. EPA. Integrated Science Assessment (ISA) For Oxides of Nitrogen – Health Criteria (Final Report, 2016). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-15/068, 2016.
[22] Brady Seals and Andee Krasner, Health Effects from Gas Stove Pollution, Rocky Mountain Institute, Physicians for Social Responsibility, Mothers Out Front, and Sierra Club, 2020, https://rmi.org/insight/gas-stoves-pollution-health.

B. Lower income communities and communities of color may be at particular risk of harm from exposure to the NO_2 emissions from gas stoves

As articulated in our April 10 comments, scientific research demonstrates at least two reasons that low-income communities and communities of color may be at higher risk of harm from the NO_2 pollution associated with gas stoves. First, individuals who already have underlying respiratory conditions such as asthma are particularly vulnerable to negative health impacts from exposure to NO_2 pollution. Lower income communities and communities of color have disproportionately high rates of asthma, which therefore places them at greater risk of harm from the NO_2 pollution they encounter.[23] Second, research shows that housing characteristics that are more common in low-income, multifamily housing—such as smaller unit size and inadequate ventilation—contribute to elevated levels of NO_2 pollution in homes when a gas stove is used. [24,25] Consequently, residents of these low-income multifamily units who use gas stoves may be exposed to higher levels of NO_2 pollution, as compared to residents of larger homes with stronger ventilation.

SoCalGas criticizes the articles that RMI cited in support of these findings, focusing on the fact that these five articles do not, in and of themselves, prove that cooking with a gas stove increases NO_2 pollution or causes asthma.[26] Of course, that was not the purpose of RMI citing these articles. The clear relationship between gas stoves, increased NO_2 levels in homes, and increased incidence of asthma is thoroughly detailed above in this letter and in other sections of the April 10 Joint Comments.[27,28,29]

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[23] *See, e.g.*, Michael Guarnieri & John R. Balmes, *Outdoor Air Pollution and Asthma*, 383 LANCET 1581 (2014), *available at* https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4465283; Christina M. Pacheco et al., *Homes of Low-Income Minority Families with Asthmatic Children Have Increased Condition Issues*, 35 ALLERGY AND ASTHMA PROCEEDINGS 467 (2014), *available at* https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4210655/#!po=78.0000; Cheryl Katz, *People in Poor Neighborhoods Breathe More Hazardous Particles*, SCIENTIFIC AMERICAN (Nov. 2012), https://www.scientificamerican.com/article/people-poor-neighborhoods-breate-more-hazardous-particles; Hatice S. Zahran et al., Vital Signs: Asthma in Children – United States, 2001 – 2016, Centers for Disease Control and Prevention Morbidity and Mortality Weekly Report (Feb. 9, 2018), http://dx.doi.org/10.15585/mmwr.mm6705e1; Centers for Disease Control and Prevention, Summary Health Statistics: National Health Interview Survey: 2015 at tbl. C-1 (2017), http://www.cdc.gov/nchs/nhis/shs/tables.htm.

[24] Gary Adamkiewicz et al., "Moving Environmental Justice Indoors: Understanding Structural Influences on Residential Exposure Patterns in Low-Income Communities," *American Journal of Public Health.* 2011, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3222513/

[25] Goldstein IF, Andrews LR, Hartel D. 1988. Assessment of human exposure to nitrogen dioxide, carbon monoxide and respirable particulates in New York inner-city residences. *Atmospheric Environment* 22(10):2127–2139.

[26] *See* SoCalGas Comments at 8–9 ("The association of socio-economic factors to asthma and other respiratory illness and gas cooking is, more often than not, missing from the cited sources," and bullet point critiques of individual articles).

[27] Kathleen Belanger et al, "Household levels of nitrogen dioxide and pediatric asthma severity", Epidemiology 24(2), March 2013, p. 320–330,PMC3686297/.

[28] Weiwei Lin et al., *Meta-Analysis of the Effects of Indoor Nitrogen Dioxide and Gas Cooking on Asthma and Wheeze in Children*, 42 INTERNATIONAL JOURNAL OF EPIDEMIOLOGY 1724 (2013), *available at* https://doi.org/10.1093/ije/dyt150.

[29] *See, e.g.*, Michael Guarnieri & John R. Balmes, *Outdoor Air Pollution and Asthma*, 383 LANCET 1581 (2014), *available at* https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4465283; Christina M. Pacheco et al., *Homes of Low-Income Minority Families with Asthmatic Children Have Increased Condition Issues*, 35 ALLERGY AND ASTHMA PROCEEDINGS 467 (2014), *available at* https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4210655/#!po=78.0000; Cheryl Katz, *People in Poor Neighborhoods Breathe More Hazardous Particles*, SCIENTIFIC AMERICAN (Nov. 2012), https://www.scientificamerican.com/article/people-poor-neighborhoods-breate-more-hazardous-particles; Hatice S. Zahran et al., Vital Signs: Asthma in Children – United States, 2001 – 2016, Centers for Disease Control and

Instead, the purpose of RMI's citation of these five sources is to show that: 1) low-income households may be at higher risk of exposure to gas stove pollution, and 2) due to a higher prevalence of existing respiratory conditions such as asthma, low-income households and households of color are more vulnerable to harm resulting from pollution exposure once they become exposed. Gas stove pollution has an equity component that should be not ignored nor downplayed.

C. In developing ventilation standards, the CEC should apply indoor air quality guidelines that reflect the latest science and protect public health, in consultation with expert agencies, including the California Air Resources Board (CARB)

The CEC should base its ventilation standards on indoor air quality guidelines that reflect the latest science to protect public health, including for the most vulnerable populations. The current standard of 100 ppb of NO_2 is ten years old and does not consider more recent science, including the finding that children experience increased risk of higher asthma severity for "every 5 ppb increase in NO_2 exposure above a threshold of 6 ppb."[30] The CEC should align its ventilation standards with the most up-to-date and most protective indoor air quality guidelines issued by air quality regulators.

SoCalGas's comments imply that the CEC would be overstepping its bounds by assessing whether the air quality guidelines it uses to set ventilation standards are sufficiently protective.[31] In fact, the CEC has not just the authority—but the duty—to address this question. The CEC has a statutory mandate to address indoor air quality when developing its building energy efficiency standards. Specifically, under Cal. Pub. Res. Code § 25402.8, "When assessing new building standards for residential and nonresidential buildings relating to the conservation of energy, the commission ***shall*** include in its deliberations the impact that those standards would have on ***indoor air pollution*** problems."[32]

In assessing the air quality guidelines to apply when developing its Title 24 ventilation standards, the CEC should draw on the expertise of California health and air agencies, including the California Air Resources Board (CARB), while also ensuring that the guidelines from these agencies are up-to-date and the most protective. CEC should also

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Prevention Morbidity and Mortality Weekly Report (Feb. 9, 2018), http://dx.doi.org/10.15585/mmwr.mm6705e1; Centers for Disease Control and Prevention, Summary Health Statistics: National Health Interview Survey: 2015 at tbl. C-1 (2017), http://www.cdc.gov/nchs/nhis/shs/tables.htm.

[30] *See, e.g.*, Kathleen Belanger et al, *Household Levels of Nitrogen Dioxide and Pediatric Asthma Severity*, 24 EPIDEMIOLOGY 320 (2013) ("Our results contribute to a growing body of literature associating low levels of NO_2 exposure with adverse respiratory outcomes in asthmatic children. Further, the apparent threshold for these effects in asthmatic children (every 5 ppb increase in NO_2 exposure above a threshold of 6 ppb was associated with a dose-dependent increase in risk of higher asthma severity score) which is comparable to the 10^{th} percentile of mean levels measured outdoors—far below the US EPA 53 ppb [long-term] standard—and with increasing risk of adverse respiratory morbidity above that level.").

[31] *See* SoCalGas Comments at 10 ("The claim infers that the current requirements are not the 'most protective,' but this is a matter for CARB to review, not CEC.").

[32] Cal. Pub. Res. Code § 25402.8 (emphasis added).

consider and apply the guidance issued by other expert regulatory bodies that have reviewed the most recent scientific evidence and developed robust, health-protective air quality guidelines.

SoCalGas asserts that "No specific evidence has been offered that the CEC has not [aligned its ventilation standards with the most protective air quality guidelines issued by regulators], having analyzed the impact of current Title 24 ventilation requirements in mitigation accumulation of indoor air contaminants against prevailing air pollutant standards."[33] In fact, as evidenced below, the CEC has not assessed its ventilation requirements in light of the most protective regulatory standards for NO_2 pollution.[34] In conducting its indoor air quality modeling to develop ventilation standards, the CEC's Code and Standards Enhancement (CASE) team[35] applied the U.S. Environmental Protection Agency's ("EPA") decade-old 2010 outdoor one-hour NO_2 standards of 100 ppb.[36] Peer-reviewed studies have found that this 100 ppb standard is not sufficiently protective of health indoors, especially for the most sensitive populations, with health effects occurring for asthmatic children with exposure to as little as **11 ppb** of NO_2 indoors.[37]

As a result, other regulatory bodies, including Health Canada, have adopted significantly more stringent guidelines for indoor air quality thresholds for short- and long-term exposure (90 ppb and 11 ppb, respectively).[38] In their thorough review of the health literature, Health Canada has also adopted more stringent ambient air quality standards for outdoor NO_2: 60 ppb beginning in 2020, decreasing to 42 ppb in 2025.[39]

[33] *See* SoCalGas Comments at 10.
[34] Nor has the CASE team included a modeling scenario for 24-hour exposure to carbon monoxide (CO), while the World Health Organization has a 24-hour CO guideline of 6 ppm, and Health Canada has a 24-hour CO guideline of 10 ppm. WHO Indoor Air Quality Guidelines: Household Fuel Combustion, 2014. https://www.who.int/airpollution/guidelines/household-fuel-combustion/IAQ_HHFC_guidelines.pdf; Health Canada, Residential indoor air quality guidelines, 2018. https://www.canada.ca/en/health-canada/services/air-quality/residential-indoor-air-quality-guidelines.html#a1
[35] Codes and Standards Enhancement ("CASE") Initiative team on Multifamily Indoor Air Quality, https://title24stakeholders.com/measures/cycle-2022/multifamily-indoor-air-quality/.a pro
[36] *See* Codes and Standards Enhancement (CASE) Initiative 2022 California Energy Code, Multifamily Indoor Air Quality Draft CASE Report at 46, 2022-MF-IAQ-D (May 2020), https://title24stakeholders.com/wp-content/uploads/2018/10/MF-IAQ_Draft-CASE-Report_Statewide-CASE-Team.pdf. Report cites CARB 2016 but it appears to be a 2010 standard from EPA. See earlier draft of report: Marian Goebes et al., 2022 California Energy Code (Title 24, Part 6), Multifamily Indoor Air Quality – Kitchen Range Hood Capture Efficiency Requirement (Mar. 23, 2020), *available at* https://title24stakeholders.com/wp-content/uploads/2020/01/T24-2022-Submeasure-Summary_KITCHENRANGEHOOD.pdf.
[37] *See, e.g.*, Kathleen Belanger et al, *Household Levels of Nitrogen Dioxide and Pediatric Asthma Severity*, 24 EPIDEMIOLOGY 320 (2013)
[38] *See* Health Canada, Residential Indoor Air Quality Guideline: Nitrogen Dioxide (2015), *available at* https://www.canada.ca/en/health-canada/services/publications/healthy-living/residential-indoor-air-quality-guideline-nitrogen-dioxide.html; World Health Organization (Regional Office for Europe), WHO Guidelines for Indoor Air Quality: Selected Pollutants (2010), *available at* https://apps.who.int/iris/handle/10665/260127. *Compare* U.S. EPA, NAAQS Table, https://www.epa.gov/criteria-air-pollutants/naaqs-table (Apr. 10, 2020).
[39] Canadian Council of Ministers of the Environment, Canadian Ambient Air Quality Standards (CAAQS), https://www.ccme.ca/en/current_priorities/air/caaqs.html

Meanwhile, CARB has begun a process to revise its older indoor air quality guidelines for emissions based on the latest science, [40] but this updated guidance has not yet been finalized. In order to ensure that the 2022 Title 24 update incorporates the best available science, the CEC should both confer with CARB as that agency updates its guidance and draw on the analyses of other expert agencies like Health Canada that have finalized robust and more recent guidelines.

The CEC should work with public health and indoor air quality experts—at CARB and beyond—to review the best available science on indoor air pollution. In setting ventilation standards, the CEC should apply indoor air quality guidelines that reflect the latest science and are sufficiently stringent to protect all Californians, including the most sensitive populations.

D. Studies based on in-home and laboratory measurements show that gas cooking can generate indoor pollution at levels that exceed air quality standards

Peer-reviewed studies show that gas stoves often produce pollution levels indoors that can exceed thresholds designed to protect health, including the national ambient air quality standards (NAAQS). As discussed in Section C, evidence shows that EPA's 100 ppb short-term NAAQS for NO_2 is insufficiently stringent to protect public health, especially for vulnerable populations. Yet many studies have found indoor NO_2 pollution levels from gas stoves to exceed even this relatively lenient 100 ppb standard.[41]

Our Joint Comments cited one of these many articles—the Logue et al. study—which found that 12 million Californians in homes with gas stoves may routinely be exposed to NO_2 levels indoors that exceed the NAAQS threshold.[42] SoCalGas directs four main criticisms at the Logue article, none of which is correct.[43]

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[40] *See* Emily C. Dooley, *California Wants to See How Cooking With Gas Affects Indoor Air*, BLOOMBERG GREEN (May 8, 2020), https://www.bloomberg.com/news/articles/2020-05-08/california-wants-to-see-how-cooking-with-gas-affects-indoor-air. Existing CARB guidelines on indoor air date to 1994 and 2005. California Air Resources Board, Combustion Pollutants in Your Home (1994), *available at* https://ww3.arb.ca.gov/research/indoor/combustf.htm; see California Air Resources Board, Report to the California Legislature: Indoor Air Pollution in California 136-37, 144 (2005), *available at* https://ww2.arb.ca.gov/sites/default/files/classic//research/apr/reports/l3041.pdf.

[41] *See, e.g.*, Laura M Paulin et al., 24-h Nitrogen dioxide concentration is associated with cooking behaviors and an increase in rescue medication use in children with asthma. Environ Res. 2017 Nov;159:118-123., p 6, doi: 10.1016/j.envres.2017.07.052 (finding that the use of a gas stove for 2 hours may increase 24-hour indoor NO_2 concentrations to levels close to 200 ppb, a value above both the annual and 1-hour EPA ambient limits and World Health Organization recommended indoor air guidelines).

[42] Jennifer Logue et al., "Supplemental Material Pollutant Exposures from Natural Gas Cooking Burners: A Simulation-Based Assessment for Southern California," *Environmental Health Perspectives*, January 1, 2014, https://ehp.niehs.nih.gov/doi/suppl/10.1289/ehp.1306673 (also finding that 1.7 million Californians may routinely be exposed to carbon monoxide levels that exceed federal standards).

[43] In addition to critiquing the Logue study in Appendix A, SoCalGas cites a different study to support its claim that gas cooking does not produce dangerous levels of indoor pollution. SoCalGas Technical Comments *supra* note 2, p.7–8 (citing W Chan et al., Ventilation and Air Quality in New California Homes with Gas Appliances and Mechanical Ventilation, prepared for CEC (2020). SoCalGas asserts that, because the Chan study found that measured concentrations were below health guidelines for most pollutants, no changes to existing ventilation policies are

First, SoCalGas criticizes the Logue study for not "measur[ing] exposures in California households," and instead relying upon "modeling methods and assumptions" that "cannot be reproduced by stakeholders."[44] This critique is misguided, as the Logue study was specifically designed as a modeling-based study in order to be able to apply findings from measurement-based studies to the population level.[45] The model's design, inputs, data sources, and assumptions are all described in great detail in the paper's Methods section. Interested stakeholders could readily apply the study's model to conduct their own analysis, using their own assumptions.

Next, the SoCalGas letter questions the emission factors used in the study. First, SoCalGas states that in the Logue study, the emissions factors "cannot be discerned."[46] However, the details of the emissions factors are laid out in the Logue study:

> *"E_i was selected from emission factors (in nanograms per Joule) measured in a recent study of U.S. cooking ranges by Singer et al. (2010). Fuel use for cooktop burners was set at 1.23 × 10^5 J/min (7 kBtu/hr) as an estimated time-averaged mean. An oven-specific fuel use algorithm was developed based on measurements of actual oven firing patterns as described below".*[47]
>
> *"Cooking burner emission factors for NO_2, CO, and HCHO [formaldehyde]were based on measurements reported by Singer et al. (2010) for twelve ranges, each including a cooktop and oven. Each home was randomly assigned the emission factors from one cooktop and one oven from the data set and those emission factors were used for all modeling of the home."*[48]

In turn, the Singer paper on which Logue relies lays out these measured emissions factors in a pair of tables in its Executive Summary.[49]

SoCalGas further questions the emissions factors in the two studies, stating "it is unclear how LBNL is using measured concentrations and whether the emission factors used in the modeling study represent peak emission rates (particularly for NO_2), time averaged emission rates, or a hybrid of these measurements."[50] The Singer paper is clear that the

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warranted. There are several flaws in this reasoning. First, as discussed in above, there is significant scientific evidence that the existing health guideline for NO_2 is insufficient to protect public health, especially for sensitive populations. Second, even though the strongest evidence of NO_2-related health harms is associated with short-term exposure, the Chan study focuses primarily on long-term exposures. In fact, the authors acknowledge that because of the time-averaged, long-term design of the study, it is possible that some "homes may have had high concentrations of NO_2 over short periods when cooking occurred." *Id.* at 89.

[44] *See* SoCalGas Comments at 3.

[45] *See* Logue, *supra* note 41 ("Measurement-based studies are imperative for understanding the physical properties that govern concentrations and exposures in homes; however, the costs and logistics of large-scale monitoring are barriers to using this method to quantify population-wide impacts."). Moreover, the study's authors verified their results by comparing their findings to the most recent in-home study at the time and found that the in-home study's "measured concentrations were on par with simulated concentrations in the present study."

[46] *See* SoCalGas Comments, p.3.

[47] *See* Logue, *supra* note 41, p.44.

[48] I*d*, p.45.

[49] Singer BC, Apte MG, Black DR, Hotchi T, Lucas D, Lunden MM, et al. 2010. Natural Gas Variability in California: Environmental Impacts and Device Performance— Experimental Evaluation of Pollutant Emissions from Residential Appliances. Tables ES-1 & ES-2 on pp. 5-6. CEC-500-2009-099-APE. Sacramento, CA: California Energy Commission., https://www.osti.gov/servlets/purl/980736

[50] SoCalGas Comments at 3.

emissions rates are "full burn emissions rates,"[51] which are measured using a prescribed burning protocol, which for stoves involves heating water for specific lengths of time, and for ovens involves heating to a series of specific temperatures.[52]

Finally, SoCalGas argues that the Logue study fails to account for "critical behavior-related variables" related to kitchen temperature rise.[53] They assume, without citing any studies,[54] that as the temperature rises from cooking, occupants will reduce appliance use or increase ventilation to outside the kitchen (with windows, doors, or other methods), thereby reducing NO_2 pollution. First, it is critical to note a number of factors beyond gas stoves influence indoor NO_2 concentrations, including the outdoor NO_2 concentration, the exchange rate with outdoor air, and the physical and chemical behavior of pollutant molecules.[55] If windows are opened and outdoor pollution levels are high, that could likely result in higher indoor NO_2 levels, due to either direct infiltration or chemical reactions with ozone from outdoors.[56]

SoCalGas's argument about behavioral changes in response to kitchen temperatures is even more problematic in light of data about range hood use. Studies consistently show that people frequently do not use ventilation while cooking. In California specifically, recent surveys suggest that less than 40% of occupants use their range hoods or open windows while cooking.[57] Thus, relying on occupants to adjust their behavior to reduce indoor pollutant concentration—whether through turning on ventilation or opening windows—is a highly fallible mitigation strategy.

CONCLUSION

Ensuring that Californians are able to breathe clean air inside our buildings is crucial to our well-being, and never has this been clearer than in 2020, when respiratory health has come into sharp focus. The time is right for the CEC, in cooperation with air quality and health agencies like CARB, to re-evaluate indoor air quality. Designing building standards that ensure our communities have safe indoor air has never been more important. The health risks of gas stove pollution are well-documented, if not yet widely known. Lower income households and communities of color are disproportionately affected by indoor air pollution, including from combustion devices. The CEC has the responsibility to develop building energy efficiency standards that reflect the latest science on indoor air pollution,

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[51] *See* Singer et al., *supra* note 48, at 5–6 tbls. ES-1 & ES-2.
[52] *Id*, p.37-39 & tbl.8.
[53] *See* SoCalGas Comments, p.3.
[54] SoCalGas does indicate that American National Standards Institute Standard Z21.1 for gas cooking appliances assumes that occupants will respond to rising temperatures by increasing ventilation or reducing appliance use. However, this is simply a modeling assumption, not evidence of actual occupant behavior.
[55] *See* Logue, *supra* note 41 (listing the parameters for the indoor air quality model).
[56] Logue does not directly model these chemical reactions in the study but notes that they could be quite large. *Id.* at Supplemental Material p. 2 ("Ozone would raise the effective NO_2 emission rate for cooking by 2-72% in summer and by 0-10% in winter depending on location and time of day. This underscores that our estimates for NO_2 concentrations in summer are conservative and that the health impact of [natural gas cooking burners] is likely even larger than modeled here.").
[57] Victoria L Klug, Agnes B Lobscheid, and Brett C. Singer, *Cooking Appliance Use in California Homes- Data Collected from a Web-based Survey*, ERNEST ORLANDO LAWRENCE BERKELEY NATIONAL LABORATORY, (August 2011), https://homes.lbl.gov/sites/all/files/lbnl-5028e-cookingappliance.pdf.

and protect all Californians including the most vulnerable populations. Ventilation is a critical tool to decrease indoor air pollution, but it is not alone a strategy for protecting Californians. A holistic look at these issues, including interagency collaboration with CARB and other environmental health-oriented agencies, is the basis for future policies that best ensure safe air for all indoors.

Respectfully submitted,

Brady Seals, Denise Grab, Leah Louis-Prescott
Rocky Mountain Institute

Sean Armstrong
Redwood Energy

Ted Tiffany
Guttmann & Blaevoet Consulting Engineers

Andee Krasner
Mothers Out Front

Pierre Delforge
Natural Resources Defense Council

Alison Seel
Sierra Club

Appendixes filed separately to the docket:

A) Individual Health & Air Quality Experts June 12, 2020 Submitted Comments on Draft Report: Multifamily Indoor Air Quality (2022 Cycle)
B) Rocky Mountain Institute and partners June 12, 2020 Submitted Comments on Draft Report: Multifamily Indoor Air Quality (2022 Cycle)