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**Rocky Mountain Institute, Sierra Club CA, EHDD Comments on
Sept 30, 2020 Indoor Air Quality Workshop**

Additional submitted attachment is included below.



October 16, 2020

California Energy Commission
Docket Office, MS-4
1516 Ninth Street MS-4
Sacramento, CA 95814-5512

Re: Follow-up Comments to the September 30, 2020 Workshop on Indoor Air Quality, Docket #19-BSTD-03 (2022 Energy Code Pre-Rulemaking)

Dear Commissioners and Staff:

Thank you for leading a workshop on indoor cooking and indoor air quality as part of the Title 24 2022 Energy Code Pre-Rulemaking. Commissioner McAllister's opening remarks clearly articulated "the need to improve air quality inside the homes through code," and this workshop is an important step toward protecting the health of Californians. The California Energy Commission (CEC), Codes and Standards Enhancement (CASE) team, and expert speakers did an excellent job leading a well-informed discussion on range hood ventilation standards and the dangers of indoor air pollution.

As staff from the California Air Resources Board (CARB) articulated in their presentation, ventilation is necessary but not sufficient to address the adverse health effects of gas appliances, and building electrification can eliminate these harms. While the CASE team's proposal would help by requiring more stringent ventilation standards for gas stoves to reflect their additional nitrogen dioxide (NO₂) pollution, ventilation alone will not solve the problem.

The opportunity to make a significant improvement in pollution levels indoors is occurring amidst a global pandemic and statewide climate crisis. COVID-19 is increasing time spent indoors, and scientists have found higher death rates of the virus when exposed to higher levels of NO₂.¹ Simultaneously, California has recently suffered from record-breaking heat and the largest wildfire season on record, in part due to climate change.² There has never been a more critical time in California state history to enact ambitious policy measures to protect public health, improve air quality, and reduce climate impacts. The CEC ought to lead the state in this effort by ensuring all new construction is built all-electric.

¹ Brady Seals and Yu Ann Tan. "Tackling NO₂ from All Sources to Help Fight COVID-19," RMI (September 2020), <https://rmi.org/tackling-no2-from-all-sources-to-help-fight-covid-19/>.

² Jonny Kocher and Leah Louis-Prescott. "Climate Change is Ravaging California. It's Time to Electrify," RMI (September 2020), <https://rmi.org/climate-change-is-ravaging-california-its-time-to-electrify/>.

These comments first respond to misleading statements by some commenters at the hearing by providing additional scientific citations to support the following facts:

1. Clear health evidence establishes that exposure to NO₂ pollution, including from gas stoves, causes asthma attacks in the short-term and likely causes the development of asthma in the long-term
2. Even under current ventilation standards, gas stoves frequently cause indoor concentrations of NO₂ to exceed health-protective threshold levels

After considering the copious evidence of harm due to NO₂ pollution from gas stoves, in order to effectively address indoor air quality in its 2022 building code, the CEC should:

3. Adopt a single all-electric baseline in the 2022 code cycle
4. Include automatic ventilation technology, especially for gas stoves, such as the technologies already on the market in Japan
5. Increase the minimum capture efficiency (CE) rate for gas stove ventilation to at least 80%
6. Implement stronger some standards to increase range hood usage rates
7. Provide more information to building occupants on the risks of exposure to pollutants from gas appliances, especially stoves and ovens

(1) Clear health evidence establishes that exposure to NO₂ pollution, including from gas stoves, exacerbates asthma in the short-term and likely causes the development of asthma in the long-term

A clear scientific consensus shows that NO₂ pollution, such as that released by gas stoves, causes respiratory harm. Many speakers acknowledged this, but it is important to reiterate that the science of health effects from exposure to NO₂ pollution is very clear. In verbal comments, the representative from the American Gas Association (AGA) attempted to discredit the association between combustion emissions and asthma, by asserting that the federal government has made no findings regarding the negative health effects of emissions from gas stoves. On the contrary, the relationship between gas cooking and childhood asthma is well-documented in peer-reviewed literature, and federal agencies have contributed to this growing body of research.³

In 2016, the Environmental Protection Agency (EPA) made the conclusive finding that there is a causal relationship between short-term exposure to NO₂ and respiratory effects like asthma attacks. The EPA also found there is likely to be a causal relationship between

³ Contrary to AGA's statement, federal agencies continue to discuss the negative health impacts of gas stoves. In the Federal Interagency Committee on Indoor Air Quality (CIAQ)'s October 19, 2019 meeting minutes, the U.S. Department of Housing and Urban Development (HUD) is funding a research study to mitigate asthma symptoms and improve indoor air quality specifically in homes with gas stoves, "which are known to emit contaminants that can trigger asthma." See: https://www.epa.gov/sites/production/files/2019-12/documents/ciaq_meeting_minutes_october_16_2019.pdf

long-term exposure to NO₂ and respiratory effects including the development of asthma.⁴ These findings are stronger conclusions than the previous EPA assessment in 2008 and also come three years after a comprehensive meta-analysis reviewing 36 years of research which concluded that children living in homes with a gas stove are 42% more likely to experience asthma symptoms and 24% more likely to be diagnosed with asthma by a doctor compared to those living in homes with electric stoves.⁵ More recently, RMI and partners conducted an extensive literature review on the health effects from gas stove pollution citing the most recent 20 years of scientific evidence that links gas stove pollution to asthma.⁶ There is clear evidence that exposure to NO₂ pollution from gas stoves can lead to asthma attacks and may cause the development of asthma from repeated exposure.

Contrary to AGA's assertions, the science linking negative health effects to gas stoves is well-established, with evidence having become only stronger over time.

(2) Studies show that gas stoves, even with California's existing ventilation standards in place, frequently produce indoor concentrations of NO₂ that exceed health-based standards

The findings presented by Dr. Brett Singer and others at the workshop established that gas stoves, under California's current ventilation standards, frequently produce levels of NO₂ pollution that exceed health-based standards. As the evidence of the health dangers from NO₂ pollution mounts, expert agencies like Health Canada have found that the existing U.S. Environmental Protection Agency (EPA) standards⁷ are insufficiently stringent to protect public health. Yet, according to studies by Dr. Singer and others, gas stoves today are failing to meet even these existing standards.

Some commenters attempted to cast doubt on the dangers of gas stove pollution by claiming that the speakers were exaggerating the indoor air quality impacts by looking at peak emissions rather than time-averaged emissions.⁸ First, it is simply incorrect that the data presented addressed only peak emissions. Data presented by Dr. Brett Singer at the

⁴ 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, p. lxxxvii, 5-247

⁵ 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>.

⁶ 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>.

⁷ The EPA's one-hour (short-term) standard of 100 ppb is defined as the 98th percentile of 1-hour daily maximum outdoor concentrations, averaged over 3 years). Environmental Protection Agency. NAAQS table. <https://www.epa.gov/criteria-air-pollutants/naaqs-table>

⁸ Timestamp 04:10:04, Kevin Messner, Association of Home Appliance Manufacturers, "I just want to be sure that everyone knows that there are indoor air quality limits set for health and safety reasons in Canada, there are outdoor limits in the US by the EPA and if these levels are unsafe and unhealthy, then people should be discussing those. But if they are, and the indoor air is within those limits, then let's not state that they're unhealthy. Having reports that are supposedly reports like the RMI report that really is out of hand and uses peak values to scare people when instead of average values is not helpful to this debate."

workshop examined gas stove pollution over a range of time periods, from long-term (over 1 week) to over the course of a 1-hour cooking simulation, not only peak measurements.⁹

In two of the studies, Dr. Singer specifically analyzed whether gas stove cooking would produce NO₂ levels that would violate the analogous outdoor air quality standard for nitrogen oxides (100 ppb over the course of 1-hour). One of these studies found that 55 – 70% of Californian households cooking with gas stoves would exceed a 100 ppb 1-hour standard during a typical winter week.¹⁰ Recent LBNL simulations of a modest meal for four showed that 4 out of 9 homes had kitchen NO₂ levels exceed 100 ppb for the duration of a one-hour time period.¹¹ Without using a range hood (capture efficiency of 0), more than half of all homes and 100% of homes that are less than 750 – 1,500 square feet exceeded a 1-hour 100 ppb standard.¹² Even at the proposed 70% capture efficiency, Dr. Singer’s analysis found that homes can still exceed the 1-hour 100 ppb standard.¹³

This standard of 100 ppb has already been shown not to be protective enough of human health, particularly for sensitive populations such as children with asthma. Government officials in Canada adopted more stringent guidelines for indoor air quality than the EPA’s outdoor standards,¹⁴ based on recent science indicating that 100 ppb is not sufficiently protective of health. Canada has acted on this issue by setting lower ambient one-hour standards of 60 ppb in 2020 and moving to 42 ppb by 2025.¹⁵ CARB is in the process of updating the indoor air quality guidelines for NO_x emissions indoors in California, but until the process is complete, it is important to understand that 100 ppb is not sufficiently protective. In order to ensure that all Californians are protected from health risks of NO₂ pollution in our homes, the CEC should apply the 42-ppb standard used by Health Canada on an interim basis, while CARB updates its guidelines.

Additionally, health harms from NO₂ pollution occur on a range of time scales, not just over the 1-hour time period in the standards. Both duration and intensity of exposure can exacerbate harm, with both long-term low levels of pollution and repeated spikes of high-level pollution adding to risk. Furthermore, repeated short-term exposure can accumulate

⁹ Brett Singer, Lawrence Berkeley National Lab, Sept. 30, 2020 Presentation Slides 6–8, *available at* <https://efiling.energy.ca.gov/GetDocument.aspx?tn=235047&DocumentContentId=67939>

¹⁰ *Id.* at slide 6 (citing Jennifer Logue et al., *Supplemental Material Pollutant Exposures from Natural Gas Cooking Burners: A Simulation-Based Assessment for Southern California*, 122 ENVIRONMENTAL HEALTH PERSPECTIVES 43 (2014), <https://ehp.niehs.nih.gov/doi/suppl/10.1289/ehp.1306673>)

¹¹ *See id.*, at slide 8 (citing Singer et al. 2017, *Pollutant Concentrations and Emission Rates from Natural Gas Cooking Burners Without and with Range Hood Exhaust in Nine California Homes*, 122 BUILDING AND ENVIRONMENT 215 (2017), <https://www.sciencedirect.com/science/article/abs/pii/S036013231730255X>).

¹² *See id.* at slide 25.

¹³ Chan et al. 2020a. Simulations of short-term exposure to NO₂ and PM_{2.5} to inform capture efficiency standards. Task 4 Final Report. <https://escholarship.org/uc/item/6tj6k06j>

¹⁴ *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>; Compare U.S. EPA, NAAQS Table, <https://www.epa.gov/criteria-air-pollutants/naaqs-table> (Apr. 10, 2020).

¹⁵ https://www.ccme.ca/en/current_priorities/air/caaqs.html

over time and lead to long-term effects. As EPA explains, “repeated short-term NO₂ exposure could lead to the development of asthma.”¹⁶

Research has shown that gas stove emissions pollute not only the kitchen, but the rest of the house, and can persist over time. Dr. Singer presented research showing elevated levels of NO₂ in the bedrooms of homes with gas stoves, persisting over the course of a whole week, with less than an hour of cooking per day.¹⁷ The mean weeklong level of NO₂ in the bedrooms of those homes that cooked with gas stoves was 10.5 ppb, with 50% higher levels in kitchens.¹⁸ Meanwhile, research shows that health effects occur for asthmatic children with long-term exposure to as little as 11 ppb of NO₂ indoors.¹⁹ Health Canada based its guidelines on the most recent science and set its indoor residential guideline for long-term exposure at 11 ppb.²⁰ Even if one were to follow the suggestion of commenters and focus only on longer-term exposure, the data presented by Dr. Singer show that gas stoves, even after turned off, can result in levels of NO₂ throughout the house that are known to cause adverse health effects for asthmatic children.

(3) In order to ensure that Californians will not be breathing unhealthy levels of NO₂ indoors, CEC should eliminate indoor sources of NO₂ pollution by adopting a single all-electric baseline in the 2022 code cycle

As the CEC acknowledged at the workshop, it has a statutory obligation to consider the indoor air pollution impacts associated with its building energy efficiency standards.²¹ As building envelopes tighten with increased energy efficiency measures, indoor air pollution becomes an even larger concern.

Speakers from CEC, CARB, University of California, Los Angeles (UCLA), and Lawrence Berkeley National Laboratory (LBNL) all noted that gas stoves and ovens produce high levels of dangerous pollutants that degrade both outdoor and indoor air quality. Electric

¹⁶ See *id.*, p. lxxxv

¹⁷ Brett Singer, Lawrence Berkeley National Lab, Sept. 30, 2020 Presentation Slide 7 (citing N.A. Mullen et al., *Results of the California Healthy Homes Indoor Air Quality Study of 2011-13: Impact of Natural Gas Appliances on Air Pollutant Concentrations*, 26 INDOOR AIR 231-245 (2015), <https://onlinelibrary.wiley.com/doi/10.1111/ina.12190>)

¹⁸ See *id.* at slide 7.

¹⁹ See Kathleen Belanger et al, *Household Levels of Nitrogen Dioxide and Pediatric Asthma Severity*, 24 EPIDEMIOLOGY 320 (2013) (this yearlong study passively measured NO₂ concentration for four month-long periods using Palmes tubes).

²⁰ 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> (Health Canada defines long-term exposure as a sampling time of at least 24 hours and ranging to a few weeks to a month, additionally Health Canada considered setting the long-term guideline at about 5 ppb but found that 90% of homes with gas stove would exceed this level. They note that 5 ppb for long-term exposure may be a useful benchmark in specific circumstances, for example certain tests on gas appliances). EPA’s long-term outdoor standard is 53 ppb, but is outdated and not sufficiently protective, based on the latest science.

²¹ 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.”).

stoves and ovens are much less polluting than gas appliances that rely on combustion, as noted by both Dr. Zoe Zhang of CARB and Dr. Yifang Zhu of UCLA. In a state that is already struggling to meet clean air requirements, it is critical to implement cost-effective solutions that reduce air pollution, both indoors and outdoors, such as building homes with all-electric appliances.²² The most effective solution to reduce NO₂ air pollution is to reduce emissions altogether by eliminating the use of combustion appliances indoors. Efficient electric appliances are available on the market as clean alternatives. Now is the time for the CEC to ensure all new buildings are all-electric and consequently as healthy and safe as possible.

An effective way to increase all-electric building in the 2022 code cycle is to move to a single all-electric baseline for all building types.

If the CEC fails to enact an all-electric baseline in the 2022 building code, the next opportunity will be the 2025 cycle, implemented in 2026, meaning California will be putting gas infrastructure into the ground for at least the next six years. This infrastructure will cost billions of dollars and typically has a 50- to 60-year asset life, which means that ratepayers will be paying for the cost of this infrastructure for many decades.²³ The three-year delay will also result in an additional 3 million metric tons of carbon emissions by 2030. If instead the state replaces all residential gas appliances with clean electric alternatives, it could cut air pollution enough to save 350 lives and \$3.5 billion in health costs every year.²⁴ The costs, emissions, and negative health impacts associated with continued gas use in buildings are unnecessary and avoidable.²⁵

Californians are now and likely will continue to spend more time in our homes than ever before with the global pandemic, longer and hotter summers, and more wildfires. Now is the time for CEC to ensure homes are built to be healthy, clean, and safe by adopting a single all-electric baseline in 2022.

(4) Automatic ventilation technology is already used in range hoods in Japan, and should be included in this building code update, especially for gas stoves

While a single all-electric baseline is the most effective path forward to reduce NO₂ and other combustion pollution, if the CEC chooses not to pursue this path, it should institute additional ventilation requirements for gas stoves. In Mr. Strait's presentation, he shared a

²² Energy + Environmental Economics. *Residential Building Electrification in California* (2019), available at https://www.ethree.com/wp-content/uploads/2019/04/E3_Residential_Building_Electrification_in_California_April_2019.pdf

²³ Gridworks. California's Gas System in Transition (September 2019). Link: https://gridworks.org/wp-content/uploads/2019/09/CA_Gas_System_in_Transition.pdf

²⁴ UCLA Fielding School of Public Health, "Effects of Residential Gas Appliances on Indoor and Outdoor Air Quality and Public Health in California | COEH - Center for Occupational & Environmental Health," [coeh.ph.ucla.edu](https://coeh.ph.ucla.edu/effects-residential-gas-appliances-indoor-and-outdoor-air-quality-and-public-health-california), April 2020, <https://coeh.ph.ucla.edu/effects-residential-gas-appliances-indoor-and-outdoor-air-quality-and-public-health-california>.

²⁵ Denise Grab and Amar Shah. California Can't Wait on All-Electric New Building Code. RMI (July 2020). <https://rmi.org/california-cant-wait-on-all-electric-new-building-code/>

staff proposal to differentiate the ventilation standards for gas and electric cooking, which is a sensible initial step to recognize the additional pollution from gas stoves.²⁶ A cooktop's ventilation standard should be stringent enough to protect against harmful pollutants. Because gas cooktops emit more harmful NO₂ pollution than electric cooktops, the CEC should implement differentiated standards, as proposed by the staff.

However, any kitchen ventilation standards will fail to provide indoor air quality benefits if the ventilation is not used while cooking. In fact, kitchen ventilation is not used routinely. A large statewide, representative survey in the late 1980's found that only 3% of California households said they used any exhaust fans that day, although 37% were near an operating gas stove for cooking and/or space heating.²⁷ More recently, 39% of households in new single family homes in California reported never, rarely, or sometimes using kitchen exhaust fans when using the stove to cook.²⁸

Dr. Brett Singer presented data at the workshop that showed that fewer than 40% of people claim to use their range hoods "always" or "most of the time." A follow-up study revealed that people actually use range hoods less than half the time that they say they do, suggesting that fewer than 20% of people typically use their range hoods. The top reason that residents cited for not using their range hoods is because they believe it is "not needed," according to 70-80% of survey respondents.²⁹ Yet, the science and health information shared at the workshop made it clear that range hoods are needed at all times while cooking on gas stoves, due to the health risks from pollutants like NO₂ that are emitted any time the burner is on.

In contrast to most other cooking pollutants, NO₂ is odorless and colorless,³⁰ so people may not be aware that it is being emitted anytime a gas burner is turned on. Many residents likely do not understand that the range hood is meant to ventilate the kitchen to remove these invisible, odorless, and harmful pollutants, not just smoke, moisture, or odors.

²⁶ Peter Strait, California Energy Commission, Sept. 30, 2020 Presentation Slide 11. Link: <https://efiling.energy.ca.gov/GetDocument.aspx?tn=234999&DocumentContentId=67873>

²⁷ Phillips et al. 1990. Activity patterns of California adults and adolescents: Appliance use, ventilation practices, and building occupancy. ACEEE Summer Study, Paper 20-4. Link: <https://www.aceee.org/files/proceedings/1990/data/Vol4.html>

²⁸ Piazza et al., 2007. Study of Ventilation Practices, and Household Characteristics in New California Homes. California Energy Commission, PIER Program. CEC-500-2007-033. Final Report, ARB Contract 03-326. Link: [Study of Ventilation Practices, and Household Characteristics in New California Homes](#)

²⁹ Brett Singer, Lawrence Berkeley National Lab, Sept. 30, 2020 Presentation Slide 28. Link: <https://efiling.energy.ca.gov/GetDocument.aspx?tn=235047&DocumentContentId=67939>, Yang et al., Lawrence Berkeley National Laboratory, Ventilation and Indoor Air quality in New California Homes with Gas Appliances and Mechanical Ventilation (March 2019), p.A-28 <https://escholarship.org/content/qt44g399sb/qt44g399sb.pdf>

³⁰ See U.S. Env't Prot. Agency, Care for Your Air: A Guide to Indoor Air Quality, <https://www.epa.gov/indoor-air-quality-iaq/care-your-air-guide-indoor-air-quality> (June 1, 2020) ("Carbon monoxide. . . is a colorless, odorless gas that interferes with the delivery of oxygen throughout the body [and] causes headaches, dizziness, weakness, nausea and even death. . . Nitrogen dioxide (NO₂). . . is a colorless, odorless gas that causes eye, nose and throat irritation, shortness of breath, and an increased risk of respiratory infection.").

Dr. Singer also acknowledged that we cannot rely on behavior change, as it is very difficult to achieve. Instead, the CEC should use technological and policy changes, as Dr. Singer pointed out, to ensure improved indoor air quality statewide. Availability of ventilation is not enough—in order to protect public health, safeguards must be in place to ensure that ventilation is actually used.

In particular, the CEC should ensure that ventilation for gas stoves is automatic and operates whenever the stove is on. Ventilation should always be used while cooking regardless of stove type, but automatic ventilation is especially necessary when cooking with gas appliances that emit the colorless and odorless NO₂.

As the representative from the California Department of Public Health, Dr. Kazukiyo Kumagai, explained, automatic range hoods are already available on the market in Japan. According to Dr. Kumagai, Japan has a variety of automated range hood systems, with models ranging from “switch linked” to “motion sensor” to “humidity sensor” to “3-minute delay switch.” Given that this technology exists on the market in Japan, it seems reasonable that it can be adopted widely in California in time for this code cycle, especially for the critical purpose of protecting our residents’ health.

Integrated sensor technology is not entirely foreign here in California. Motion and infrared (heat sensing) occupancy sensors are common in the market for lighting, mechanical, and even receptacle loads. This is the same sensor technology that unlocks a hotel door with a key card. These technologies could be employed for gas cooking with minimal cost and disruption to existing market technologies. A similar approach has been used with humidistat controls for bathroom exhaust required under Title 24, Part 11 CALGreen from residential buildings. For optimal indoor air quality, California ought to require automatic range hood systems, especially for gas stoves, in this code cycle.

(5) The minimum capture efficiency (CE) rate for gas stove range hoods should be increased to at least 80%

The CASE team’s proposal of increasing the capture efficiency (CE) to 70% is a good first step, but due to household and behavioral characteristics, is not a sufficiently protective value. Based on the Lawrence Berkeley National Laboratory (LBNL) simulations, which modeled range hoods with CE of 60%, 70%, and 80%, the results suggest that requiring a minimum capture efficiency of at least 70% is needed to “avoid unacceptably high NO₂.”³¹

³¹ Chan et al. 2020a. Simulations of short-term exposure to NO₂ and PM_{2.5} to inform capture efficiency standards. Task 4 Final Report. <https://indoor.lbl.gov/publications/simulations-short-term-exposure-no2>. Model simulations were performed to determine the level of range hood CE that would allow cooking scenarios to occur in the majority of new homes being built in California while maintaining pollutant concentrations below EPA outdoor guidelines, if the range hood is used throughout cooking. The three modeled CE scenarios most studied are 60%, 70%, and 80% CE. If no range hood is used, the analysis estimates that approximately one-third (31%) of new CA homes will have NO₂ concentrations above the 100 ppb 1h threshold. Modeling showed a CE of 70% is necessary to reduce the occurrence of homes exceeding the 100-ppb threshold to less than 1% however that assumes optimal conditions that may not be possible/practical in the home.

However, there is still risk to residents when using 70% CE range hoods based on the modeling, and therefore 70% is not protective enough for residents' health. Plus, these results may underestimate factors that in practice require a greater CE to avoid high levels of indoor NO₂. CEC should instead require a minimum range hood CE of 80% for gas stoves to protect residents from NO₂ pollution.

There are a few key reasons why a CE of 70% may not adequately protect Californians from unsafe levels of NO₂. First, CE can be greatly impacted by factors present in homes, rather than in laboratory settings. Some factors that can decrease capture efficiency are cross drafts, people standing near the stove, clogged grease filters, and emissions that persist after cooking is completed.³² Another issue is that the LBNL modeling, which informed the CE standards, assumed that a whole house ventilation system was operating.³³ However, this assumption is probably not the reality in most homes, as another LBNL study found that 75% of new homes did not operate this type of ventilation system.³⁴

Behavioral factors can also influence the CE. These include types of food cooked and how it is cooked. LBNL's extensive modeling shows that CE on the back burners is much better than the front burners, yet there is some evidence that front burners are used more commonly.³⁵

Additionally, pollutant levels may be underestimated. The LBNL researchers note that the analysis that helped inform the new CE requirements considered meals that would produce substantial NO₂ but that these pollutant emission rates are "far from" the highest emissions values that have been previously reported in the technical literature.³⁶ Also, as California housing becomes more overcrowded,³⁷ the LBNL modeling assumptions on occupant numbers and amount of cooking will not be adequately protective in many cases. Due to the evidence that home and behavioral factors impact the use and therefore efficiency of range hoods, promoting minimum standards at a higher CE level of at least 80% is vital to sufficiently reduce health risks from cooking with gas stoves.

(6) Considering new evidence of the minimal usage rates of range hoods, stronger noise standards are also necessary

³² See e.g. Thomas J. Phillips, 2019. Ducted Range Hoods: Recommendations for New and Existing Homes, ROCIS (Reducing Outdoor Contaminants in Indoor Spaces) Issue Brief, <http://rocis.org/sites/default/files/user-files/ROCIS-Ducted-Range-Recommendations-Dec-2019-Update.pdf>

³³ Chan et al. 2020a. Simulations of short-term exposure to NO₂ and PM_{2.5} to inform capture efficiency standards. Task 4 Final Report. <https://escholarship.org/uc/item/6tj6k06j>

³⁴ Chan et al. 2020b. Ventilation and Air Quality in New California Homes with Gas Appliances and Mechanical Ventilation. LBNL. CEC Final Report CEC-500-2020-023, p 5, <https://www.osti.gov/biblio/1509678-ventilation-indoor-air-quality-new-california-homes-gas-appliancesmechanical-ventilation>.

³⁵ Chan et al. 2020a. Simulations of short-term exposure to NO₂ and PM_{2.5} to inform capture efficiency standards. Task 4 Final Report. <https://indoor.lbl.gov/publications/simulations-short-term-exposure-no2>.

³⁶ See id, p. 22

³⁷ Los Angeles Times. Mapping the country's crowded homes. <https://graphics.latimes.com/crowding-map/>

As Mr. Strait pointed out, noise is a major factor in a residents' decision to use or not use a range hood while cooking.³⁸ Dr. Singer showed that sound is the second biggest reason residents choose not to use their range hoods.³⁹ This suggests that quieter ventilation could help increase use of ventilation and reduce pollution. CEC should consider a more stringent sound standard, along with the recommendations above.

The current proposal is no more than 3 sones at "working speed," but Mr. Strait's presentation states that fans will be "much noisier at higher speeds, such as those needed to ventilate a large (three burner plus oven) cooking event."⁴⁰ CEC should tighten the sound requirements to be as low as reasonably possible at all levels: 1 sone at 100 cfm, 2 sones at 200 cfm, 3 sones at 300 cfm.

Most exhaust fans can achieve 1-2 sone at a low fan setting of 100 cubic feet per min (cfm), which is standard for the EPA's Energy Star for Homes certification.⁴¹ In fact, of all 107 hoods listed, all products produce 0.3 to 1.5 sones at speeds between 100 and 230 cfm. Not a single Energy Star product listed produces more than 1.5 sones at top speed. For higher settings, experts recommend that home applications stick to sone levels of 3 sones or less at 200 cfm or more.⁴² There are also products on the market that operate at 250-300 cfm with sone levels of 2.5-3 sones.⁴³

New noise levels will need to be tested, which can be accomplished before the code goes into effect. If testing cost is an issue, then at a minimum, the assessment should test noise at the higher flow rates of 200-300 cfm to address high emission events and assume that noise levels will be much better at 100 cfm. To accompany these changes, duct specs, inspection, and training are critical to achieving strong hood performance in the real world.

Given the availability of quieter products, there is no reason to allow noisy exhaust fans to be installed, especially knowing that most residents will not turn them on if they are too

³⁸ Peter Strait, California Energy Commission, Sept. 30, 2020 Presentation Slide 13. Link:

<https://efiling.energy.ca.gov/GetDocument.aspx?tn=234999&DocumentContentId=67873>

³⁹ Brett Singer, Lawrence Berkeley National Lab, Sept. 30, 2020 Presentation Slide 28. Link:

<https://efiling.energy.ca.gov/GetDocument.aspx?tn=235047&DocumentContentId=67939>

⁴⁰ Peter Strait, California Energy Commission, Sept. 30, 2020 Presentation Slide 13. Link:

<https://efiling.energy.ca.gov/GetDocument.aspx?tn=234999&DocumentContentId=67873>;

CASE team's 2022 Multifamily Indoor Air Quality Draft Report (2020). Link:

https://title24stakeholders.com/wp-content/uploads/2018/10/MF-IAQ_Draft-CASE-Report_Statewide-CASE-Team.pdf

⁴⁹ STAR Product Finder. Link: [https://www.energystar.gov/productfinder/product/certified-ventilating-fans/results?formId=152427-5615-48-4-](https://www.energystar.gov/productfinder/product/certified-ventilating-fans/results?formId=152427-5615-48-4-01998948&scrollTo=1601&search_text=&unit_type_filter=Range+Hood&brand_name_isopen=0&duct_size_isopen=0&markets_filter=United+States&zip_code_filter=&product_types=Select+a+Product+Category&sort_by=efficacy_1_cfm_w&sort_direction=desc&page_number=0&lastpage=3)

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⁴²ROCIS, "Range Hood Supplement 2: Selecting A Range Hood | ROCIS.Org," rocis.org, December 2019,

http://rocis.org/range-hood-supplement-2#_edn3.

⁴³ Products with these specs include: [KOBE Brillia CHX91 SQB-1](#) (3 sones, 300 cfm), [Zephyr Power Typhoon Series AK2100BS](#) (2.5 sones, 300 cfm), [Proline PLJW 125 series](#) (1.5 sones at 385 cfm), [KOBE Premium RA38 SQB-1](#) (3 sones at 300 cfm)

loud. The CEC and CASE team should consider stronger some standards to increase range hood use and improve residents' air quality.

(7) Building occupants need more information on the risks of exposure to pollutants from gas appliances, especially stoves and ovens

It is alarming that residents' number one reason for not using range hoods all the time is that they do not feel that ventilation is needed.⁴⁴ No matter how protective the state ventilation standards are, a range hood will fail to improve indoor air quality if it is never (or rarely) turned on. Therefore, educating the public both on the health benefits of electric cooking compared to gas, as well as the importance of using range hoods when cooking with gas, will be crucial to achieve widespread indoor air quality benefits.

To better ensure residents are breathing healthier indoor air, the CEC ought to require an advisory note on all range hoods that cooking without the range hood could lead to pollutant levels indoors that exceed thresholds used for outdoor standard. The label should also include the CE and noise ratings. This warning should be differentiated between electric and gas stoves to reflect different degrees of danger. These could resemble the labels that are already required for the dwelling unit ventilation. This would presumably be low-cost, and an additive protective measure to any improvements in capture efficiency and some standards.

Conclusion

In summary, scientific evidence is clear that gas appliances in buildings are responsible for avoidable health impacts and poor air quality. All-electric new construction is a cost-effective measure that the CEC can and should take to achieve the sought-after indoor air quality benefits for Californians.

The CEC has made great strides to date in improving the health and safety of our buildings, including throughout the process of this 2022 building code update. By hosting this indoor air quality workshop, CEC demonstrated its commitment to air quality and public health through the Title 24 building code. The staff and CASE team have worked hard to improve the code by including provisions such as differentiated standards for gas and electric cooking. Now the CEC should adopt a single all-electric baseline to achieve health, climate, and economic benefits statewide. If gas appliances are still allowed, CEC should ensure that

⁴⁴ Brett Singer, Lawrence Berkeley National Lab, Sept. 30, 2020 Presentation Slide 28. Link: <https://efiling.energy.ca.gov/GetDocument.aspx?tn=235047&DocumentContentId=67939>

all Californians are able to breathe healthy air in their homes by improving the quality of ventilation, especially to address the unique health threats posed by gas stoves.

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