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CALIFORNIA ENERGY COMMISSION

In the matter of:	)	Docket No. 19-BSTD-03
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2022 Energy Code Pre-Rulemaking	)	RE: Advances in Scientific Understanding of the Impacts of Indoor Cooking and Associated Ventilation on Indoor Air Quality
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COMMISSIONER WORKSHOP

Held remote via Zoom

California Energy Commission
Warren-Alquist State Energy Building
1516 Ninth Street
First Floor, Art Rosenfeld Hearing Room
Sacramento, California 95814

Wednesday, September 30, 2020

Reported by:

E. Hicks

APPEARANCES

COMMISSION

J. Andrew McAllister, Chair

STAFF

Peter Strait
Payam Bozorgchami
Susan Wilhelm

PANELISTS

Yifang Zhu, Environmental Health Sciences Department in UCLA School of Public Health
Brett Singer, Staff Scientist and Principal Investigator (PI) in the Energy Technologies Area of Lawrence Berkeley National Laboratory
Marian Goebes, Associate Technical Director - TRC Energy Services
Elizabeth Scheehle, Chief, Research Division - California Air Resources Board
Zoe Zhang, staff air pollution specialist, Indoor Exposure Assessment Section of the Research Division within CARB
Pat Wong, Air Resources Supervisor I at California Air Resources Board
Bonnie Holmes-Gen, chief of the Health and Exposure Assessment branch at the Air Board.

PUBLIC SPEAKERS

Debra Kaden, Ramboll
Susan B.
Jeffery K. Smith, World Health Organization
Mike Moore, HVI
Brady Seals, Rocky Mountain Institute
Stephanie Morris, Mothers Out Front Silicon Valley
Tim Carmichael, Southern California Gas Company
Tom Phillips, Healthy Building Research
Christine James, Climate Health Now
Kyoko Hibino, Save Porter Ranch
Kevin Messner, Association of Home Appliance Manufacturers
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Robert Gould, San Francisco Bay Physicians for Social Responsibility

I N D E X

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P R O C E E D I N G S

SEPTEMBER 30, 2020 9:05 a.m.

MR. STRAIT: All right. Shall I do some ground rules before we get started proper just to tee up, like, how the Q&A is going to work and some of this?

MR. McALLISTER: Yeah, please. Just start out introducing, and I'll jump in here, Peter, when you're done with the initial.

MR. STRAIT: Excellent. So greetings, everyone, in the audience. We're all here to discuss indoor cooking and air quality. I've got an agenda on the screen right now, so I'm going to do two things. First, I'm going to just quickly walk through the agenda to set the stage for how this panel discussion is likely to progress. And, two, I'm going to go over a few quick tips on interacting with the panel and making sure that everyone's questions get answered. We are going to have the majority of our open discussion amongst participants at the end of the panelists' presentation and discussion, so just as I go through this, please keep that in mind.

We're going to start with introducing all the panelists and the commissioner so that everyone in the audience knows who is speaking and what's brought them here today. The commissioner is going to give a brief statement of the purpose of this workshop and what we hope to accomplish here. I'll be giving a brief presentation that sets out the

problem statement that we're here to address, which is the interaction of indoor cooking activities and equipment and ventilation requirements.

My colleague, Susan, will be giving a presentation, then, on what some of the California Energy Commission's energy-related research has been into these topics and into the broader context of ventilation.

Then, we'll move on to our panelists. I'll be asking them to introduce themselves. But we have a total of five panelists today. The first, Yifang Zhu, from UCLA, she will be joining at 10:00. She has a much more limited schedule, but she will be on in time for the first session. Brett Singer, another researcher, working with Lawrence Berkeley National Labs. We have Martin Goebes -- I'm sorry, Marian Goebes; I read that wrong -- that works with some of our Codes and Standards Enhancement Team that are responsible for many of our code change proposals. We have two representatives, Pat Wong and Zoe Zhang, from the California Air Resources Board. And again, I'll give them a chance to make their introductions later. And we have a fifth panelist with the California Department of Public Health, Kazukiyo Kumagai.

The first thing, we'll have one session between our first two panelists, a second session with our three panelists. Each session will be presentations followed by

some panel discussions.

For members of the audience that have technical questions about the content being presented by panelists, we'll want you to use the Q&A box to type those questions in, and then we can get to those questions when there's a pause or break in the presentations and panel discussions.

We'll have a second session of panelists. We will then, at the end of the paneled presentation, open it for general questions, again, related to the content of the presentations, and we'll read ones -- we'll start by reading ones that came in in the Q&A and then move on to some live questions as much as we might have time for.

Depending on how long we go after the panel presentations, we will likely have a break for lunch, followed by a staff presentation which will set up the commentary that we want to hear from the public and give the context of what we are looking for in terms of specific topics we want your opinion on. Obviously, when we get to open public commentary, folks are free to say anything that they want to make sure the commissioner and staff and other participants hear, but this just gives us the things that we need to know for -- in order to engage in our rulemaking activities. And then once we've opened the mic to the public and heard what you have to say to us, we'll give some closing remarks to close out the day.

When we get to the open comment period, just in

order to make sure that everyone has a fair chance to speak, we will be asking that if you're a member of a group that there is one group representative that gives your statement or that has your communications ready. We do not want to put a time limit on comments. But again, if we need to, if we see a large number of participants, then we may need to implement a five-minute or a three-minute limit on commentary just so that we can make sure everyone has a chance at the mic. But, otherwise, we're going to do everything we can to get as many of your thoughts communicated to us, to the collection of state representatives and researchers that are present today, as well as to our commissioner and other decision-makers.

So, with that, let's go through and do some introductions about who's on the panel. And I'm just going to go in the same order that we have here on the agenda, but I'm going to start with the -- sorry. I'll go through the same order that we have here on the agenda and I'll end with the commissioner so that the commissioner can then give his opening statements. When I introduce you, I think what the public most wants to hear is not just who you are and who you're with but what brings you into the realm of indoor air quality research and what you've been working on, the things that you find to be important, that you want people to know that you're actively working on and engaged with.

So, with that, Brett Singer, would you care to

introduce yourself to the assembled public?

MR. SINGER: Yes, thank you. Can you hear me okay?

MR. STRAIT: Yes, you're loud and clear.

MR. SINGER: Wonderful. So I lead the Indoor Environment Group and I work with the Whole Building Systems Department at Lawrence Berkeley National Laboratory. I've been doing indoor air quality research since 1998 starting with second-hand and then third-hand tobacco smoke. I've done a lot of work on exposures, looking at especially how building efficient homes impacts our equipment exposures and ways to maintain good indoor air quality as we improve the energy and carbon performance in our buildings. I've specifically done a lot of work looking at gas appliances, and I'll be speaking in the session, so I'll stop there.

MR. STRAIT: Excellent. Thank you.

Marian, would you care to introduce yourself next, please?

MS. GOEBES: Sure, no problem. Thanks, everybody, for joining today. My name is Marian Goebes. I'm a member of the Statewide CASE Team, and I'm leading the Multifamily Indoor Air Quality CASE Report. I am at TRC. I've been here for about ten years. I conduct evaluation and market research on energy efficiency and indoor air quality topics. I've also been on the ASHRAE 62.2 committee, and I chair the Multifamily Working Group for ASHRAE 62.2. And prior to joining TRC, I

worked on the LEED for Homes Program and set up the Indoor Air Quality Requirements Fair. And prior to that, I was in graduate school studying indoor air quality topics. So thanks very much for having me on.

MR. STRAIT: Excellent. Next, Pat or Zoe or both. I guess starting with Pat, would you care to introduce yourself?

MR. WONG: Yeah, my name is Pat Wong. I'm the manager of the Indoor Exposure Assessment Section of the California Air Resources Board. Our interest of indoor is our section does do -- fund a lot of research regarding indoor air quality and personal exposures. One big interest which we are working on is, I guess, the effects of building HVAC systems and so forth that can modulate indoor air quality and, I guess, Zoe will talk about some of her work.

MS. ZHANG: Thank you, Pat. This is Zoe Zhang. I am a staff air pollution specialist, Indoor Exposure Assessment Section of the Research Division within CARB. So Pat has given a very nice, brief introduction of our section. And so, for myself, specifically, I was involved in contract management and also doing in-house study with the purpose to understand California's exposure issue, air pollution, including -- toxins. And also we are looking for policies and management and technology to mitigate California's exposure. So we collaborated with a lot of federal and state agency to

find a way to help reduce people's exposures. Thank you.

MR. STRAIT: Excellent. Thank you very much.

Last, Kazukiyo Kumagai -- I hope I'm saying that correctly -- from the California Department of --

MR. KUMAGAI: Perfectly. Hi, my name is Kaz Kumagai. I am the lead of the Indoor Air Quality Program with California Department of Public Health which is located in Richmond. We basically work on any kind of IAQ issues. But recently we've been pretty busy on eval of the fatal actions being caused by e-cigarettes or marijuana; also wildfire. And this year, all of a sudden, we were pulled into COVID. But today I will be talking about some of the outreach work that we've done on emissions testing and dampness and mold. So that will sort of give you an idea of what kind of outreach we did help with the state. Thank you.

MR. STRAIT: Excellent. Thank you very much.

And, finally, Commissioner McAllister, would you like to introduce yourself to the audience?

COMMISSIONER McALLISTER: Great. Well, thank you, Peter. I'll just take the mic here for a little bit. You know, for my brief framing comments, as I sat down to think about what I would say, they ended up maybe not being quite as brief as I might have liked, so you'll bear with me. I wanted to make sure to give the necessary attention to this topic.

First of all, a few thank yous. Thanks to the

Atomsy (ph.) Groups collectively that are participating here today and just generally to raise awareness on this issue. I think by doing so you're elevating this in an appropriate way, and it is time for us to address during our code update process. So it's really -- thanks for asking us to do this, and we certainly wanted to respond.

And I also wanted to thank all the industry groups collectively, again, for their recent work on a number of fronts but in particular developing a new standard for range hood capture efficiency. So that's very timely to provide the new tool in our toolbox. It's certainly another lever we can pull to help influence how our buildings perform. It's a very new standard and it's still sort of in the consensus development process. But it is a positive development, so we're thankful for that. We need all the tools we can to address this issue.

And then, finally, I want to thank our sister agencies, the ARB and the Department of Public Health and others, for their willingness and ability to dedicate some staff resources to this and work together as participants in this workshop. And certainly, you know, helping the agencies to respond to this pressing issue, certainly this and other issues that are increasingly coming to the floor in today's reality, and that's kind of what I wanted to talk about a little bit just to contextualize this.

So, you know, right now, over the weekend and Monday, Tuesday, we have two fires that are still basically uncontrolled, the Zogg fire up in Shasta and the Glass fire in Napa and Sonoma. I mean, Napa and Sonoma, again, you know, it's some set of developments that are creating the foundation for this devastating, just horrific development that we're now seeing basically every year. I mean, these harrowing situations are just something that are a direct impact of climate change and they are something that we have to deal with.

In California, we really are on the front end, on the leading edge. We live in a rapidly and dramatically deteriorating climate situation. And mitigation and adaptation are both front and center. You know, we need to mitigate as much as we possibly can to stem the long-term effects of climate change. But adaptation to wildfire, to the way we build our buildings, to how we manage air quality, those investments also have to come in parallel, and this is happening really faster than we had wished it would have. But it is happening, and it's just facts that we have to deal with, so, you know, mitigation by reducing the contributions we're making to the greenhouse gas burden through efficiency, renewables.

Very excited about the load flexibility discussion in order to help incorporate renewables more quickly and

effectively and then adaptation, you know, adjusting how we do business in this day, how we build for resilience to the massive insults that climate change is now thrusting upon us. And indoor air quality is an important component of this overall context. And, again, we're learning quickly. And I want to just, again, thank the experts that you've already heard the introductions from that are going to contribute the substance to today and going forward. And we've really got to find ways to accelerate our responses on both fronts, mitigation and the adaptation.

So we must base our decisions on where to take the building code on the best information available. And the state of knowledge is evolving, as we'll hear today. You know, what we know about exposure patterns, what that looks like in reality across the diversity that we have in California -- you know, we're a huge state, 40 million people, incredible geographic, cultural diversity, incredible diversity of building stock. Existing buildings and new buildings often require distinct conversations and distinct research, so we have to capture that diversity.

And then what we know about the health impacts of that exposure, you know, the health science, there's obviously a long and robust history. We have ARB here today. There are decades and decades of research on the health impacts. Putting those in context of today and where we're likely to be

going in the future is also, you know, an urgent public health need.

So we have an obligation in the building code to care for public health, and that means doing a deep dive on indoor air quality, you know, the buildings and air quality inside the buildings built under those codes, and then apply the tools we have in the codes, the levers that we can pull to ensure healthy air. So we absolutely want to do that. That's why we're here today.

So today's workshop. Peter introduced it well so I'll try not to repeat too much. But you also have a workshop notice and it said, you know, incorporate recent advances in the scientific understanding of pollutants emitted during indoor cooking activities and the efficacy of equipment that minimally complies with existing ventilation standards. So that ventilation piece is something that we really need to push forward and help it evolve in a positive direction.

Several other organizations and members of the public reached out to the CEC and we really appreciate that and we want to respond to those concerns and ask specifically for a joint agency workshop together with the ARB, and so we're really thankful to have that collaboration with the ARB. There are a lot of complementary skills across our two agencies, and I think -- and authorities, as well, that complement each other, so working together and kind of

embracing those complementarities is something we absolutely want to do.

So the goal of this workshop is to solicit input from experts, feedback from stakeholders and members of the public ahead of the staff work, as Peter mentioned, in amending the standards, hopefully reaching consensus on the scientific record and then establishing with this the factual basis of ending the Energy Code for 2022. And we do this every three years, and I think in terms of our de-carbonization project, lots of interlinking themes here in terms of de-carbonization indoor and outdoor air quality. And so our building standards fit into that overall context, and it's also helpful to develop a long-term vision so beyond this workshop. And I'll talk a little bit about that in just a second.

So we'll get up to date from the experts on the state of the science of indoor air, specifically in the kitchen, and the patterns of that in the real world status in terms of pollutants and exposures, and then to locate this in the context of indoor air quality more generally. And then, second, to understand the impacts of those exposures on human health. And then, third, to look at solutions, including any necessary changes to the ventilation requirements, volumes controls, equipment, those possibilities within the building code, and that is to begin to map all of this to the options

we have under state and federal statute for purposes of the 2022 update. So this specific workshop goes into that hopper for the staff to do that work and make a proposal to update the building code.

And we have a very substantive agenda today. I don't want to take up too much more time here so we can get to the main course. And that is the couple -- the pair of presentations in the 10:00 hour, first by Professor Yifang Zhu of UCLA, who will be with us at 10, and then Brett Singer of LBNL, who you heard from already. So having -- as an LBNL alum from Building 90 up there doing energy efficiency work and actually did a couple years' worth of work for myself. Early in my career made a stop up there doing low-income, multifamily public housing assessments of energy efficiency. And back then -- well, obviously, different context in the early 1990s, but, you know, these indoor environments and the equity lens that we increasingly look through are really critical to keep in mind as we have this indoor air quality discussion.

And I also just, finally, before I wrap up, want to point out that we really appreciate everybody putting their comments into the record already. We've seen a number of things come in to the docket already and then look forward to public comment today. And then further written comments are due on October the 12th, at 5 p.m., so I'm really looking

forward to all of that input.

And then I also wanted to note an upcoming workshop. So there's obviously a strong link between the discussions around indoor air quality and that around building electrification. And to put today in a bit more context in terms of the overall code update, staff is holding a workshop on October 6th -- the notice went out yesterday, I believe -- to address how the standards might encourage greater use of electric (indiscernible) technologies for low-rise residential buildings, high-rise residential buildings, and selected non-residential building categories. So that's October 6th. And I look forward to many of you participating then, as well. Eugenna (ph.) just posted yesterday afternoon. So I wanted to just make sure to locate that today in that context of the discussion and identify platforms for participation going forward.

So, with that, I will pass the baton back to Peter from our Building Standards Office. And, Peter, really, thanks a lot to the Energy Commission staff. I want to thank you and the whole Building Standards Office and Payam and others for organizing today. A lot of schedules and logistics to work through, and I'm glad it's really come together for a substantive set of presentations. So thank you very much. And back to you.

MR. STRAIT: You're welcome. I am very glad that we

were able to pull this together as we were. I know we did this on a pretty rapid turnaround, and I appreciate your patience, as well, with us ironing out some of the bumps with bringing everyone to the table.

So, with that, I'm going to share my screen again so that I can tee up a PowerPoint presentation. Let me see where that is. Here we go. So, again, for those that might have been joining a little bit late, this is a Commissioner Hearing on Indoor Cooking, Ventilation, and Indoor Air Quality. We are having a Pre-Rulemaking Hearing and Panel Discussion. That means that we are before the formal rulemaking cycle that will start early next year. This is an opportunity for us to take commentary where we have a lot of flexibility to design and craft language and consider alternatives and options. And, therefore, the main goal of this from a staff perspective is to create the record needed for an update to our rules while we have the flexibility to consider all of the alternatives that are on the table.

We've already gone over the agenda. So just by way of an amount of background, first: Recent advances in the understanding of pollutants generated by indoor cooking -- and that means cooking activities as well as cooking equipment -- and including research published by UCLA and by the Lawrence Berkeley National Laboratory, have called into question the sufficiency of existing kitchen ventilation

standards.

Several public advocates, including the Sierra Club, have requested a hearing based on these studies and a summarizing paper published by the Rocky Mountain Institute. And we are happy to meet that request.

And this is a little bit of behind-the-scenes inside baseball, but a portion of LBNL's research characterizing the capture efficiency of range hoods led to development of an ASTM standard, ASTM E3087, which is a method of testing and determining that statistic for equipment. The ASHRAE 62.2 Range Hood Working Group -- and ASHRAE 62.2 is a model code relative to indoor air quality in residential buildings. Their Range Hood Working Group made recommendations for development of a Home Ventilating Institute or HVI rating procedure based on this new standard, which resulted in the HVI 917.

HVI is one of the major rating bodies for kitchen range hood equipment. I know that the Association of Home Appliance Manufacturers or AHAM also has a rating program that they have, and this is something that, on the industry side, you can have your products officially rated and certified to operate according to their stated statistics so that folks that are making the choice of model know how much airflow they're getting, how noisy it's likely to be, and these other aspects that can really influence their decision and their

likelihood to use this equipment.

Similarly, the Range Hood Working Group is a consortium of various industry representatives and they are a consensus-drive process, so this is something occurring with a lot of industry input. It can be a process that can happen on varying time scales, but this happened to line up very nicely for consideration of this topic.

The problem statement that we have is that pollutants resulting from indoor cooking activities, and these pollutants include nitrogen oxides, carbon monoxide, fine particulates, and a few others, can reach levels that affect human health.

Minimum standards for kitchen ventilation, and specifically for kitchen range hoods, may not reduce the risk of exposure to harmful amounts of these pollutants to a sufficient degree. You know, the standard that's currently in ASHRAE 62.2 is a minimum standard, and we're trying to find out how that aligns with what the need for ventilation is in that space.

Fan noise may also contribute to occupants avoiding the use of their hoods. That is even in cases where these are installed. The fact that some of these pollutants are odorless, colorless, you can't necessarily tell how much of them are there, means that folks may avoid the use of the range hood for any number of reasons or simply forget to turn

it on.

And staff are therefore seeking to create a rulemaking record that: First, establishes that there is a need for greater stringency based on scientific data; and then supports the adoption of a specific enhanced minimum standard. So we both have to show that there really is this problem but also justify any particular landing point that we decide to reach. So those are the primary things that staff needs to accomplish in order to bring this into a rulemaking as we plan to do.

Sections affected, for those that are code gophers like I am, that like to dig into this stuff, I mean, the Energy Code sections that apply to these requirements are Section 120.1(b)2. This applies to the ASHRAE 62.2 requirements to attached dwelling units in multifamily settings.

And then Section 150.0(o) applies ASHRAE 62.2 requirements to low-rise and detached dwelling units.

These ASHRAE sections are specifically in ASHRAE 62.2 Section 5. That's where we have a minimum airflow rate of 100 CFM.

And ASHRAE 62.2 Section 7.2 has a three sone maximum on sound. However, this is a maximum at quote/unquote working speed, which might not apply to the higher speeds -- like, either the maximum speed setting of a kitchen range hood or

the higher speeds that we're finding to be necessary to accomplish sufficient ventilation in that context.

More about the regulations. Ventilation and filtration standards have been a longstanding component of the Energy Code. And, in fact, reference to ASHRAE 62.2, and the 2007 version specifically, was added to the 2008 Energy Code. So these are requirements that have been present for over a decade. We've recognized the need for kitchen ventilation for it to be effective and this feeds into the ventilation standards that are throughout both the residential and non-residential buildings, including reference to other ASHRAE standards. You know, not every state references ASHRAE's 62.1 or 62.2, but we make sure to here in the Energy Code.

Ventilation standards are unique relative to other efficiency standards because they have to address both under-ventilating and under over-ventilating. That is, if we were to simply say you can't use more than X amount of energy because it would be excessive, someone might choose to use less energy by just not providing sufficient ventilation. We have to prevent that circumstance. At the same time, we don't want someone turning their residence or a commercial setting into a wind tunnel because they were able to up-sell some of the equipment well beyond what that space needs. So we have to look both at how effective that equipment is and make sure we're requiring that enough be present but not too much.

Ventilation standards also cover a multitude of equipment types and ventilation approaches. Our standards generally try to be technology agnostic. We say there are many ways to solve the problems that you have in a building, ventilation being one of them, and we're not trying to put our thumb on the scale and say one approach is better than another. All we're trying to do is say when you take this approach, when you use this piece of equipment, that equipment is effective and it is sufficient to do what you're stating that its purpose is to be.

So, with that, I'm going to turn it over to our first staff presentation, talking some about the research that the Energy Commission has directly participated in or been associated with and some of the work we've been doing up to this point to advance these standards and our understanding of ventilation and kitchen ventilation specifically. So let me stop sharing my screen.

And, Susan, would you like to take over? Susan, you are still muted.

MS. WILHELM: Thank you, Peter. I trust you can hear me now.

MR. STRAIT: Yes.

MR. BOZORGCHAMI: I apologize, Susan. This is Payam. Can you just state your name and your affiliation? We have to do that for the recording. Sorry about that.

MS. WILHELM: Yes, yes, yes. Yes, thank you. I am Susan Wilhelm. I am team lead for energy-related research at the California Energy Commission, and I'm really delighted to be here today and to offer you an overview of the Energy Commission's indoor air quality research.

I will start by saying a few words about where our funding comes from. Then I want to highlight some key findings of our past research with pretty much an exclusive focus on our residential work. I want to say a few words about important research gaps. And I'll close just by letting you know how you can stay involved, how you can be aware of research opportunities, or aware of opportunities to submit comment or otherwise be involved with public process.

So the Energy Commission has a large R&D program. We invest strategically in research and development to support California in achieving its ambitious policy goals. A portion of funds from two of our funding sources, namely the Electric Program Investment Charge or EPIC and the Natural Gas Research Program, support energy-related environmental research.

The energy-related environmental research program is fairly broad. We do research to help ensure that our clean energy future is protective of public health, equity, environmental resources, and that our energy system is resilient to the changing climate that Commission McAllister spoke about earlier. Indoor air quality is one subtopic of

the work that we do.

And our funding sources, just to say a few words about them, are able to target public interest research that isn't otherwise covered by market actors and that, you know, benefits the people who are consuming gas and electricity in the state.

Our indoor air quality work has been highly leveraged by the U.S. Department of Energy, and the U.S. Department of Energy has also provided co-funding for some of the studies that you've supported on California buildings.

So let's jump in to some of the key findings of our indoor air quality research. And again, I'm going to focus on residential work, but I'd like to note that we have also supported substantial research on indoor air quality in California's commercial buildings and schools.

For more than ten years our indoor air quality research program has been supporting development of healthy Title 24 standards. You're going to hear a lot more about this today, so I'm just going to point to a few highlights spanning, you know, reports released between 2009 and 2020. Way back, research established a need for mechanical ventilation in new homes. You know, as we're tightening homes and, you know, creating homes with lower air exchange rates, we've got to have mechanical ventilation to address air quality concerns. CEC-funded work also found homes, a lot of

homes, with natural gas cooking routinely experienced concentrations of nitrogen dioxide that exceed healthy thresholds. This goes for both ventilated and unventilated kitchens but is typically worse in kitchens without ventilation.

A study of new homes built after Title 24 started to require minimum mechanical ventilation found that most systems were meeting the airflow requirements from a technical standpoint, but many systems weren't being used as intended, and poor labeling of systems controls may be a contributing factor to misuse and underuse.

Also -- research that meeting minimum airflow requirements as they're now framed isn't sufficient to ensure adequate removal of pollutants. For example, most new homes still are not meeting the referenced exposure level for formaldehyde. And we've also seen that a given airflow doesn't ensure adequate capture and efficiency, which is the more relevant metric for performance from an indoor air quality and health standpoint.

In addition to research that directly supports Title 24 standards, CEC has also funded research to improve approaches to building tight homes with ventilation systems that are designed with both health and energy use in mind. LBNL's Residential Energy Savings from Air-Tightness and Ventilation or RESAVE study found substantial health impacts

associated with indoor air pollution in California. About 400 to $1100 per person, per year, for tens of millions statewide.

The study also developed a priority list of contaminants to support evaluation and strategies for improving indoor air quality. The research team found that tightening residential envelopes could decrease residential energy demand substantially. And from an implementation side, the study found that proper commissioning of residential systems as well as development of range hood performance ratings was, at that time, very much needed. And as you heard from Peter, progress has been made, at least with regard to range hood performance ratings.

The state also, you know, pointed out that there are opportunities for smart ventilation which strategically times ventilation to address concerns related to health and energy, opportunities to save 30 to 50 percent of ventilation-related energy.

CEC-funded research has also funded development of a framework to integrate concerns related to energy and indoor environmental quality in the context of multifamily home retrofits. So the issue here is that existing protocols and tools to support selection and implementation of housing energy retrofits typically are based on energy use models, engineering judgment, kind of simple financial cost-benefit analysis, but they rarely consider potential positive or

negative effects of retrofits on indoor environmental quality. This work found that energy retrofits in multifamily housing can improve both comfort and indoor air quality in addition to saving energy, but an integrated approach is needed to encourage apartment energy retrofits that provide indoor environmental quality benefits. And I would say that additional work is needed in this area.

Building on prior research related to ventilation strategies that optimize for energy consumption, air quality, and occupancy, CEC supported a study on smart ventilation for advanced California homes. The research team at LBNL found that simple and inexpensive controls could reduce ventilation-associated energy use by at least half for new and existing homes in California and across, you know, a range of climates that we have in this state. These simple controls involve single-zone ventilation that basically they're -- based on outdoor temperature so that you're not needing to do extra space conditioning of that outdoor air. The study found that multi-zone ventilation approaches didn't show much potential for additional energy improvements. And I would note that LBNL's analysis here considered total energy consumption as well as cost and a time-of-use rate structure and peak energy demand.

Next, I'd like to briefly touch on knowledge gaps that merit further consideration. So this slide is my laundry

list of issues that we need to consider to improve our ability to provide healthy indoor environments in a cost-effective and energy-efficient way.

Title 24 applies, as you know, to new construction and building renovation, but we need strategies for existing homes and, in particular, for the multifamily buildings that are typically occupied by low-income renters and, you know, that are prevalent in disadvantaged communities. We may need additional guidance to support indoor air quality in occupied buildings as they're operating in the real world. You know, we saw from some of our earlier studies that putting standards out may not be enough. There's also the operations side of things.

It's undeniable that climate change is impacting our state. And one of those impacts is that it is exacerbating extreme heat in California. This brings up a number of issues. A new design for the energy ramifications, the building energy use ramifications of extreme heat episodes that are more frequent, more extreme, and that are prevalent over a broader range of California, and how do we design for resilience in the case of public safety power shutoffs during extreme heat episodes? As we know, and as some of you may be experiencing at this moment, wildfires can have enormous impacts on indoor air quality. If you don't already have an air purifier, I recommend it.

And we'd like to know more about both the economic and health dimensions of equity impacts of energy-related interventions in multifamily homes. And, you know, we talk a lot about equity impacts from a cost standpoint, but as we saw on a prior slide, exposure to poor indoor air quality in California is a substantial cost in our homes, and there's a health side to this equity issue as well. We need to make sure that we are providing indoor air quality to low-income and disadvantaged communities.

I would note that new homes in California, for the most part, still exceed OEHHA's formaldehyde standards.

And, finally, although our focus today is residential, it's too relevant not to mention the fact that we need to develop controls and strategies to help address commercial building operations for smoke, for pandemics, and other exceptional situations.

So in the context of all of those important issues, I've put forward a few research gaps. While it seems from prior research that regulations and standards aren't enough to guarantee healthy indoor air quality and that we need to support the operations phase as well; how do we do that best, and what kind of controls might we need in multifamily buildings?

Secondly, improved understanding of people's actual exposures to and the health impacts from indoor air pollution

in residential kitchens is needed. And we especially need a more nuanced understanding of exposures and health impacts to vulnerable populations, to the elderly, to asthmatic children, and others who are particularly vulnerable.

As you saw in my earlier slides, CEC has funded some earlier work -- early work on developing an integrated framework for indoor environmental quality and energy implications of building energy retrofits, but we need to do more to quantify and leverage the synergies between healthy homes and energy efficiency retrofits. We need to do this in a manner that helps us incentivize retrofits with health benefits.

More work remains -- especially in multifamily context and even more so in commercial buildings -- to develop cost-effective strategies that balance concerns related to cost, indoor air quality and microbes, and we also -- as I mentioned earlier -- need to design our buildings to operate reliably and resiliently in a changing climate.

And, finally, point number five here, I'd just say that there are several issues that need further exploration in the context of multifamily retrofits. You know, we still need to understand more about whether retrofitting the multifamily envelope is enough or if we need to internally seal between units. And I would also point out there's still the outstanding issue of potential health impacts of spray foam

insulation.

So I'd like to invite everyone to follow the Energy Commission's energy-related environmental research program. You can stay informed of research opportunities as well as workshops by going to our listserv page and subscribing to the appropriate listservs. And I would point out that our workshops include workshops to engage the public when we're in the process of planning what research we're going to fund. And in my group we typically also do workshops prior to release of a research solicitation because we like to sort of socialize what we're thinking in a public forum and get input from stakeholders and the research community.

You can always submit public comment. We read everything you say. I know many of you have submitted comments already to the Title 24 docket. But we also have an energy research and development ideas exchange, and you can let us know what you think about our research program or research gaps through that forum.

I'd like to thank the researchers and staff who are behind the success of our indoor air quality research. We dug up a list of all the work that we've -- the final reports we've published from indoor air quality research program over the past 14 years. And I'd like to call out our colleagues at Lawrence Berkeley National Lab in particular. I think you'll hear from Brett Singer later today as well as Iain Walker, and

thank you both, as well as others on your team. And a final thank you to staff who have managed our past work in this area. And a welcome to Alex Kovalick and Maninder Thind who recently joined and will be supporting our indoor air quality work moving forward.

And you can always reach out to me now or later with any questions. Thanks.

MR. STRAIT: Thank you very much.

So very quickly I notice two questions in the chat and one coming in through the Q&A. Two of the question chat are just general.

First, will presentation materials be made available after this workshop? Yes, staff will be docketing our presentations into the pre-rulemaking docket, so they will be available. Other panelists are invited to do the same. Obviously, if they are -- it's up to them whether they would like to submit that to the public record. But if there is no reason not to, then we would ask that they do so.

Then someone asked if there's anything we can do to improve a particular person's audio quality. Unfortunately, I do not have access to an enhance or a turbo button, so we will do what we can to resolve issues. But in the case that there are any technical difficulties, we will simply pause the presentation or the work that we're doing for a couple of minutes to see if we can sort it out. This may also, though,

be a situation where the show must go on. You know, we've had situations where, in the middle of a presentation, there are significant power outages taking part of Sacramento out. And if something like that happens, we'll just have to work around it. So we'll do the best we can.

COMMISSIONER McALLISTER: Hey, Peter, actually, I wanted to just -- we've had, you know, a lot of workshops, and if presenters could -- if they're on their computer audio and using the mic from their computer, often it helps the quality to switch over to phone call. So you can have Zoom actually call you on your phone, and that tends to -- if that's the issue, that tends to improve audio quality. So that's on the presenter's side.

MR. STRAIT: Yeah, yeah. And if anyone is coming in or, for whatever reason, has to come in as an attendee but is here to be a panelist, you can raise your hand in the box, and I can note your name and see if you're on the invite list and promote you and if need be -- because generally the way Zoom works is you'll get a unique link if you are to be a host, a co-host or a panelist. But if there's a problem with that link and you have to come in using the general link, we have ways of solving that, so it shouldn't be too big of an issue there.

We also received one question in the question and answer box asking what upcoming workshops we have to address

extreme heat adaptation, mitigation, and building resilience. We have additional workshops scheduled on different topics that have been proposed for update in the energy code. These include measures that do have a beneficial effect on adaptation and mitigation. We're looking at a small amount of insulation improvements. We're looking a great deal at integration and advanced controls. So those topics are threaded through on these kind of system-by-system workshops that we're doing. Folks that have the interest, we would invite anyone to participate in these additional workshops. Some of the notices are already on our docket and some will be published. If you're not already on our listserv, please go ahead and add yourself to the listserv so you can be notified of all of the workshop notices that we put out and so that you can gain the benefit of participating on each of these building-system-by-building- system workshops.

COMMISSIONER McALLISTER: I wanted to comment a little bit on this as well. Thanks for that question. So there is -- so Title 24 -- one forum for that discussion on resilience -- there certainly is some legislative activity on fire response that does affect builders and how buildings get done that are outside of Part 6 but will affect the building code broadly. And then also beyond the building code itself, the Energy Commission does a lot of work around the climate impacts and extreme heat impacts on the energy systems of the

state themselves. And so I think that's one place where, you know, we see power plants getting less efficient, we see transmission having a capacity that has to be de-rated when you have extreme heat. You know, obviously we have system planning issues and resource adequacy that are meant to ensure that our electricity and natural gas systems are protected, and certainly the electricity system has enough capacity available, sufficiency, but also the resource adequacy program is making sure that those resources are available for any contingencies.

And increasingly, the load flexibility -- you know, it's a tenuous connection with indoor air quality, but it is a renewables issue and a local renewable integration issue as well. Flexibility of our buildings is a way that we can improve their performance with respect to climate change for sure. And so, again, those are all tools that we have in the toolbox for the overall greenhouse gas and energy optimization discussion. So there's a lot of moving parts, a lot of gears in the machine here, and Title 24, Part 6, is one of those. So, anyway, hopefully that helps.

It's challenging to be involved in all of these forums just as a human with limited time, but we certainly think that Part 6, which is our core responsibility here, is an important forum to level set and to provide access to participation to affect the building code for stakeholders.

So thanks for that question.

MR. BOZORGCHAMI: Peter, we also have Ms. Elizabeth Scheehle. She raised her hand. I'm going to unmute her.

And please state your name and your affiliation. It looks like you're muted.

MR. STRAIT: Yeah, one other quirk about Zoom. We can enable someone to unmute themselves, but then they also have to unmute themselves, so it's a two-step process as opposed to some of the other web tools we've used like Webex in the past -- do it a little bit more quickly.

But, Elizabeth, you're live.

MS. SCHEEHLE: I apologize. Maybe I misunderstood. I am introducing one of the items for CARB later on and I thought you said to raise your hand if you needed --

MR. STRAIT: Absolutely. I was just going to ask if you are representing a panelist. Let me just go ahead and promote you right now.

MS. SCHEEHLE: Thanks.

MR. STRAIT: Boom. There we go. And hopefully that didn't automatically re-mute her. I think it might have. But panelists are able to freely mute and unmute themselves and share their screens.

MS. SCHEEHLE: Thank you.

MR. STRAIT: You're welcome. I do know also that we are expecting some attendants or participants -- if they can

find the time from -- gosh, I'm going to get it wrong if I try to spell it out -- but OEHHA, the Office of Environmental and Human -- oh, geez, I will mess it up. But another one of our state agencies dedicated to -- oh, here we are. Yeah, let me promote this first panelist. Boom.

It looks like Yifang -- and I hope I'm saying that right -- has just joined us. Welcome.

COMMISSIONER McALLISTER: Welcome, Professor Zhu. We're all waiting for our hard start at 10:00, so thanks for fitting us in to your schedule.

So, Peter, why don't we move forward with this next panel?

MR. STRAIT: Absolutely. Yifang, you should be able to share your screen. Let me know if you have any issue doing so.

MS. ZHU: All right. Does it work for everyone? Can everyone see my screen?

COMMISSIONER McALLISTER: Yes, thank you.

MR. STRAIT: Yes. And thank you very much for making yourself available for this.

MS. ZHU: Oh, happy to be here. And thank you for having me. Just let me know when you're ready to start -- for me to start.

MR. STRAIT: Absolutely. Go ahead.

MS. ZHU: All right, okay. So thank you for

allowing this opportunity to share some of the results from our study supported by Sierra Club on the facts of residential gas appliance, indoor/outdoor air quality, and public health in California. So instead of sharing PowerPoint slides, I want to walk you through this story map. The reason is this story map, we find, is more interactive and actually provide more degree levels of details of data to walk you through about what we found.

To just give you some overview about our main funding in this research project, it's really mainly in three parts. The first part is about indoor air quality. So overview, we found residential gas appliance, they meet a wide range of pollutants including carbon monoxide, nitrogen dioxide, and fine particulate matter, including ultrafine particles. And use of those gas appliance in indoor environment, they can result in (indiscernible) conditions and hazardous levels of indoor air pollution. And we also estimate those gas appliance contribution to outdoor air pollution in California and with mainly the gas water heater and the home heating devices. They are the most important ones that contribute to outdoor air pollution.

And we also ran a simulation study where we basically assumed that all the fossil fuel burned gas appliance get transitioned into clean energy-generated electricity-operated gas appliance. And then we calculate how

much PM 2.5 will reduce -- will be reduced in the air and how much life can be saved and how that translate into monetized house benefits. And we did the study through -- also through the lens of environmental justice considerations. The reason is, number one, disadvantaged communities, they're already disproportionately experiencing poor housing conditions and they're already living in old (indiscernible) gas appliance. They use those gas appliance. It makes it very hard for them to retrofit or engage in any incentive programs to replace their old ones to electric ones.

And those lower income communities, they're usually also families. They're usually in apartments, they're renters, and so they may not have control over what kind of a gas appliance replacement and maintenance they can have control over. And those vulnerable communities, they're already experiencing some cumulative impacts of (indiscernible) environmental and social conditions. So the air quality impact from the use of gas appliance to potentially compound on those existing stressors they already have to experience in those communities.

So this story map will be -- make it interactive. Like, for example, when we talk about disadvantage community, you can click on this, and it will direct you to the OEHHA website or disadvantaged community definitions, and the maps are readily available.

And the report is actually already published. You can access the report by click on this link in our story map, and that will direct you to UCLA Center for Occupational and Environmental Health website where you can download the whole report by clicking on this link.

So let's get into the details about the study. The study starts, you know, starting with some background about natural gases. In this study we basically use gas and natural gas interchangeably as our vocabulary. And they're responsible for electric generation, building and heating and cooling. And we know in California gas is still the primary energy source. And over 2.1 trillion cubic feet of gas got consumed in 2018. So that translate into about 20 percent of residential consumption itself make up 20 percent of the overall pie of all the gas that is consumed in California, and that is equivalent to about 7.1 percent of the natural gas at a national level. And more than 90 percent of the household use gas for at least one purpose. And when it comes to cooking, almost 70 percent of the household they actually use gas for cooking purposes.

So you can move on, just click on, and continue going through the story map. We're going to get into some health effects about those pollutants. So the pollutants that is related to gas appliance usage that including -- click on that. You can click on the link. It will direct you to the

CDC and EPA website where they're going to talk about those pollutants and their health effects. You can get more input information from those websites. And specifically to chronic and acute health effects associated with gas, with pollutants emitted from those gas appliances, you can click on table like this, and it will pop up and show what are the acute and chronic effects for nitrogen oxide and carbon monoxide, fine particulate matter, ultrafine particles, and formaldehyde. And they also give you link specific to what is going on which -- where we see this table in the report.

So this gives a sense about the type of pollutants that are associated with gas appliance usage. And just examples of those residential gas appliance that we are focusing on in this particular study including heating devices, water heater, oven, and stove. And the reason that we are interested in their usage in the indoor environment and the potential health effects and exposure levels is we know people, in general, spend more than 90 percent of their time indoors, so emissions coming out from those gas appliance could potentially contribute a substantial portion of their total daily exposures to those different type of pollutants.

If we move down, then we actually did a simulation. This is, again, focusing on the cooking but not quite factor in the cooking food side but just running the gas appliance by doing cooking activities. So if you click on this table --

figure -- it will show you under a scenario where we actually estimated the gas appliance during cooking how much CO and NOx levels we expect when both oven and stove are used for about an hour to two hours. And we put those into context about the current National Ambient Air Quality Standards and California Ambient Air Quality Standards. I want to put a note here because currently there's no indoor standard for any of those pollutants. So technically speaking, you cannot violate Ambient Air Quality Standards indoors. Nevertheless, we want to put those kind of standards on those figures just to give you a comparison about the level that we are seeing here. So CO is not a real -- you see they're pretty low nowadays from the emission in the gas appliance, but NOx could be high. And then the NOx, especially in the apartment -- again, this is related to the environmental justice issues. People living in smaller spaces have less space to dilute and vent their cooking emissions from the gas appliance, and they experience high levels of NOx exposures from those gas appliance.

So the emissions data that we've got to calculate those indoor concentration levels are basically compiled from a literature search. We compiled a long list about what kind of gas appliance are out there, what is their energy, how much fuel they have to burn, and what is the emissions factor for each gallon fuel it burned, and so on and so forth. So with those emission data, we put it into an indoor dynamic model

and estimate the indoor levels and/or different scenarios.

So moving on. Here are the specifics about how the data are calculated. If you're interested in reading more details about the method, you can go to the report, and there is a (indiscernible) with all the details and method that is highlighted in the report.

And then through our study we also found there's a lot of missed opportunities for California residents to reduce their exposures. For example, we found there's only less than 35 percent of California residents actually use range hood, and when they use them they might not even use them properly, although it may not be maintained properly. So that is, you know, to us, I think it's a missed opportunity. In practice, we can recommend to use those range hood more regularly and make sure they are properly sized for the oven or stove you are using and they're properly installed and maintained. And that the proper ventilation is to be vented outdoors, not just circulated. There's some certain type of range hood that actually circulate within the indoor air. That's not helpful.

And also we found there's a very big data gap in terms of a hot water heater and furnace that's supposed to vent their emission outwards, whether they're going to leak, to what extent they leak actually indoors. So we found good amount of primary literature to specifically looking into that.

And then, in general, we just don't know how old gas-powered appliance are maintained in those residence. So those are issues, I think, needs to call attention and then probably with future data collection and research to look deeper into those issues.

And exposure and vulnerability considerations. As I mentioned, there's always additional consideration in the disadvantaged community. They disproportionately experience poor housing conditions, and there's some evidence showing that even children in lower income families, they actually spend more time relative to others because they don't have other places or back yard to go to. And also there's -- I mentioned there's exceeding of CO and NO2 levels were higher for apartments because their size is small and there's maybe even more number of people living in those smaller spaces. In particular, add to the concerns about overcrowding rate, you know, average, especially in those disadvantaged communities. So adding all of those together, they put additional risk for environmental justice communities across California.

So the second part of our analysis for assessing outdoor air quality and health effects and -- so mainly focusing on the total emissions. So this is a study that we basically look into what kind of pollutants, which appliance in the indoor gas appliance can contribute to those emissions. So it's not surprising that heater and water heaters --

because they're supposed to vent outdoors -- are the main contributors to NOx levels and (indiscernible) environment. So the analysis actually focusing on NOx and then related secondary particulate matter PM 2.5, and primary PM 2.5, from those two types of gas appliance.

So in this study we did a simulation, scenario where we basically went through -- first went through in each county, how much NOx -- take NOx as example. Click on this. It will show you in each county how much NOx, nitrogen oxide, are emitted each year. And you can click, and it's not surprising Los Angeles has the highest level. But you can also move your cursor around and get more specific data at each county level. And while this -- the gas appliance actually comprise 3 percent of total NOx is actually close to all the light-duty passenger vehicles through the state.

So to estimate the health effects, we rely on existing epidemiologist literature about those response relationship between PM 2.5 and the premature death. And to do that, we need to translate the NOx level into PM 2.5. So here is how we did it. So for total PM 2.5 for particulate matters, they come from two major sources. One is the primary PM 2.5, meaning those particles directly emitted from residential appliance ash particles into the air. And we got those data from California Air Resource Board's Emission Inventory. And they can also be formed in the atmosphere

through chemical reactions. We call them secondary PM 2.5 aerosols. And specifically for this study we're focusing on nitrate PM 2.5. Those are the particles that form in the air following the NOx emission. So we put those two together. We estimate in the scenario, if we retrofit all the gas appliances in California and then using clean electricity how much PM 2.5 reduction we would expect to see throughout the state. Right. So here is our estimates. And if you click on here, it will show you the map. Again, break down by the county, at a county level.

So, overall, we're seeing the reduction for PM 2.5 to result in 354 fewer deaths, premature deaths, in the whole state, about close to 600 fewer cases of acute bronchitis, and close to 300 fewer cases of chronic bronchitis. So when we add all of those numbers together, we use EPA's map to convert it into dollars, and that is equivalent to about 3.5 billion in monetary health benefits per year in California. And this is using data in 2018, the latest data that we can have access to.

Again, if you click on this, you would see individual county level and in those populated counties you really have a high benefit. That's not surprising to see that.

So just to put everything into summary, in this study we're focusing on residential gas appliance. We found

they emit a wide range of pollutants, CO and NO2, NOx, PM 2.5. All of those can adversely affect human health. And those health effects are both short-term and long-term. They're including not just respiratory illness but also cardiovascular disease and even premature death. And use of those gas appliance, they can result in hazardous levels of indoor air pollution. This is particularly problematic for NO2 in kitchen when cooking activity is going on, you know, if cooking long enough and doesn't have a good ventilation. Outdoors this could actually exceed the ambient levels.

And we also found there's less than 35 percent of California residents actually use the range hood during cooking, and that, to us, is a missed opportunity. This actually should be encouraged, advocated, and can -- you can really reduce -- significantly reduce exposure to indoor pollution when people are cooking.

And the gas water heater, water heating devices, and home heating devices like furnace, they're the most responsible for the (indiscernible) and we estimate there is a total of about 16,000 tons of NOx and 12,000 tons of CO that are emitted from all the gas appliances in California in 2018. And again, the map will allow you to get into more county-specific data if you're interested.

And if we retrofit all of those gas appliance, replace them by electric ones, and make sure electricity is

from clean energy, then that can bring substantial PM 2.5 reduction. And that PM 2.5 reduction will translate into fewer (indiscernible) and fewer cases of acute and chronic bronchitis each year in California. And that brings substantial monetary benefits; 3.5 billion is our estimate.

And again, I just want to emphasize through our research we realize disadvantaged communities are really important and should be the focus for any future study moving forward. Those communities, they disproportionately experience poor housing conditions and they are already bearing disproportionate burdens from air and other water pollution. And those old and unmaintained gas appliance and smaller and overcrowded space act together just put additional stress and risks to those people living in those disadvantaged communities.

So here is the references that is used in this story map. Again, if you're interested in the whole report, you can click on this link and then you can click here where the whole report is readily available to download if you are interested in learning more details of our study. So thank you for the opportunity to present our work. I'm happy to take any comments and questions from the audience.

MR. STRAIT: Thank you. I think, first and foremost, can you copy the link to that story map into the chat box so that the --

MS. ZHU: That's a great idea. That's a great idea. Let me see.

MR. STRAIT: And, for now, I'm going to open this up for questions from the other panelists. We'll go to questions that we see from the audience at the end of this session. That way, we get both of our session presentations done and then address any technical questions.

So, Brett, I believe you're up with the next presentation. Are you ready to go?

MR. SINGER: Yes, I am. I hope I am. Let me see if I can -- I need to share a screen, correct?

MR. STRAIT: In a moment. Before we do that, I just want to make sure you're teed up. Do any of the panelists have any questions for --

I'm sorry, do you prefer just being referred to as Ms. Zhu or Yifang or --

MS. ZHU: Whatever works for you. Let me put it -- yeah, because it won't allow me to copy/paste here. But I will -- yeah, I think --

COMMISSIONER McALLISTER: I'll call you Professor Zhu; how about that? And thank you very much for being with us. And I want to make sure we can take full advantage of your time because I understand you're only here until 11; is that correct?

MS. ZHU: Yes. I have a UCLA -- there's an

orientation going on today.

COMMISSIONER McALLISTER: Yeah, well, that's a good sign that there are at least some students. Yeah, are there some students physically there? I hope so, anyway. Tough time to be a college student.

So I'm going to propose that Brett Singer just go ahead, and then we'll hope to have a little bit of interaction between the two of you and amongst any other panelists who want to chime in before the 11:00 hour, just to make best use of your time.

MR. SINGER: I'm also -- I'm good for -- I don't have -- my constraints aren't as tight, so if there are questions you want to make sure you get in to Professor Zhu, I can certainly wait. It's as you prefer.

COMMISSIONER McALLISTER: Why don't you go ahead? I think we have some time, and it would be good to kind of have that full context in order to have questions for both of you, because I think that could be helpful.

So anyways, sorry, Peter. Back to you. I just wanted to jump in there quickly and propose --

MR. STRAIT: Oh, no. Brett, by all means, go ahead.

MR. SINGER: There's the screen. Okay. And then let's see if I can get the -- sorry about that. I'm in the wrong spot. I'm seeing the presentation in reverse. It's like watching a movie backwards. Okay. Okay, can everybody

see the presentation?

MR. STRAIT: I think we're good.

MR. SINGER: And my sound is okay? I'm just doing it off the computer. My mic sounds like it's fine, right?

MR. STRAIT: You are loud and clear for me.

MR. SINGER: Perfect, okay. So I just want to dive in, and I want to acknowledge -- Susan already acknowledged the funding program, the Building America Program, the DOE. Some of the work units here was also co-funded by some grants (indiscernible) from U.S. EPA, and the Department of Housing and Urban Development. As she had mentioned that this data comes -- what I'm going to show you today came from a number of studies supported by the CEC. They're there. There will be a record of this. The most recent was a study we just completed back in March. At least nominally, we're still writing papers to report that effective kitchen ventilation for healthy ZNE homes with natural gas is PIR-16-012. We had a partner for that, was the Association for Energy Affordability. I want to really acknowledge my colleagues. That's me on the left, then Dr. Rengie Chan (ph.), Dr. Woody Delt (ph.), Doughar Ranji (ph.), and Dr. Iain Walker (indiscernible).

We'll start with the summary points. Some of these have been made already. Gas burners and cooking, each generate pollutants that can degrade indoor air quality.

Using gas burners without venting can cause the indoor one-hour nitrogen dioxide concentration to exceed the thresholds for outdoor standards. And Professor Zhu gave a very nice description of how we use the outdoor standards as reference points even though they don't directly apply indoors. Cooking without venting can cause 24-hour PM 2.5 to exceed ambient standards and guidelines.

Pollutant levels increase with cooking, and they're going to be higher in smaller homes. And that's sort of an obvious point, I think, but it's worth mentioning. And Professor Zhu alluded to this as well. So people living in smaller homes are sort of disproportionately affected. And, as we know, that generally means disadvantaged communities.

Venting range hoods can effectively control cooking foods. Over-the-range microwaves actually perform generally similarly to common range hoods. Maybe not quite as well but the over-the-range microwaves actually can work.

Capture efficiency -- and I'll describe what that is in more detail -- but basically it's how much of the air pollutants that are generated at the cooking surface get -- or a cooking appliance get captured and removed by a venting range hood. That varies by airflow, and it also varies between using the front and back burners, and that's an important point.

Venting at the 100 CFM that's currently required by

Title 24 appears to be inadequate for range hoods to control indoor air quality. Use of hoods with capture efficiencies up to 65 or possibly even 75 percent are needed to protect indoor air quality in all new homes and particularly in those less than 1,000 square feet, and it's even more acute for homes that are less than 750 square feet.

Range hoods are not used routinely and they're actually also used much less than people claim. And Professor Zhu mentioned this. And the news is just going to get worse because even what they say they do, they actually do less than that. And I'll show data from that.

So cooking on burners are important sources. Again, Professor Zhu noted this. If all goes well, they produce carbon dioxide and water vapor. The water vapor can itself be a problem. But gas burners also -- when everything is working well, they're going to produce nitrogen oxides including NO, NO2, and HONO, and they will also produce some formaldehyde. Almost always they're producing a lot of ultrafine particles. Electric coils and even toasters, they also produce ultrafine particles. But, importantly, the cooking also produces pollutants, so it's not just the burner. It's the cooking also.

One quick note: Induction burners appear to emit many fewer ultrafine particles and no NOx. So within electric -- we group electric together, but there's actually

probably a pretty big distinction between induction and resistance electric.

We did a study to try to figure this out. This is similar to the work that Professor Zhu described that they did. This predated that by a few years. It was a paper from 2014. And the first work was actually done a few years before that. And basically what we did is it's a physics-based simulation. What we did is we modeled what happened in 6600 homes in southern California for which we had data from the 2003 Residential Appliance Saturation Surveys. These were, like, real homes with real people who reported how much they cooked. So we actually had data from those particular homes, we had the size of the home, we had the year that the home was built so we could estimate air exchange rate based on infiltration. We had to figure out the cooking durations every time they did cook. We did some web-based surveys to get numbers for cooking durations. We used measurements of emissions from ten ranges, used ranges. We looked at a winter week. We included NO2 from outdoors. CO is pretty low outdoors, so that really didn't contribute much. And then we compared the Ambient Air Quality Standards much the same way they had prior.

The results are over there on the right. We calculated a really alarming fraction of homes would routinely -- these are homes that did cook -- say they cooked

with gas. So this does not include homes that had gas but never use it. But of the homes that have gas burners and said that they used them regularly, we estimated that as many as more than half would routinely have NO2 exceed this 100 PPB one-hour standard.

That's models, right? So then the question is: Okay, models are fine; but what about measurements? Can you verify that with measurements from homes? And, in fact, we did. So what you're looking at here is results from another CEC study. We sent sampling packages out to 350 homes. Most of those had gas but there was a fraction that had electric as a control. And what you're looking at is the one-week integrated nitrogen dioxide, only the indoor source. So we factored out the amount that was coming from outdoors, so we measured outdoors. That's estimated, but it's a pretty robust estimate. And what you see is the amount of NO2 over the course of the week in the bedroom. So this isn't the kitchen; this is the bedroom. And you see that when you have electric cooking and you cook more, you don't get any more NO2. You get small amounts. And that could be just an artifact of the calculation but basically no increase with electric cooking. But as you cook more with gas, you get more NO2. So this is, like, rock-solid evidence that it is the gas cooking that's leading to substantial NO2. And these numbers are certainly consistent with what we got from the model. They're actually

significantly higher than what we got from the model in terms of one-week concentrations, in part because we selected homes that were smaller on average, so these were homes that were 100 to 130 meters squared. You can roughly multiply by 10 to get to square feet.

And then the kitchens -- the concentrations -- we also mentioned concentrations in the kitchen. Those were about 50 percent higher, okay? And that's also consistent with the modeling that Professor Zhu showed and some other modeling we did. So if it's higher because that's the source. It does mix throughout the house.

There's another set of measurements we did because that was time integrated. But we said, okay, what about the short term? Can we confirm the short term? So we went to nine homes. They were not random. It was a sample of convenience. But there was nothing special about these homes. And I'm showing you an example here. On the right-hand side you see concentrations of nitrogen dioxide on the top panel and carbon dioxide on the bottom panel. And then in the red is where we measured in the kitchen. The blue is in a bedroom on a second floor in this house. And then the black down below is in the living room. And what you see is, again, in this case, the concentration in the kitchen went way higher than in the bedroom.

And that, in part, is because of the ventilation.

This is a house that had an ERV, a whole house ERV, and the two floors were actually relatively well separated with the ventilation system because each floor was ventilated. So there was supply air and exhaust air from each floor, so there was less mixing in this house than some others. But the point there's half an air change per hour is actually more ventilation than is required in new homes in California, so this is a well-ventilated house. And even in this well-ventilated house where you didn't use a range hood, when we did the simulated cooking, you got above 100 PPB over more than an hour several times. Of those nine homes, four of them actually had NO2 above 100 PPB over that one hour through this kind of moderate, like, simulated dinner's worth of cooking. And then several others were between 50 and 100. So with a little more cooking they were even over 100 too. So this kind of verifies that this is something that's not unusual. In fact, it's just the opposite. It seems like it's very easy to find this when you go out and take measurements in homes.

So getting to the capture efficiency, the range hood as a solution, as I think Peter mentioned in his talk, we do in California, thankfully, require venting range hoods. They're not required everywhere. Those venting range hoods work by pulling air up from the cooking surface and exhausting it directly outside. That's what we mean by venting. Capture efficiency is the fraction of what's emitted down at the cook

top off on the left there. It gets pulled up directly and removed to the outside as opposed to mixing in the house. Obviously, higher capture efficiency is better.

And we've done lots of work both in the field and in the laboratory. That's my colleague, Dr. Woody Delt. In this case, he was doing some stuff with cooking. We very often simply it and just boil pots of water for the range hood testing we've done. I think it was Peter or -- I think Peter mentioned there is an official ASTM test method, a certified test method -- HVI has picked this up -- that my colleague, Iain Walker, Dr. Iain Walker, shepherded through. The work that I'm presenting here for capture efficiency is not measurements made with that ASTM test method. It's made with a quicker dynamic method that we can do. The standard test method takes -- you know, it can take an hour per test or something -- or longer. Ours takes ten minutes per test, so it's more suitable for research in both the field and the lab.

So what you're looking at here is just some data. It's a very busy plot. We tested in the laboratory seven hoods from a low-cost, you know, $40 hood up to a high-performance hood that cost, at the time, $650. You know, prices vary, but there were a couple Energy Star hoods there. If you look off to the right, the results you're seeing are capture efficiency. On the top is when we did backburners. We put two pots of water on the backburners, and on the front

we put -- the bottom is the front burners. And you see the cubic feet per minute along the top and the liters per second along the bottom. And there's two vertical lines drawn. 100 CFM is the current standard for Title 24 requirement and also the ASHRAE. There's also a recommended value that HVI has for a 30-inch-wide range which is 250 CFM. And maybe not surprisingly, you see that at 250 CFM -- let's start up there on the right. If you're cooking on your backburners, you actually have very, very high capture efficiency. Unfortunately, if you move to the front burners, you see that high-performance hood did very well. That's the blue upside down triangles on the top. But a lot of the other hoods we tested, even at 250 CFM, only did, you know, 50, 60 -- 68 percent or something at 250 CFM. And then you get out to 100 CFM, and on the backburners it's pretty good. It's maybe 60 percent. But on the front burners it's down around the 30 percent capture efficiency, so that's not very good.

And we have some data from surveys suggesting -- and I think our experience is that most people preferentially cook on the front burners. It's just easier, right? You put the pot right on the front burner. People who I have been badgering for years -- I think I have a small collection of people who cook preferential on the backburners now, but that's not a representative sample.

In that project I just mentioned, we had this

question about whether over-the-range microwaves. When we started our study, at the time, there were no microwaves that had HVI certification for airflow, so actually they weren't even allowed, technically, under the Title 24 standards. Since then, many of them have been measured by HVI to verify their airflow.

Off on the right is an important point. You see two different airflow configurations on the top right. Microwaves are actually shipped to re-circulate. So they pull air up through the bottom and then they spin it out through the grills at the top there in the front or sometimes just over the door, re-circulating it back to the room. But they could be reconfigured to have air come in both from the bottom and the top front and then go up and out either through the back or the top part in the back to go out so they can be configured to a venting condition.

What this shows here is the capture efficiency as a function of airflow for the six over-the-range microwaves that we tested. That's the red and the blue symbols and then the green also. And then we tested two range hoods kind of at the same time, same methods, et cetera. You see similar trends, right? So capture efficiency goes up with airflow. Again, you see much higher capture efficiency in the back compared to the front. And then it looks like for these two ranges they were slightly better than the over-the-range microwaves.

Maybe on the order of 5 to 10 percent from the back and maybe 10-plus percent on the front.

In that simulation analysis that we did, we also said, okay, what happens if people use their range hoods? At the time, we took a capture efficiency at 55 percent and that was based on work we did on the field. Again, that's probably too high for what people commonly did because people commonly used their front burners. But if we assume 55 percent capture and assume that everybody had a venting range hood and used it every time they cooked, okay, off on the right there you see we go from 55 to 70 percent of the homes exceeding the NO2 standard to 18 to 30 percent. Now, that's still terrible, but it's much better. So range hoods actually can make a big difference.

I'm going to skip this, but this was just showing in those nine homes several of them had venting range hoods, and when we used the venting range hoods, we were able to calculate the percent deduction. And house 1 had a really good range hood, so that reduced the concentrations by something like 80 to 95 percent. Some of the other ones, 6, 8, and 9, you see that it was anywhere from, you know, less than 5 percent up to a maximum of about 50 percent. There was one oddball point there. But the effectiveness of these range hoods really does vary a lot in practice. And that's why Peter mentioned earlier that the capture efficiency, we want

to actually have a certified capture efficiency rating.

There's some data showing that in homes when people use the range hoods -- so this was that same random 50-home study -- and what you see, if you look along the bottom there, we asked the people, you know, how often do you use the range hood when you cook, either most of the time, half the time, infrequently, or never? And then what you see is that when compared to never, people who said that they use their range hood at all, even infrequently, had lower concentrations of NOx and NO2 in their homes. So this is a good data segment that shows that when people are using them, at least they're saying they're using them, they are reducing their concentrations.

We did some simulations to try to figure out what capture efficiency is needed because we know that the 30 percent or whatever you're getting at 100 CFM is not good enough. So the same kind of simulation modeling. We account for emissions, we look at ventilation, and we're looking at new homes, we're looking at code-required ventilation, and then looking at different capture efficiencies to account for removal. We also account for deposition of NO2, et cetera. And we're doing this for NO2 and PM 2.5. Similar details here. We're looking both at the emissions from the gas burner, from the cooking, and then also from outdoors. And the idea here is, as I mentioned earlier, there are emissions

not just from the gas burners but also from cooking, so that range hood is not just for the gas burner; it's for all the cooking. So even if you have electric burners, you still need the range hood to deal with PM 2.5 and other things emitted by the cooking.

So our framework is that we're trying to achieve a situation where every or almost every new California home has ventilation equipment that, if used appropriately, enables the occupants to cook routinely without being exposed to hazardous air pollutant levels inside. I think everyone -- I hope everyone would agree that that's a good objective.

We looked at NO2 and PM 2.5. For PM 2.5, we used the target of 24-hour World Health Organization guideline of 25 micrograms per meter cubed. We also looked at the federal 24-hour standard of 35. But obviously if you achieve 25, you make 35 also. And we accounted for outdoor contributions using outdoor monitoring data in California.

And then we took data -- again, this is a standard for new construction. So we looked at what fraction is single-family detached, attached, multifamily. We looked at the different sizes of the units. We accounted for the different ventilation that's required. For NO2, we were interested in the short-term, so we kind of worked out a reasonable meal for four that involved cooking pasta with some meat sauce and garlic bread, some broccoli, a nice healthy

meal. Got to have the broccoli in there. And then we're able to, you know, calculate the distribution.

This is a distribution of burner minutes based on -- I'm sorry, what we're showing here is that the cooking we used here is actually, you know, relatively consistent with what we did previously in the previous study.

For PM 2.5, we treated it just the total amount of particulate matter that was emitted by the meal. We went into the literature and we had a pretty heavy-duty PM 2.5 day. So there were three meals that all produced PM 2.5. Maybe this is not what you want to cook every day, but we said you should be able to cook it on any given day. So wake up, have some bacon, eggs, and hash browns, stir fry chicken and vegetables, and a pasta bolognaise for dinner. We didn't really do wine pairings but we can talk about that later. But the point is that these are relatively high but they're not crazy particle levels emitted from cooking.

And then we took outdoor PM 2.5, outdoor 02. There were some other parameters. The PM 2.5 similarly gets intercepted when it's coming inside. Same thing. And then some of it deposits inside. Same thing with NO2.

So what we're looking at here, this is a relatively complicated plot -- I'm sorry, a table. We're looking at the percent of homes that exceed the 1-hour NO2 standard with cooking that pasta meal and for homes of different sizes.

Okay? And along the top we broke it down into four groups. Larger than 1500 square feet -- now, obviously, cooking the same meal in a really big house is not going to have the same impact as cooking it in a smaller apartment. So you see that when there's no capture efficiency, okay? Actually a lot of the larger homes don't necessarily see that 100 PPB standard.

Let me say one other thing about that 100 PPB standard. And I should have said it earlier. The threshold or the concentration is for the outdoor standard. When you're using outdoor Ambient Air Quality Standards, those things are designed to be only as protective as they absolutely need to be for the general population and sensitive subpopulations but not the most sensitive individuals. But because they're a regulatory requirement, they're not set at a level with any margin of safety. They are set only as low as they absolutely have to be, and there's a lot of other considerations in terms of what's achievable, et cetera, because they're regulatory. So this is not like a safe level. When you are at 100 PPB or 99 PPB, some people are still being harmed, okay, as compared to if you look at, like, OEHHA has the referenced exposure levels or that World Health Organization guideline level. The guideline or the referenced exposure levels are set at safe levels, so there's a factor of safety there. So below that level, if you're below the OEHHA level, then you should be okay even for sensitive individuals. That's what they're

designed for. So we really don't want to receive this 100 PPB. So if you look, you see that for 1,000 to 1500 square foot homes, if we get to a 55 percent capture efficiency and it's used all the time, then we're below 1 percent of the homes would have a problem.

And, by the way, the framework is -- we're looking at people in each home cooking. So we understand that not everybody cooks all the time but everybody should be able to cook. If you go to a 750 to 1,000 square foot home, you need to get to a 65 percent capture efficiency to get below this 1 percent threshold. And if you go to a home that's less than 750 square feet, you need to get all the way up to 75 percent capture efficiency.

Now, for PM 2.5 to get below that 25 micrograms per meter cubed, you don't need as stringent of a capture efficiency, and partly that's because the homes are mechanically ventilated 24/7. If someone turns their ventilation off, then this equation changes. But assuming that their code required ventilation is operating, if you get to a 60 percent capture efficiency, you're fine for the 750 to 1,000 square foot. In fact, you can even go to 55 percent and you're fine. But to get to that 750 square foot apartment or small house, you need to get to 65 percent capture efficiency, and you'll probably know that these are not as stringent as for the NOx controls. So for homes that don't have gas, you

don't need as good of a range hood.

I'm going to skip over that slide.

We mentioned how many actually use range hoods. This was a survey we did in southern California, and credit to SoCal Gas for helping with this. And what you're looking at is the blue bars are people who say that they use their range hood always, red is most of the time, and green is sometimes. And then we broke it up to homes that have range hoods that exhaust to outside versus blowing air back into the kitchen. Remember, it wasn't required to have the venting range hood until 2008, January 1st, 2008, and then actually there was the housing places there, so really it was much later, 2010, '11, where homes started being built where all of the homes had them. So we see more people say they use them in homes with venting. Interestingly, if you ask why don't you use your range hood --

MR. STRAIT: Brett, I'm sorry. I'm going to cut in here really quick. I know we're closing in on 11:00, and I do want to provide enough time so that Professor Zhu can address any questions that we have there. So the survey results are interesting, but can we either pause or wrap this up fairly quickly so that we can allow some times for questions?

MR. SINGER: I'm going to stop right there. Let me just say that what we found is that people even use them less than what they say. So they probably use them about half as

much as what they say they use them. And then I'll stop.

MR. STRAIT: Okay. So very quickly, then, Professor Zhu, do you have any questions for Brett Singer based on the presentation that Brett just put together?

MS. ZHU: I find it very interesting. Thank you, Brett, for sharing. I'm actually very interested in the survey data. And (indiscernible) I'm glad there's a recent paper published. It can definitely help to better refine our analysis. Thank you very much for sharing your insight on the range hood. I think we should really -- that is an opportunity that there's lots of things that we can do to protect -- reduce indoor exposures.

MR. STRAIT: All right, Brett --

MS. ZHU: And I saw some questions in the chat. I already tried to answer some of those by typing in answers. If any other questions, I'd be happy to answer.

MR. STRAIT: Let's go to Brett, and then we have one person that has their hand raised that might not be able to access the chat, and then we can do some of the typed questions. If we run out of time for the questions that were entered into the question and answer box or ones that have shown up in the chat, I can email them to you and we can figure out a way to then post any answers or replies you want to give to our docket.

MS. ZHU: Sure. Happy to do that.

MR. BOZORGCHAMI: So, Peter, I'm going to unmute Ms. Debra Kaden. She had a few questions in the question and answer box, so she might -- we might be able to answer a few of her questions real quick.

Would you please state your name and your affiliation, Debra? Thank you.

MR. STRAIT: And, Debra, you will need to unmute yourself as well. She was unmuted and then she re-muted. I'll click the 'ask to unmute' button.

MS. KADEN: Hi. Did I unmute it this time?

MR. STRAIT: Yes. You're good, you're good.

MS. KADEN: Thank you very much. Thank you both for the presentation. I thought they were very informative. I wanted to ask a general question.

MR. BOZORGCHAMI: I apologize, Debra. Can you state your name and your affiliation? I apologize. We have to do that --

MS. KADEN: Oh, I'm sorry. My name is Debra Kaden. I'm with Ramboll. And I had some questions about -- that either of the speakers could answer. There are many important indoor air pollutants including mold, pests, pet dander, second-hand smoke, PM 2.5. So the first part of this is: Can you put some context around the importance of NO2 relative to these other important pollutants which may differentially impact lower-income and minority populations?

And, secondly, as the UCLA study properly points out, increasing the frequency of range hood use and improving the efficacy of ventilation technology would also reduce exposure and protect public health to all of these pollutants. Might this strategy be a broader approach to improving indoor air quality from all sources?

MS. ZHU: I guess I can start. Do you guys want me to start?

MR. STRAIT: Sure. Actually, let me preface by saying, really, we know that these particular pollutants are a result of using kitchen equipment for cooking, and since it's raised in that context, that's what we're focused in on for this particular hearing, but we do recognize that those other pollutants are why we have the other ventilation standards that we have. But please go ahead, Professor.

MS. ZHU: Yes. That's a really good point. I want to echo that. And I also want to mention, you know, in the past, the air quality in-house research field tend to study those pollutants individually. But nevertheless, in reality, people are exposed to all of those together. And I think the field is moving towards to more incorporating (indiscernible) pollution exposures. There's already lots going around for Ambient Air Quality to study (indiscernible) and PM as a mixture. And there will be more studies, I think, coming out addressing these mixture issues that when people are exposed

to more than one pollutants. But I think the comment -- the focus of today is focusing on NOx, and that's why the focus is on the NOx emissions, which, as Brett also mentioned, is still the most important from indoor gas appliance.

MR. SINGER: Yeah. And I'll add, I think it is a very good point. The health effects mentioned at the outset are really concentrated in people who have preexisting respiratory conditions, so asthmatics, COPD, et cetera. And those conditions are both more prevalent in disadvantaged communities and they are exacerbated also by outdoor air pollution. So in communities where people are living with more outdoor air pollution, these effects of the indoor air, especially of NO2, are going to be more acute and more problematic.

And then you mentioned some other things, allergens, et cetera. There's a whole confluence of exposure and indoor air quality issues that come with living in substandard housing without adequate ventilation, et cetera, that's really beyond the scope of this. But I think that the key point is that it is -- the issues we're talking about are going to be more acutely felt by people who have these other air quality challenges.

MS. ZHU: And I also want to add another angle -- sorry, the other scope of our one-year literature review project for Sierra Club that is the climate aspect. Yes, range hood can

reduce indoor exposures, but using the gas appliance is not just emitting those criteria air pollutants, but they're also a huge (indiscernible) emissions. And that is actually -- I think if you electrify those indoor gas appliance, they can help both from the house affect the air pollution side but also from the climate mitigation side. So I want to make sure this point is coming through even though our study is out of the scope of what we put into our report.

MS. KADEN: Thank you.

COMMISSIONER McALLISTER: Thanks for that question. I really appreciate all of the beautiful questions coming in on the Q&A and the chat as well, and, Professor Zhu, your real-time response to many of those technical questions, so thank you.

I wanted to jump in and just ask -- I guess amplify a couple of questions that have come in because I had noted them down as well. I'm wondering about, you know, fixes for the underutilization of existing range hoods and what your perspectives are on behavioral approaches and kind of how education -- you know, if you know there's a problem, does that make people more likely to use them? And, you know, the hard fix would be more automating, make sure they come on, you know, through some -- a little bit more draconian building code requirement.

So I guess I'm wondering, sort of, how you might

weigh the different options and their potential effectiveness, recognizing that here we're talking about new construction for the most part. And, you know, the existing building stock also requires solutions here which we haven't really touched on in this context. But certainly it's a relevant thing going forward. But the educational piece and how people can change their behavior to improve their indoor air quality in their kitchen.

MR. BOZORGCHAMI: We have Sean Armstrong also raised his hand.

MR. STRAIT: Actually, before we go to Sean, I do want to be respectful of people that typed in their question into the Q&A box.

MR. BOZORGCHAMI: Sure, sure, sure. Sorry about that.

MR. STRAIT: And the reason we unmuted Debra is because she had a question in there. So let's go to those first while we have the professor's contribution. Important that we have one person that asked: If asthma is associated with gas cooking due to nitrous oxides, why isn't nitrous oxide itself associated with asthma?

I'll start by saying my understanding of the science is that as much as NOx can trigger an asthmatic episode in someone with the condition, the science is much murkier as to whether someone would develop asthma due to exposure to

nitrous oxide. Is that the case?

COMMISSIONER McALLISTER: I wanted to actually get an answer to my question about the range hood, and then we can go to the additional questions. And certainly I want to take advantage of Professor Zhu while she's with us rather than, you know, more broad answers, so thanks for that.

MR. STRAIT: Yeah. My apologies. If we could address McAllister's question first?

MR. SINGER: Professor Zhu, is there anything you want to note about that or --

MS. ZHU: Brett, you want to start first? You can go ahead.

MR. SINGER: Sure. It's an excellent point and I think it's a question for the commission as to what you see as your role in terms of providing both equipment and kind of information and automation. So we know Susan Wilhelm mentioned earlier that our study found that the new homes we looked at were built with the code requirement (indiscernible) ventilation but many people have them turned off. And the code actually has had a fix already in there. It was not being widely enough used which is there's supposed to be some -- a plaque or something informing the resident what that is and having better information and more clear note directly on the switch to the ventilation system about what it is and how to use it could help that. There's a, you know, ongoing

question about how automated or how much the occupant should have that ability to turn it off.

For kitchen, there's a development happening of automated range hoods. Preliminary work on this over many years has found that people don't like them to come on automatically but do want to have the control -- and in part because they're so loud, which is one of the reasons why people don't use them. But there's this question about do people have enough understanding that they're supposed to use them? I think we've shown that -- the biggest reason people don't use it is that they think it's not needed, okay, by far.

COMMISSIONER McALLISTER: Okay, great. Thanks. Let's see if we can get some more -- some questions specifically to Professor Zhu before she has to leave. So thanks.

Peter, I'll hand it off to you guys in a minute.

MR. STRAIT: Sure. And I'm looking. The other questions in the Q&A box don't seem to be specific to Professor Zhu's presentation. But if you've already read some of those questions, are there any that you would like to respond to?

MS. ZHU: I saw a question asking about the story map. I think I put it in the chat box early. Maybe people just have to scroll up a little bit to find the story map. I'm happy to share it with CEC after this.

MR. STRAIT: Certainly.

MS. ZHU: By email. And I also want to just build on what Brett just mention, you know, on the behavior side. I think education is always important and public health, and communication is also very important. And when we educate people, trying to change behaviors, I think what message we want to communicate is very important. We actually -- my colleague at UCLA did a study when they are trying to communicate importance on those issues that we talk about some of those today. Like, more from the saving energy side. They found the message, if the message is crafted from, oh, this will save you money, save energy, it doesn't really trigger any behavior changes. But if the message is created from it will protect your health, protect your children's health, and that message get taken more seriously. So I think there is a whole -- there's a whole field, a separate field, about how to communicate the right message, the public health message, to change behavior. So that's definitely something I think is very relevant in this context.

And I also just want to reflect a little bit more, like, my experience seeing what -- you know, the multiple source emissions get reduced over time. So there's three pillars. The fuel needs to get cleaner, the engine is to get more efficient, and people need to drive less. You know, I think we all know which of those three are more of the least

effective is people driving less. So changing behavior is very difficult. I think if there's anything that we can do on the technology policy side to use engineering controls rather than rely on people's behavior, that will yield better results in my opinion.

MR. KUMAGAI: This is Kaz Kumagai. Can I jump in?

MR. STRAIT: Certainly. You're on the panel.

MR. KUMAGAI: I want to share a slide about this. Can you see the screen?

MR. STRAIT: I see a thin white line. There it goes. Now I see it.

MR. KUMAGAI: How is this?

MR. STRAIT: It's a slide with some of these sensing options?

MR. KUMAGAI: Yes, yes. So I don't see everything. Oh, okay. So, actually, I'm from Japan and, you know, it's always interesting to compare what kind of products are on the market. So, you know, as you folks requested, I did a couple of Google search, and I asked a couple of friends that works in the industry, and I found a couple of automated range hood, so I'll share them with you. So one is -- one type is like this one. When you turn on -- when you start cooking, the fan will automatically operate. The second one, it has a motion sensor, and when there's someone close to the cooking top, there's a infrared sensor that will detect the human, and the

range will automatically start. And the third one is -- this one is a humidity sensor. So actually it's monitoring the humidity level difference caused by cooking. And in addition to that, this is not a automatic sensor, but there's also another product that will delay to turn off the switch. So the technology is already out there. It's a matter of the U.S. market or the California market will take that into consideration or not. So that's all from me.

MR. STRAIT: Thank you very much. I know we actually are -- staff are paying attention to some of these available technologies. And as much as we've seen some adoption of the commercial space, we see that it's been slow to enter the residential space, at least in the U.S. And obviously given that we have some constraints relative to cost-effectiveness, we're keeping a close eye on what the cost premium is in the U.S. for products with these types of controls and interactions. But, no, it's very good to know that that technology is there and can be very effective in the space of automating and removing that decision-making component so that -- to address this issue and ensuring the equipment gets used.

COMMISSIONER McALLISTER: So I want to encourage everyone -- so it looks like Professor Zhu had to leave, and so she was really only with us until 11. But I do want to encourage staff or ask staff to keep track of all the

questions that have come in. And to the extent they are for her and that there are more questions that people want to ask of her, we can work with her to hopefully get some answers and bring those into the docket and get those into our formal process.

MR. STRAIT: Certainly.

COMMISSIONER McALLISTER: And so thanks for that. And let's see. Why don't you all keep going through the questions to the extent that we have a little bit of time and see if Brett or any of the other panelists want to answer those.

MR. STRAIT: Absolutely. Some of these questions seem like they're fairly straightforward and just kind of clarifying some of what was presented.

First, the question I asked earlier was actually answered very nicely by T. Williams in the chat box, who said that the consensus is that nitrous oxides are an agent for asthma exacerbation but not a cause of asthma development. And this is borne out in EPA, World Health Organization, other consensus-based sources. And that's my understanding of the science as well.

Brett, is that your understanding.

MR. SINGER: Yes.

MR. STRAIT: So someone asked what value we used for electricity emissions, if we used a fixed value or a time of

use or a statewide average or local. The emissions values that you used for electric cooking were directly from measuring a test set-up and running a simulated event; is that correct?

MR. SINGER: I think that refers to the work Professor Zhu was doing.

MR. STRAIT: Oh, okay. I'll have to clarify. If it is a question for Professor Zhu then we can forward that on.

And there's also a question -- this was during Zhu's presentation about the impacts -- like, where their estimates of the impacts of PM 2.5 were from or some more technical detail there, so we can pass those on.

Let's see. We have someone asking how to make ranges quieter at higher airflows. That's going to be a question, I think, later. And it's more a question for industry manufacturers. It's not really related to the technical presentations thus far about emissions.

MR. SINGER: By the way, the PM 2.5, was the question about how we got emission rates for PM 2.5 from cooking?

MR. STRAIT: No, no. The PM 2.5 question is how -- can you explain how the -- if PM 2.5 is generated by the act of cooking, like, how that impacts estimates of overall premature death, bronchitis, and other health benefits for PM 2.5 broadly, at least as I understand the question.

MS. SINGER: I can answer that, actually, which is that we make the simplifying assumption that the PM 2.5 from cooking is equally harmful as PM 2.5 outdoors, so a lot of the health effects estimates of PM 2.5 are based on epidemiology, epidemiological investigations. It's looking at outdoor PM 2.5 levels and resulting hospitalizations and medical impacts, effects documented through the medical system, so heart attack, strokes, et cetera. So it's a simplifying assumption that, you know, may or may not be precisely correct.

MR. STRAIT: Sure. We have a question whether 100 percent usage of range hoods is assumed for baseline energy consumption purposes. I can answer that in the affirmative. Our performance software, when we talk about compliance with energy standards, assumes that this equipment gets used. There isn't a penalty for additional usage. We're expecting people to be able to use it for all of their cooking events.

We have someone that's asking about how they can find out whether their kitchen range hood is a venting range hood. It strikes me that based on your slide, if the range hood is blowing air back into the space, then it is probably on a re-circulating mode rather than a venting mode where it would only be sucking air and blowing out of the building. But otherwise, I'm not sure whether we're able to really provide that answer.

Can you speak to how folks can -- is there a common

way that these models are set up to be able to go between venting and re-circulating?

MR. SINGER: Yeah. I mean, in order for them to vent, you need to have the vent connection, so they need the duct work that connects the range hood to the outside. Ironically, we did find one case -- in the study we did for the ARD, we went into a home in Sacramento that was, I think, renovated in 2008, and there was a microwave there that was connected to a vent but was configured to re-circulate because they had not changed the fan configuration.

But for the microwaves, you literally need to turn the fan. And again, they're shifting the motor to re-circulate, so before they're installed they need to be reconfigured to --

MR. STRAIT: All right. We have someone asking what capture efficiency would be needed to ensure a safe level of NOx for a home with a gas stove. I think one of your slides actually answered that. (Indiscernible) 1 percent rate that we had to get a capture efficiency depending on the size of the building somewhere between 55 and 75 percent.

MR. SINGER: Yeah. Marian Goebes is going to address that in her talk coming up as well.

MR. STRAIT: Okay. We have someone asking how your capture efficiency -- how the capture efficiency standard accounts for differences between use of front and back

burners. Like, does it weight them a certain way or is it like a total capture?

MR. SINGER: Right. So the way we did it was somewhat theoretically saying this is the capture efficiency you need. That ASTM test developed by my colleague, Emakur (ph.), actually uses two simulated front burners recognizing that that's the more challenging condition and that's the way most people cook. So the capture efficiency would calculate -- is what you need to achieve. And then the hope is that HVI will -- the manufacturers will submit their products to HVI for testing and using, like, the standard method, and that will reflect front burner use. Obviously, you know, depending on the details of exactly how people cook and move around the kitchen, you know, it's going to vary for each person. But the idea is that the capture efficiency test is designed to give you front burner capture efficiency that, you know, should be fairly robust for most cooking.

MR. STRAIT: Certainly. We have a couple of other questions that are directed to Dr. Zhu, so I will dismiss a few of those from the chat box. And, again, we'll send those on after the conclusion of this meeting.

Let's see. Recent study -- that's not a question. Okay, that's not a question about the technical content of the presentation. So this is, again, about how the software handles energy usage. It's really tangential to the

presentations we have here.

When determining a target minimum RHCE -- which range hood capture efficiency, I'm assuming -- was the model based on a single well-mixed zone for the entire house -- would you consider the worst-case exposure that of persons in the immediate vicinity of the cooking activity? I think it was the latter.

MR. SINGER: So when we did our modeling, we considered that house as being well-mixed as kind of more solid, robust assumption. And then we accounted for an enhancement of somebody who would be in the kitchen during. And that enhancement was based on literature values of how much higher concentrations are in the kitchen. I believe when UCLA did their simulations, they modeled the kitchen as a separate volume, but you should, I think, refer that part of the question to -- and as a result, that much higher concentration. But that question should be referred to Professor Zhu.

MR. STRAIT: Yeah. No, I'm familiar enough with the content of the UCLA publication that, yes, they looked specifically at emissions occurring at the stove and in the kitchen area, and we're not assuming much, if any, mixing. But again, the technical details I know for that question are -- those are actually answered in the report.

We have a question about how capture efficiency is

affected by other fans in the home. I think the capture efficiency as basically a test measurement in a test environment doesn't consider those interactive effects and is really just looking at the interaction between the range hood and the stove itself, correct?

MR. SINGER: Correct. There could be effects. That was, I think, asked by Sean Armstrong. And he is correct that, you know, other exhaust fans interfere with the airflow. You know, basically, the competing -- for certain location purposes we're looking just at the effectiveness of the range hood independent.

MR. STRAIT: Certainly. It's worth noting, also, I know, if at least one other participant was on the line, they'd be quick to point out that there are other ventilation strategies that are allowed by ASHRAE, so it is not a strict requirement that a kitchen range hood be present. Again, these are requirements if there is range hood being used for this purpose as opposed to another ventilation strategy; here are the criteria it has to meet. But this is by far the most common ventilation strategy for this area, and in a lot of ways it is the most effective since it is available right there at the source of the emission.

Let's see. We have a question. The CEC mechanical ventilation report published earlier this year and conducted by LBNL, which looked at various pollutants in homes with

mechanical ventilation had lower pollutant concentrations for various cooking-related pollutants compared to their earlier 2009 report. NOx was slightly higher. Since the 2020 report included mostly gas ranges, while the 2009 study was almost exclusively electric ranges, does this research show that the gas ranges are not a significant source of indoor pollution in the home? That's kind of an interesting question the way it's phrased.

MR. SINGER: Yeah. So it is a very interesting question. That study was single-family, detached homes. Almost all of them were very large. So it's consistent with our expectation that -- and, actually, there was cooking in some homes, so those were -- the gas burners were a relatively small source in those homes. They did have some impact but -- and then there were some range hood use as well. So it was a combination of the homes being very large, modest amounts of cooking, and actually some range hood use to cut maybe some of the worst situations of cooking or large cooking amounts.

If we do see the people use their range hoods more -- this was a point earlier. People use them less than they say, but it's not completely irrational. We monitored cooking in both the single-family homes and an apartment study, and we do see that when people cook more they use their range hood -- they're more likely to use their range hood. And in the homes where people -- cooking that involved

particle emissions, they were more likely to use their range hoods. So there is some rational assessment of risk happening for people in deciding when to use the range hood.

MR. STRAIT: All right. Speaking merely from my own personal experience, prior to reading a lot of this research, I know I would use my range -- my ventilation if I was cooking with more than one burner and if there was some sort of smell coming on that clued me in that, hey, there's something happening here or, like, smoke. But that if I was just using a single front burner and it was frying an egg without a lot going on, I wouldn't necessarily remember to switch that on. But that -- now I've learned.

MR. SINGER: Yeah. And, frankly, you know, if you're in a, you know, 2500 square foot house, and you're, you know, boiling a kettle of water, it's better to use your range hood, but you're not necessarily going to reach a hazardous condition under that use case. Whereas, if you're cooking dinner for four, then it's much more important to do so.

MR. STRAIT: Yeah. I'm going to take one more question before we move on to some of the other panelists. Because some of these questions I see are fairly general on a topic and might be best done after all the panelists have had a chance to present and might be answered by some of the other panelists' presentations.

But one person actually asks as a question to staff,

they say: Current field verification protocols require confirmation of range hood flow rate. However, your research points out that many kitchen exhaust appliances ship in re-circulation mode and are installed this way even when there is a duct to the outdoors, like you just mentioned. Would it be possible to update the verification protocol to ensure that kitchen exhaust is installed to exhaust to the exterior and is not in re-circulation mode. And I can say we can certainly look at the verification protocol and see if that is an important step -- or see about adding that as a step in that process. So, yes, staff feedback like that or considerations like that are exactly what we're looking for in developing a potential update to the standards we have on the books, so that's excellent to point out.

MR. SINGER: Peter, if I could just quickly comment on that too? That study went to 70 single-family, detached houses. I think something like 38 of them had over-the-range microwaves that had that configuration issue that we mentioned, and all of them are configured to vent. That doesn't mean that it happens in all homes.

MR. STRAIT: Oh, sure, sure.

MR. SINGER: It just means that it didn't appear to be common. And then they found that almost all of the range hoods could also produce -- could move 100 cubic feet per minute, although not all of them, as installed, did that on

the lowest speed. So they couldn't move that amount of flow at the setting that would meet the sound requirement. So there may be an issue about whether the hoods are being installed with adequately sized ducting and (indiscernible) pressure ducting to allow them to move the amount of air that they're supposed to move.

MR. STRAIT: Certainly. So with that, I'm actually having a small problem with Microsoft software, so just one moment. But I'd like to move to our next panelist which -- if I can pull back up the agenda. Here we go. There we go. So our next panelist is Marian Goebes with TRC.

Marian, would you like to -- are you teed up to present?

MS. GOEBES: I should be. Are you able to hear me okay?

MR. STRAIT: I'm able to hear you, and I can see that you're sharing your materials.

MS. GOEBES: Okay, great, great. All right. And then I just switched to presenter mode. Are you still able to see the screen, the slides?

MR. STRAIT: Yes.

MS. GOEBES: Great, great. Well, thanks so much. I'll be presenting today the proposed range hood requirements, what the current proposal is, and the rationale for those for Title 24-2022.

So first off, I want to start off with a big thank you to all the stakeholders that have provided comments throughout the process, industry representatives, nonprofit groups, advocacy groups, researchers. Thank you so much, all, for your comments. They continue to shape the proposed requirements.

So today we'll start off with an overview of the current proposed requirements, and then most of the time will be spent on the whys behind those. So we frame this as questions that we thought stakeholders might have including requirements of always use airflow, where is there now this capture efficiency path, how did you set the capture efficiency path, and why do they differ -- dwelling and its size. I think some of that we can go through pretty quickly based on the previous presentations. Why are requirements more stringent for hoods over natural gas ranges than electric? Again, some great background already by Professor Zhu and Dr. Singer on that, but we'll see more here. And then how did you set the airflow requirements, how many products meet the proposed requirements, and are they more expensive? And then, finally, why didn't we tighten the sound requirement? And then the last will show the markups in the Title 24 language for the proposed requirements.

So starting with the proposed range requirements. This should look somewhat familiar compared to previous

workshops but also a little bit different. You know, a big difference is that now we're framing the minimum capture efficiency and minimum airflow requirements for demand controlled range hoods based on floor area as opposed to dwelling unit type. And that's based on the research from Professor Zhu and Dr. Singer showing that, you know, pollutant levels are really tied to the size of the units. And then we also have the last two options that have not been touched at the bottom of the screen. In addition to -- or instead of doing a capture efficiency path or a minimum airflow path for demand controlled range hoods, you could also install a downdraft exhaust range hood with a minimum of 300 CFM or continuous exhaust in the kitchen at 5 kitchen air changes per hour at 50 pascals. And that's only for enclosed kitchens, and those last two options are directly from ASHRAE 62.2.

MR. STRAIT: If I could cut in really quick?

MS. GOEBES: Yes, please, please.

MR. STRAIT: We're having some folks saying we're seeing your next slide and your notes and folks are asking if you are in the right present mode; if this is intended.

MS. GOEBES: I see what you're saying. You know what? I think I'm displaying from my second screen. Let's see. Does that help?

MR. STRAIT: Yes.

MS. GOEBES: Okay, great. Thanks for that heads-up.

MR. STRAIT: No problem. Thanks to the folks on the chat that pointed it out.

MS. GOEBES: For notifying. Thank you.

So just to kind of quickly show you this or walk you through this table, you can see the most stringent requirements are for range hoods over natural gas ranges and small units, so less than 750 square feet. And then the least stringent requirements are for hoods over electric ranges, at larger sized units, or over natural gas ranges over 1500 square feet.

So the first question is, hey, requirements have always used airflow; why is there now a capture efficiency path? So Brett, I think, has already described what the capture efficiency is but, just recapping, it's the ratio of captured pollutant to total pollutant released expressed as a percent. And under the proposed requirements, the manufacturer would be responsible for having that capture efficiency tested using that ASTM method. But the main reason why there's a capture efficiency path is because it is a direct measurement of pollutant removal.

As you'll see in a few slides, and as I think you saw in Brett's presentation, capture efficiency and airflow generally increase together, so as you increase the airflow you generally get a higher capture efficiency from the same hood. But airflow is really only a proxy for measuring

pollutant removal. It's capture efficiency that's the direct measurement.

So for this cycle, the proposal is allowing either path, capture efficiency or airflow. The main reason why airflow is still allowed is because most products don't have capture efficiency levels published at the moment. So either one is allowed currently, but future cycles -- hopefully by 2025 -- we can just move to capture efficiency since that is the direct measurement.

The next question that you may have is: How did you set the capture efficiency requirements and why do they differ based on dwelling unit size? So again, the presentations early this morning, I think, frame this quite well. In general, the requirements are based on that LBNL research that Brett and Ranji had led. So what they had done was to conduct a physics-based simulation model to calculate air pollutant concentrations in homes from cooking. And they ran Monte Carlo simulations which means running the same model various different times with several variables changed under each scenario, including home size, housing characteristic, outdoor conditions, and indoor pollutant dynamics. And then the goal was to find out, okay, what capture efficiency is needed under certain conditions so that no more than 1 percent of homes would exceed unacceptable level of pollutants. And so, again, they found that smaller homes means less dilution of

pollutants resulting in higher concentration, so that's why the requirements increase with smaller home sizes.

So moving in to this table. This should look familiar because it's what Brett was presenting earlier. A version of this was published in the report from LBNL released in March of 2020, although, as you'll see in this first footnote here at the very bottom, LBNL has conducted additional modeling since releasing that paper which we used for this table, and so that's where that 75 percent for hoods that use natural gas ranges for units that are 750 square feet or smaller came from. You know, these numbers should look familiar based on what Brett just presented. So, again, you can see higher requirements in general to keep NO2 within acceptable levels and then as units get larger.

And then one other note in terms of what did we identify as acceptable levels. Again, we looked to the LBNL research there. And as Brett just mentioned, they used EPA NAAQS standards for PM 2.5 and then the World Health Organization guidelines for PM 2.5 which are slightly stricter than the NAAQS standards.

So the next question is: Why are requirements more stringent for hoods over natural gas than electric ranges? So it's been discussed earlier today PM 2.5 is released from the general cooking processes, so any cook top, regardless of the field type, will have PM 2.5 generated during cooking, but

natural gas cooking appliances also releases NO2. So some examples of -- you know, the many literature that's been supporting this includes a study done by Kathleen Belanger in 2013 that found that asthmatic children are at higher risk for more severe asthma symptoms even at low levels of NO2 and that risk rises as NO2 rises. And then a study done by the EPA in 2008 that found that homes with gas stoves have 50 percent to 400 percent higher concentrations of NO2 than homes with electric stoves. So bear in mind, you know, that's fairly old data. This would not be reflective of new homes built today. But, in general, this is definitely indicating that we're getting higher concentrations of NO2 with gas stoves, and that does lead to conditions including asthma.

And so, again, the LBNL simulations found that a higher capture efficiency is required to maintain NO2 within acceptable levels compared with the PM 2.5 in small homes.

And then one other note. I know Professor Zhu was also mentioning CO being released from NO2. But in general, field studies and also simulations have found that NO2 much more frequently exceeds standards than carbon monoxide in homes with natural gas cooking appliances. Actually, in one of her slides I saw that, in general, the carbon monoxide -- you know, the simulations were finding that carbon monoxide was within limits but NO2 was exceeded, so that backs up that understanding as well.

So the next question is: How did you set the airflow requirements? So we talked through where we got the capture efficiency requirements. Again, that is based on the LBNL research. To get to airflow, we contracted with Texas A&M University earlier this year to conduct capture efficiency and airflow testing. And the target was specifically for product types that would be installed in smaller homes such as multifamily units. So we focused on testing on microwave over-the-range hoods, otherwise known as OTRs, and undercabinet hoods since those are typically installed in small units. They tested five products. They used that ASTM method E3087 which is what is included in the proposed requirements. That does simulate front burner cooking. And then we used the (indiscernible) results to correlate capture efficiency with airflow. So you can see the results off to the right. We tested each product at two airflows. As you can see, you know, capture efficiency does increase for each product with airflow, but it's not always the same relationship which, again, just highlights the point that it's capture efficiency that is the better metric as opposed to airflow.

And then, you know, in general we're finding -- so from this graph, then, we were able to translate those capture efficiency requirements from the LBNL study to what the equivalent airflow requirement would be. And I'll note that,

you know, this is based on a limited number of products. It's only five products. But LBNL has done some testing using that different capture efficiency metric that Brett described. And for their front burner cooking they found that between 200 and 300 CFM are needed to achieve 70 percent capture efficiency. And that does line up with what we found here. So you can see with your eye, hopefully, 70 percent capture efficiency is roughly 270 CFM, so it is within that range that they had identified as well.

So now getting into product availability questions. How many products meet the proposed requirements? So this is some analysis we did based on the HVI database. So the table on the left is showing those microwave range products, otherwise known as OTRs, and then the table on the right is showing undercabinet range hoods that would be meeting the proposed requirements. So we're starting off -- this slide is showing you according to the CMF, and then the next slide I'll remind you how this correlates to the proposed requirements in terms of, you know, size of unit and whether it's electric or natural gas range.

So you can see in general that we've got pretty good availability of products for microwave range hoods up to 200 CFM over 80 percent. It does start to drop in the mid-200s, and then by 290 CFM, which is what is required only for small units with natural gas ranges, you know, we're down to 8

percent of products that would be available to meet that for the microwave range combination OTRs.

For undercabinet range hoods, better availability there, so almost all products provide up to 200 CFM. And we still have half of the products meeting that requirement at 290 CFM.

And I also want to note these are all reflecting horizontal configurations. As Brett was saying, range hoods can be configured under either horizontal or vertical. The percent compliance actually increases for vertical so this is more of a worst-case scenario.

And then one other comment is that chimney hoods, which are commonly installed in larger units such a single family homes, all of the tuning hoods we reviewed would meet at least 290 CFM requirements. So, you know, the pain point is much more on the type of products are installed in small units.

So then just tying that availability back with the proposed requirements. Most products, most OTRs and undercabinet hoods would comply, would be able to be installed for units that are greater than 750 square feet with electric ranges or greater than 100 -- excuse me, greater than 1000 square feet with natural gas.

Some products, so about a third of the OTRs and two-thirds of the undercabinets, would comply for small units, so

less than 750 square foot units with electric ranges or in that 750 to 1000 square foot range that have a natural gas range. And then a few OTRs, you know, about 8 percent, and about half of undercabinets would comply with those most stringent requirement which is for the very small units, less than hundred 750 square feet with natural gas ranges. So, in general, proposed requirements are achievable, particularly for units with electric ranges and/or medium to large units.

The next question was about, you know, are compliant products more expensive? So we did some comparisons here and found that microwave range hoods that are greater than 250 CFM were more expensive compared to those that were 100 to 250 CFM. On average was about $140. So a reminder, again, that is for the smallest unit for electric ranges or less than 1,000 square foot with natural gas ranges. And then undercabinet hoods that were greater than 290 CFM, those were more expensive compared to 100 to 290 CFM undercabinet hoods. They were more expensive by about $270, on average, although there's fairly low precision there since, as I described before, most products do have an airflow greater than 290 CFM. And then calling out, again, that's the most stringent requirement. That's only in small units with natural gas ranges.

So overall, you know, a lot of units wouldn't have to be using more expensive products. But in some cases, you

know, they would be moving to a more select products that do tend to have higher costs, but we do think this is necessary, based on all the health evidence we've discussed.

Last question is: Why didn't you tighten the sound requirement? I'll just start it by saying that we wanted to. We understand that surveys have shown that noise is a deterrent from range hood use. There is an existing sound requirement in the standard. So, as you all probably know, Title 24-2019 requires demand controlled range hoods meet a requirements that's from ASHRAE less than or equal to 3 sones at 100 CFM.

So we looked at a couple different options. The first was: Can we add a sound requirement at the higher airflow that would be required? So, for example, could we put in a new sound requirement at around 250 CFM? We got some great feedback from manufacturers said, hey, that would require product retesting, and they are trying to move away from their current test points. In particular, the current test points include an unrealistically low static pressure, and they're trying to increase that static pressure to better reflect field conditions. So we don't want to require them to do retesting at these old test points, so we didn't want to impose a new sound requirement at the old test point, so that's why we didn't put in something at, say, 250 CFM.

More recently, we thought, well, hey, how about we

just use the existing test points of 100 CFM, but instead of allowing 3 sones we tighten it down to 2 sones? That's actually in the product certification requirements for Energy Star range hoods. But we did some analysis -- great work here by my colleague Mia Nakajima who put together this plot on the right. You can see that for products that tested at 2 sones or less at 100 CFM -- that's on the left bar -- they didn't have much of a change in sone at 250 CFM compared to products on the right bar that were between 2 and 3 sones at 100 CFM. So for the products on the left that tested at 2 sones or less at 100 CFM, they had an average sone of about 6 and a half sones at 250 CFM. And then the products on the right that were between 2 and 3 sones at 100 CFM, their average was 7 sone at 250 CFM. And you can see a big range in both groups. So there just wasn't much of a difference there to support changing the requirement. So we've left it as-is but highly encourage the future Statewide CASE Teams to look into a new sound requirement for the next cycle.

And last slide here before I get into some acknowledgements and, you know, would be happy to take questions is the proposed requirements. So this is a markup. This is how it would look in under 150.0(o)1Gb, repeated in 120.1(b)2Avi for high-rise multifamily. Of course under multifamily unification this would hopefully just show up once in the code.

Just some quick legends here. Purple is what's currently required under Title 24-2019 because of its reference to ASHRAE 62.2. So if you look in Title 24-2019, you will not see this language, but you will see a requirement to meet everything in 62.2, and then when you go to 62.2 you will see this language. And then the red is the new proposed requirements.

So exhaust systems in non-enclosed kitchens must meet 1, 2, or 3 below. Exhaust systems in enclosed kitchens must meet 1, 2, 3, or 4 below. So, again, 4 is that continuous exhaust option.

So, starting with 1, that is the new language that we're really proposing: A vented range hood with at least one speed setting with a minimum capture efficiency shown in table 120.1-A, measured in accordance with ASTM Standard E3087 at a nominal installed airflow described in HVI Publication 920. So that's the new capture efficiency path.

Or a vented range hood with at least one speed setting with a minimum airflow of -- instead of 100 CFM; that's the current requirement -- the CFM shown in Table 120.1-A. And then we just called out the -- clarified the testing condition.

Or a vented downdraft kitchen exhaust fan of 300 CFM, or that continuous exhaust at five kitchen air changes per hour.

So with that I want to thank very much my Statewide CASE Team members, Mia Nakajima, Elizabeth, and Cathy Chappell at TRC, Dave Springer at Frontier, Kelly Cunningham and Mark Alatorre at PG&E; contributors including Jim Sweeney and his team at Texas A&M; many collaborators, in particular Brett Singer and Rengie Chan. Again, thank the stakeholders for their comments and their feedback. It's been really helpful. And of course Energy Commission staff for their collaboration.

And that's my information. I think what I'll do is I'll go back to the proposed requirements and then go to questions, please. Or, I forget --

Sorry, Peter, is it another speaker and then questions?

MR. STRAIT: No. Actually, what I'm planning on doing, I'm looking at the question and answers that are in. If they are general questions, I'm going to hold them until the end of the presentations because they might be answered by future presenters. If they are specific to the content of a particular presenter, then I'll go ahead and tee them up. And I will, at this point, open it up for any of the panelists that have any questions for you about the material that you presented, if they'd like to ask their questions in real time. If anyone is speaking, since I'm not hearing anyone, note that you might be muted. Not hearing anything at the moment and not seeing anything. And again, I'm seeing general questions

in the chat thus far.

I'm going to go ahead and move on to the next presenter, then, which is the California Resources Board. Are you prepared to present?

MS. SCHEEHLE: Yes, thank you. This is Elizabeth Scheehle. I'm the chief of the research division at CARB. And I'll start out and hand it over to Zoe to go through most of the presentation. I believe she's pulling up the presentation.

So really happy to be here to talk about indoor air quality and the kitchen ventilation and health effects and our next steps. Like I said, I'll go over a few high-level slides on natural gas appliances, including the need for building electrification, and then hand it over to Zoe for the remainder of the presentation. So next slide, please?

Natural gas appliances are direct sources of air pollutants and greenhouse gases and, therefore, contribute to multiple pollution concerns. Based on our emission inventory, natural gas used in the building sector results in about 82 tons of NO2 per day, about four times the emissions from electric utilities and close to the emissions from light-duty vehicles statewide.

From a climate change perspective, about 25 percent of California's greenhouse gas emissions come from residential and commercial buildings and 10 due to the natural gas use in

buildings. The large contribution of emissions from natural gas appliances to criterion greenhouse gas pollution demonstrates the need to move forward with building electrification.

And just another couple high points on how that would improve health benefits. You've heard this a little bit earlier so I won't spend too much time on it. But it can obviously provide substantial health benefits with 100 percent of electrification reducing deaths and acute and chronic bronchitis, as well as other health benefits that we're not quantifying here, but there are many of them including exposure to fine particles as well. And what happens indoors also impacts outdoors, so many of the appliances can have outdoor air pollution which we'll get into later, and it is something to be considered in this analysis, as well, with venting occurring into the outdoor environment through the vent hoods.

And so with that -- and I just wanted to finish on mitigation approaches such as kitchen ventilation really help a lot. They don't solve the problem. As we heard earlier, there are instances where people don't use them and there's still a capture efficiency rate that we have to account for, so addressing the root cause is important, but this is a really, really important step as well to moving towards protecting people's health indoors.

So, with that, I'll turn it over to Zoe for the presentation on emissions, ventilation, and research. Thank you.

MS. ZHANG: Thank you, Elizabeth. Hello, everyone. This is Zoe Zhang. I'm going to go over the remainder of this presentation.

So of all the natural gas appliances used in buildings, natural gas cook stoves are one of the highest concerns, especially for indoor air. Numerous studies have shown cooking is a major source of indoor air pollution. Pollutants from cooking including criteria air pollutants like NOx, CO, and PM 2.5, air toxins like formaldehyde and PAH, as well as greenhouse gas like CO2. Reducing indoor exposure to these air pollutants is important given the health effects associated with acute and chronic exposures to air pollutants in cooking emissions.

Comparing emissions from different heating sources, studies found higher levels of air pollutants like NOx, CO, and ultrafine particles when cooking with natural gas stoves versus electric stoves. Many homes with natural gas stoves exposed routinely to NO2 levels exceeding federal and state Ambient Air Quality Standards. Studies also found children in a home with a gas stove have higher risk of occurrence of asthmas.

To improve air quality during cooking, there are two

undividable keys: air pollution from cooking alternatives from both fuel combustion and food processing. To eliminate air pollutant from fuel combustion, combustion-free heating sources need to be in place. That's where building electrification is called for. However, building electrification won't solve the other half of the puzzle. Air pollution is from food processing, moisture, and odors. So kitchen ventilation is another key to improve air quality during cooking. However, based on a survey by LBNL, not everyone use their range hood during cooking. This implies that kitchen range hood won't be the only solution. Building electrification and strong kitchen ventilation requirement are both essential to address the cooking emission issue.

Building electrification can't completely eliminate the combustion air pollutants from gas appliance. Then what about the effectiveness of kitchen ventilation? I think Brett has introduced this very thoroughly. So here is an example for LBNL study which showing a wide range of performance of kitchen range hood. However, this also deliver a message that the high efficiency kitchen range hood could reduce air pollutants level by higher than 95 percent. Therefore, kitchen range hood could be a very effective method to improve indoor air quality if it's designed, installed, and used properly.

However, the current requirement in the building

code for kitchen range hood, 100 CFM, is not sufficient to remove cooking emission. So here is another study by LBNL which you have seen before by Brett's presentation. So higher standards, higher CFM, or more direct measures like capture efficiency that is sufficient to protect people against cooking emission is needed in the building code. Therefore, CARB recommends to strengthen kitchen range hood performance requirements in current building code cycle.

In summary, natural gas appliances cause great health impacts. High capture efficiency kitchen range hood is needed to address these health impacts, but it's not sufficient. Building electrification is indispensible component to eliminate these health impacts.

Next, I'm going to briefly introduce the additional projects related to gas appliances in cooking emission by CARB. Since the release of CARB's Indoor Air Quality Guidelines in 2005, many agencies and organizations have strengthened their Outdoor Air Quality Standards or Indoor Air Quality Guidelines. For example, this slide show CARB's initial Indoor Air Quality Guidelines for NO2 and the subsequent standards and guidelines that have been strengthened by the other agencies and organizations. We will look into the process of updating our indoor air quality guidelines based on scientific evidence.

We have an ongoing research contract with UC Davis

to assess impacts of building air tightness on indoor air quality, GHG, and energy in mid- or high-rise multifamily buildings in California. These projects started March this year and is expected to complete in August 2022. The PI will measure infiltration of particles in gases between and among multifamily apartments with data collected in the field. The PI will compare mixed-fuel, which is gas and electric, and all-electric buildings for indoor air quality and GHG by modeling.

Another research contract will focus on total exposures in disadvantaged community. It will be approved in the upcoming board meeting in October. We expect to kick it off next spring. The purpose is to identify localized sources and the personal activities that are linked to elevated air pollutant exposures in disadvantaged community in California.

The PI will conduct indoor, outdoor, and personal monitoring in four disadvantaged communities, potentially two in East Bay and two in Fresno and Bakersfield areas. Source studied will include electric and gas appliances.

For these two research project, if anyone is interested in it and want to keep track on their progress, please let me know, and I will add you to the distribution email list for the quarterly progress reports.

With that, I want to thank CEC for organizing this workshop and thank everyone for your participation and any

questions. Thank you.

MR. STRAIT: Thank you very much. I'm just taking a moment to answer -- there were some folks that had some questions about what is a PAH? And so we're typing out some answers to that. Let me check the questions to see if there are -- so there is a question relative to your research and presentation. And the question is: Did you conduct a literature search and literature study review to identify literature published since the 2013 LIN study? And they're mentioning that the data collected in that study was largely collected before the year 2000. My apologies. Are you muted?

MS. ZHANG: Oh, no. Pat or Bonnie, do you have an answer to that?

MR. WONG: Yeah. Can you -- one part I missed about that. You said literature collected before which study?

MS. HOLMES-GEN: This is Bonnie. I think this is referring to the asthma comments. Is that correct?

MR. STRAIT: I'm not 100 percent sure. This is the account from LDELL. It should be in the Q&A window if you want to pop that open.

MS. HOLMES-GEN: Right. And, I mean, we have several ongoing research projects on asthma and including actually collecting data on using GPS-enabled inhalers to understand more about individuals that are -- you know, when and where people are having asthma exacerbations and using

increased medication. So I know that we are doing -- you know, we are regularly updating our literature on asthma as we are preparing for and conducting these studies, and we do have ongoing research on asthma to better understand impacts and locations and sources that are causing exacerbations. So I can get more information about where and when we've done these literature searches, but I would say, yes, we are reviewing -- we are constantly reviewing and updating the literature on asthma.

MR. STRAIT: LDELL asks a follow-up question. They're asking: There was a study by Wong, et al., in 2013, that included more than 250,000 children in 31 countries that found no association between gas cooking and asthma. And they're asking how to reconcile the results of that study with the conclusions of the LIN study.

MS. HOLMES-GEN: Yeah. I mean, you know, we'll get some responses from some of our staff. I'm sure that there's always an ability to find studies that have varying results, but, you know, we have reviewed the study that we just posted and it was included in our presentation, and we do find that the study techniques are robust and the findings are valid and should inform our work and our policy. So we can continue to provide some additional answers, but we find the study to be robust.

MR. WONG: Yes. And this is Pat. The study we are

referencing is a meta analysis of, I believe, 1,000 other studies together. I forgot the exact numbers. So you're right, there are some studies that show no effects, and there are some studies that did not, and normally you need this type of analysis of a number of studies to be able to come up with a topic conclusion. So, yeah, I'm not saying there's anything wrong with Wong 2012 or '13 study but, you know, all studies are done under different conditions.

MR. STRAIT: Sure. I do notice there's just a general question whether we are going to be saving the Q&A in the chats after this presentation. We are going to make every effort to do so. We're still adjusting to using Zoom, and I believe it does have features to allow us to save these. And after saving them, unless there is a technical issue, we will absolutely post all of this to the docket. So I don't see -- I'll mark these as answered.

So I'm not seeing any other questions specific to this presentation. So are there any -- do any of the panelists want to ask anything of the presenters?

All right. Not hearing anything. I'll move on to our last panelist presentation, Kazukiyo Kumagai, with the California Department of Public Health.

Are you ready to present?

MR. KUMAGAI: I believe so. Can you see my screen?

MR. STRAIT: I can hear you, but I'm not seeing your

screen yet.

MR. KUMAGAI: Oh, I'm sorry.

MR. STRAIT: Yes, now I can see your screen.

MR. KUMAGAI: Okay. So, hello. My name is Kazukiyo Kumagai, but you can just call me Kaz. I work for the California Department of Public Health, and I lead the Indoor Air Quality Program.

The assignment that I was given was to answer -- probably to answer this question: Does CDPH have the authority on any IAQ issues? So I will try to answer that. And if we do not have the authority, I will share what kind of -- what are the ways that we can help?

And let's see. This is just a regular disclaimer. So what I say today does not reflect what our department says, so please keep that in mind.

For those of you who don't know who we are, actually, we are the oldest IAQ program in this country. We have been established in 1982, and we are mandated to develop guidelines, coordinate efforts, and conduct research to improve indoor air quality in the state.

But today I will basically share with you about the outreach that we're doing or the guidelines that we developed which you can find on our website.

So in the beginning, let me jump in to the question whether we have the authority or not. The answer to this

question is, no, we do not have the authority. I don't know if that's a good thing or not, but at least it gives us some flexibility.

And then probably you may want to know, then, who has the authority? So basically, when it comes to IAQ in a lot of issues, it's the local jurisdictions that has the authority to enforce them. And depending on the jurisdiction, some counties will have environmental health officers, another will have public health officers. In some counties it could be the building inspectors that inspects the buildings or the residences and assess the building conditions.

So next I will share with the ways that we could sort of help or share the way that we are guiding the public, helping the public to give some tools so that when there's a IAQ issue, they have some power to use. So I will talk about two topics. One is on- chemical emissions from building materials or materials used in buildings. Another one is on dampness, mold, and health.

So, first, about the chemical emission, from CDPH we have this -- we developed this standard called 1350. The official title is called Standard Method for the Testing and Evaluation of Volatile Organic Chemicals from Indoor Sources Using Environmental Chamber. The purpose of this standard is, of course, to minimize the VOC exposures in indoors. And there's a lot of sources that you can find in indoors, so it's

not just building materials but also, like, insulation, furniture, et cetera, et cetera, et cetera. So we want to know what kind of chemicals are emitted. And so by understanding that, we could choose the materials that we want to install in the building environment.

This standard has been widely cited in various standards. For example, building standards in ASHRAE, California Green Building Code, IGCC. Also, it's used or cited in building rating systems such as LEED or Well. Also, there's a couple of product manufacturers. They use this or cite this, for example, in productivity standards. There's another one that the industry is trying to push but have not come with a consensus to develop a health-based emission standard. So I would emphasize this is health-based emission standard, not just emission standard itself. And then, also, like flooring or carpets industry, they are citing or using this standard method.

So to go deeper into this Standard Method 1350, it defines how the products are packed, shipped, and documented before they are tested. And then next phase is -- it mentions how to prepare the samples. If it's going to be tested in the chamber, what are the testing conditions in the chamber? And then the chemical -- the way to analyze and calculate the chemicals. Once the chemicals are analyzed, it has a unique table which shows the maximum allowable concentration of

specific chemicals. And then, after that, it has the quality assurance and, at the end, it has a portion that mentions about how the testing reports should be certified by certification bonds.

So like I said, this standard is very unique. Usually, standards only have the testing method itself. But in this standard, it also has the allowable concentrations, the 35 chemicals that you can see on this table. I will not go through, of course, all the chemicals, but if you are interested, you can find the standard on our website.

So then, next, I will change gears to building dampness, mold, and health. About this topic, we have developed a statement that you can see on the screen. And the highlight of this statement is in the gray box which I will enlarge in the next screen. So what it says is, in red, presence of water damage, dampness, visible mold, or mold odor in indoor environments is healthy [sic]. So that's what it basically says. And in a lot of cases like the commercial labs or contractors -- I mean, not contractors; consultants -- they tend to do air sampling when there's a mold issue. But in this statement we are saying we do not recommend measuring microorganisms, especially the airborne ones, because it's very difficult to find a linkage between the health effects and the airborne microbials.

And to explain or to share how this statement had

influence to the public, in 2016, there was a new residential building code adopted, and it defines what substandard buildings are. And in it, it says if you see dampness in habitable rooms or visible mold growth which is determined by a health officer or a code enforcement officer, that building will be declared as substandard housing. So this is sort of new to the state or actually in the whole country since there was no definition to assess dampness and mold in the past.

So suppose you're the public. So you see the statement, you see what's written in the building code, but you may want to know: So who should I ask in my county? And a lot of -- especially the renters were just passed around by various bodies. But to avoid that, we made this database which shows or where you could search whom to contact in your county. So this is what the website looks like. If you scroll down, you could type in the name of the county or city, and then it will give you who to contact, the phone number, and some of them it might have the email address.

We did have difficulty identifying all the contacts in the counties. So we didn't mean to humiliate them, but we just wanted to sort of share with the public that these -- we could not find the contact info in these counties or jurisdictions. So if someone finds them, you know, they could sort of update us, and we could add that information to our database.

Besides that, besides this database, as another product of outreach, we have made a video and which is posted on YouTube which tells you -- which is sort of a guidance to the code enforcers how to assess dampness and mold.

And another one is -- this is under public comment right now, but two decades ago our department was sort of assigned to draft a booklet that the renter should receive when they -- before they sign a contract, which is on mold and moisture for renters in California. So this is still open for public comment until November. So if you're interested, please go to our website.

So this one I already shared, but I think this -- what do you call it? -- this automatic range hood system may be one of the answers to resolve the classical IAQ issue which I mean is the human behavior. So if there's a decision process to reduce IAQ, in a lot of cases the occupants will not choose the right -- make the right decision. So maybe having the option of this kind of system may help. This is just my personal opinion.

Going through this, it looked like we're only doing outreach, but we are doing some research. The stats are here. And going back to the first question: Do we have the authority to improve IAQ? The answer to that is no. Basically, it's done by the locals. And the ways that we could help? I think a lot of work has been already done by

LBL or UCLA, but we could also help as a research group. And based on the findings from the research, we could help develop solutions. And at the end, of course, this is our main purpose, but we could help promote healthy IAQ in California.

So that is it. Thank you.

MR. STRAIT: Thank you. I'd better unmute myself first. As a note for folks that are providing answers into the Q&A, we absolutely appreciate folks that are taking the initiative in the chat box and in the Q&A box too. It helps support learning by everyone. To the extent we are dismissing some of those that are not strictly questions, we mean no disrespect. I'm just trying to keep this very clear and open so that I know what to read to the other presenters. So please don't take it as a slight if I move things over to that other tab.

We do have a couple questions on the technical content here. First, from Yi Tien (ph.). CARB stated that buildings represent 25 percent of California greenhouse gas emissions. And is this all buildings or is it specifically residential buildings? And then they also stated that 10 percent of emissions are associated with natural gas use in buildings. What are the emissions sources of the other 15 percent? This looks like it goes back to the prior presentation by CARB, but I don't want to let that slip by accident.

MS. ZHANG: Yes, sure. This is Zoe of CARB. So it's 25 percent GHG emission account for both commercial and the residential buildings. And that 10 percent emission from natural gas use and the remaining GHG emissions from, let's say, for example, electricity generation used in those buildings, and also there are some other small pieces like, say, waste management, something like that. But 10 percent of GHG in combination is a big chunk of that whole GHG emission from the building sectors.

MR. STRAIT: Excellent.

Cal Smackna (ph.) asks -- and this is relative to the current presentation -- is there any data correlating the presence of mold in sealed envelope dwelling units and verified mechanical ventilation rates?

MR. KUMAGAI: I have to ask myself. I'm not sure. I'm sorry.

MR. STRAIT: We can also email this question to you after the presentation if you want your staff to follow up.

MR. KUMAGAI: Okay, yeah.

MR. STRAIT: Let me copy that over to the notes that I have.

And then that one's not a question. Let me check the chat box, see if there were any questions that came in. I do not see any additional questions for this presentation in particular, so I'm going to go back to some of the general

questions. This is just going to be for all of the panelists.

MR. BOZORGCHAMI: Peter, this Payam. Apologize. If anybody of the attendees would like to raise their hand and ask a question, we're more than welcome to take those too.

MR. STRAIT: Yes. Now that we're at the end of the panelists' presentations -- obviously, if any panelist wants to jump in and ask questions or discuss with any other panelists, please feel free to jump in at any time. And anyone that wants to ask a question that hasn't done so via the either chat or the Q&A, if you want to raise your hand, then I can unmute you so you can ask your question.

Some of the general questions that we have received, I'm just going to go back to the earliest and work through. Amy Dryden (ph.) is asking: Can we discuss physical range hood design factors, so just coverage over burners, that affect capture efficiency? And are there opportunities to have range hoods rated on capture efficiency to inform product selection?

So I'll start off by saying part of the goal that we're having or one of the items of conversation is that we noticed that there is work toward creating an HVI rating program that would allow these to be rated using that CE metric and that that would inform purchasing decisions as well as be available for incentive programs that might operate in certain spaces as well as standards that we might establish

here in the California Energy Commission.

And that actually feeds into the next question I see from Randy Young asking how this would be enforced for alterations given that many homeowners change their own hoods without a building permit. Randy is correct that a building permit is not generally needed to replace an over-the-range hood or over-the-range microwave. So the context at the moment is really focused on a standard for newly constructed buildings for that reason. However, to the extent that we create that capture efficiency requirement and that rating system comes to exist, that can also inform folks looking to replace their equipment in an alteration context and hopefully be the basis of some incentive programs, possibly some other activity that would make it more likely to put those appliances in those spaces.

MR. BOZORGCHAMI: Peter, we have a question from Susan B., I think it is. I apologize. Please state your name and affiliation.

MR. STRAIT: We have to -- there we go.

MS. B.: Hi. Thank you for -- is this the time for public comment? That was my intention.

MR. STRAIT: We're still focusing on questions based on people that want clarification or more information about the presentations to really lay that groundwork first.

MS. B.: Okay. So sorry.

MR. STRAIT: Not a problem at all. We are coming up on 12:00. I was going to ask whether we wanted to move straight into a public commentary after these questions or if we wanted to have a break for some food. I suspect that a lot of folks are probably quietly and secretly eating at their desks at the moment. But for the moment, let's work through the questions on technical content first and then we'll talk about commentary.

Actually, Brett, do you want to talk about the physical design factors that you found influenced capture efficiency?

MR. SINGER: Sure, briefly. We did this -- actually, we looked at this -- it's in a 2012 paper, but it's pretty intuitive, actually. The farther out the range hood comes, the better your capture will be for your front burners. A lot of range hoods cover the back but don't really cover the front burners. And then the more that it has an actual hood design, generally they work better. So some of them were just kind of flat surfaces with a small opening for the exhaust air and so modestly blocks the flow up and then you're trying to suck it through a small surface.

The microwaves, you would think that they would, because of the form factor, they would be very good for the back, and they are. Not very good for the front. But what we what we've come to realize is that the amount of air that they

pull in from those openings at the top of the microwave, the top front, varies, and that helps a little bit with the front of the capture efficiency on the front burners as well.

We see, I would say, more variability in the capture efficiency based on the design elements in the range hoods than we do in the microwaves, just because the microwaves are all much more similar. But there is some very variation in the design.

And then I think Tom Phillips is on the line. Tom likes to talk about things you can do where you bring kind of extra panels out to make an even bigger hood and that certainly works from an engineering perspective. Obviously, the aesthetics may or may not work for everybody, but in short, if it has a hood, it's better. And the larger the hood is, the better it is to kind of temporarily capture the exhaust and suck out from there. Whereas, the more flat it is, then the less opportunity you have. So you can overcome that with higher flow, but it does create a design challenge.

COMMISSIONER McALLISTER: Can I -- Peter, I wanted to step in and ask a couple of clarifying questions here.

MR. STRAIT: Certainly.

COMMISSIONER McALLISTER: So, hey, this is Andrew McAllister. Thanks, Brett, for that. I had a question about this, kind of related to this. Does it help to have makeup air nearby in terms of creating the kinds of airflows that you

need to be more effective, to capture? That's one question. So, you know, if you had an inlet near the exhaust duct work to bring in outdoor air and maybe baffle in there somewhere, would that help with the capture efficiency? That's one.

Then, number two, in your presentation, you made a point I found interesting that induction inherently produced, I think it was, fewer particulates than resistance electric cook tops. And I'm wondering if you have any idea or can speculate about why that might be the case?

MR. SINGER: Well, so the second one is actually relatively easy. And the physical mechanism by which the electric coils produce the ultrafine particles is it's the same mechanism when you turn your furnace on for the first time every year and it stinks. So basically there's accumulated dust and organics that have settled onto the coils or the heat exchanger, and then when you heat those up, they go out into the air, they volatilize, and some fraction of those will then re-condense into ultrafine or very, very tiny particles. So that same thing happens and to a smaller extent every time you turn on your coil or even just if you have a glass top. It's a hot enough surface that you're really going to volatize it if it's on that surface. The induction cooking, by contrast, doesn't get as hot.

There's another issue we haven't talked about at all which I think is actually pretty important. Not my area of

expertise. I've done a little bit of reading. But there's some information available which is safety and fires, so injuries in fires. The susceptibility or the risk of gas, electric coil, and induction burners present very different pictures for fire and injury hazards. Coil are particularly dangerous because we turn off the burner and you remove the pot. The surface remains very hot. So if you drop a towel or something or your young child comes and touches that surface, there's going to be a burn or potentially a fire. Obviously, gas can produce fires too. A lot of cooking fires are from the cooking itself. Induction presents a lower risk for both the injuries and the fires, so it's another advantage for the induction.

On the other question was about --

COMMISSIONER McALLISTER: Makeup air.

MR. SINGER: Yeah, so this concept of creating kind of an air curtain, right? You bring air in from below and then your makeup air comes directly in from below and then, you know, goes right up to the hood. In theory, that can work really well, right? Obviously, if you're standing over it and you're doing a lot of activity, that breaks up the capture of any range hood and would also break up that air curtain.

So the air curtain, there's an engineering benefit to doing it, but then it so much more constrains your design, right, and adds cost to have to, you know, provide that makeup

air directly at that point. So, yes, is it an effective engineering solution? But it is a much more complicated and potentially more expensive solution as well.

COMMISSIONER McALLISTER: All right, thank you.

MR. STRAIT: Do you have any other questions, Commissioner?

COMMISSIONER McALLISTER: No, I think I'm good for now. Let's see. I guess I did want to sort of talk through the rest of the session here. We are after -- we're kind of at lunchtime. I do want to give you and staff and, you know, some of us opportunity to actually have a little bit of a break. But on the other hand, we're not that far away from finishing up since Susan already went. And then the second staff presentation would be the only remaining formal presentation, and then we would have public comment. And so I guess I wanted to just get a read together on whether we should take a break or whether we should just plow on through.

MR. STRAIT: Yeah. The staff presentation really is just to tee up the public comments and kind of provide a little more context, explain a little bit about what the energy commission can do, et cetera. We could do a show of hands for folks that feel we should take a break. That might be a good democratic way to do it.

Before we do that, we just have two more general questions I want to very quickly get out of the way that

should be easy to answer.

COMMISSIONER McALLISTER: Great. Go for it.

MR. STRAIT: First, and this is directed at Marian, and this is the question: What static pressure is associated with the proposed minimum airflow rates or minimum capture efficiency?

MS. GOEBES: Right. The static pressure is -- I believe it's -- sorry, can you repeat the question again, please?

MR. STRAIT: The question is just: What static pressure is associated with the proposed minimum flow rates?

MS. GOEBES: Right. So for the minimum airflow rates, it's .25 -- sorry, it's -- yeah, it's .25 pascals or .1 inch water pressure for the capture efficiency. That's the (indiscernible). It's the static pressure that would be related to whatever the equivalent nominal installed airflow is according to the HVI standard 920. So it's going to vary a bit by product.

MR. STRAIT: Yeah. We also have a general question, and anyone who might know can jump in and answer. Is the capture efficiency metric based on the front burners? I think we might have answered this in --

MS. GOEBES: That's right. The ASTM method is based on the front burners. Sorry, I just misspoke on that. It's 25 pascals or .1 inches water pressure.

MR. STRAIT: Oh, .1?

MS. GOEBES: That's the air -- yes. And then, again, the capture efficiency static pressure is based on the nominal installed flow. And then, yes, the ones that we've been using is -- our results and the ones required in Title 24 proposal is the ASTM which is the front burner testing.

MR. STRAIT: Lastly, I know one more question popped up. Wayne Aldrich (ph.) asks: If there is a proposal to interlock the range controls to the hood fan, that is certainly a concept that we're aware that might be an approach. We would need to know a lot more about the prevalence -- the market availability of that in the U.S. and the associated marginal cost to know if it's something that the Energy Commission could require. But it's certainly something staff is aware is a potential, and so it's part of what we're looking at.

MS. GOEBES: Yeah, I think it's a great idea. I know it's gone into a couple of projects, but that seems to be kind of the best practice but hard to require and code.

I want to say one other thing, too, also, just to build on what Brett had said about the differences in PM 2.5 by fuel type. This is, I think, still a hot topic of debate. It would be great to get some research on this before the next code cycle. The studies that I looked at, I know Professor Zhu had cited a couple papers in her UCLA research paper. And

then one that I found that really did a comparison, it was interesting, there was actually more PM 2.5 by mass under one fuel type, but then more PM 2.5 by number of particles under the other fuel type. So it's not really clear when you say, you know, one produces more, it actually depends on which metric. Again, like, in terms of a micrograms per cubic meter, I believe the gas range produced more. But in terms of a particle -- number of particles -- the electric, I believe, produced more. I might have gotten that switched in terms of which produces -- you know, which have more in terms of the metric, but I do know that one produces more, you know, depending on the metric you're looking at.

MR. STRAIT: Sure.

MR. SINGER: If desired, I could say another word or two about that, but I don't want to --

MR. STRAIT: Oh, certainly.

MR. SINGER: Yeah, so the regulated pollutant is the mass of particulate matter that is measured through a very specific set of equipment. And we use 2.5 as a (indiscernible) point because that's the size of particles that can get down into our lower respiratory system, as opposed to PM 10 which is more up top. There's this separate thing of -- we mentioned the number of particles or ultrafine particles. They generally don't have a lot of mass, but they are considered hazardous because they can move through the

body's defenses in ways that larger particles cannot. The question of whether gas versus electric has -- first of all, neither one of those burners generally produces a lot of PM 2.5 NOx. And then in terms of the number concentration, the number of particles, or the number of ultrafine particles, from what I've seen, generally, gas produces more. And then the electric is very dependent on the conditions. Because, as I mentioned, it's not the electric coil itself; it's stuff that's depositing on the coil or on the surface. So depending on the environment, you could have, you know, widely varying ultrafine particle emissions from the electric. Whereas, the gas itself, the gas burner will itself produce ultrafine particles.

MR. STRAIT: The last question that I have here to answer is from LDELL who just submitted: What is the magnitude of the difference in risk of range or cook top fires injuries and deaths for electric versus gas? Do we want to go to that level of detail on this? Or can you speak to that right away? Can someone speak to that right away, I should ask.

MR. SINGER: Someone put in the chat from the NFPA cooking fire data shows that electric cooking represents about three times more cooking fires than gas cooking, but there are twice as many electric ranges, so that would be -- you know, if we divide 3 by 2 you get 1.5 times many. When I've looked

at this, I wasn't convinced that we have clear enough data on that. You know, a lot of this is sort of observational reported; not controlled study kind of data. So, you know, the fires are an issue with both. And I think there's a separate report on burns. I don't have the data handy, but maybe if we come back after a break I can try to figure that out.

MR. STRAIT: Sure. We're getting a couple more. This is the last one and then I'm going to -- okay, we've got a couple more.

Steve Gatz (ph.) from Whirlpool is asking: Of the range hoods available that exceed the minimum airflow rate required to make the CE requirement, how many of them would also require makeup air due to exceeding the 400 CFM limit? And I'm not sure if we have the ability to answer that question on the --

MS. GOEBES: Right. I was going to say, I think actually all of the range hoods that we looked at in terms of availability, we stopped at 400 CFM because we assumed that they wouldn't be putting in higher than 400 CFM.

MR. STRAIT: Yeah.

MS. GOEBES: You know, range is such a small unit. So I think that the availability and pricing that we showed was for whatever the requirement is, 290 up to 400.

MR. STRAIT: Yeah. And I'll add that we do assume,

for example, if somebody is installing something of that size they know they're going to -- they know when -- that engineer that's responsible for that knows when they're going to start needing makeup air. For example, if an engineer knows they're building a passive house, those are very tight and they, by definition, need makeup air, so some of that is going to come down to that engineer involved.

MS. GOEBES: Right. And then one other thing that I put in the chat is that we had also, on the Statewide CASE, had included -- and this is in the more recent version of the report so I don't know if the stakeholders have seen it -- but there's a requirement -- there's a reference within Title 24, Part 6, where these range hood requirements are laid out, there's a reference to meeting the California Mechanical Code Section 7 requirements. And that spells out minimum volume of air for combustion air. And we did do some quick back of the envelope calculations and found for small units you wouldn't generally be able to put in a gas range, a gas water heater, and a gas furnace because you wouldn't have enough -- you would not meet those requirements in terms of sufficient combustion air, so they are going to come up against that issue as well.

MR. STRAIT: Sure. We've got a couple of kind of related questions. I'm going to ask these two at once.

COMMISSIONER McALLISTER: Peter, let me just --

MR. STRAIT: Go ahead.

COMMISSIONER McALLISTER: I want to just step in and make a proposal just to set expectations here. So I think we should definitely continue as long as these questions are coming in along this theme. This is really nice clarification and I don't want to impede that, so please continue to moderate that. I'm going to propose that once the questions peter out for the panelists that we have online right now, we break, and then we come back after a half an hour, and then you can step in and kind of set up -- do the final presentation to set up the comment period because I think we're anticipating a fair amount of public comment. So I think that would be the most humane path forward, and we can sort of just trigger that when we work through this particular back and forth.

MR. STRAIT: Agreed. I don't think anyone wants --

COMMISSIONER McALLISTER: Does that sound good?

MR. STRAIT: -- a risk of people being hangry when we're taking public commentary.

COMMISSIONER McALLISTER: So hopefully that sounds good and we'll go forward like that. Thanks.

MR. STRAIT: Okay. So this is just -- I'm going to read these two because they're somewhat related. Eric Reynolds asks if there's been research on emissions differences between gas and specifically induction. And then

Denise Grab (ph.) asks: Would smooth top electric stoves or induction stoves present the same fire risk or less than gas and coil electric? Does anyone want to speak to that level of detail of your induction versus the other options?

MR. SINGER: We did just a few measurements of the ultrafine particle emissions from induction and it's in a published paper. It's a very small note. It was maybe, you know, on the order of 10 to 15 of each or something. So that's why I said they appear to. I'm not aware of more systematic or larger research, but I think it's warranted.

In terms of the glass top, I haven't seen research on ultrafine particle emissions from glass top or details on the burner, but the glass top do have that key feature of remaining very hot after you turn it off and remove it. So it's not as sharp as it is to coil because the coil is kind of underneath there, but I think that the basic issue is the same.

MR. STRAIT: No, I certainly remember an old science class where we had to heat and bend glass tubes, and it will stop glowing long before it stops being able to burn you, so I definitely get that.

Ann Harvey (ph.) asks: Can hood fans be triggered by PM concentration rather than motion range controls or humidity, et cetera, since the particulate matter correlates with the need for higher settings on the fan?

MS. GOEBES: I think in concept, yes. And, Brett, or maybe if Mike Moore is on the phone from (indiscernible) Ventures, was that with -- I know there's been an energy -- excuse me, a (indiscernible) technology study that was funded by the DOE looking at smart hoods. Was that triggered by PM 2.5 or was it a different pollutant that triggered the range hood to turn on?

MR. STRAIT: Who was the other person you were asking? Was on the attendees? If they can raise their hand, I can allow them to speak.

MS. GOEBES: Right. Or maybe, Mike Moore, if you're able to just type it in. But I think in general I would say, you know, theoretically, yes. But we did do -- I will say the Statewide CASE Team also looked into, you know, are there products available that we could require that do use some sort of sensor such as a pollutant-based sensor or occupancy. And, you know, we didn't find one based on PM 2.5 -- we looked for that -- or NO2. It's not integrated, although I think that would be feasible. The main reason why we didn't require an automated hood was for the reasons that have sort of been described already today. You know, Brett mentioned that, in general, occupants want control over their range hood, and so we were concerned that without a lot of market use of these types of products -- because we found very few that are available on the market right now. And so these certainly

would be required without much market testing. We were concerned that people would disable them, similar to how a lot of people have disabled their Z ducts or trickle vents by putting cardboard over them because they hate the draft. So we're just concerned about that aspect.

And then, you know, we also received a lot of comments about different proposals for what should be required in terms of the trigger. PM 2.5 occupancy, heat, humidity, just trigger whenever -- you know, switch whenever it's turned on. And we felt that more investigations were needed to understand which of those pathways or approaches would be the best one and, in particular, which would be the most amenable to the user before we could require it in code. So we think this is a great idea for an emerging technology study, but in terms of requiring it for 2022, we just felt like the market wasn't there and the research wasn't there.

MR. SINGER: I can comment briefly. There are very good, robust PM 2.5 sensors. They don't actually see all of the PM 2.5 that's generated from cooking just because of the way that they detect PM 2.5. But they probably could be fairly robust in terms of helping to reduce PM 2.5 exposures if they were, like, tied to a range hood. So it's something that, you know, could be considered.

And then for NO2, it's almost certain that there are no affordable, low-cost sensors. Those PM sensors are

probably $15 or up at bulk scales and probably function well for at least a few years. For the NO2, there's not an affordable sensor that I think has been validated to be reliable, you know, over time and at the concentrations needed.

And then when you start bringing in a sensor-based control, then it, I think, complicates the challenge of how do you require that it lasts for a sufficient period of time? So in commercial buildings in California, for example, we have CO2-based demand control ventilation. And in the code there's a requirement that the sensors should be rated to operate for at least five years. There's not enforcement of that. It turns out that they actually do seem to be much better once the code required that five year. Even though it was just a nominal requirement, we saw the sensors get better. That could just be a correlation not necessarily causation.

But there's still a question of what happens beyond those five years. You install the system. Six, seven years later, does that mean your system now is operating incorrectly because it's based on this detection that is inaccurate? So sensors are great but there does need to be, you know, at least an initial reliability and some requirement for the duration, and then also some kind of maintenance or some on-board diagnostic to determine when the sensors are problematic.

The last thing I'll say, consider your car. Your car obviously works on lots of sensors, but your emission controls in your car require air-fuel ratios, stoichiometric air-fuel ratios, which are detected by an oxygen sensor. Very often you will get an error message that your oxygen sensor is not functioning properly. So there's actually a sensor to check the sensor because that's such a critical control. So I think when we're starting to move -- if we're going to be relying on these kind of sensor-based controls, then we need to have good diagnostics of -- and alert to when the sensors are not functioning properly, and I think we're somewhat far away from that.

MR. KUMAGAI: This is Kaz of CDPH. To add to Brett's comments, I also think that we need to understand the interference to those sensors. For example, we use particulate sensors. Maybe, like, the fan might be going on all the time during wildfire season, so the interference, the duration, there's a couple of things that we need to understand what's specifically linked to the cooking activity.

MR. STRAIT: Thank you. Makes sense.

We have one person had their hand raised but they've put their hand down. So I'm not seeing any more questions. We have one person that's talking about what we allow, and obviously the building code at the moment allows all of these sorts of solutions. It's a question of what should become

part of the minimum code requirements, noting that the code is a minimum standard and, like I said, best practice is somewhat difficult to always integrate as your minimum requirement.

But for now, let's go ahead and move to --

MR. BOZORGCHAMI: Peter, this is Payam. I apologize.

MR. STRAIT: Yes.

MR. BOZORGCHAMI: Mr. Jeffery Smith, you had your hand raised. Did you want to speak, or did you get your question answered?

MR. STRAIT: Oh, he's raised his hand again. Here we go.

MR. SMITH: Hi, I'm Jeffery Smith. I'm a consultant with the World Health Organization here in Geneva so I won't be having lunch now. It's about 9:30, 10 p.m. But my point I wanted to make was made by the last commenter that there would be many false positives in trying to use PM 2.5 low-cost sensors. I'm WHO's low-cost monitoring expert working in community engagement, citizen science. But there would be a lot of false positives and, as the other speaker had said, especially during wildfire seasons or highly polluted environments. The fan would be coming on.

And then, you know, trying to do a demand-controlled ventilation based on PM 2.5 brings a lot of complexities. The users would feel that it's running on too long because we

would program it probably to run for an extra 5 to 10 minutes after the level is no longer detected because it's not detecting the ultrafines or the nanoparticles, and this would become irritating to, let's say, household homeowner users. That's all I had to say. Thanks.

MR. STRAIT: Thank you very much. We're glad to have you as part of our participants.

MR. BOZORGCHAMI: Peter?

MR. STRAIT: Yes.

MR. BOZORGCHAMI: Mike, I think that's Michael Moore --

MR. STRAIT: I believe so.

MR. BOZORGCHAMI: -- raised his hand. Please state your name and your affiliation.

MR. MOORE: Thank you. Yes, this is Mike Moore with Newport, here today representing HVI, and also I worked on the smart range hood project, as Marian mentioned earlier. And we did look at many different environmental sensors as well as pollutant sensors and what's been said about these sensors and their limitations are certainly valid. I just wanted to say that a lot of that can be overcome by the algorithms, the control algorithms that are written to interpret the signals that are being sent by the sensors.

And a lot of the work that we did in that project also looked at user acceptability. We had a very small sample

set, but we did a lot of tests and also got some feedback from those users for multiple scripted scenarios as well as just kind of ad hoc cooking. And so these are -- there are certain challenges to the technology, but there is a lot of promise with it, as well, and nothing that can't be overcome at this point. We're hoping these products will be available in the market in the near future, so look for that DOE report when it's released. Thanks.

MR. STRAIT: Thank you. I notice that Eric Reynolds actually entered into the chat. If we could quickly answer his question? I thought that the chat that we were having, this conversation about these PM 2.5 sensors, was responsive, but they were simply asking what detection technologies at what cost and high production volume could be integrated into induction or electric stoves. It feels like we've already answered their question, but is there anything else people want to say specifically to Eric's question?

Okay, not hearing anything. We are at 12:40. If we take the break now for --

I'm sorry, go ahead. Someone want to speak? I thought I heard something. I'm sorry.

If we want to take a break now, we would be returning at 1:10. Staff would give a short presentation to tee up public commentary, and then we'd basically go through the list based on whoever wants to raise their hand to speak.

So is there anything else folks want to say before we go and get some food?

Not hearing anything. I want to extend my sincere thanks to all participants, any and all that were able to join up to this point but might not be able to make it back after the call or after the break. Otherwise, I'd encourage everyone, you know, go out there, refuel, get your thoughts in order, and we will come back at -- let's actually round up to the quarter. Let's go to 1:15 when we return, and we can start the public process.

And I will meanwhile whip up a quick slide to let people know and I can share my screen so that we can see it.

(Lunch break)

MR. BOZORGCHAMI: Peter, this is Payam. Are we going to start with the raised hands first or are we going to go right to the Q&As?

MR. STRAIT: Let me see what's been typed in. Because, again, we should be getting public comments rather than Q&A. And the ones that are still in the Q&A right now I can dismiss these. These were from previous. I know we saw some things in the comment box. Also, I know we will eventually also have to allow the folks that are call-in only to provide their comments. They'll likely be after we use the raised hands. And I think there is a key combination if you're dialing in by phone that will allow you to raise your

hand.

MR. BOZORGCHAMI: Yes. It's star 6 to mute and unmute yourselves.

MR. STRAIT: Yeah. There is a Robert Gould that mentioned that they have a time limit of 2 p.m., so if we see them back on with their raised hand, we can allow them to speak, kind of get that done. If anyone else has any specific pressing time constraints, let us know. We'll do our best to accommodate, but we don't want that to become an opportunity for people to simply jump the line all told. So until Robert gets back, I'm just going to take them in the order that they're here on the screen. So the first person with a comment is Brady Seals.

I'm going to allow you to speak. Please remember to introduce who you are and, if you're representing anyone, who you're representing for the benefit of our court reporter.

MS. SEALS: Hi, good afternoon. My name is Brady Seals and I work at the Rocky Mountain Institute. I'd like to just start by thanking the Energy Commission for hosting this important workshop and really thank you to the leading researchers and experts for taking the time out of their busy schedules to be here today.

Prior to Rocky Mountain Institute, I worked for 11 years on household energy cook stoves and indoor air pollution globally, and I'm proud to continue this work at RMI.

You know, there really are few things more rewarding than knowing you played a small role in helping a family get access to truly clean and safe cooking for the first time. And I fundamentally believe that if we continue this energy and health leadership in California, we will have many more of those moments.

A stated impetus for this workshop is the advancement in our scientific understanding of the health effects of indoor air pollution, and the evidence is now very clear. For a long time, nitrogen dioxide was used as a proxy for measuring exposure to air pollution but that has changed with new studies showing that exposure to nitrogen dioxide, on its own, even in short doses and at low levels, can lead to a variety of health effects. The latest 2016 Environmental Protection Agency's Integrated Science Assessment or ISA analyzed all the latest literature and found for the first time there is a causal relationship between short-term exposure to NO2 and respiratory effects, and there is a likely causal exposure for long-term exposure and respiratory effects including the development of asthma for which we have the strongest evidence.

So in this 1,000-page document, very comprehensive, something else became clear which is that indoor exposure is critical. Two key points from this ISA I want to mention. Number one is that the evidence shows that indoor exposure to

NO2 may be associated with more health effects than outdoor exposure. And, two, repeated short-term exposure leads to long-term exposure and increases the incidence of asthma.

So in this same study the EPA states that homes with gas stoves have 50 to 400 percent higher concentrations of NO2 than homes with electric stoves. So it seems very clear to me that cooking on a gas stove at home is very likely a source of repeated short-term exposure. And our exposures are not equal. Children are more susceptible to illnesses from air pollution. Their lungs take years to develop. And lower income people and people of color experience many factors which makes them more vulnerable to gas stove pollution, a major one being that already having asthma. In California, one out of seven children have an asthma diagnosis, and in some counties that number is one in four. For these reasons, we can no longer rely on outdoor thresholds that are both outdated and unsafe to model what our indoor air levels should be.

As we heard today from UCLA, CARB, and LBNL, these outdoor standards are not sufficiently protective of health. So we've asked the CASE Team to look at the example of Canada who have reviewed the same health science, including U.S. studies, and revised both their outdoor standard and their indoor guidelines for NO2. The feedback we received was that U.S. standards are preferred. And so in that case, we must

accelerate the development of these U.S. guidelines. Luckily, in California, we have the Air Resources Board, one of the strongest air agencies in the country. And from the presentations we saw today, they are ready to engage in this process. So my ask to the CEC is to please prioritize this work with CARB so we can finally, once and for all, use a U.S. benchmark that are truly protective of health in modeling our ventilation standards.

My next and last ask to you is this: We can and should work to make ventilation as strong as possible, but ventilation only works when it's on. I was going to say that we know from surveys that four to six out of every ten people in California don't use their ventilation, but now, after hearing from Mr. Singer, I realize that number may be closer to eight or nine in ten. And the top reason is that people don't think it's needed, so we need to change that with not just education but clear labels including warning labels. What's really needed is automatic ventilation while cooking like we saw in Japan. If ventilation is what we rely on to safeguard us, it's like the seatbelt to our car, and we can't only use it sometimes. For this reason, I think we need to move towards decarbonizing our homes, and that includes decarbonizing our kitchens. Again, I'll just note the strongest evidence we have for NO2 is repeated short-term exposure leading to long-term exposure.

Thank you very much for the opportunity to comment, and I look forward to your continued leadership on this issue.

MR. STRAIT: Thank you very much for your comments.

I've been asked to confirm which of our panelists are actually back. You know, we all had the same 1:15 time, and all of this is being recorded for everyone's benefit, but if each person that was on the panel could speak up briefly just to let us know that you're back from your break?

COMMISSIONER McALLISTER: Hey, Peter, this is a Commissioner Workshop, of course, so I just wanted to let everybody know I am back as well, so I'm listening in. So thanks, everybody, for your questions.

MR. STRAIT: Excellent. Thank you.

MR. KUMAGAI: Hi, this is Kaz Kumagai and I'm back.

MR. STRAIT: Excellent.

MR. SINGER: Brett Singer. I'm back.

MR. STRAIT: Excellent.

MS. GOEBES: Marian Goebes. I'm also here.

MR. WALKER: This is Brett's colleague, Iain Walker. I am also back.

MR. BOZORGCHAMI: Wonderful. Thank you.

MR. STRAIT: Yeah, thank you very much for that.

Our next commenter is Stephanie Morris. Stephanie, I'm going to -- there you go. Someone else beat me to it.

MS. HOLMES-GEN: This is Bonnie Holmes-Gen. I'm

here, and I believe there are other ARB. I believe that Zoe and Pat will also be --

MS. ZHANG: This is Zoe Zhang.

MS. HOLMES-GEN: Yeah, okay.

MR. STRAIT: Excellent, excellent.

MR. WONG: Yeah, back as well. This is Pat.

MR. BOZORGCHAMI: Go ahead, Ms. Stephanie. Please state your name and your affiliation.

MS. MORRIS: Yes, hi. Can you hear me okay?

MR. STRAIT: Loud and clear.

MS. MORRIS: My name is Stephanie Morris and I'm a volunteer leader with Mothers Out Front Silicon Valley. I live in Campbell, California, and I'm a mother of an 11-year-old whose future I am gravely concerned about. On behalf of Mothers Out Front, a growing grassroots movement of 35,000 mothers and others mobilizing for a livable climate for all children, I thank you for hosting this very important meeting. We commend you for being the first state agency to host a workshop on gas stove pollution and indoor air quality, a big concern of ours, particularly during this time of sheltering in place.

A clear body of evidence demonstrates the damaging health impacts of gas stove pollution. As mothers, we are especially alarmed by the fact that children growing up in homes with gas stoves are 42 percent more likely to experience

symptoms of asthma. We are deeply concerned that lower income communities and communities of color may be at higher risk of health impacts from indoor pollution due to higher asthma rates and building conditions that can result in higher nitrogen dioxide concentrations. And we are alarmed by the fact that indoor air can be so contaminated that the same air, if found outdoors, would exceed legal limits. Why would we set standards for outdoor air quality but neglect the quality of our air indoors where we spend far more time?

The current public health crisis only heightens the urgency to take bold and effective steps to reduce indoor air pollution. Therefore, we urge you to do everything in your power to protect public health by: A, implementing protections and adopting rigorous standards for indoor air quality; and, B, by accelerating a just transition to all-electric buildings.

We have four specific asks of you today. First, we ask you to set ventilation standards that ensure all Californians, including the most sensitive, will be protected from the health risks of gas stove pollution at all times. Ventilation must be automatic as there is evidence that occupants frequently do not use range hoods and powerful enough to reduce nitrogen dioxide pollution below a threshold that protects public health.

Second, we ask that you set a new U.S.-based

guideline for nitrogen dioxide concentrations. Rather than lose valuable time reinventing the wheel, we suggest that you adopt or adapt the excellent nitrogen dioxide standards of Canada or the World Health Organization. Collaborate with CARB and gather input from health and air quality experts, particularly those who have published recent studies on this topic, to ensure that even our most vulnerable communities are protected.

Third, in addition to setting health- and energy-based ventilation standards for new construction, we urge you to adopt requirements for existing buildings as well. Retrofits should comply with new construction requirements so that older buildings will also be cleaner and safer when renovated.

Fourth, we urge you to adopt an all-electric building code starting in 2022. Over 30 California cities or counties have passed reach codes that exceed state standards in response to their communities' concerns about climate, health, and safety. We ourselves have spent countless hours writing to our council members and supervisors, speaking at city council meetings, and writing letters to the editor. You could save us, the city, and the county staff countless valuable hours if you would go ahead and adopt the baseline statewide code requiring that all new construction be all electric. The technology is there. We need you to insist

that we build with it.

Please don't delay. Our children will be living, studying, and working in these buildings for decades to come. We owe it to them to ensure that their homes, schools, and workplaces are as safe and healthy as possible and that they'll have a habitable planet to live on.

Thank you very much for listening to this comment and for your workshop today.

MR. STRAIT: Thank you very much.

Yes? Go ahead. Payam, it sounded like you were going to say something?

MR. BOZORGCHAMI: No, no. I just unmuted Tim Carmichael.

MR. STRAIT: Yes, please state your name and affiliation. Tim re-muted themselves.

MR. CARMICHAEL: Can you hear me now?

MR. STRAIT: Yes, yes, we can.

MR. CARMICHAEL: Good. Good afternoon. I'm Tim Carmichael. I'm with Southern California Gas Company. I wanted to first start by thanking you for the opportunity to comment on the important work being done on improving indoor air quality in California homes. I also want to thank the presenters and the CEC staff for all your work to bring today together and to Commissioner McAllister for hosting a workshop on this important issue.

Several speakers today recommended improved ventilation, new requirements around ventilation, and more efforts to get people to use ventilation systems that they have installed. It was good to hear the experts note that appropriate ventilation improves indoor air quality by removing multiple pollutants and, therefore, has multiple health benefits for Californians.

I want to key on one of the details which I believe was flagged in a slide from Brett Singer, and that's the massive number of existing houses and apartments in California. We have to think about how we can improve ventilation in these pre-2009 homes and apartments. SoCal Gas and other California utilities have a variety of customer programs to advance weatherization and install more efficient appliances in homes. In low-income communities, we have programs to evaluate homes and repair or replace appliances that are not working properly.

As CEC staff member Susan Wilhelm noted in her presentation, ventilation retrofits can have a significant improvement on indoor air quality. We would like to partner with the Energy Commission to look at how we might be able to expand these efforts to improve ventilation in already-built homes and apartments to improve indoor air quality.

There's been a lot of important information discussed during this workshop. SoCal Gas will be providing

additional written comments to the docket.

Thank you, again.

MR. STRAIT: Thank you, Tim.

And as a note, I know I mentioned a staff presentation. We didn't want to get in front of folks with prepared statements. So at the end of this, after we're done taking public commentary, I'll present that material just to help to assist people in providing written comments they might want to submit after the workshop.

So next up is Tom Phillips. Tom, please state your name and your organization, if any.

MR. BOZORGCHAMI: Tom, you're going to have to unmute your name -- yourself, sir.

MR. PHILLIPS: Am I unmuted?

MR. STRAIT: There we go.

MR. PHILLIPS: Okay, hi. Yeah, thanks for hosting this great workshop and addressing this important issue and getting together so many experts. I just wanted to also just briefly summarize some written comments and a quick background summary. I've worked on indoor environmental quality for several decades at the Energy Commission and then the Air Resource Board and developed indoor air quality guidelines for combustion pollutants and then as a volunteer and consultant, and have helped develop indoor air quality guidelines for green building programs and for community-based type

organizations and now including range hood -- best practices for range hoods. So I've closely followed a lot of the key research and have worked on some of the related research as well as legislation.

So with that background, I just wanted to summarize my written comments that I submitted. First off, it's great that we've got the environmental health and IAQ experts together, but it should have been done at the beginning of the process rather than towards the end of the rulemaking process. So hopefully, you know, we will learn that lesson and correct it. Also, we need to bring in input early from the community-based organizations, your environmental justice and disadvantaged community groups.

In terms of technical type comments, in rough order of importance -- I haven't seen the updated revised version of the CASE report, so I see some improvements there, and I've had some discussions with them, so take some of this with a grain of salt, but I mainly want to address a few key things. One is that this is a new standard for industry for manufacturers, for builders, designers, for homeowners, and so on, so there's probably going to be some confusion and inertia, so I think it's really important to do a real aggressive effort on training, on outreach, on getting guidance in the compliance manual. And also getting a lot of the best practice information into CALGreen because it's not

something that, you know, fits into a minimum standard and that can be easily enforced necessarily, but it's other things where we can do much better than Title 24, and CALGreen should have incentivized that.

For example, you know, a lot of hoods probably have better -- we can get better capture efficiency and noise and so on than some of the minimum standards that are being required, so we really need to create the market demand and then the infrastructure to implement that properly because, otherwise, we could have a rash of poorly designed and installed range hoods and nobody will be happy.

Some other key points. I request that you require product labeling of not only the Title 24 requirements on the hoods or exhaust systems for capture efficiency and noise, but then what the product is actually rated at so anybody can go in and see just how good this stove is compared to the standard and create some demand for better products that way.

A few issues that I'm not sure have been addressed yet. One is more specifics on duct design, more details to reduce pressure and flow problems and reduce grease buildup. And so that's pretty commonly done and that's pretty straightforward.

Also, measures to specifically achieve certain depressurization limits to avoid back-drafting, naturally vented combustion appliances. It only takes a couple pascals

to depressurize water heaters, for example, gas water heaters that are naturally ventilated. So I'm not sure that the CMC requirements that were mentioned today will do that, so that needs to be verified and suggested some other approaches that other states have used.

Let's see. Depressurization. There's various other guidance that should be in the training and compliance documents. Also things like hood depth and width and coverage and so on and minimum height that were mentioned earlier today. And there's, you know, best practice guidelines out there. The HVI has guidelines and so on and manufacturers have recommendations. So we need to provide some clear guidance there. And, similarly, guidance for island and peninsula installations because those require higher flows and wider hoods and so on.

And then wall ovens haven't really been mentioned, but they can be a significant emission source, and they haven't been vented for decades, but it is feasible, I think, to interlock them with a nearby range or ceiling exhaust or something. And so that should be considered, especially when, you know, people are using them a lot you can have prolonged periods of pollution indoors.

And I think that's probably about it other than we need to look maybe more carefully at some of the modeling assumptions that went into, say, burner emission rates and

ventilation rates and things like that and make sure we're really addressing some of the worst-case situations as we protect some of the more sensitive populations, especially, say, in lower income households.

And that's it, I guess. Thank you very much.

MR. BOZORGCHAMI: Thank you, Tom.

MR. STRAIT: Thank you very much.

MR. BOZORGCHAMI: Next is Christine James.

MR. STRAIT: Yes.

MR. BOZORGCHAMI: State your name and your affiliation. Thank you. And unmute yourself.

MS. JAMES: Hello, everyone. Thank you so much for the opportunity to speak today. My name is Christine James. I am an allergist immunologist by (indiscernible) representative of Climate Health Now, an organization of health care professionals who recognize climate change as a public health emergency.

In my field, pollutants like nitrogen dioxide are particularly detrimental for my patients. I take care of patients with respiratory diseases like asthma and COPD, and their growing exposure to pollution makes it more difficult for them to manage their diseases on a day-to-day basis. Many of them are very much aware of outdoor air pollutants. However, they are not necessarily aware that indoor pollution from sources such as gas stoves emit pollutants like nitrogen

dioxide or particulate matter 2.5, which can irritate their airways and worsen their control.

For my patients who live in lower income communities in which old gas stoves without ventilation are used frequently, I see increased symptoms like cough, wheezing, and I find myself prescribing more and more inhalers which can be difficult in terms of cost and to their own fatigue in having to keep track of their medications. And these pollutants affect both children and adults. No age group is really spared. And in speaking to the disproportionate burden of these pollutants on African-American and Hispanic communities, this is particularly troubling to me as these are also the groups that face the highest burden of asthma.

I've already seen that my prescriptions can only go so far in terms of treatment. If our patients are constantly exposed to the triggers that worsen their diseases, then we will never manage to get ahead of their health issues. This is why investing our efforts into initiatives such as setting new guidelines for nitrogen dioxide concentrations and new ventilation standards is so important. We need to take a multipronged approach that addresses the long-term management of their disease, which includes acknowledging and addressing the environmental changes we must make. Thank you very much.

MR. STRAIT: Thank you.

MR. BOZORGCHAMI: Thank you, Christine.

Matt Pakucko (indiscernible). Please state your name and your affiliation. And you need to unmute yourself. Sorry.

MS. HIBINO: Hi, can you hear me?

MR. BOZORGCHAMI: Yes.

MS. HIBINO: Actually, my name is Kyoko Hibino. I'm sorry the name was, kind of, wrong.

MR. BOZORGCHAMI: Oh, no worries.

MS. HIBINO: But good afternoon. My name is Kyoko Hibino. I am a cofounder/director of Save Porter Ranch. Save Porter Ranch is a local grassroots organization with mission to protect, preserve, enhance the communities from the impact of gas and oil operation by building community awareness. In 2015, our communities faced worst gas blowout in U.S. history from Southern California Gas Company's Aliso Canyon Gas Storage Facility in San Fernando Valley out of Los Angeles. Twenty-three thousand people evacuated. We are exposed to not only methane gas but chemicals including benzene, formaldehyde, crude oil, and many more toxic chemicals which is not disclosed. Few times we are advised to stay inside of the house to avoid getting oily residues spilled in the community for the effort to stop the blowout which was not successful.

The community, including me, suffered headache, nosebleed, cough, rashes, respiratory issues, heart

palpitation, and many more from the gas blowout. It is known that facility has been leaking and emitting for decades, and it is still leaking. Many residents developed asthma, heart issues, we have a cancer cluster, layer type of cancer, the cancer without family history. It became public health crisis.

Since we exposed to the chemicals constantly for long time living next to the gas facility, now we became sensitive population. We know what gas does to our health as environmental justice communities. Due to higher prevalence of existing conditions such as asthma, we are more vulnerable to harm resulting from pollution exposure once we become exposed.

Outdoor air quality in our neighborhood is not good as long as this canyon facility is operating. It is crucial to be able to breathe clean air at least inside our home for our wellbeing. A recent finding in a study is shocking. The fact that we not only exposed to the gas, chemicals, carcinogens outdoor, but we exposed nitrogen dioxide, carbon monoxide, formaldehyde in our home by cooking on a gas stove burning the same gas we are poisoned and causing two to five times, sometimes hundred times higher than the outdoor air pollution level exceeding EPA's standard outdoor guideline.

Gas stove pollution should not be ignored or downgrade. The problem is we don't have any regulation for

indoor air quality. Indoor air quality is so under-looked in the building and energy code. CEC has a statutory mandate to address indoor air quality when developing its building energy efficiency. We need more stringent guideline for indoor air pollution measurement for carbon monoxide and the nitrogen dioxide. The current standard of 100 PPB of nitrogen dioxide should be updated to current data when the health effect (indiscernible) for asthmatic children with exposure to as little as (indiscernible) PPB of nitrogen dioxide indoors.

CEC should align its ventilation standard with the most up to date and the most protective indoor quality guidelines issued by air quality regulators. CEC should set ventilation standard to reduce nitrogen dioxide pollution (indiscernible) threshold that protect public health for most sensitive population.

Nonetheless, CEC should put regulation to ban gas stove hookup in the new construction for 2022 code cycle. The study says it aimed to move to all-electric new construction until next cycle with the result in additional 3 million tons of carbon emission by 2030. It is not the time to argue whether people like gas stove or not. It is a must to protect public health. Thank you so much.

MR. STRAIT: Thank you very much.

Our next commenter is Kevin Messner. Kevin, please state your name and your affiliation.

MR. MESSNER: Yes, thank you. This is --

MR. STRAIT: Something just happened to cut off Kevin's audio. Let me click this button.

MR. BOZORGCHAMI: Let me -- there we go.

MR. STRAIT: Sorry about that. I don't know what happened.

MR. MESSNER: Okay. No problem. That's all right. Just as I said my name it's, like, cut him off. Yeah.

This is Kevin Messner. I'm with the Association of Home Appliance Manufacturers. We represent manufacturers of range hoods and we also represent manufacturers of air cleaners, I wanted to mention as well.

So I wanted to make just a general statement on this issue largely. We want to be part of the discussion on indoor air quality and venting, and we've done that for many years with air cleaners at CARB, I think, in a very good way for everyone. And then there are some really good discussions that are happening on a technical level at ASHRAE on the proper ventilation for cooking. And again, we're happy to participate in that and want to participate in that and have been actively involved with this well before this workshop.

But I also wanted to speak to one other thing. I'll have another technical (indiscernible) is this -- and I'll just call a spade a spade -- the politicization of this issue or the, I guess, the overlay of this issue or the

electrification advocacy effort and using this issue to scare people -- and I say scare people -- that indoor cooking is unsafe. And 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 set in the U.S. by EPA. And if these levels aren't safe and aren't healthy, then people should be discussing those. But if they are, and the indoor air is within those limits, then let's not state that things are unhealthy. And 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. So we find that very disconcerting, and I wanted to put on the record that if people want to work on this issue, let's work on it. But if there's electrification advocacy efforts, let's divorce that from this.

Now, on the technical thing, also related to this, is the building codes should focus on ASHRAE consensus standards that have been approved. And I did want to mention the example like the nominal installed flow. That has not been approved, and CASE was, I think, recommending to move forward with that, but we would advise against that. We don't want to start using standards that are not approved by ASHRAE 62.2 and insert them in the building codes. That's not a good way to proceed. So I will end with those comments and

appreciate the time.

MR. BOZORGCHAMI: Thank you, Kevin.

Wendy, I'm going to unmute you. And please state your name and your affiliation after you unmute yourself.

MS. RING: Hi. Thanks for the chance to share my thoughts with you today. My name is Wendy Ring. I'm a family doctor with a Master's Degree in Public Health and the director of Climate 911. As a doctor, I spent 30 years taking care of poor people, and much of my work on climate is about air quality and impacts of climate change and fossil fuels. You've heard about numerous studies about the health harms of gas stoves.

I want to tell you a personal story. I produce a podcast called *Cool Solutions* about climate action from the bottom up. Two years ago, I did an episode about Sonoma Clean Powers Program bundling rebates so that people rebuilding after the 2017 fires could have all-electric, zero carbon homes. As part of my background research, I read the study about gas stoves and indoor air pollution done by Lawrence Berkeley National Lab, Stanford Department of Environmental Engineering and San Diego State University of Public Health, and I interviewed Dr. Singer.

In our home, for many years, we had a beautiful antique gas stove with no ventilation hood. And if it had had one, I would have used it rarely. Before reading that study,

I knew that acute exposure to nitrogen dioxide causes and exacerbates childhood asthma and increases hospitalizations and deaths from cardiovascular disease. What I didn't know was that 50 to 70 percent of homes with stoves like ours have indoor nitrogen dioxide levels which regularly exceed national air quality standards, exposing 12 million Californians every year with people cooking and young children having the highest levels of exposure.

During the time that we had that gas stove, as a working single mom, my young son played around my feet as I prepared meals. He developed asthma. When I got married, my husband took over the kitchen. He had a heart attack and developed severe heart failure. Of course, after reading the Berkeley National Lab study, I wasted no time getting rid of that old stove and buying an induction range.

But most of the people with unventilated gas stoves are not like me. They're more like my low-income patients who live crowded into small apartments where cooking is more frequent, concentrations of indoor pollutants are much higher, people are much closer to the kitchen, and more have asthma and risk factors for cardiovascular disease. Environmental injustice occurs indoors as well as out, and a just solution must include retrofits of existing housing.

So what is the solution? Better range hoods are not enough since 70 to 85 percent of those who have them don't use

them regularly. Education by a builder doesn't last beyond a change of occupants. And if I, with all my degrees, didn't know how to keep my family safe, I doubt more education is the answer.

The most effective measures to protect public health don't rely on changing individual behavior. John Snow, the father of public health, didn't tell people not to drink from the pump contaminated with cholera. He removed the handle. Automatic ventilation of gas stoves doesn't remove the whole handle. Vented gas stoves would still pump pollutants into outdoor air causing 12,000 deaths in California every year. Fugitive natural gas emissions with global warming power 80 times greater than carbon dioxide would still drive climate change, worsening air quality indoors and out.

Stanford researchers estimate that each day of wildfire smoke causes 1,000 elder deaths and 1600 emergency room visits, and that's not all from being outdoors. In northern California where we don't have central air conditioning and in low-income households around the state without central air, particulate levels with windows closed are 64 to 80 percent of outdoor levels. With AQIs in the red and purple zone, that's really dirty indoor air. Add a heat wave, and if we open our windows to cool off as I longed to do the other night, indoor particulates rise to 80 to 95 percent of outdoor levels.

To protect indoor air quality, we must stop burning natural gas. You can't separate causation from happenstance with a sample size of two. I'll never know if my son got asthma or my husband lost half his heart function because of our gas stove, but if you take the handle off the pump by requiring that new homes have electric stoves and eliminate the exposure my family experienced for 12 million Californians, you'll save tens of thousands of lives every year. You've made great strides toward homes that run on clean electricity. Now, please make sure they're equipped with clean electric appliances. Thank you.

MR. BOZORGCHAMI: Thank you, Wendy.

Lauren Cullum, I'll unmute you. Please state your name and affiliation, too, also. Sorry about that.

MS. CULLUM: Yeah, you're fine. Hi, this is Lauren Cullum with Sierra Club California representing 13 local chapters --

MR. BOZORGCHAMI: Sorry about that. That was me. Sorry.

MS. CULLUM: Can you hear me?

MR. BOZORGCHAMI: Yes. Apologize.

MS. CULLUM: Did you get my name and affiliation at least?

MR. BOZORGCHAMI: Would you please state it one more time? I'm sorry.

MS. CULLUM: You're fine. Lauren Cullum, a policy advocate with Sierra Club California. And I'm here representing 13 local chapters in California and half a million members and supporters throughout the state. I'd like to thank you for putting together this workshop on what we see as an incredibly important issue, especially right now as Californians are spending more time inside their homes to protect themselves from COVID-19 infection and hazardous air pollution caused by wildfires. And I'd like to thank you for including voices today from the public health community and air quality regulators and experts.

As we know, gas appliances produce a range of air pollutants linked to both acute and chronic health effects, including respiratory and cardiovascular illness and premature death. And stoves and ovens are the gas appliances that contribute most to indoor air pollution since they are not typically vented outdoors like water heaters and furnaces. So we really appreciate the agencies working together and with experts to address this issue and strongly support the proposal to set ventilation standards that specifically address the air pollution from gas stoves. These new standards are well supported by scientific evidence and vital to protecting public health.

As a panelist noted today -- but I think it's worth bringing up again -- research shows that after cooking for one

hour with a gas stove and oven, peak levels of nitrogen dioxide inside the kitchen are so high that they exceed both state and national outdoor acute air quality standards. Studies have found that 12 million Californians are regularly exposed to levels of nitrogen dioxide from gas stoves that would violate the national ambient air quality standards. This means that the air quality inside our homes is so bad that it would be illegal if measured outside. And inhaling these levels of NO2 is extremely dangerous. Evidence has shown that gas stoves and nitrogen dioxide pollution can increase the risk of asthma, especially for children and the elderly.

And there is an equity component here that must be prioritized. Low-income communities and communities of color are at high risk of harm from the NO2 pollution associated with gas stoves. Housing characteristics that are more common in low-income communities such as smaller unit sizes and inadequate ventilation contribute to higher levels of NO2 pollution in homes when a gas stove is used. Add that onto the fact that these communities are already experiencing cumulative impacts of systemic environmental injustice and racism. The poor indoor air quality exacerbates the health and economic burden these communities are already facing, so we urge the CEC to take this into consideration when developing building standards, including ventilation

standards.

Last point I'd like to make is that we agree that more stringent ventilation standards are needed to protect the health of Californians, but we also learned today that range hoods aren't being used routinely and they aren't a perfect fix to the problem, especially considering most people still prefer to cook on the front burners. Switching to electric cooking appliances such as induction stoves would help ensure that we are truly eliminating the pollutants from fuel combustion during cooking.

Building electrification is a solution to not only reducing greenhouse gas emissions but also protecting the health of Californians, especially the most vulnerable and sensitive populations. Phasing out polluting gas appliances to highly efficient electric alternatives for heating and cooking will lower NOx pollution, present 350 premature deaths annually, and produce $3.5 billion in annual health benefits.

To conclude, we urge the CEC to ensure that ventilation standards reflect the latest science and are sufficiently stringent to protect the public health of all Californians. And we also urge the CEC to continue to work with air quality and health experts and agencies like CARB to design building standards that prioritize the health and safety of Californians such as an all-electric baseline for the 2022 code. Thank you so much.

MR. BOZORGCHAMI: Thank you, Lauren. And sorry about the mess up.

MR. STRAIT: We did it to the other guy; now we've got to do it to everyone, right?

MR. BOZORGCHAMI: Mr. Williams, I'm going to unmute you.

MR. WILLIAMS: Okay. I'm Ted Williams. Can you hear me okay?

MR. BOZORGCHAMI: Perfect. Thank you, sir.

MR. WILLIAMS: I'm Ted Williams. I'm senior director of codes and standards for the American Gas Association. I have been working in indoor air quality related to gas appliances, and I've been in gas appliances in particular over 34 years, including I've worked with the U.S. Consumer Products Safety Commission both on vented gas heaters, space heaters, and also gas cooking products. At the time of the gas cooking product looking at carbon monoxide specifically. I also am a member of the ASHRAE Standard 62.2. I've been a member of that organization since the year 2000.

We're coming at this issue from outside looking in. We're a national organization looking at California policy. We rely on our members such as SoCal Gas to argue or advocate its interests within the state of California. However, I am struck by the discussion today particularly by health effects and how insular this discussion is with respect to certain

data and studies that don't agree with what's going on federally.

We monitor regularly the activities of Federal Interagency Committee on Indoor Air Quality. That's some 26 federal agencies chaired by U.S. EPA Indoor Air Quality Program. They do not see the same relationship with these products, these cooking products, and emissions of nitrogen dioxide or other products of combustion and health effects. They are monitoring this work. They are aware of the RMI and the Sierra Club, their reporting activities. However, there is no active effort among the federal agencies to look at further issues, particularly with respect to asthma. (Indiscernible) participant in the asthma, whether or not it's put on by the CIAQ, various regions of the U.S., that look at all manner of asthma triggers and sensitive populations, low-income populations, and asthma rates are -- contribute over various sources.

In no case have I seen any recent accounting for combustion emissions from unvented appliances and specifically in this case food products as being associated with those kinds of issues. And so, you know, I'm not going to preach from Washington, D.C., where AGA is located, on what California should do, but I think that California certainly should be looking at what's going on federally. And if RMI and Sierra Club believe that this is such an issue for

national health, they ought to be advocating to those federal agencies for control, in particular, the U.S. Consumer Products Safety Commission.

Now, there have been some correspondence with CPSC regarding that they should maybe look at gas ranges, but there has been no proposal for a Consumer Protection Act regulation of those products, and that's a serious shortcoming in trying to protect public health, particularly coming from organizations who are first and foremost interested in electrification for climate concerns, who have (indiscernible) onto indoor air quality as being sort of a soft spot in the issue of the correct use of natural gas.

I'll also mention that we have some serious concerns with the source of a lot of these calculations with respect to increased fatality rates, as going back to the emission rates from the appliances themselves and the statements about NO2, in particular, exceeding national outdoor standards and the source rates that produce those estimates. And Dr. Singer's work is the specific source of that kind of information and that commentary is (indiscernible) various Lawrence Berkeley National Laboratory public releases.

Our concern, frankly, is that we don't have a robust view of what is coming out of -- and the combustion emissions from these products and that has really been published in a transparent way. And to that need, to develop that

information, we're currently putting together a program which should being in the month of October to test gas ranges operating both on natural gas and propane and looking at five pollutants: carbon monoxide; nitrogen dioxide; PM, ultrafines, and 2.5; formaldehyde; and, as an addition, krinolin (ph.) as a potential species of volatile organic compounds which we don't expect to find but, nevertheless, the (indiscernible) to take a look and see if we find anything.

This program is being put together with funding from American Gas Association, the Association of Home Appliance Manufacturers, who Mr. Messner, an earlier commenter, represents. We're looking at three additional industry associations for potential funding. We've contacted three testing laboratories to bid on the work. The project -- the criteria for those bidders is to either have a status as nationally recognized testing laboratories as recognized by the U.S. Department of Commerce, or industry experience in testing these products, or both qualifications. Nevertheless, we're awaiting bids from those organizations.

And essentially what we're doing and planning to do in the scope of work is to continue the tests on the operation of residential gas cooking appliances operating both on natural gas and propane to measure those five compounds. We're also looking at doing whatever we can within the scope of the program and the sampling (indiscernible) to develop air

free data, that is, data on combustion emissions absent the (indiscernible). And so that is more directly supportive of modeling work that can be done to look at different configurations of kitchens and occupancies, sizes, and the like.

So, anyway, that work is going to go ahead. Our target is to complete that work by the end of the calendar year, to publish that work. AGA has a separate effort underway and discussions with National Institute of Standards and Technology, NIST, to design and develop a modeling program that's all through different configurations of (indiscernible) to essentially -- sort of the same scenarios but (indiscernible) in terms of adjacent occupancies, rooms and the occupancy.

So anyway, that's where we're going on this, and we hope to find at least for the industry for the first time to develop the information and data that's publicly available and transparent for the use of other researchers for decision making. But we see that as the first step and -- first principles for looking at this issue in terms of exposures because in our review, for example, the Sierra Club report which covers a number of issues -- the Sierra Club (indiscernible) UCLA School of Public Health looked at it. And essentially 210 sources cited in the report referring to health effects and emissions related to indoor air quality.

And in all those -- we've reviewed them all. We find that we keep coming back to this issue about source rates for what the gas appliance actually produces. And we think that is where the industry needs to be having (indiscernible).

So anyway, that concludes my comments, and I appreciate the opportunity -- the Commission to put this workshop together and to give us a chance to hear our background and work. Thank you.

MR. BOZORGCHAMI: Thank you, Mr. Williams.

Next, Mr. Robert Gould. Please state your name and your affiliation. Yeah, I think you have to unmute yourself. There you go. Thank you.

MR. GOULD: Okay. I'm Dr. Robert Gould representing San Francisco Bay Physicians for Social Responsibility. Just as a little background, after working as a pathologist for over 30 years at Kaiser Hospital in San Jose, since 2012 I've been an associate adjunct professor in the Department of Obstetrics, Gynecology, and Reproductive Sciences at the UCSF School of Medicine, working as a collaborator with our program on reproductive health and the environment. I've been on the National Board of Physicians for Social Responsibility since 1993, serving twice as the president in 2003 and 2014.

PSR, for which I'm speaking today, represents thousands of health professionals who speak for the health of our patients and communities who are increasingly impacted by

the current and unfolding public and environmental health impacts of global warming and the clearly connected issues of air pollution. Because of this, we support increased electrification of our infrastructure provided by renewable and sustainable non-nuclear sources as replacement for natural gas in support of climate, respiratory, and cardiovascular health.

As such, I'd like to thank the California Energy Commission for holding this important workshop on gas stoves and indoor air quality and setting an example for other states to deal with these largely hidden public and individual health issues. We at PSR hope you'll be able to follow this session with concrete actions to address a variety of issues I'll be addressing in brief, reinforced by the excellent presentations by many experts earlier today.

Beyond protecting climate health, our desire to replace the use of gas stoves stems from the fact that the combustion of gas inside our homes produces harmful indoor air pollutants, specifically nitrogen dioxide, carbon monoxide, nitric oxide, formaldehyde, acetaldehyde, and ultrafine particles. According to the EPA's 2016 Integrated Science Assessment on Nitrogen Dioxide, there was strengthening evidence of NO2's effect on the body, including a causal relationship between short-term exposure to NO2 and respiratory effects, with the EPA also finding that long-term

exposure to NO2 is likely to have a causal relationship regarding respiratory effects. These odorless and undetectable gas combustion pollutants are associated with acute and chronic respiratory diseases such as asthma, with African-American and Hispanic children with asthma likely being the most disproportionately burdened by indoor air pollution from gas stoves. Inequity of such impacts is reinforced by housing conditions whereby factors including smaller unit size, greater occupant density, and often inadequate stove top ventilation contribute to elevated concentrations of NO2 in lower income multifamily buildings.

And of course we need to consider the heightened impacts of outdoor air pollution suffered by these same multi-burdened communities.

Of additional note regarding impacts on children, a 2013 meta-analysis looking at the association between gas stoves and childhood asthma found children in homes with gas stoves having a 42 percent increased risk of experiencing asthma symptoms or current asthma, a 24 percent increased risk of ever being diagnosed with asthma by a doctor or lifetime asthma, and an overall 32 percent increased risk of both current and lifetime asthma.

As well, a 2018 study published in the *Medical Journal of Australia* indicate that for 12.3 percent of asthma sufferers age 14 or younger in Australia, the condition was

triggered or worsened by exposure to gas stoves.

Given this increasing evidence of inequitably distributed harms caused by gas stoves, SF Bay PSR believes that while we move in California to increase sustainable and renewable electrification that CEC has a duty to set ventilation standards to ensure that our most sensitive populations are adequately protected, particularly at times when COVID and our extended fire seasons have kept so many indoors.

Our current standards of 100 parts per billion of NO2 is ten years old and needs to be reexamined in light of more current findings in the scientific literature. Resetting standards that could provide -- that could be more health protective of our population in line with new global standards such as developed by Health Canada could involve collaboration with CARB, including solicited impact from experts who have recently published on these issues.

In closing, I want to strongly second the very thoughtful comments expanding on the issues of public health and equity offered by my friend and colleague, Dr. Wendy Ring. Thank you for your time.

MR. BOZORGCHAMI: Thank you, Doctor.

We have one comment that came in to the questions and answers, and that's by -- I believe it's Michael Moore. And it says: CEC Staff, ASHRAE 62.2 has makeup air

requirements that are currently adopted by the state. There doesn't seem to be much awareness of this on the call.

So I believe there is, Mike, and I think Jeff Miller on our team has been overseeing and looking into that and is part of the ASHRAE 62.2 that's been dealing with that.

With that, there's one more presentation that is going to be given. That's going to be given by Peter Strait again. That is --

MR. STRAIT: Yeah.

MR. BOZORGCHAMI: Go ahead, Peter.

MR. STRAIT: Yeah. Before we do that, I'm going to go through the call-in only users to make sure none of them have comments they need to make. I can see the last three digits of each phone number, so I'm going to read the last three and then unmute that person and ask if they have a comment they would like to make. And you can simply say, no, that you're willing to move on or if you have something you want to put on the record.

So the first in this list is a phone number ending in 301. Do you wish to make a comment on the record? You are currently unmuted, I think. I'm sorry, I've enabled you to unmute. You can still unmute yourself.

Okay, I'm not hearing anything from that person. They are not unmuting.

So I will move to the next person. This is phone

number ending in 681. You are able to unmute yourself if you have a comment you would like to make.

All right, not hearing anything.

Someone is asking do they push something. I believe there is a key code for unmuting your line.

MR. BOZORGCHAMI: Star 6.

MR. STRAIT: Star 6.

And also, there is some police activity in the area, so there is a small chance that I might need to leave the call in a hurry. Otherwise, I do have a presentation to make to tee up the written comments that we want people to submit to us after the workshop.

Next up is a phone number ending in 066. If you have a comment you would like to make, then please unmute yourself.

(No response)

MR. STRAIT: All right. Next up is 009. If you have a comment to make, please unmute yourself.

UNIDENTIFIED: Thank you. No comment.

MR. STRAIT: Thank you.

Next up is a phone number ending in 472. I'm unmuting now. If you would like to make a comment, please unmute yourself.

(No response)

MR. STRAIT: Next up is phone number ending in 591.

I'm allowing you to talk. If you have a comment to make, please unmute yourself.

(No response)

MR. STRAIT: Last is phone number ending in 600. I'm allowing you to speak. You can unmute yourself if you'd like to make a comment.

(No response)

MR. STRAIT: And actually, following that, there is someone identified as Call-In User 1. I'm going to also allow that person to talk. If you have a comment to make, please unmute yourself.

MR. STRAIT: Hearing nothing.

I'm going to share my screen so I can give a closing presentation, so just one moment here. Here we go. Share that.

So this is a quick presentation on the California Energy Commission's authority and options for setting improved standards, and this is given to benefit you in providing additional written comments following the workshop. First, the Energy Commission's authority to adopt standards is in statute. We are authorized and directed to reduce the wasteful, uneconomic, inefficient, or unnecessary consumption of energy by, among other measures, adopting building energy efficiency standards. And that's located in Public Resources Code Section 25402, if anyone is curious to crack the books on

that.

Two principles. First, energy spent on ventilation is necessary. That is absolutely a necessary use of energy. However, energy spent on ineffectual ventilation would be wasteful and inefficient. So that is where we find it within our purview to adopt standards.

Updating ventilation standards to an appropriate, necessary level falls within this authority and is consistent with statutory direction to consider indoor air quality impacts as a part of developing building standards.

The options that we consider for us to have an easy time adopting them need to fall within this authority. There are possible ways to do other things, but that is the easiest path for making an improvement.

In terms of criteria, staff has identified the following criteria as potentially shaping any proposed standard:

First, we want to know what rating metric that standard should be based on, meaning potentially basing it on the new ASTM capture efficiency metric or using an appropriate cubic foot per minute of airflow as a proxy for pollutant removal. That is a portion of information that is readily available and has already been certified to.

Second, we want to look at cooking energy source, meaning potentially making a distinction a standard we set

between natural gas and electric cooking equipment.

Dwelling size is a factor, meaning that we know we would like to or possibly appropriate to make a distinction between either single-family or multifamily dwellings or based on a square footage threshold.

And last is sone, which is potentially increasing the stringency of the maximum sound level requirements in addition to capture ability to address these concerns about usage of installed hoods.

To give a little more detail on each, first, for the rating metric, staff is aware that the amount of air moved by a kitchen range hood fan is only one factor in its ability to capture cooking pollutants and combustion gases.

ASTM Standard E3087-18 establishes a capture efficiency metric that takes a holistic look at the effectiveness of over-the-range devices in capturing and removing pollutants. This metric is proposed for inclusion in ASHRAE 62.2, though has not yet been added to that standard or adopted, as Kevin Messner mentioned, by some other broader industry standards. Most equipment has not yet been rated using this new metric as a result.

Staff is interested in hearing from stakeholders whether this new metric should be used as the basis for an updated standard, if, instead, a proxy CFM value should be used, or if both options should be available for installers

and for manufacturers.

The second criteria of energy source. We know that cooking released fine particulate matter that is known to be harmful to public health, as well as volatile organic compounds. Cooking using a combustion fuel such as natural gas additionally releases nitrogen oxides that can have immediate impacts such as triggering asthma in sensitive individual, as well as some quantity of carbon monoxide and other pollutants.

Staff need to consider a standard stringent enough to address all pollutants. However, a standard sufficient to protect against combustion byproducts may be overly stringent if it's applied to electric-only cooking.

Staff are therefore interested in hearing from stakeholders -- and I think we've gotten some of that feedback from the commenters that commented verbally -- on whether a separate, lower standard should be available for dwellings that do not provide natural gas or other combustion fuels for cooking.

The third criteria is size. The concentration of indoor pollution resulting from cooking relates directly to the total air volume of the indoor space. As noted in studies and by commenters, multifamily dwellings, which tend on average to be smaller than detached single-family dwellings, are therefore more likely to have more impacted indoor air

quality after what would otherwise be an identical cooking event.

Staff therefore needs to consider a standard stringent enough to address the worst case, these multifamily dwellings. However, a standard sufficient to protect smaller multifamily dwellings may be overly stringent if applied to larger single-family dwellings.

For this reason, staff is interested in hearing from stakeholders whether a separate lower standard should be available for single-family residences or for dwellings above a minimum size. And we've already seen in one presentation how we can break down different thresholds for different sizes of dwelling.

Finally, there's sone. Staff is aware of research indicating that occupants can be inconsistent in the use of kitchen range hoods even if the equipment is available. One factor in the choice to use or not use an available hood is the noise the hood generates during operation.

The current requirement to be rated at no more than three sone at quote/unquote "working speed" is roughly equivalent to 43 decibels. And I want to say this is very roughly. But, nonetheless, that would be half the level of noise of an operating refrigerator or dishwasher. However, fans will be much noisier at higher speeds such as those needed to ventilate a large -- for example, a three burner

plus over -- cooking event.

Staff, for this reason, is interested in hearing from stakeholders whether a more stringent sone limit should be considered alongside these improvements in capture efficiency.

Lastly, the action items that staff are taking away from this meeting and the action item for you. First, staff will follow up on this hearing by preparing a draft proposal to update kitchen ventilation and range hood requirements with consideration of the public record resulting from this hearing.

Staff will also host a future workshop to present that resulting draft regulatory language to stakeholders and the public.

And staff are hosting separate, additional workshops on the other proposed amendments to the California Energy Code, including workshops on other -- in improving our consideration of electric technologies and building approaches.

The action item for stakeholders and members of the public are asked to submit any additional written comments by October 16th, 2020.

And so I'm going to open it up for any final questions that folks have, but I'm going to do so with this information on the screen about how to submit your comments.

The easiest way to submit written comments to us is by submitting them to the 2022 pre-rulemaking docket which can be found at this link. And this is also where these presentations will be made available. If need be, you can also email comments to staff and ask us to assist you in docketing them, and we can do so. Note that comments directly to staff without direction to docket it will not be automatically docketed because we can't risk that someone is not intending for something to be a part of the permanent record or shared with the public, so we will need that clarification in order to do so.

With that, I will continue sharing my screen, but I will open the participants tab. Mike, I see you have your hand up again, so I'm going to allow you to speak.

MR. MOORE: Thank you, Peter, yes. Thank you for the opportunity to comment. And HVI certainly does want to provide comments on this, and I see the deadline is October 16th. Part of being prepared for the comments or for providing informed comments would be getting that final case report. And I'm just wondering what the timing is for that so that the industry, you know, has time to review the case report and then provide comments on that? And if that will be within this window that we're looking at here and provide sufficient time?

MR. STRAIT: Payam, can you answer that? I'm

actually going to have to mute myself and hop off the call, though I will leave my screen sharing this information.

MR. BOZORGCHAMI: Sure. Mike, give me one second. I'm going to bring up --

MS. GOEBES: I can actually -- this is Marian. I can speak to that.

MR. BOZORGCHAMI: Yeah.

MS. GOEBES: So my understanding is that the draft -- I'm sorry, the final CASE report deadline is October 14th. But, Mike, you bring up a good point that that doesn't leave much time between when comments are -- when the comment deadline would be until after the CASE report is published, so we can try and bump that up a little bit to give you a little bit more time between when comments would be accepted. We were trying to allow a little bit of time, as well, between the workshop and when that final CASE report would be published so that any comments provided during this workshop could also be incorporated in the final CASE report.

MR. BOZORGCHAMI: Yeah. So this is Payam again. Mike and others, there will be another workshop where we will be presenting the final stance where the Energy Commission is going to be proposing for the 2022, okay? And that one is, right now, currently scheduled for October 29th. So the CASE report will be posted a few days -- I shouldn't say a few days, excuse me -- a few weeks or if not earlier on our docket

so that you could review the final CASE report prior to the actual 2022 pre-rulemaking proposal. So this workshop is regarding the scientific information you've seen so far from Brett Singer from LBNL, Dr. Zhu from UCLA, and Marian Goebes. So if you have comments on those, you're more than welcome -- or anything you've heard today -- you're more than welcome to submit your comment by the 16th. But the final CASE report will be posted way before the second staff -- or, actually, the first staff workshop for the 2022 pre-rulemaking. This is a commissioner workshop. So there's two different workshops for this topic.

COMMISSIONER McALLISTER: I wanted to just jump in real quick and resolve -- there have been a couple questions coming in. And at the beginning we said, and the notice actually says, that comments would be due on the 12th. And so here's it's -- we've pushed that back by four days, evidently, so that's fine. If there is an issue of this sequential nature and people really want to kind of get comments on the CASE report in sooner rather than later, they should feel free to submit them any time. But there will be multiple opportunities for comments with ample time to have a look at the CASE report. So just wanted -- so, for now, it's the 16th, not the 12th, and I think we should put out a notice that lets the world know that. And then, afterwards, you'll see future opportunities for the workshop on the 6th and then

following later in October with the proposal itself. So just clarifying.

MR. MOORE: Thank you.

MR. BOZORGCHAMI: Thank you, Commissioner. Thank you, Mike. Since Peter is out right now dealing with other matters, any other comments or concerns?

MS. GOEBES: I did want to say, though, just -- this is Marian again in response to Mike's comment about not seeing the final CASE report. We have not made significant changes to the other measures, either the central ventilation duct ceiling measure which was not discussed today or the (indiscernible). You know, those are both pretty much the same as what you saw before. And then in terms of the range hood proposal, the meat of it is what you saw today. I called out a couple of the other, you know, minor things such as the reference to the CMC Section 7. There's also some new guidance in terms of requirements for builders to provide more education to the building resident or the owner to give to the building resident in the case of a multifamily unit. But what you saw today was, I think, the meat of it. So please do respond to that in terms of your comments.

MR. BOZORGCHAMI: Yes. And the sooner we get the comments, the better we are. Thank you.

Tom Phillips had a question, raised his hand. I'll unmute you. Please state your name and affiliation again.

MR. PHILLIPS: Hi, Tom Phillips, Healthy Building Research, Davis, California. In my written comments I also raised some issues about preventing contamination of outdoor air inlets for ventilation systems, especially, say, central ventilation systems for multifamily. There's a lot of field and modeling research to show that there can be significant contamination from outdoor sources such as nearby busy roadways and commercial businesses and industrial sources, construction sources, urban canyons. And then also there's guidelines out there from, I think, Seattle, New York. And then ASHRAE has some procedures to address these issues. And some of those guidelines and standards are based also on preventing vandalism and contamination from chemical, biological, or radiological releases and attacks. So there's a lot of fairly simple prevention that can be done in locating the air intakes away from roadways, upwind of sources, and also making them inaccessible to vandals and things like that. So that's another key way to cut the pollution off at the source in your building. And it's going to be a while before we get all electric cars and clean up all our other outdoor sources and wildfires, so in the meantime we need to think about the outdoor source control as well. Thank you.

MR. BOZORGCHAMI: Thank you, Tom, for the comment.

Anyone else?

MR. BOZORGCHAMI: I believe, with that, I think

we're done for the day if there's no more questions or comments or concerns that's being raised.

Commissioner, would you like to say a few words?

COMMISSIONER McALLISTER: Yeah. I just wanted to thank you, Payam, Peter, the whole team, for putting together and orchestrating a really productive day. I think this has really been terrific. I mean, the substance and the collegiality and lots of strong opinions. And, you know, this is a really important issue and I know there are just a lot of -- just a lot of urgency to moving forward on this. And the towns we live in, you know, really are sort of traumatic in a lot of ways and so I really appreciate people taking time in their day thinking about this, putting together comments, basing them on the most cogent arguments possible, and just the quality of this discussion I'm really heartened by. And thanks for our sister agencies for being -- particularly ARB -- for being with us today. And really looking forward to reading everybody's comments.

But thanks, you all, for sticking with us until mid-afternoon. And with that, I think we have a lot to work with and looking forward to a really robust populated docket with all of your comments coming in and beyond that, future interactions with all of you as we dial in the proposal and move forward with the overall 2022 code update. So with that, I want to just say thanks again and take good care. And we

are adjourned.

MR. BOZORGCHAMI: Thank you. Thank you, Commissioner. And also, please take note of the docket and please submit your comments, as Commissioner McAllister said, by October 16th. Thank you so much.

(Whereupon, the Workshop was concluded at 5:26 p.m.)

CERTIFICATE OF REPORTER

I do hereby certify that the testimony in the foregoing hearing was taken at the time and place therein stated; that the testimony of said witnesses were reported by me, a certified electronic court reporter and a disinterested person, and was under my supervision thereafter transcribed into typewriting.

And I further certify that I am not of counsel or attorney for either or any of the parties to said hearing nor in any way interested in the outcome of the cause named in said caption.

IN WITNESS WHEREOF, I have hereunto set my hand this 14th day of October, 2020.

_____

E. HICKS

CERTIFICATE OF TRANSCRIBER

I do hereby certify that the testimony in the foregoing hearing was taken at the time and place therein stated; that the testimony of said witnesses were transcribed by me, a certified transcriber and a disinterested person, and was under my supervision thereafter transcribed into typewriting.

And I further certify that I am not of counsel or attorney for either or any of the parties to said hearing nor in any way interested in the outcome of the cause named in said caption.

I certify that the foregoing is a correct transcript, to the best of my ability, from the electronic sound recording of the proceedings in the above-entitled matter.

Angie Duray

October 14, 2020

ANGIE DURAY