MEETING

STATE OF CALIFORNIA

AIR RESOURCES BOARD

JOE SERNA, JR. BUILDING

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

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APPEARANCES

BOARD MEMBERS

Ms. Mary Nichols, Chairperson

Dr. John Balmes

Ms. Sandra Berg

Ms. Doreene D'Adamo

Mr. Hector De La Torre

Mr. Ronald Loveridge

Dr. Daniel Sperling

Supervisor Ken Yeager

STAFF

Mr. James Goldstene, Executive Officer

Mr. Tom Cackette, Chief Deputy Executive Officer

Mr. Richard Corey, Deputy Executive Officer

Ms. Lynn Terry, Deputy Executive Officer

ALSO PRESENT

Dr. Marc Fischer, Lawrence Berkeley National Laboratory

Dr. Mark Jacobson, Stanford University

Dr. Alan Lloyd, International Council on Clean Transportation

Dr. V. Ramanathan, UC San Diego, Scripps Institution of Oceanography

Dr. Erika Sasser, United States Environmental Protection Agency

Mr. Durwood Zaelke, Institute for Governance and Sustainable Development

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PROCEEDINGS

CHAIRPERSON NICHOLS: Good morning, ladies and gentlemen. And welcome to visitors, as well as to our distinguished panel of presenters this morning.

The May 24th, 2012, public meeting of the Air Resources Board will come to order.

We customarily begin our meeting with the Pledge of Allegiance to the flag. It's been moved this morning for photo purposes I guess, but it's right up here. So would you all please stand with me.

(Thereupon the Pledge of Allegiance was Recited in unison.)

CHAIRPERSON NICHOLS: All right. The Clerk will please call the roll.

BOARD CLERK MORENCY: Dr. Balmes?

BOARD MEMBER BALMES: Here.

BOARD CLERK MORENCY: Ms. Berg?

BOARD MEMBER BERG: Here.

BOARD CLERK MORENCY: Ms. D'Adamo?

BOARD MEMBER D'ADAMO: Here.

BOARD CLERK MORENCY: Mr. De La Torre?

BOARD MEMBER DE LA TORRE: Here.

BOARD CLERK MORENCY: Mayor Loveridge?

Mrs. Riordan?

Supervisor Roberts?

BOARD MEMBER ROBERTS: Here.

BOARD CLERK MORENCY: Dr. Sherriffs?

Professor Sperling?

BOARD MEMBER SPERLING: Here.

BOARD CLERK MORENCY: Supervisor Yeager?

BOARD MEMBER YEAGER: Here.

BOARD CLERK MORENCY: Chairman Nichols?

CHAIRPERSON NICHOLS: Here.

BOARD CLERK MORENCY: Madam Chairman, we have a quorum.

CHAIRPERSON NICHOLS: Thank you very much.

On behalf of all of us, I want to send our greetings and best wishes to Barbara Riordan, who had planned to be with us this morning, but her husband had a health setback so she wasn't able to join us today. She'll be watching us on video. We all send her our very best.

I have a couple of announcements, which are mandatory here.

First of all, that anyone who wants to speak on this or any other item is asked to fill out a request to speak card. They're available in the lobby outside the auditorium, and it needs to be turned into the Clerk.

The Board will impose a three-minute time limit for this particular hearing on members of the public who

want to add something to this discussion. This is not an item that we're going to be taking action. We're not planning to take action this morning on the informational item, although we do have one consent item I guess on the schedule.

And I'm also supposed to point out the emergency exits for the room for safety reasons. In the event of a fire alarm, we are required to evacuate this room and to go down the stairs and out of the building and to wait until the all-clear signal resumes. So I think that's it for official announcements.

The first item on our agenda is a consent item number 12-3-1, the public hearing to consider approval of the proposed South Coast State Implementation Plan provision for the Federal Lead Standard. And because this one has been in such good shape, I think we believe that it could go on consent.

But I need to ask the Clerk if there have been any witnesses who have asked to testify. There have not.

Are there any Board members who want to see this item removed from the consent calendar?

Seeing none, then we have Resolution 12-20 before us. And we have to ask for a motion and a second.

BOARD MEMBER BERG: Move adoption.

BOARD MEMBER BALMES: Second

CHAIRPERSON NICHOLS: Second. All in favor, please say aye.

(Ayes)

CHAIRPERSON NICHOLS: Great. Thank you very much.

The second item on the agenda is a special presentation on short-lived climate pollutants. This is an especially timely meeting, considering last week's announcement that the G-8 countries have joined the Climate and Clean Air Coalition for reducing short-lived climate pollutant. This is a Coalition that was initiated by the United States and five other countries earlier this year.

California has been regulating these pollutants as part of our air quality and climate programs for some time, and I'm really looking forward to hearing from our panel of experts to give us the latest findings and to update us on policy efforts for dealing with these pollutants.

California's focus on reducing the health impacts of particulate pollution has had a wonderful added benefit of reducing black carbon, which although we didn't know it at the time we started or at least we weren't focused on this, is a very important short-lived climate pollutant. ARB has also adopted several measures to reduce other

short-lived climate pollutants, including hydroflourocarbons and methane, which are becoming increasingly interesting as we focus in on issues of distributed generation and agricultural waste management and so forth. I think that the stars are aligning, if you will, towards trying to develop a more wholistic policy about dealing with methane.

Before we hear from our speakers, our Executive Officer James Goldstene is going to begin a brief staff presentation to set the stage and then he's going to introduce our distinguished panel.

So Mr. Goldstene.

(Thereupon an overhead presentation was presented as follows.)

EXECUTIVE OFFICER GOLDSTENE: Thank you, Chairman Nichols. I'll take just a few minutes to introduce the subject of short-lived climate pollutants and our actions to reduce these pollutants.

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EXECUTIVE OFFICER GOLDSTENE: Carbon dioxide is the main climate pollutant, remains in the atmosphere for about a century. Since carbon dioxide presents the majority of greenhouse gas emissions and is long-lived, reducing carbon dioxide emissions is essential to meeting the climate program goals.

The benefit of reducing carbon dioxide will take time to be realized, because this pollutant persists so long in the atmosphere.

In contrast, the short-lived climate pollutants have a relatively short lifetime in the atmosphere, from a few days to a few decades. As a result, near-term actions to reduce these pollutants can have a more immediate impact. These short-lived pollutants include black carbon, the black soot portion of health-damaging PM2.5, methane, and hydroflourocarbons, industrial chemicals used in refrigeration and air conditioning.

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EXECUTIVE OFFICER GOLDSTENE: From a global perspective, the category of short-lived climate pollutants is responsible for 37 percent of total climate pollutant emissions. Black carbon alone is 23 percent of the total. Methane is another 13 percent. And hydroflourocarbons are one percent, but growing fast.

This compares to carbon dioxide at 56 percent of the total nitrous oxide, another long-lived pollutant that contributes about seven percent.

The primary difference in California is the greater proportion of carbon dioxide emissions and relatively less black carbon and methane.

Some of this difference is the result of

California's air quality programs. Also, developing countries have a different mix of sources such as coal cookstoves or a large number of rice paddies that contribute relatively more black carbon and methane.

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EXECUTIVE OFFICER GOLDSTENE: This slide highlights actions that we take in California that reduce emissions of black carbon, methane, and hydroflourocarbon. Over the past decade, the cleanup of diesel engines has been the focus of our efforts to meet air quality standards and reduce community toxics risk. The Board's recent advanced clean cars rulemaking will further reduce fine particulate emissions, and California state law has phased out the majority of agricultural burning.

The Board has also put into place limits on emissions of hydroflourocarbons from large commercial refrigerant systems, car air conditioners, and smaller sources.

Methane sources that have been reduced include landfills and oil and gas operations. In addition, the Board's Cap and Trade Program includes an offset protocol to recognize methane reductions from dairies.

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EXECUTIVE OFFICER GOLDSTENE: California's programs to reduce transportation emissions have

dramatically improved air quality and have had the added benefit of reducing black carbon. By 2020, there will be an 80 percent reduction from 1990 levels. This is being accomplished over a 30-year time period of growing fuel consumption.

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EXECUTIVE OFFICER GOLDSTENE: The phase-out of rice, straw, and other agricultural burning in California has led to an 80 to 90 percent reduction in the number of acres burned. In addition, restrictions on residential burning are in place in most urban areas. These measures have been important contributors to progress in meeting air quality standards for particulate pollution.

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EXECUTIVE OFFICER GOLDSTENE: As hydroflourocarbons replace ozone-depleting substances banned under the Montreal protocol, emissions are expected to double by 2020.

ARB regulations require repair of leaks in large commercial refrigeration systems, such as those found in supermarkets. And ARB's advanced clean car regulations incentivizes alternatives to current refrigerants in automobile air conditioning. These efforts should achieve a 25 percent reduction in California's total hydroflourocarbon emissions by 2020. Also, all major

California utilities participate in a U.S. EPA program to collect and destroy refrigerants when residential appliances are recycled.

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EXECUTIVE OFFICER GOLDSTENE: While methane has been regulated in California for many years, there are still opportunities to do more. Landfill gas emissions are regulated to reduce both ozone-forming emissions and greenhouse gases.

Livestock emissions are currently the largest source of methane in California and provide some of the greatest opportunities for further reductions.

In 2011, the Board adopted an offset protocol for dairy projects under the Cap and Trade Program.

We are also planning a 2013 rulemaking to reduce methane emissions from oil and gas production.

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EXECUTIVE OFFICER GOLDSTENE: Although California continues to reduce ozone pollution generated by in-state source, global background ozone is increasing. While methane reacts too slowly in the atmosphere to effect the formation of regional ozone, on a global scale, it contributes to the formation of background ozone. As air quality standards tighten and regional ozone controls are implemented in California's non-attainment areas, global

background ozone will become an increasingly important factor.

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EXECUTIVE OFFICER GOLDSTENE: Now let me introduce our six speakers.

Professor Mark Jacobson of Stanford University will talk about short-lived climate pollutants on a global scale. For more than a decade, Dr. Jacobson has examined the effects of particles on global warming, cloud formation, and local weather. His early studies were the first to look quantitatively at the various ways black carbon can impact climate.

Professor Ramanathan of U.C. San Diego's Scripps Institution of Oceanography will provide an overview of his California studies. Dr. Ramanathan has been one of the foremost scientists bringing the need for action on short-lived climate pollutants to the attention of policy makers and leads a multi-campus team investigating this issue for ARB.

Dr. Mark Fischer, a staff scientist with Lawrence Berkeley National Laboratory, will present his research findings on methane emissions in California. As part of ongoing work for ARB and the California Energy Commission, Dr. Fischer and his colleagues are quantifying the sources of California's greenhouse gas emissions and their trends

over time.

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EXECUTIVE OFFICER GOLDSTENE: Dr. Erika Sasser, a Senior Policy Advisor for the U.S. Environmental Protection Agency, will talk about the EPA's report to Congress on black carbon and recent developments within the International Climate and Clean Air Coalition for reducing short-lived climate pollutants. Her work focuses on the design of policies and strategies that integrate public health and environmental goals with climate mitigation efforts.

Durwood Zaelke is the Founder and President of the Institute for Governance and Sustainable Development and the Director of International Network for Environmental Compliance and Enforcement. His presentation will address the growth in hydroflourocarbons and an international effort to use the Montreal Protocol to reduce and eliminate them by 2050.

And finally, Dr. Alan Lloyd, our former Chairman and Cal/EPA Secretary, will conclude the presentations with a policy perspective on reducing short-lived climate pollutants. Dr. Lloyd is the President of the International Council on Clean Transportation, and his work focuses on the viable future of advanced technology and renewable fuels, with attention to urban air quality

issues and global warming.

Dr. Jacobson is the first speaker. So without any questions, we can just ask him to begin.

CHAIRPERSON NICHOLS: Thank you.

DR. JACOBSON: Thank you for the introduction and thank you for having this meeting.

So my goal is to talk about the global impacts of black carbon and a little bit about brown carbon, which goes along with black carbon, but also methane, the effects on climate and atmosphere composition and health.

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DR. JACOBSON: So I want to start with what are the overall impacts of black carbon. Why do we care about it?

There is a health impact that we all know about. But on the worldwide scale, about one-and-a-half million or more people die prematurely from exposure to soot, which is the main component of which is black carbon and the three main types of soot. There is open biomass burning soot, biofuel burning soot, and fossil fuel. And these death rates are primarily the result of biofuel and fossil file. The biofuel burning causes six to seven times more deaths because most of these deaths be in developing countries. But still, in the U.S. overall air pollution causes about 50- to 100,000 deaths from air

pollution, and a portion of this is due to soot as well.

We think it's the second leading cause of global warming, black carbon is, behind carbon dioxide and methane.

There are greater impacts of black carbon over the Arctic than over lower latitudes. So even if -- there is not a lot of black carbon emitted over the Arctic, except from aircraft and ships that go nearby. But because the black carbon travels long distances when it gets over the Arctic, there are several feedbacks that cause it to have a strong impact, along with greenhouse gases have a similar stronger impact over the Arctic.

It's very short lived in the atmosphere. Its main removal mechanism is wet removal or rain out. It gets removed by rain. Because it's short-lived, we think its control can reduce warming quickly. And in fact, this will be very important when we try to think about saving the Arctic see ice, which is expected to disappear otherwise in 20 to 30 years. And methane as well is relatively short-lived, although it's longer lived than black carbon.

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DR. JACOBSON: So methane, which we think is the third leading cause of global warming, is important because also it has greater climate impacts over the

Arctic than other latitudes. And its moderate lifetime, eight to twelve years, allows it -- if we control that, we can also help to save the Arctic.

The reason we want to save the Arctic from melting entirely is because the Arctic is reflective. And if it disappears, we uncover the dark ocean below. And that allows more sunlight to get absorbed by the ocean, triggering a faster warming of the ocean and subsequently the air and the global climate. So in fact, some people think there could be a tipping point if the Arctic ice disappears, you will get this rapid warming of the entire climate faster than currently is occurring.

And methane also produces ozone globally. And natural gas is a source -- a major source of methane. And I'm going to talk about that later in this presentation. But that's really growing, especially in shale gas through hydrofracking, which is -- there is a big potential growth of hydrofracking in California, which I think is relative.

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DR. JACOBSON: So I just want to spend a couple minutes saying why does black carbon have a strong climate effect and how does it impact the climate?

It has impacts on the clear sky within clouds and on surfaces. So in the clear sky, it's a strong absorber of solar radiation. Greenhouse gases absorb red radiation

primarily. The black carbon is important because it absorbs sunlight directly. The black carbon heats up and radiates heat radiation to the air around it.

And, in fact, it's -- well, then when it gets coated by other pollutants that form a shell around it, the particle is larger, so more sunlight gets refracked into the particle that is eventually absorbed by the black carbon. So, in fact, on a global scale, the coating due to the aging of black carbon in the atmosphere can double the heating rate of black carbon.

So black carbon per unit mass causes over a million times more warming than carbon dioxide, but there is a lot more carbon dioxide in the air, which is why carbon dioxide is more important.

But in terms of clouds, black carbon can effect clouds in several ways. It gets incorporated inside of cloud drops. When that happened, the water in the cloud drop actually is a shell already. So you get this enhanced focus, optical focusing that heats the cloud drops directly. So you can start to burn off the cloud just by incorporating black carbon in the cloud drops. I'll show in a picture of this in a minute.

Also, the black carbon between cloud drops can heat the cloud because there's light bouncing around in the cloud, and eventually that gets absorbed by the black

carbon. And that causes the cloud to warm and burn off as well.

Also, black carbon below and within a cloud heats the air. So that what's called stabilizes the air below the cloud, making it harder for heat and moisture to get to the cloud, preventing the cloud from growing further. It diminishes the clouds by stabilizing the air.

When black carbon deposits on surfaces, such as snow and sea ice in particular, it darkens the snow and sea ice and can cause that snow and sea ice to melt. This is one of several reasons actually black carbon has a stronger effect over the Arctic and over snow at high latitudes in Canada and Russia and Europe than it will at lower latitudes.

Another impact is when black carbon is in the air over snow, it not only absorbs sunlight coming down, but also reflective light coming up. There's two light sources that we absorb. As opposed to over a dark surface, it's only absorbing the sunlight coming down.

Finally, when it heats the air and the ground, black carbon causes more water to evaporate either from the ocean or soil and moisture. And that water vapors is a greenhouse gas itself. So also a positive feedback due to water vapor warming.

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DR. JACOBSON: This is a plot showing how the Arctic sea ice is declining. And it's declining rapidly. It's actually expected to decline even faster. As you get close to the Arctic, almost totally disappearing. The whole thing is expected to collapse the Arctic sea ice. So this is estimated to occur in the next 20 to 30 years or so.

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DR. JACOBSON: In terms of the clouds, I mentioned that black carbon causes clouds to disappear if it's incorporated in them.

This is a satellite image over southeast Asia, China which indicates all that brown stuff is pollution. And the clouds have disappeared effectively in the presence of the pollution and when we started off-shore where the pollution is starting to end.

So you can actually just burn off clouds over a large region. This allows sunlight to pour to the surface, causing rapid heating of the surface. So this is one of the strong feedbacks of black carbon.

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DR. JACOBSON: Globally, as I mentioned, there are three main sources of black carbon. There's open biomass burning which causes about 37 percent of the source of black carbon. And then there's road transport

and non-road transport. Well, there's fossil fuels which include transportation, other types of fossil fuels and also residential biofuels.

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DR. JACOBSON: I just want to show a couple slides how black carbon is distributed. This indicates the emissions of all sources of black carbon in South America and Africa, a lot of it is on biomass burning. In southeast Asian, a lot of it is biofuels. And in Europe and in the U.S., a lot of it is fossil fuels. In Asia, you also have fossil fuel as well.

But as the black carbon ages and transports in the atmosphere and spreads globally, including over the Arctic and hemispherically, so we get a larger spread of the actual concentrations in the air compared with the emissions. And then some of it gets absorbed in clouds or a lot of eventually -- in fact, all of it gets absorbed in clouds because that's the main removal mechanism. About 90 percent is removed by precipitation.

This shows a distribution of these clouds and the concentration of the black carbon in the clouds. And then finally it gets positive to snow and sea ice. And there, it can reduce the reflectivity the snow and/or sea ice that has climate effects.

Now, there's brown carbon -- I mentioned also is

basically dark matter that can absorb. It's not so strongly absorbing as black carbon, but it can absorb really strongly in the UV wave lengths and visible wave lengths, in particular, but it may be causing a significant portion of warming as well, but not quite so much as black carbon. And it's distributed globally and has some of the similar sources.

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DR. JACOBSON: In terms of health effects, this shows that a lot of the health effects, including mortality, are over southeast Asia, but there are mortalities in the U.S., California, and worldwide. Over a million and a half people are estimated to die from soot from fossil fuel and biofuel carbon, about 200,000 are from fossil fuels and the rest from biofuels.

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DR. JACOBSON: In terms of the global temperature response of black carbon versus carbon dioxide, this shows the 100-year climate effect of eliminating black carbon versus CO2 versus methane. And CO2 --

CHAIRPERSON NICHOLS: That is a ten-minute warning. You've got a couple more minutes.

DR. JACOBSON: CO2 causes a greater overall impact. If you control it, it reduces temperatures more, but black carbon is the fastest method of slowing global

warming. And methane is the second fastest, and CO2 is the third fastest but most important.

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DR. JACOBSON: There are another perspective. Total net absorbed global warming is on the right. That's due to greenhouse gases, plus fossil fuels plus biofuel soot warming, and a little bit of urban heat island but offset by cooling. So the point here is if you clean up just the aerosol particles, mostly which cause cooling, you actually will increase warming rapidly, because most of the global warming that's occurring today is being masked by cooling particles.

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DR. JACOBSON: And I'm almost done here. This shows greenhouse gas footprint of methane from shale gas -- methane carbon dioxide from shale gas, conventional goods versus coal over a 10 to 20-year time frame. Most people look at the 100-year time frame. But because the sea ice is disappearing rapidly, the 20-year time frame is probably most relevant.

And shale gas which is mined by the hydrofracking where you take water and put chemicals in to break up the rock, that causes more leakage. So these are each low and high estimates of the total potential CO2 equivalent emissions. Over the 20 year time frame, shale gas causes

slightly more warming overall due to the combination of CO2 plus methane than coal, either deep mine or surface mine coal and conventional gas is also on par.

I think these are really important to consider, because there is -- I think California has the largest shale oil reserve in the country. And so there's probably I think a lot of gas companies are -- and oil companies are buying up water rights to plan fracking in the near future.

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DR. JACOBSON: Just to summarize, soot and methane are the second and third leading cause of global warming, respectively. Kills over a million and a half people world wide per year and methane increases ozone, which causes global warming impacts. Temperature increases due to both air pollution. And controlling soot and methane may be the only methods of preventing the loss of the Arctic sea ice and tipping points to more rapid global warming.

Thank you very much.

CHAIRPERSON NICHOLS: Thank you.

Does anybody have a question right now? If not, we'll probably hold them until the end. Okay. Thanks.

MR. RAMANATHAN: I first want to thank CARB for organizing this hearing. And I want to thank CARB for

inviting me. I'm truly honored to be here.

As Mark already informed you, about 40 percent of the total global warming is from the short-lived climate pollutants.

One of the most powerful argument in favor of getting rid of these pollutants is there are practical and proven ways to do so. And an equally powerful argument is that when you do mitigate the emissions, they are gone within few weeks, instead of 10, 15 years.

So the question is: Do we see this? Has any region in the planet done this? That's the focus of our investigation funded by CARB. It's a multi-institutional investigation by UCSD, Berkeley, and Pacific National Lab.

So what you are after is: What has California done in terms of getting rid of these pollutants and do we see their effects?

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MR. RAMANATHAN: So I wanted to review some of the data we have collected in modeling studies. So these are some of the topics. Instead of spending my ten minutes on describing these topics, I go to the results. And honestly, this is the first of its kind study done on this problem. And so far, this whole short-lived pollutants is we have done this in our models. Believe us, if you get it, it will be gone. But now we have data

to show it is has really happened in California.

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MR. RAMANATHAN: So we have over 50 to 60 stations around California, both urban and remote locations. And what you see is that black carbon concentrations have reduced dramatically statewide both in urban and rural locations. This is not because of some accident or meteorology. This is because of the policies California has enforced to get rid of the soot.

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MR. RAMANATHAN: So the next one -- the top one curve shows, so the black curve is actual concentrations of black carbon in rural locations. So you're not sniffing the plumes behind trucks. And we also show both in red and green curves the trends in the emissions. Those are your policies. Reduce those emissions, and we see the effects in the atmosphere. So this is exactly the point of short-lived pollutants. You take an action today; they are gone tomorrow. So are the climate effects.

And the bottom one shows the trends in various pollutants. They're not changing. It's just black carbon, which is changing. So this would remove the sceptics from the system. Natural change is happening. Okay.

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MR. RAMANATHAN: So the next one is the Berkeley study. That's part of our team. This is in urban locations. Over 60 stations. Goes back to 1960s. You see how dramatically there was a drop. And starting from 80s to 2000, another 50 percent drop. Okay.

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MR. RAMANATHAN: So going on, the other major discovery of this study -- this is again a teamwork -- is there are two types of pollutants in soot. One is black carbon. That's the black stuff you see coming out of flames. The second one is when you have forest fires in the smoldering phase, you see whitish smoke; right? We think of them as cooling ourselves. This study shows they're not as white as we thought them to be. They are very brownish. And we show they're absorbing as much as 20 to 30 percent of black carbon in all of the wavelengths where the sunlight is maximum. So there is heating going on, which the global ICCP models are not aware of. My distinguished colleague here, he's one of the few guys who uses modeling studies and some observations.

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MR. RAMANATHAN: So the next one is the same study -- independent study by the Berkeley group, sniffing flames, biomass smoke in San Luis Obispo, 150 fires. And

their data confirms what we found at San Diego using satellite data and surface report.

So I think this really places this brown carbon. What does this really mean? Models suggest this white stuff that's coming out has got organic carbon is really a cooling agent. We're finding not really so, which means even open fires and forest fires may be contributing to warming of the region.

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MR. RAMANATHAN: So next going on, we also have excellent study looking at single particle phase to see where this is coming from. So we know in southern California it's primarily fossil fuel and so-called secondary fossil fuels. The so-called organics coming out as particles and going on to northern California. Biomass burning takes a little bit of a larger role.

So we really pinned this all the way from an individual particle the a state finder of facts.

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MR. RAMANATHAN: Next comes to the what is happening in terms of climate change over California because of this reduction. Okay.

The first step is to calculate -- to estimate the actual energy trapped. So on like approaches done in other studies, our study's primarily observation focused.

We take satellite observations. We take NASA's network over California and also California network and calculate what's called forcing. I'm not going to get into that. It's basically how much energy is trapped by this soot over California.

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MR. RAMANATHAN: So the top one shows this unit might not make sense to you. Soon I talk to you in metrics, which is more understandable to general public. But just shows that our retrieval of the heating of black carbon over California is sort of consistent with what the emission inventory suggest in terms of spacial pattern. And, you know, for example, the units go from over one to two-and-a-half. The energy trapped by carbon dioxide is on the order of one-and-a-half. So it's sort of locally a large effect.

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MR. RAMANATHAN: So here we summarize this energy heating trapped over California by the soot and this other brown carbon. And these would have been at least twice as large 20 years ago. So thanks to our policies, we already cut down this force. But what does that mean to our temperatures and precipitation? So that's the next part of our study.

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MR. RAMANATHAN: So this is again one of the first studies which are being done. This is part of our team. They developed a model which focus over California few kilometers to scale, and we are just in the process of simulating this.

First, we have to bring the models to agree with what we are seeing from the data. That process is not completed. By summer, we hope to have some estimates of how have the temperatures and precipitation over California have responded to this reduction in pollution by us. And what it mean to the rest of U.S., because these pollutants travel from west to east. So our reduction of black carbon would cut down the climate work force over rest of the U.S. So those are some issues we are after.

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MR. RAMANATHAN: So let me summarize our major studies. And I want to say again this study is the first of its kind to evaluate an observationally-based regional scale effects of soot.

Again, I want to emphasize, as a scientist, there are very few places on the planet where you can do such work. The reason is you need unquestionable observations of the air. You know, you institute policies. You know how much you've reduced, but you don't know what the

effects are, unless you measure them.

So that's why I'm so grateful to the state for collecting this data. I have nothing to do with this collection of data. We are just using it.

So what did we find? So, statewide, black carbon is being reduced by as much as 50 percent since the 1980s. Okay. We still adding up various numbers how much of it is due to diesel and how much it is cutting down open biomass. Also issues we will go after in the next three to four months.

And then the second is this study, so far we have model studies such as Dr. Jacobson suggests about the brown carbon. I think this is the first time we have actual numbers of this forcing directly from measurement. So we know brown carbon adds a significant amount. So this is a new thing we have to factor in.

And then I give the statewide reduction of the forcing. This means to a scientist what per square foot means, but we soon convert into metrics, which policy makers can understand. So that's coming soon.

I, again, want to conclude California's successful policies for reducing black carbon. Our intent was not on climate, more as health effects, that's the beauty of the short-lived climate pollutants. They have such huge health effects. In fact, we can do it for

health effects just like California did. And climate could be the beneficial in the sense you push down the so-called dangerous climate warming at least by 30 to 40 years down the road. So you get time to effectively cut down other pollutants. Thank you so much.

CHAIRPERSON NICHOLS: Thank you. We'll continue on.

MR. FISCHER: Good morning. Thank you, Chairwoman Nichols and Director Croes, for inviting me.

Also many thanks to Nizad Motolibe (phonetic) who helped organize all of this.

I'm going to say a little bit about air quality and climate-forcing from methane, and in particular, the increases in methane from the pre-industrial era have had an effect on not only background ozone but also climate that it is now something that California is taking seriously in terms of estimation and control in the future. And say something about our work to quantify the emissions today, and then conclude with some of the benefits for mitigating methane.

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MR. FISCHER: The first slide shows some global trends in methane. The top graph shows methane from 1000 to 2000 AD. And you see in the advent of the industrial era a very sharp rise in methane. This is most likely due

to human activity. There isn't any known natural process that would lead to this.

The recent trends through blue detailed measurements performed by the National Oceanographic and Atmosphere Administration show that rise through the 70s and 80s, but a leveling in the more recent decades. And this is unlikely to be something to do with atmospheric removal of methane. It is -- which is primarily by OH radicals but more likely due to a leveling in emissions globally.

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MR. FISCHER: The next slide shows a depiction of the estimated anthropogenic emissions globally. You can see Dr. Jacobson said something about this before. Large emissions from enteric transformation, which translated to the everyone is livestock breathing out methane as part of their metabolic cycle. And then additional processes, emissions from agriculture, from fossil fuel, production and use, and from the disposal of solid waste.

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MR. FISCHER: Turning now to the air quality impact of methane globally, methane is a hydrocarbon which, like more complex and more reactive hydrocarbons, if interest present in the atmosphere long enough will react with sunlight and NOx to form ozone. Methane has a

long lifetime in the atmosphere. Translated, that means it doesn't react very quickly compared to other VOC, but there is enough of it in the atmosphere it's responsible for about the half of the global background ozone.

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MR. FISCHER: If we look at ozone concentrations over time, they are in general increasing globally from the pre-industrial. There are significant variations with space, different places on the planet see different increases. But these are not directly attributable to variations in methane. It is sort of producing a smooth background on ozone in some sense.

However, if methane and other species change over time, ozone is expected to change with those species. And there are predictions that by 2100 if controls on species are not put in place that ozone could exceed and the background levels could exceed air quality standards. So this is of some interest and concern.

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MR. FISCHER: Conversely, the next slide shows what would happen if we started to mitigate -- that is, reduce methane emissions. It would have a benefit in terms of reducing the background levels of ozone. And the figure shows a model depiction of what might be expected. And I think this is going to be a subject of future

research to verify. As Ram pointed out, there is no substitute for measurement.

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MR. FISCHER: Now turning to California's methane budget, I'm showing a depiction of greenhouse gas emissions as a function of time from the CARB inventory. It shows that with a very truncated scale, CO2 is by far the largest source of greenhouse gas, but methane, nitrous oxide, and high global warming potential or hydroflourocarbon gases are also present in that mix.

Something this slide does not show but I want to emphasize is that the emissions of these non-CO2 species are very uncertain. And this is something that is very hard to get one's hand around, because there are sources that are not readily metered in the same way that fossil fuel emissions are metered. Things like the amount of methane coming from livestock or landfills is something that one can measure in specific locations, but it is not trivial to extrapolate to a large geographic region.

And the National Research Council conducted a sort of overview study of the uncertainties in these emissions and found that they could often be as high as 100 percent, particularly in the developing world. But I think some of these same problems apply here.

I'm now going to say something about using the

atmosphere effectively as a test tube to look at what the likely emissions from California are.

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MR. RAMANATHAN: And what we're doing here is combining measurements of methane, both here in California -- the figure in the top center shows a tower south of Sacramento where we're taking these measurements. And then both global background methane, which is important for this problem, a meteorological model which give us the representation of how sensitive the measurements are to emissions from California, a model for the emissions which has to have spacial resolution that allows us to identify the regions that our towers are studying in a specific matter. And then what's labeled here Bayesian emissions. And for everyone, what that should mean is essentially a statistical comparison between the measurements and the model prediction of what we ought to see that allows us to say something about whether the emission model is correct or needs to be modified. And the result of that combined process is an improved estimate of the emissions.

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MR. FISCHER: So what we've done in order to start this work -- and this is something that's been going on since the early 2000s -- is to build spatially explicit

models of the emissions from different sources. And this slide shows the methane emissions from a variety of different sources. And these are -- this is not work that we have done by ourselves. This is very collaborative.

It includes sources like landfills, livestock, natural gas, petroleum production and use, wastewater management, mobile sources, landfills, wetlands, and agriculture. So we try to represent all the sources that can readily be identified. And it is conceivable there is an unidentified source, but I think the chance is relatively low.

We've then taken these maps, summed all of those emissions by different sector and scaled them to the current CARB inventory to produce a map that is shown here as a first estimate of what we would expect.

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MR. FISCHER: Then, as Ram pointed out, no substitute for measurements -- this is a measurement-based study. We make measurements in as many places and as much frequency as possible. Here, I'm going to focus on the sites which are being currently operated to measure methane. And for lack of a pointer, I would just say these include a site over San Francisco, Mount Sutro, a site south of here I mentioned before near Walnut Grove, and a series of sites in the Central Valley, including

Tuscan Butte, Sutter Butte, Madera, Arvin, and Tranquility. The other sites that are shown here are either coming into operation or will soon be operational for judging California's emissions.

I should add that La Jolla and Trinidad are long-term measurement sites that haven't been included in this particular study but may be relative for future work.

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MR. FISCHER: To summarize the results from this initial study, the work in the sort of valley of California has shown that there is roughly 90 percent of the estimated emissions captured by the measurements that are now being made and that the emissions are through this inverse modeling process estimated to be about 50 percent higher than what the base line CARB inventory would suggest.

And so this suggests that there are either underestimates or additional sources that haven't been identified. And the additional towers will help constrain southern California. And I'm going to cut to the chase here.

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MR. FISCHER: In terms of the summary of measurements, our initial work suggests that the emissions are somewhat higher than the current inventory. Some

additional work by CARB staff at Mount Wilson is in general terms sort of in the middle between current CARB inventory and what we're finding for northern California.

Recent work by NOAA is underway, and that is being prepared. And sort of hearkening to the work of Mark Jacobson mentioned, initial work by U.C. Irvine in southern California has shown using isotopic measurements that southern California air contains a significant enhancement in methane, which has the right signature for natural gas or petroleum modifications. So there is a question: What are the sources?

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MR. FISCHER: So to summarize, the co-benefits of reducing methane are: To improve public health, reduce mortality, improve the quality of crop production and forest health through reductions in ozone, that methane is also a strong forcing agent 70 times greater than CO2 on a 20-year basis.

And what that's saying is while not as immediately effective as black carbon, it has the potential for improving our climate warming problem.

And then in conclusion, I will just say these have already been covered.

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MR. FISCHER: And I thank you very much.

In closing, I'd like to acknowledge the excellent work that's been done, not only by the Air Resources Board, but also by NOAA-ESRL Bolder, who have dedicated their efforts to long-term monitoring of climate-forcing agents and really deserve support and applause for that effort.

CHAIRPERSON NICHOLS: Thank you.

DR. SASSER: Thank you very much. I'm very pleased to be here today. I'm Erika Sasser from the U.S. EPA. And I have served as the Chairperson on our report to Congress on black carbon. I'm going to talk about that today and also cover some of the international developments in the other groups that are working on black carbon and short-lived climate pollutants.

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DR. SASSER: Just to give you an overview of the key points, we feel the targeted reductions in black carbon can provide significant near-term climate benefits. And moreover, there are very substantial health and environmental cobenefits that would flow with those reductions. And I think in many cases, those health co-benefits may be the driver for decision makers. So they're very important here.

We certainly know there are a range of control technologies and approaches for reducing black carbon.

Those have been demonstrated to be quite effective. And in fact, U.S. black carbon emissions of been declining. And we expect that trend will continue over the next 20 years, largely due to controls on diesel engines.

Controlling all direct fine particle emissions from sources is a very effective air quality management strategy, and we're going to talk a little bit about that strategy in comparison to other types of carbon controls.

And then as I said, I'll talk a little bit about the international picture and what UK is doing.

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DR. SASSER: In October of 2009, the U.C. Congress requested that we issue a study on black carbon. And they asked us to cover both domestic and international emissions and mitigation options and then the health and climate benefits that would flow from those mitigation options.

We just finished this report in March, and I brought copies for the Board of the executive summary of that report so you can read those at your leisure.

And the report and all of its chapters are available online. EPA is continuing to be environmentally friendly and paperless. It's a pretty big volume.

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DR. SASSER: I'm not going to cover all of this

because I think Mark Jacobson covered a lot of the features of black carbon. But I do want to point out some of the features of black carbon have significant implications for our mitigation strategies. In particular, the fact that they are directly emitted as particles means we're focusing on a specific kind of control that's a little different from what we might think of from an overall air quality management perspective where secondarily formed particles are also a big part of the picture.

Here, we're talking about direct PM emissions, and we're very much focused on the location of those emissions because this is a regional pollutant. It's not globally averaged or well mixed. Therefore, we have to think about where the reductions are taking place.

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DR. SASSER: The health effects of black carbon in general are understood to be very similar to those of PM2.5 in general. I know the Board is very familiar with those health effects. So you're familiar with cardiovascular effects being the primary link to premature mortality. And also, of course, an array of respiratory effects associated with exposure to fine particles.

And on the international sphere, one of the big contributing factors to mortality is exposure to indoor

smoke from solid fuels. And Mark Jacobson mentioned this.

This is, in fact, in terms of total deaths probably the biggest factor, but certainly we also look at ambient pollution as well. And one of the interesting features of black carbon is that it tends to be located where people are. So that means when you reduce black carbon, you're reducing exposure very significantly.

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DR. SASSER: In the U.S., the picture looks like this. So if you look at the scale on the right-hand side of this graphic, you will see that the total volume of elemental carbon black or carbon being shown is relatively small, 1.3 micrograms per cubic meter represented in red. That's an annual average, compared to a national standard of 15.

But you'll see also if you look at the map it's concentrated in major urban areas. That tells us these emission are affecting a very large number of people. If you looked at a global map, other countries would see potentially greater levels in urban areas. But of course, they also have greater people in urban areas. And there, we're talking more about residential exposures to the smoke from biomass and solid fuel burning.

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DR. SASSER: In this terms of emissions, I think

we've already seen one graphic that shows global emissions. Let me just highlight here the side-by-side of U.S. versus global. You'll see the pie charts look a little different. They are not drawn to scale. The U.S. is actually only 12 percent -- eight percent of global emissions.

So in terms of the total volume of U.S. emissions, it's quite a bit smaller than the global total.

But you'll also see the U.S. pie chart has a very large segment of orange, which here represents transport global source emissions. And approximately 93 percent of that orange part of the U.S. chart is for mobile diesels. That's all different kinds of diesels, including on-road, off-road, locomotives, marines, and aircraft.

Globally, the pie chart is a little more distributed between different sectors. You see the residential sector, cookstoves are approximately 25 percent of the global total as shown in blue. Industry is larger globally, shown in yellow. That's about 20 percent. U.S. emissions have been declining and ambient concentrations have been declining as well.

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DR. SASSER: Targeted strategies to reduce black carbon can provide near-term climate benefits. And in particular, as Mark Jacobson pointed out this may be very

important for sensitive regions such as the Arctic and the Himalayas. But the word "targeted" is very important here, because not all black carbon emissions reductions are created equal. So things like global diesel where you have sources that are rich in black carbon relative to other constituents are very fruitful opportunities. Some other sectors are potentially less fruitful or still more questionable.

We also would emphasize reductions in black carbon and greenhouse gas are complementary strategies. They are -- black carbon reductions are not a substitute for greenhouse gas reductions. And in fact, I would encourage us not to think about it as Dr. Ramanathan said buying time. In fact, we need to reduce CO2 immediately. But the manifestation of that will take several decades. Whereas, black carbon, the manifestation of benefit will occur sooner. It's very important that we pursue them simultaneously.

The health and environmental benefits of black carbon reductions are very large. The U.S. has done some -- U.S. EPA has done some estimates of the different kinds of particulate matter and how the different reductions would translate into public health benefits. And what we find is that directly emitted particles, such as black carbon, are among the most beneficial strategies

from an air quality management perspective. There are very strong benefits associated with reducing direct particle emissions. So that would include black carbon and other directly-emitted particles. And globally, of course, there are huge benefits, including hundreds of thousands of premature deaths potentially avoided each year. And that is a conservative estimate. Could be millions of deaths avoided.

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DR. SASSER: As I mentioned earlier, we think it's very important to consider both the location and timing of emissions and to account for the co-emissions that go along with black carbon, because certainly many other components of the mixture, many other aerosols are cooling. And so teasing out exactly how that relationship works for an individual source is very important.

The control technologies are out there already. We know how to use them. In fact, many state and local areas have found these strategies to be very effective. We have seen some areas that have residual non-attainment problems turn to direct particle emission as a very effective strategies for bringing their area into attainment. And certainly the cost of many of the strategies are very reasonable.

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DR. SASSER: Total U.S. black carbon emissions are going to be reduced significantly by 2030.

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DR. SASSER: If you look at the mobile source pie chart here, you will see the actual projected trajectory. This is due to controls on new engines. So we project between the current -- which is 2005 -- and 2030 about an 86 percent reduction overall in U.S. black carbon emissions -- I'm sorry -- from mobile sources. That's about a 40 to 50 percent reduction in overall black carbon. And this is coming largely from non-road and on-road diesel reductions.

I should point out here that retrofits would be in addition to the benefits that are shown in this slide. This is showing simply the results of new engine requirements as the engine fleet turns over.

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DR. SASSER: Other categories in the U.S. are projected to stay more stable. In fact, stationary sources have already come down a lot, more than 70 percent since the early 1900s. Residential wood combustion is a category we're looking at closely, because we are in the process of reviewing the NSPS for residential wood heaters. And certainly open biomass burning is a global source and very important to consider.

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DR. SASSER: Let me briefly mention global opportunities. They are different because the source mix is different. Here, we see more emphasis on cookstoves and small industrial source. In sensitive regions like the Arctic, we see an emphasis on residential wood burning, partly because the Nordic countries are substantial. They have a large portion of their emissions in that category.

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DR. SASSER: Let me turn now just for a minute to of the other things going on globally.

In February, the Climate and Clean Air Coalition was launched. This has already been mentioned. The list of countries is growing substantially. And I think in particular, James mentioned the G-8 joining. I think this is really important because it includes Russia. And Russia is one of the biggest contributors globally. So it's a very important addition to the Coalition.

There are five initiatives that have already been announced as part of this coalition: Two of them focus on black carbon, and two of them focus on methane, and the last is HFC focused.

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DR. SASSER: In addition, there are a number of

other things going on internationally, including as of two weeks ago, the inclusion of black carbon among the PM measures that have been added to the Gothenburg Protocol. This is essentially the European Air Pollution Convention, the first negotiated air quality agreement to include black carbon. That's very significant.

There is a lot of work going on under the Arctic Council. I listed three of the groups working there. These are focused more on scientific study and policy recommendations to the ministers of the Arctic nations. But there are a lot of very important work coming out from these groups.

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DR. SASSER: The IMO is also considering adding black carbon requirements and considering whether this should be applied specifically in the Arctic, as shipping is expected to increase in this region.

And the Global Alliance for Clean Cookstoves, which has been in operation for almost two years now, has very ambitious goals for replacing large numbers of stoves with clean stoves. And they have climate as part of their overall program. And they're doing a lot of research looking at black carbon emissions from stoves.

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DR. SASSER: Since I'm out of time, I won't spend

any time really on the U.S. efforts of methane.

I do want to point out though we have a number of -- the EPA has a lot of involvement in global methane initiative and also in the variety of voluntary programs that are listed here. And in addition, we get a lot of methane co-benefits from our NSPS reductions, including our recent NSPS on oil and gas sector.

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DR. SASSER: Similarly, on HFCs, we have a lot of programs and regulations in play. And we have recently proposed with Canada and Mexico to amend the Montreal protocol. I think Durwood is going to talk about that.

And we have a number of domestic programs, the SNAP program focusing on identifying alternatives to ozone-depleting substances and the responsible appliance disposal, RAD, program, which was mentioned earlier by James and which California is a strong participant in, in addition to our Green Shield Partnership.

So I will stop there. Thank you very much.

CHAIRPERSON NICHOLS: Thank you. Appreciate it.

(Thereupon an overhead presentation was presented as follows.)

DR. DURWOOD: Thank you very much for the opportunity to testimony with this distinguished panel this morning.

My name is Durwood Zaelke. I will indeed talk about the HFCs, specifically how we can reduce them on the Montreal Protocol.

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DR. DURWOOD: Climate protection today is as much about speed as it is scale. So it's important for us to focus on the short-lived climate pollutants in addition to the CO2.

Warming impacts are here, and we need to do three things to get back into a safe zone. We need to control CO2, which requires emission limitations. It requires that we learn how to capture and reutilize and safely store CO2 emissions. Stanford is setting up the Carbon Reutilization Institute, who's also started Colara (phonetic) which is capture CO2 at the Moss Landing Power Plant and turning it into carbonate building material.

We have to do the short-lived climate pollutants because we can do them so quickly and because we can get reductions in warming so quickly. Cutting just two of them, black carbon and the methane and ozone can cut the rate of warming in half globally and in the critical Arctic by two-thirds. When you add HFCs, we get even more than that. So speed and scale is the mantra.

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DR. DURWOOD: Now HFCs are different than the

other two short-lived pollutants we've been talking about because they're not air pollutants. These are factory-made gases. And right now, their contribution is very small. That's the good news. The bad news is they're the fastest growing greenhouse gas in the United States and in many other countries. The United States last year, they grew by nine percent between the -- actually 2009, 2010. That means they're going to double by 2020. Globally, they're growing even faster, 10 to 15 percent. They'll double in less than five years.

If we don't constrain them, they can contribute as much warming as about 27 percent of CO2 by 2050. And if we succeed, as we must, in bending the CO2 curve to the 450 PPM level that will keep us we hope below two degrees of additional warming and we don't constrain the HFCs. They'll be up to 45 percent of the climate-forcing of CO2. We cannot tolerate that.

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DR. DURWOOD: Here's a chart that shows the growth from 1990, 2002, 2010, and the sectors.

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DR. DURWOOD: This is another very interesting chart that shows one of the reasons that HFC demand is growing so fast because the demand for air conditioning is growing so fast.

Last year, it was record emissions for greenhouse gas by the U.S. 5.9 percent increase. And specifically when EPA announced these rather discouraging numbers, they said this was driven in part by excessive demand for air conditioning. The hotter it gets, the more air conditioning we need. The more air conditioning we need, if we don't constrain HFCs, the more HFCs we'll use.

This is the 50 largest cities in the world. And they're growing demand for air conditioning. If you look at the highest bar for Numbi, that city in India alone will have air condition demand that's about 25 percent the entire United States.

So the world is getting warmer. The world is getting richer. The world wants more air conditioning. That means more HFCs under business as usual.

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DR. DURWOOD: This is the curve that shows where CO2 is going. And it also shows where the HFCs are going. And it also has the stabilization curve for CO2 at 450. So the range of HFCs is going to be so high. As I said, 27 percent under business as usual up to 45 percent, if we constrain CO2. And we can't win the climate protection battle unless we control the growing HFCs.

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DR. DURWOOD: Now, the good news for all of the

pollutants we're talking about today is that they are short lived. The mix of HFCs today and projected for the future is about the global average is 15 years. Fifteen years is not as short as black carbon. It's about the same as methane. But it is very short compared to CO2. So we think of CO2 as a century problem. But in fact, 20 to 25 percent of CO2 stays in the atmosphere for millennium, a thousand years and beyond that. So we have a longer legacy problem that is going to require the carbon removal strategies that I mentioned.

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DR. DURWOOD: This is the chart from Ramanathan's work is later interpreted by UNEP and the Shindel team. It shows that we can cut the rate of warming globally in half with just black carbon and the methane. And we can stay below two degrees out to past 27. That's a critical guard rail for us. 1.5 is much safer. That's the bottom line there. We can stay below that to 2045 probably, assuming we do the CO2 as well.

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DR. DURWOOD: Now if we add the HFC -- and this is Ramanathan's work, you see the bottom black line allows us to stay below two degrees as long as we are doing the CO2 as well out past 2100. So these non-CO2 pollutants together are absolutely essential for climate protection.

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DR. DURWOOD: Now more good news. HFCs can be taken out with the Montreal Protocol. This is the most successful treaty the world has ever created. We've taken out 100 similar chemicals by almost 100 percent in the 23 years of this treaty. And we've gotten incredible climate collateral benefits. If you go back to the early warning from Molina and Roland in 1974, solving the fluorinated gas problem that otherwise today would equal the CO2 contribution, it would otherwise have equaled the CO2 contribution. So we've delayed climate forcing with our successful flourinated gas efforts by 41 years. We'd be that much deeper into the yogurt. And we've also built the capacity in every country to solve this problem, including with HFCs.

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DR. DURWOOD: Here's a relative comparison what the Montreal Protocol has done. If you look at the graph on the far left, the blue one, you see we've got about 200 billion tons of CO2 improvement. You look at what Kyoto is trying to do for us, our international climate treaty in the middle. It's very modest, five to ten billion tons. Very, very modest. And we're still struggling.

And then you look at the orange bar on the far right and you see how much more do we get by reducing the

HFCs through the Montreal Protocol. We could get 100 billion tons or more. That could be equal to about five to eight percent of the total mitigation the world needs to stay below two degrees. This is a very, very big piece. And it's true a treaty that has never failed to do its job.

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DR. DURWOOD: So as we heard, there are proposals. The first proposal couple years ago to reduce the HFCs was from island states. Last night, I was giving a briefing to Island states at the New Zealand Embassy because they are experiencing sea level rise and increased storm surges. They want to know how to survive and they need fast mitigation. They know they can get it from the Montreal Protocol. We're facing some opposition from China and India, but I'm confident soon we will be able to overcome that.

Another very important point about the HFC mitigation under the Montreal protocol is that we can do it for pennies per ton of CO2 equivalent in mitigation. That's the public cost. We have a special funding mechanism, the multi-lateral fund. And we can pay globally with the U.C. contributing about 25 percent of that a couple of billion dollars and get this amount of mitigation. It's a very, very good carbon.

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DR. DURWOOD: We heard about this new coalition. I think this is very important because it's bringing developed and developing countries together in a solutions-oriented approach.

I went to the first ministerial meeting in Stockholm on the 24th of April. And the tenor of that meeting was completely different than the climate meetings that I also go to. Climate meetings, you feel like they're being guarded by the dementors from Harry Potter who sucked the hope out of everyone in had the room. You go to the Coalition for Climate and Clean Air and you feel optimism. We need optimism. We need success which will breed more success so we can avoid going from climate denial to climate despair. Despair that we don't know how to solve climate change.

This is why it's fun to be in California. This is the optimistic place. This is the solution-oriented place. And what you do here, the world needs. Thank you.

CHAIRPERSON NICHOLS: Thank you.

DR. LLOYD: Good morning. It's a pleasure to be here. Thanks for organizing this. Pleasure to be before you, Chairman Nichols and fellow Board members and also taking part of this distinguished panel.

Durwood gave a ringing endorsement of all the

work you've done. If that could be applied to the budget, we would be all in really good shape.

I will try to go through the slide in the order I have them. In some cases I'll skip them and keep an eye to the clock, knowing how rigorous the Chairman keeps us to the time.

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DR. LLOYD: First slide basically summarizes here the key thing to look at in that case. If you just look at CO2 measures, then you can see we get into that over two degree limit. But by adding the bottom one, adding CO2, methane, and black carbon measures, then in fact you have a much greater impact, reinforcing what was said before and the importance of coupling the short-lived climate burdens. That does not include the HFC Durwood mentioned.

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DR. LLOYD: Just want to mention here bring it back the California actions. We talked about the highly successful Diesel Risk Reduction Plan. I think there's still more to be done on that, I'll say later.

LEV III was an important milestone in recognizing black carbon as a climate warmer with the comprehensive report to do that. And again, you've gone ahead also and agree with previous speakers here the importance of

measurements. So you've got the measurements there and a very effective research problem.

I wrote this before I heard this morning the ways in which the research -- the farsighted research is coming back now and being able to translate it into regulatory programs. So kudos to the ARB. Tremendous example.

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DR. LLOYD: Another piece of the LEV III I want to mention is the setting of the one milligram per mile PM standard, which is very important to address the concern that you develop ultra-fines from the new generation of technologies there. That may or may not materialize, but ARB is ahead of that. And I think that was the piece that we were talking about.

The other piece of that was the extension of credits for the low greenhouse gas global warming potential refrigerant and leak systems. Again very important piece of the family of technologies.

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DR. LLOYD: Erika has mentioned this. Others have mentioned it. But I want to put this in the context to the California showing leadership on this for a long time, not all together from climate, but obviously starting off with regulating greenhouse gas from cars and then AB 32.

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DR. LLOYD: This is being coupled and I think Erika mentioned that.

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DR. LLOYD: Just want to highlight here accelerating reduction of methane from landfills. I think James mentioned a lot of is being done. I think the measurements you saw Dr. Fischer mentioned shows more can be done.

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DR. LLOYD: I think this -- also I want to highlight some of the challenges of the HFC, which I think is still playing out. And the Board based that in AB 1493.

But I do, following that, the Commission delayed the enforcement of the mobile air conditioner rule two years until later this year. Recently, the courts rejected the patent claim of 1234 YF, which is the preferred refrigerant by the auto companies.

Also want to point out some of the European citizens and environmental groups are very concerned about the flammability and toxicity about 1234 YF. And they favor CO2. Those of you around 1493, we heard the same issue come up during that time. As I said the auto makers are committed to that.

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DR. LLOYD: I would say -- and I show a slide here, but I think again the U.S. policy of crediting is a better approach in light of the uncertainties in terms of global refrigerant supply.

But also alternatives to 1234 YF may be increasingly important. And I don't think the Board should rule out -- and maybe we go back and re-examine CO2 although EPA has not issued a unique fitting rule that would permit CO2 systems, despite the SNAP approval and their lower life cycle cost.

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DR. LLOYD: And this shows an example of some work that we've commissioned ICCT, by ICF. And you can see the impact here business as usual for the base line. And then if you look how that turns over -- and all of those are about the same region. In fact, CO2, R-744 is basically the same as 1234 YF.

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DR. LLOYD: If you look at the cost here, just highlight the green, which is the CO2. That's less expensive in many areas. And compared to the blue, which is the 1234 YF, which could have a major impact. And recognizing CO2, if that leaks, you're getting more CO2. And you're not jeopardizing the potential for some huge

emissions in the developing countries. As Durwood mentioned, if you look at China and India, the number of people wanting air conditioning is just escalating.

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DR. LLOYD: So some recommendations here in terms of leveraging what you're doing under AB 32, and that is to look at the report -- the statewide emissions -- with an eye to the short-lived climate pollutants here.

Look at the difference by regions, by sources, and then both near-term and long-term climate impacts. That's both the 20-year and the 100-year we talked about before -- and identify some of the greenhouse gas emissions targets for 2020 that includes some of the short-lived pollutants and maintain existing stringency on greenhouse gas.

Update the plan for achieving maximum technology feasible and cost effective reductions and take into account all the measures here.

And this is some feedback we've had, some environmental groups, when we talked about the black carbon issue. Keep the short-lived climate pollutants, particularly black carbon, out of the market-based mechanism. Real concern there about trading off something that is both a toxic as well as a climate pollutant.

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DR. LLOYD: Lastly, to reinforce what we heard before. Stay committed to CO2. Another substitute that's got everything. And then treat the short-lived climate warming pollutants as complimentary.

Adopt explicit goals to limit the rate of climate change and near-term climate impacts. Very, very important.

And we heard on the black carbon of the Arctic.

Also recognize the snow pack in California is extremely important. Snow packs generally will be impacted by black carbon, which can actually lead to excessive melting.

Include the short-lived climate pollute in the statewide greenhouse gas inventory and the AB 32 planning process.

And review existing regulations that reduce short-lived climate pollutants and quantify their climate co-benefits.

Undertake an assessment of uncontrolled statewide sources of short-lived climate pollutants. That ties in with some of the G-8.

And I would say, I know you've done a lot with the on-road. My understanding, some of the construction retrofits, that's being delayed. A lot can be done to speed up those issues and prioritize those speed up

strategies that can rapidly be implemented. And we've said comments that consider more rapid phase-in of the one milligram per live LEV III PM standard. I know there is a review on that coming up in several years, so I know that will be taking part, as a matter of just reinforcing what we state.

And marine emissions that we heard before are a significant piece of the pie here. And I'm always showing now some reactions surprisingly coming up with lower sulfur diesel, making some real progress. I think California has identified this issue more from local pollution, but I think it can also build on this by being the home of a major marine black carbon den at a port, port of L.A., Long Beach, or Oakland where in fact you've got the tools and that can be used for the shipping. And I think you've got the resources. And I think it would be extremely worthwhile to do that and keeping with the type of work you've done before. So with that, take again and congratulations on holding this hearing and looking forward to follow up. Thank you.

CHAIRPERSON NICHOLS: Thank you very much, Alan.

Did you have any remarks?

I'm going to turn it over to the Board for some further discussion. I just want to say thank you so much to the members of the panel who've taken the time to come

and talk to us this morning. And thank you for your kind words. Obviously, it's always gratifying to be praised. But I'm particularly interested in talking about how we can use this kind of thinking to do a better job of focusing our efforts and making sure that as we face the next round of AB 32 implementation, which is going to be upon us next year when we have to produce a new Scoping Plan -- it will be five years since the first Scoping Plan.

And I'm looking at Alan Lloyd because he played a critical role in the advisory panel on that one.

But we need to not only build on and take credit for what we've done, but also to really think about whether there are new and better ways to go about achieving the kind of long-term results that we are all looking for that may not have presented themselves through the laundry list of regulatory measures that we've been dealing with to date.

So I think you've given us a number of interesting suggestions of things that we could be thinking about, but we may want to flush them out a little bit more and also just to perhaps to ask a few additional questions. So I'll start with anyone who cares to jump in.

Yes?

BOARD MEMBER D'ADAMO: Well, ditto to what you just said.

And of course, we've got the Scoping Plan coming up and I'm sure that staff is busy thinking of ideas to present to the Board. But it sure would be terrific if this distinguished panel could help us to brainstorm. So I know you all followed remarks that compared that you felt comfortable with.

But just looking outside the box, if you could get us to be thinking beyond broad terms in terms of reducing the emissions, but also some specific control strategies.

Alan, I think I heard you correctly; the focus you're suggesting ought to be regulatory strategies. And that's what we're in the business of doing. So anything that we could do to tweak the existing regulations -- the speed-up strategy, I think I understand where you're going with that. But anything beyond regulatory measures that we have already taken.

MR. JACOBSON: The way I view it is there are two ways to control. Either you can control the emissions of existing sources by improved technologies or you can replace existing sources with new technologies, such as vehicles, put particle traps on existing vehicles, or you can go to different types of vehicles, like more electric

vehicles or hydrogen fuel cell vehicles.

So I think -- I don't know whether it's in the purview of the Board in terms of the control, but I in the long-term, you really do want to go to a more clean fleet. And one way to accomplish that is through these one milligram per mile emission standards that encourage more use of electric vehicles, for example, than passenger diesel or gasoline vehicles.

But that I think is really the way that you have to move forward is by doing this large scale convention. So anything can you do to encourage a large scale conversion to clean renewable energy including electric power and transportation and heating and cooling will go a long way, especially because there is going to be a, as I mentioned, large growth of natural gas use in California. And because there is a large natural gas resource and the price has gone down.

So I think in order to prevent that -- the effects of that, like the enhanced leak methane, might need to take some proactive -- do something proactive to prevent it in advance -- stronger regulations in advance, seeing that there is going to be this huge growth and this huge additional methane release, for example.

So anyway, I think there are two strategies are to increase the controls on the existing black carbon

emissions and methane emissions, but also try to do the large scale conversion to clean and renewable energy systems and electric power to really eliminate this problem entirely.

CHAIRPERSON NICHOLS: Comments?

Yes, I'm sorry. Was there another response? Yes.

DR. LLOYD: I was just going to respond to DeeDee's suggestion.

I think one thing which I got out of this morning is the -- again, the reservoir of tremendous research capabilities within California and the networking with national. But knowing the process where research programs are set above, usually then there is two to three years from the time everything is cleaned up.

I would suggest, as we heard this morning, there is some results already coming out, so maybe some more alerts, rapid response, that these are sufficiently certain that now you might consider some action being taken rather than the research program and the reports come to you in maybe three years time and then you lose maybe some of the urgency.

Obviously, that's all the caveats and academics want to make sure of everything. As we've seen with clean air, you don't have to know with 100 percent certainty.

But you can know and take action. That would be one suggestion.

CHAIRPERSON NICHOLS: Okay. Thanks.

BOARD MEMBER SPERLING: I do want to complement the panel. I thought they were all excellent presentations. Really helped us understand better the problems and the opportunities and emphasize how important these short-lived climate pollutants are.

And I look at it -- up here, we're looking at it from the control of California and what we can do and/or should do. And we do have this leadership role we've already taken on.

In this case, I look at that graph that James Goldstene put up. And California does have much more -- its emission inventory is much more weighted towards CO2 than the others. So it does raise the question how do we proceed on some of these other short-lived pollutants. And clearly, we should and can and are.

So you know, one is -- I guess I have three thoughts/questions.

One is regarding the vehicles. And I'm wondering with the air conditioners in the vehicles -- mobile air conditioners, there are incentives built into the new rules we just voted on to reduce -- to emphasize the use of pollutant gases that are less climate-forcing.

I guess it's for Tom Cackette.

Are those incentives strong enough, do you think? Do you see if there is a role or opportunity or value in doing something stronger in that area?

CHIEF DEPUTY EXECUTIVE OFFICER CACKETTE: Well, I think there was one comment about how the performance approach we took does send the continually unstable signal to the industry versus let's ban this refrigerant or favor that refrigerant. And obviously, what's happened in Europe seems to be -- and with the suppliers seems to be a problem getting the 1234 out there in the volumes we need. So I think the structure of what we did still makes sense.

As to whether there should be greater credit in some way or something else to force it, I guess I would tend to resist that a little bit, because I think it's better to have the actual incentive tied to the environmental impact where you have the climate change more closely than trying the favor one over the other.

So I think we're okay for right now. But I think ultimately it's going to be whether the industry produces 1234 or whether we have to go back to ground zero and provide enough time for the CO2 approach for that to work.

Under our rule, what that means is if we can't reduce the HFC emissions enough, they're going to have to increase the efficiency of the car to make up for it. So

we kind of adjust for this. I think there's certainly room to do that because the standard -- the tailpipe standard we adopted were certainly not the absolute maximum feasible standards. So there is room to switch from one to the other while this air conditioning thing sorts out.

BOARD MEMBER SPERLING: One little question and one big one. Just so I understand. We worked the black carbon. Can you add to that?

DR. LLOYD: My comment from the graphs that I showed, there is no reason to rule out CO2. But unless EPA adopts a unique fitting rule, it cannot be used. So that's an impediment.

DR. DURWOOD: I'll add to this by saying that I? agree with Dr. Lloyd that we should use regulatory measures when we know something is as bad as HFCs are, wherever we can.

And the current rule seems like a reasonable way to start giving credit for. But you might look very carefully what the European rule is to set the GWP limit at 150 GWP right now. That's under review. Could go down.

So we do need more pressure. Is the supply of the HFC 1234 YF enough yet? Alan mentioned that patent challenge has been successful in Europe so far, and that

will presumably lower the price when the other competitors who have patents on production, but not the use are able to get into the field.

So I wouldn't give up on the opportunity to look at further restrictions. It's a factory made gas. It's bad. We should have a plan to eliminate it over an appropriate period of time.

CHAIRPERSON NICHOLS: That's a key factor, both the time and the plan.

You've got the floor, and then Ron Roberts and Dr. Balmes.

BOARD MEMBER SPERLING: Just a little bit and then a big one.

The little one is just understanding the black carbon, we look at it -- we've looked at it from a health perspective, and it's very -- there's small particles, small one micron or less than 2.5 has a much bigger health effect.

I'm wondering -- this is a technical science question. And that is that as we think about the regulation of PM, as we focus more to size as opposed to mass, does that strategy make sense also from climate perspective? In other words, if you have one gram, is it worse with a lot of little particles or a few big particles? Or does it matter? I would think a lot of

small particles is worse; right? So that's good, because that means our strategy for health effects is going to be well aligned with climate.

CHAIRPERSON NICHOLS: I see some head nodding. But maybe Mark and --

DR. JACOBSON: Well said.

Diesel exhaust and the size of most black carbon particles are less than .1 micron, like 75 nanometers. So it's much smaller.

But then the grown by condensation and coagulation. Or they become larger and coated and this increases their warming effect.

So they're naturally very small particles when they're emitted. When they grow, they actually get into the optically -- optimal size range which is like 1.3 microns. And once they get into that range, then they have the maximum potential. But they're not -- black carbon itself is not usually that large. It's usually a coating of other material on top of it that increase the light in the particle that increase.

So it is consistent, in other words, with the health -- same particles that are causing health problems are the same particles causing climate problems.

BOARD MEMBER SPERLING: This is the really big concern I have is that what we're seeing in the oil and

gas industry is there is a lot of gas -- shell gas being produced as a few of you have referred to. But it's now turning out that probably from a carbon perspective, the greater problem or challenge is that a lot of those rigs and a lot of the production is moving away from the shell gas to exploiting oil out of the shale. What's happening is that oil is mixed with gas, and the gas doesn't have much value and the oil has lots of value.

What's happening is now really for the first time in decades, in the U.S., they're starting to not only let a lot of this gas just leak out, but they're burning it and flaring it. And the data I saw from last year from DOE says that the amount of flaring dramatically increased in the U.S. because the oil companies -- the oil and gas companies have very little incentive to do anything but flare its gas. And it's not going to get better because oil prices are likely to stay high. There's problems collecting the gas.

So this is something that I think -- and it's probably -- looking at the data is probably going to be the biggest source of increase of short-lived pollutants into the foreseeable future, unless something is done about it.

And California, I don't know exactly the role of California here, because we don't really have that much

shale. We have some in Monterey, but not nearly as much as other parts of the country, but it still is -- could be significant.

This is partly a question of: Am I on the right path here?

And number two is: This is something that should be coordinated with EPA much more so. And can we hope for some leadership out of EPA on this issue? And if not, what do we do here in California? So that's both a technical as well as a policy.

DR. SASSER: That is an excellent point. This is something that the Arctic Council has been increasing focused on in their search for answers for that region as well. Knowing that oil and gas exploration is increasing, that the flaring as you pointed out is increasingly common mechanism of getting rid of this unwanted gas. In that case, of course, the flaring is occurring in a region where the black carbon is ending up where we don't want it, which is on snow and ice.

I don't think we have the answers yet in terms of exactly what the relationships are and exactly what the trajectory is in terms of projected increases. I think this lot of this is developing very real time very quickly.

I think it's a very important area. And anything

that we can do or you can do collaboratively to investigate this would be really welcome.

I know Canada is also extremely interested this, and they have some research going on right now looking at the actual emissions from these flares and how much of it is black carbon. And I think there is also a lot of unintended methane release going on at these facilities.

DR. FISCHER: I'd like to comment.

With regards to emission the flaring with the black carbon and pollutants that are normal, there is also this leakage that's not captured by the flaring when you have shale and just methane pops up, it also gets into the groundwater. So there are places in Pennsylvania, for example, that the groundwater methane content is huge. Not everyone. About 10 to 15 percent of the groundwater samples that were collected had methane in them in higher concentrations than the UK allows. And some people have probably seen like on the water on fire, but that's more rare from the sink as a result.

So there is a leakage source, and there is also the flaring off source. But from my understanding -- I'm not an expert on the resources -- but California actually has the largest oil shale reserve in the country and especially in the Central Valley. And so that's probably where the next ground zero or hydrofracking is going to

occur for oil.

BOARD MEMBER SPERLING: At some later time, I'd like to hear -- that's not my understanding, so I'd like to hear more on that.

My last closing thought on this is we do -- at the risk of making our low carbon fuel standard more challenging, we do have a mechanism in place with a low carbon fuel standard to handle these flaring and emissions. And so that's just a comment.

I don't really think you need to get into, unless -- I know Richard's cringing down there.

CHIEF COREY: This is Richard Corey. I'll be brief on this.

But that is correct. One of the intents of the low carbon fuel standard is to count for the carbon intensity of oil. Part of that is the work that we are doing with Adam Stanford to account for EOR and flaring and fold in fracking elements. There is much more work to be done in that as that plays out. That was touched on here. But that work is underway.

And I want to raise this because I think it's also relevant. It was touched on here. The reference to the Monterey shale. That's a very large formation, in the billions of barrels and is anticipated to go the additional fracking for that oil.

So California, we really don't see natural gas fracking. We certainly have oil fracking. And we have been working with the Department of Conservation Division of Oil and Gas and Division of Thermal Resources and their work and regulation for enhanced reporting of fracking activities and fracking materials and so on. So that is work that's underway as well.

CHAIRPERSON NICHOLS: It turns out that wasn't an area that was being followed through California. It came up in a rather surprising way. So I don't want to cause there to be undue controversy, but I was just interested in that last exchange between you and Dr. Jacobson about the flaring issue. Can you explain a little bit more about what it is you disagreed about?

BOARD MEMBER SPERLING: Well, I don't -- the only thing question is how much of this shale rock is in California and exploitable for gas and oil. And you know, the analyses I've seen suggest -- well, there might be a huge number, but compared to other places in the U.S. and the world, it's not huge. Although that can still be a big number for us. It can still be important. And I guess there probably should be an assessment of industry plans industry California.

CHAIRPERSON NICHOLS: I see. Thanks.

Supervisor Roberts.

BOARD MEMBER ROBERTS: I'll try to be quick.

First of all, thank you for the report. The group of you -- you've actually left me a little bit optimistic, especially over the short-lived things.

I just recently spent some considerable bit of time in China, and I saw those clouds, Dr. Jacobson, that you referred to and up close. In fact, I don't think I saw a blue sky the whole time I was there. And I was in all parts of the country -- 13 different cities as part of our visit.

And it was where they were moving the coal from the mines to the shipping points using these 40-ton diesel trucks that had no visible systems on them to reduce. So they were getting not only the -- what is happening because of the coal they're burning for power, but also the transportation of that to the various places where they did.

And I was kind of depressed, but you made me feel a little bit better about this. Thank you.

Last night, Sandy and I and Tom were on a presentation from the manufacturers of emission control systems. And not surprisingly, as many of you have been in the past presentations, they were encouraging us to take regulatory actions and then showing us what technologies may or may not be there. Their call for the

regulatory efforts were such stronger than their optimism over the technological systems that are there essentially in the short term.

But one of the things that did come up about might merit some discussion -- and I think maybe ties in somewhat is that in some cases -- in this case in the diesel exhaust where we put the regulatory effort in place, but that it sounded like that our efforts in enforcement maybe are not measuring up to the regulatory effort. And we're seeing far less of the benefit than we might if maybe we had a more aggressive enforcement effort.

It may be the enforcement is also based on technologies on measuring things that aren't quite there. So it's with a lot of enthusiasm that you go into the regulatory effort, but there is a whole series of things that has to happen to make that effective, I think as was presented to us last night. There's some things left to us to do. It's real easy to adopt rules, but really I think our success has come because we adopt rules that are effective over time. And it isn't just driving innovation blindly, but trying to understand what practically can be done.

CHAIRPERSON NICHOLS: We have heard I think from some of the companies that we're not quite as far along as

we should be in terms of actual enforcing some of our retrofit requirements. And it sounds to me like they have a point to be made.

I'm sure the other issues are resource allocation and all that. But I don't know, James, if you want to comment on that, or Tom.

EXECUTIVE OFFICER GOLDSTENE: I'll ask Tom to comment.

CHIEF DEPUTY EXECUTIVE OFFICER CACKETTE: I think the whole issue that some of the retrofit manufacturers raised with us caused us to go back and look at the rule, how it's being implemented. The first deadline was last January. So with our reporting requirements, we have some data and we have some anecdotal information. We kind of combine it together to look at what is really happening in the field. And I think there are two factors possible.

Number one is that a number of the provisions that we put into the rules reflect the economy did, in fact, reduce the number of retrofits that were expected to occur from when we had the original rule out there. So that's one factor. And the first year that reduction is quite large. It will be less than in the next two or three years.

The second thing is whether there are people just ignoring the rule. And we know that there are because we

already have some enforcement cases underway, and we plan to publicize those when they're completed.

But the extent of non-compliance I don't think we really know. We always expect it would be some. But whether it would explain the much lower market for retrofits, we don't believe that's the only explanation, by any means. So we're jumping on this to make sure we understand and sharing data with the retrofit manufacturers and agree to share their in-the-field experience so we have a clear picture we can share with you.

CHAIRPERSON NICHOLS: I think that is a very good response and is also very important to remind ourselves that I know we disappointed some people when we made the decision to slow down the pace of implementation of some of these rules when we were faced with the worst economy that anyone could remember, particularly in terms of its effect on construction industry and other people who are big users of diesel equipment. So there is no question there is a balance here.

But even so, it sounds like there is at least something worth investigating to see if people are paying attention to these rules that there is no point in adopting them otherwise.

Dr. Balmes -- I'm sorry, Dr. Ramanathan, you had

a comment.

DR. RAMANATHAN: Just a quick comment on what Supervisor Roberts said.

The same situation exists in India, vast improvements of brown cloud. We were discussing what more can California do, I'm really excited about that. But I think equally exciting is how to put our knowledge into action in the field. And I think I know India is tremendously interested how do we cut down our diesel pollution.

I talked to the Minister of Environment in India. So I think this is something CARB may need to think about, communicating that knowledge to the international group. There are going to be communities for collaboration and industries.

And so I know, Chairman Nichols, you travel abroad and major meetings. This is an issue worth thinking about. I know China will be interested. We know cookstoves is a problem, but we want to cut down our diesel issues. So there is an opportunity here from for California to reach out.

CHAIRPERSON NICHOLS: I agree. I've been very pleased both the past and the current Governor have been very supportive of the idea that California is not an island and that what we should be exported where it makes

sense and we should be looking for ways that we can participate.

And recently, we've been approached in a much more proactive ways than I've ever experienced by people from the U.S. State Department to be of assistance to them, as they also are working in both China and in other forums to see where we can provide technical support and analytical support. I think it's maybe somewhat surprising to some that we have such a large presence and involvement.

But clearly, once you venture into the realm of global pollutants, you are, in fact, in a global environment. So it really behooves us to pay attention to these things and take advantage of the opportunities that we've been given.

Okay. You had a different comment?

BOARD MEMBER BALMES: Yes. But I'm happy to stay in the global arena.

So several of you to my -- first of all, I want to say this was really a pleasure and great education for me to hear such a distinguished group of scientific panelists. And I have to say, even though I've been interested in black carbon from stove emission for a long time, I learned as a part of this process about brown carbon from my briefing from Bart Croes last week. So

that alone is worth the entire workshop for me -- or the entire hearing.

But several of you mentioned the issue of biomass burning in residential settings. And there is this Global Alliance for Clean Cookstoves which Dr. Sasser mentioned. And it is an area where there is a tremendous cobenefit in terms of health, as you've mentioned. In fact, you all were siting the last version of the World Health Organization's Bureau of Risk Assessment Global Burden of Disease. As probably some of you know, there is a new one coming out, which shows more deaths attributable, more disability just of life year attributable to biomass burning because cardiovascular disease is now going to be considered in addition to respiratory disease and lung cancer.

So it's a tough issue, cookstoves in the developing world. And where does CARB fit in?

I'm not a big fan of offsets in general. And in the past, I've been concerned about offsets staying as much as possible in California.

But on the other hand, cookstoves are not a California problem. And to address the issue of cookstoves, I'm wondering where CARB has a role, because I think it would be helpful if we could move in a direction of trying to identify an offset mechanism that was

verifiable, which is always the trick with regard to cookstoves in the developing world.

And, you know, some of my colleagues at U.C. Berkeley are actually working on verifiable mechanisms to make sure cookstoves are actually being used. Because you can distribute cleaner cookstoves, but they have to be used and that has to be monitored. But there are increasingly promising ways one can do that with cell phone technology, for example.

So I just want to throw that out there. I don't have a ready answer how we can have a role. But the Global Alliance for Cookstoves is well intentioned as it is and with Secretary Clinton be being supportive -- actually being sort of a founding energy of that Alliance and Julia Roberts being the spokesperson, it's still a small minuscule effort in terms of resource.

And India, for example, hasn't really signed onto the Global Alliance for Clean Cookstoves for whatever reasons.

So, again, I would encourage us to sort of think how we might be able to contribute to this, if not coming up with an offset mechanism, a way we can contribute to research to help develop ways to verify use of clean cookstoves.

CHAIRPERSON NICHOLS: I can hear all over the

blog-asphere people thinking right now about ways to create an offset program verifying the news of a new kind of cookstoves. I think that's a really good idea.

Dr. Sasser.

DR. RAMANATHAN: I'm so happy that you raised this issue. We are doing a cookstove project in U.C. San Diego in India. And the compliance issue was an issue not anymore. For example, in our project we have a 50 cent temperature monitor attached to the cookstove. And then it transmits the information to cell phone. And then it's transmitted to Climate Exchange Commission to keep track of how long they use.

And the second question you asked what is it California can do? We have found that what's called four stroke cookstoves. I think of it as a five dollar solution, a smaller fire for oxygen cuts down the black carbon emissions by almost 80 percent. So these technologies are really developing in the US and parts of Europe. So there are ways, but we need to understand the local culture, because it can't be developed here in isolation and collaboration as people are trying to do.

I know Berkeley has done work a lot of cookstove has done. So I think we're filling the U.C. Campuses, Stanford --

CHAIRPERSON NICHOLS: Spread this around.

DR. RAMANATHAN: There is tremendous work going on on the cookstove issue, both on the science and the technology side.

CHAIRPERSON NICHOLS: Thank you.

Did you have your hand up, Dr. Sasser

DR. SASSER: Let me add a couple points to that.

I think I would echo the basic point a lot of the research that's happening at California Universities is very important. And particularly I would point to the health research going on. I think one of the contributions of the new global burden of disease study will be it attempts to integrate both the outdoor ambient exposure with the indoor exposures and to give us a more complete picture of what exposure in particulate matter in all environments does to public health. I think that will be an enormous advance for the health community. And it's very, very important for application in these contacts where we're talking about an indoor source that a lot of the emissions end up outdoors in ambient air. And the exposures are effecting the entire community. And that's really important.

BOARD MEMBER BALMES: That's why we switched from indoor pollution in the last WHO document to household air pollution.

And actually, we're only going to be able to take

credit for a portion of outdoor air pollution in India and China, which it's not the entire world in terms of the contribution of household air pollution to outdoor pollution and the global burden.

DR. SASSER: The other point I wanted to make, I do think there's some sensitivity -- you brought up the question of India and why India has not joined the Global Alliance.

I have heard there is some nervousness on the part of some countries about the fact the Global Alliance is including climate related considerations, in particular, the investments in black carbon. Of course, there is a feeling that the developed countries have not done what they should on CO2 and now turning their attention to short-lived forcers. Again, it can't be a substitute for action on CO2. And to the extent the countries perceive it is a substitute because it's easy or cheaper or can be done elsewhere, that produces some resistance. That's part of the total package and message we have to send.

CHAIRPERSON NICHOLS: Thank you for that reminder.

Dr. Zaelke.

DR. ZAELKE: I think that's a very important point.

The climate negotiations going on last week and this week, the short-lived climate forcers are getting a lot of attention. But they're also getting some blow back because the U.S. is leading this coalition. There is a great suspicious that it might be a slight of hand to excuse our poor performance on CO2. So be very careful about offsets that trade the very short-lived black carbon for the very long lasting CO2. You always lost in such a trade.

Now, Kirk Smith's work I think at Berkeley includes offsets for the CO2 reductions from stoves. That might be fine, that particular piece. Maybe with black carbon you can think of an offset for other short-lived pollutants, not for CO2. Because if we get into that, we're seen as promoting the trade off of short-lived for CO2, this coalition is going to die.

CHAIRPERSON NICHOLS: That's a pretty complex political environment -- geo-political environment.

MR. JACOBSON: So the analogy to cookstoves in California is really there is less indoor burning of wood for heating. And there is outdoor agricultural burning and other types of burning that may be not the high concentration in terms of the population effects, but still have impacts on climate and some health effects.

I think you can certainly rationalize focusing on

those burning sources for heating and also for agricultural burning.

But there is also some benefit to California directly of reducing pollution in Asia -- of the Asia particulate due to the fact there is in long-range transport as shown many years ago. And so there is some direct effect. It's not just an offset. It's actually may be some small method.

CHAIRPERSON NICHOLS: Good point.

I need to include my colleagues down on this side just to see if anybody has anything in addition.

I just have one other area. I'm not even sure I have a question here so much as a request for any thoughts anyone might have about how to approach this problem.

We have really focused on three different aspects of the short-lived climate pollutants here. And the one that strikes me as having kind of at the moment at least the most salient issues from the government regulatory side is actually the methane issue, because of a number of different processes that have come to the floor. We've got landfill operators looking for ways to convert more methane from landfills into a usable fuel. And we've got people wanting to inject biogas into pipe lines, from renewable sources, but use it for both transportation fuels and for other purposes as functional equivalent of

natural gas along with, of course, global concerns about what that might do to displace other kinds of renewable fuels.

We've got proceedings going on in different places to try to find better ways to get the waste, especially from dairies, to be used as a useful fuel and take that methane and capture it, instead of having it be a problem.

So there just seems to be at the moment kind of a critical mass of people who are interested in this problem. And I guess this is one that's very California because we have an awful lot of agricultural waste and landfills. And we also have a lot of policies that relate to renewable energy and to trying to keep things out of landfills.

And I'm just curious whether any of you see kind of a sweet spot there, if you will, in terms of how to look at this issue that might be of some assistance in terms of helping to once again have California be in a position to offer some leadership in other places.

And this is kind of an open-ended question, but I would invite anyone who has any thoughts on it to jump in here. Okay, stumped the panel. I see one brave person willing to engage.

MR. JACOBSON: I think I want to focus a little

bit of attention on this because you mention natural gas for vehicles. But the electricity is four to five times more efficient than any combustion force. So the cost of electricity is one-forth to one-fifth per unit gallon of gasoline equivalent.

I drive an electric car. I drove it here. It's powered by solar electricity from my roof. Comes here and the equivalent is 80 cents a gallon of gasoline. But there is no combustion, so there is no CO2 emission, except in the building of the solar panels.

So I think this is really the direction. Because of the efficiency of electricity, in particular, and the cleanliness if you develop it from a clean source -- even from a dirty source -- even if you use background electric power grid, 30 percent reduction in carbon emissions.

If you really want to control all the CO2, plus the black carbon, plus the air pollutant that cause health, you get a 99 percent reduction of all your health effects, you really want to go towards this electricity and/or electricity plus hydrogen maybe for long-term long-distance trucking.

And it's just the technology is moving so fast. Right now, you can charge the Tesla Model S you charge it in one hour, you can go 310 miles with the 440 volt charger, 160 amps.

And I think that's really the direction to control all these pollutants simultaneously. And all these other efforts are going to be good to try to capture gas and stuff, but I think the more we keep focusing on combustion as a potential, the longer we're delaying converting to this large scale really clean potential energy source.

CHAIRPERSON NICHOLS: Good point.

Yes, Dr. Fischer.

DR. FISCHER: I think Mark raised a really good point. I think there should be also continued emphasis on public transportation and moving people to the extent it works into communities that don't require a lot of motor vehicle use.

Beyond that, with respect to your direct question on the existing sources, I'm not an expert on the details of the regulations for the air quality aspect, but I understand that some of the hesitance to adopting methane reviews revolves in part around a concern that that could have adverse impact on air quality. And I think that larger issue needs to be examined.

And then California already is doing very sensible things with respect to landfills. A lot of that really motivated by toxics being driven from the landfills by sub-surface pressurization, which was then mitigated as

a byproduct mitigated methane.

But just examining across the spectrum of sources for California, what the sort of combination of cost effective and environmentally benign -- those are always trade-offs -- options are is something that has been examined partially, but I think deserves some more examination because much of the earlier work has been a relatively narrow cost benefit analysis. And I don't know how many of you are familiar with the idea of life cycle assessment, but I think that might be a good direction to go.

CHAIRPERSON NICHOLS: Thank you. I think we're rather steep in that at the moment because of our work on the low carbon fuel standard. We've been pioneers.

BOARD MEMBER SPERLING: Not responding to that particular comment, but to what you said, it occurs to me that many of the policy options that are kind of floating out there, we're really already doing in one way or another. We have the mechanisms and probably -- and there are some additional things we could certainly do.

But it seems to me what we can really do is highlight both in an economic analysis, but highlight in terms of our actions the benefits with respect to these short-lived pollutants and really highlight it. And in that way, support what EPA might do and what

international. Because we've kind of ignored it. But it's there.

CHAIRPERSON NICHOLS: We've taken it for granted. We are already doing it. Why do we talk about it because it's already happening; right? I understand the point.

Dr. Lloyd.

DR. LLOYD: Yeah, suggesting the way you described it, Chairman, triggered to me a thought to pull together a task force to look at this wholistically the dialogue between Dan and Mark between what are the resources in California existing, but in the future, and what we can apply here. And methane for many years is just a throw away. It was non-methane hydrocarbons.

I don't think we've really done a good job maybe working with the CUC, but having a very focused short-term turn around effort explicitly on this and looking at the issues that may be effecting California, but may be working with EPA on the potential flaring issue.

And I have a question here I don't know. But the point is the extent of flaring -- and as Dan pointed out, why can't we use satellites on this sort of thing. Can we or not? Or are there resource in California and may be other places that can do that?

But I think having something focused on this and basically giving its own lifetime to methane in addition

to the other part I think would be very, very time --

CHAIRPERSON NICHOLS: It's enough to make anybody's head hurt.

But I know that people in southern California who operate sewage treatment plants and who went into using the methane to power motors and generate some electricity are facing requirements to control NOx at those facilities. They are having problems meeting the NOx requirements. They're talking about getting out of this business. And the air regulators have a very, very hard decision to make about where and how to push on this because nobody wants to make that trade-off between conventional air pollution and greenhouse gases.

But if we don't regulate very cleverly, we could end up making that tradeoff, whether we could it explicitly or implicitly. These are the kind of things we're kind of right in the middle of I think right now and have to deal with.

Did you have just a head nod? Okay. Thanks.

I think we've come to the end of the discussion. And it's been absolutely terrific. It's really an honor and a pleasure to have an opportunity to engage with this panel. We appreciate very much your coming over to speak to us.

I think what we should do probably is take a

five-minute break. And then when we come back, we have a very pleasant responsibility, which is to make some awards. So we'll see you all back here in about five minutes. Thanks.

(Whereupon a recess was taken.)

CHAIRPERSON NICHOLS: Okay. I'm very pleased to announce the last item on today's agenda, which is the Air Resource Board's Haagen-Smit Clean Air Awards. These awards are named after the Air Resources Board's first Chairman Professor Arie Haaen-Smit who was the first person to identify the role of photochemistry in the formation of smog.

And after I announce the winners and highlight their accomplishments, I'm going to ask them to join me at the podium. Actually, I think I'm going to have them join me over here on the steps to receive their awards for photos and then say a few words as well. So I think we have some slides here. I've never had my very own slides before.

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CHAIRPERSON NICHOLS: But we have a slide show that highlights the three winners. The first of the three recipients is Dr. Janet Arey for her work in the area of air pollution research. Second is Dr. Judith Chow for her work in the area of science and technology. And third,

Ms. Jananne Sharpless for her work in the area of environmental policy. So the three sort of span the key areas of our work.

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CHAIRPERSON NICHOLS: The first award to Dr. Janet Arey is for a person who has been teaching and conducting research on atmospheric chemistry for over 30 years.

In 1982, she jointed the Statewide Air Pollution Research Center at the University of California at Riverside. She is now a professor in the Department of Environmental Sciences and in the Environmental Toxicology Program.

She's an expert in atmospheric chemistry with a focus on ozone-forming pollutants and toxic air contaminants. Her work has improved scientific understanding of ozone formation and atmospheric reaction of toxic air contaminants. Her work confirmed important atmospheric processes that transform toxic hydrocarbons that are emitted by motor vehicles and other combustion sources. And her research has also included assessments of toxic constituents of diesel exhaust with different fuel formulations.

In other words, I think it would be fair to say a great deal of her research underlines much of the

regulatory work that this Board has done over the last decades.

Dr. Arey's expertise and commitment to public health is evidenced by her work with the World Health Organization and the International Agency for Research on Cancer. She has served on work groups supporting both of these international organizations, and she's also been honored as a Fellow of the American Association for the Advancement of Science in 2002.

In addition to her scientific research, Dr. Arey has also been a mentor to many. She has served as a graduate advisor to a number of students who are now working to improve public health and the environment in a variety of different settings.

So this award is not only a recognition but a way of thanking you for your many years of research that's helped to provide the foundation for ARB's action to protect public health and the environment. Thank you.

(Applause)

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CHAIRPERSON NICHOLS: The second award goes to Dr. Judith Chow who has 35 years of experience as a research scientist. She is a professor in the Division of Atmospheric Sciences at the Desert Research Institute in Reno, Nevada, just over the border. Dr. Chow is also the

founder and leader of DRI's environmental analysis facility. She joined DRI in 1985 after receiving her Doctorate of Science Degree from Harvard University. Dr. Chow is internationally known for her expertise in particulate matter pollution. She's worked to characterize and quantify complex atmospheric particles, establish monitoring and laboratory techniques, and analyze the composition of fine particulate matter and fugitive dust.

Her scientific work has been wildly used to support air pollution control efforts in California and around the world. She has participated in major health and exposure studies in Mexico, China, as well as the United States designing measurement techniques. Her studies that link atmospheric particles to sources of air pollution have supported numerous regulatory actions in the San Joaquin Valley and South Coast Air Districts.

Dr. Chow has also served on a number of scientific committees, including the National Research Council's Board of Environmental Studies and Toxicology, the Department of Energy's Atmospheric Radiation Measurement Science Board, and the Air Monitoring Subcommittee of the U.S. EPA's Clean Air Scientific Advisory Committee.

Thank you to Dr. Chow for your commitment to the

development of scientific methodology that have supported many of the California's clean air actions.

(Applause)

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CHAIRPERSON NICHOLS: And then the third award -- we are actually allowed to have three awards. This is a really a remarkable accomplishment is to Ms. Jananne Sharpless, who has been a leader in California public policy for 35 years. That seems impossible to me. She has served as a Cabinet Secretary for the Environment, the Chair of the Air Resources Board, and appointee to the California Energy Commission. So she's kind of done it all.

In these capacities, Ms. Sharpless has been a leader in promoting clean air and clean energy. Her efforts have helped provide the groundwork for transitioning California to the next generation of clean alternative fuels and technologies.

During her tenure at ARB, Ms. Sharpless led the Board in the development of regulations for cleaner burning gasoline and low and zero emission vehicles. In 1990, she presided over the adoption of the first ZEV regulation requiring auto makers to produce zero emission vehicles for sale in California. So she did the mandate, but then Alan got to star in the movie.

That mandate was groundbraking and visionary, providing international leadership and setting the stage for the next two decades of work on zero emission vehicles.

This year, ARB expanded and strengthened the ZEV program as a part of the advanced clean cars rulemaking. And it really built on the terrific work that Jan did.

During her tenure as Commissioner of the California Energy Commission, Ms. Sharpless was instrumental in establishing policies to support renewable energy in California. She also continued to define and establish California's leadership in developing and adopting energy efficiency standards.

For the past 18 years, Ms. Sharpless has served as Chair of the Health Effects Task Force of Breathe California, as well as a member of the Advisory Board of U.C. Davis Institute of Transportation Studies. She has also served on the U.S. Department of Energy's Advisory Board and on the Sacramento Transportation and Air Quality Collaborative, along with other public service activities, too many to mention.

Thank you, Ms. Sharpless, for your important contributions to improving California's air quality. Thank you.

(Applause)

CHAIRPERSON NICHOLS: Now I'm going to ask each of the award winners to come up to say a few words. I guess we'll do that part at the podium and then do some photos with everybody from the Board.

And while I'm running down there to hand them their awards, we can have any other Board members comment who would like to do so.

Does anybody have any other words they would like to add? This is just an opportunity for you all to say a word. So we'll start with this one. If you want to, is this microphone on. Here is your award. And we'll have a photo.

DR. AREY: I just want to say thank you. And over the years, I've had several opportunities to collaborate with the scientists at the California Air Resources Board and had many meaningful collaborations. In fact, some of my favorite memories are from field studies that was sponsored by the California Air Resources Board. I got to go to Torrance and Glendora and Claremont and see beautiful sunsets and sunrises. Unfortunately, when these occurred, I was on the roof changing filters.

As time went on, the graduate students got to go have the memories. And some of them are actually sitting in the audience now because they're working for the Air Resources Board. They got to go to Redlands and North

Main and Riverside and Banning and Pine Mountains.

But all of these field studies produced really important significant results. And the thing about it was that they compliment perfectly with the work we do in the lab, because we would put chemicals into our environmental chambers into reaction and sometimes toxic products and then go out into the field studies and see what was happening in the atmosphere and the reactions that were happening.

Each year in the spring at Riverside, we teach an introductory atmospheric science class. And this year, I have graduates in it. And of course, it's introductory atmospheric science, so we include early air pollution. And we always tell the students how California has always led the nation, not only they lead the way in understanding how smog occurs and how toxics are formed and transformed in the atmosphere, but also on regulations and things that actually work, making legislation that works.

So right now, in fact, probably this very minute because of the task is due tomorrow in class, the students are on your work site looking at the archived air quality data. And they've even been given a city and year in the South Coast air basin and looking '01 and '02 and ozone and making comments on the chemistry and looking upwind

and downwind. They're going to look in time. They'll see the difference between the 1970s and current things. So they'll get to know first hand how effective the work of the California Air Resources Board has been.

And so for me, it's very meaningful to get this award and I really very honored. Thank you.

(Applause)

CHAIRPERSON NICHOLS: All right.

DR. CHOW: Thank you. I'm very honored to have been granted such a prestigious award. I am especially humbled looking at others that prior and current recipients for whom I have respected and look at the stature and their achievements. Those I learned so much from them during my education and my career as an air pollution scientist.

The State of California provide one of the best opportunities for that in the world to give us opportunities to study and refining air pollution concepts. Dr. Haagen-Smit demonstrated that 60 years ago as part of his intuition looking at the causes of photochemicals map. But there's still plenty of opportunities for us today to look for new discoveries.

Over the years, I'm also have benefit from the excellent staff, policy makers, and the members of the Board for ARB, as well as research projects sponsored by

ARB who in central California and other work in California as well that together we have learned so much from many of the diverse projects over the past 25 years. Therefore, this award is as much of recognition their contribution as of my own.

I'm also grateful to those who submitted and supported my nominations. The future of air quality science is in controlling multiple pollutant and multiple effects. As Dr. Haagen-Smit was a pioneer in this area, during the early 1950s, he started Los Angeles phenomenon with chemistry. That's a good example of multi pollution air quality management.

And this morning, we heard a lot of issues including transport from China that effect the pollution in the west as well as long and short-lived climate pollution. So that our future I believe is not only to try to understand -- better understand the interactions among air pollutants and their diverse effects, but also to transfer this knowledge to other countries so they can also achieve the clean air benefit that are being attained in California. Thank you.

(Applause)

DR. SHARPLESS: Well, it was a real joy to be able to sit in the audience and listen to the discussion of the last item. It sort of brings back really fond

memories. And Mary and I go back a long ways. She was both my predecessor and my successor. So congratulations, Mary, on that feat.

I do want to thank everyone for the award. I'm grateful to those who have nominated me and to those who selected me to receive this award.

I'm also honored and feel truly humbled to be given this award, by its very name, Haagen-Smit, represents perhaps the highest recognition that one involved in the air quality arena could receive in the state of California.

I appreciate the glowing remarks of your Chairwoman Nichols, particularly in light of her own illustrious accomplishments.

As we all know, such accomplishments cannot be done by one person alone, but takes the efforts of many. And I would like to take this opportunity to thank those who have given tireless efforts and dedication in making these strides possible during my tenure: My former Board members, the incredible staff at the Air Resources Board that I look around and now see have white beards and less hair. So it's pretty amazing. But they were terrific and they still are terrific.

The support of the NGOs representing both the health organizations and the environmental organizations.

The important research that we just heard about conducted by academia that fed into our regulatory process and those, yes, in the industry who met the challenge, developed the technology, and often exceeded the goals.

There are many who helped me along the way. And there are three colleagues that I would like to name who have since passed away who will especially helpful to me: John Doyle, my very able assistant; Chuck Ingret, a former Assemblymember and Chairman of the California Energy Commission; and Carl Moyer, who many of you in this room will remember.

I'm proud of the vision and the legacy which has been the landmark of this Board. The goal has always been to protect public health. And while those who succeeded have made substantial progress in meeting this goal, there is still a lot of work that needs to be done.

I've been pleased to see that subsequent Boards have continued to support and strengthen the fuel standards, the mobile source standards, and particularly the ZEV portion of the program. It's awesome to see so many growing numbers of vehicles on the road today.

I offer my congratulations to those who have persevered and kept the faith that we could have electric hybrids, all-electric, and fuel cells occupying our roads, despite the hue and cry of the naysayers.

Having gone through similar battles, I acknowledge and applaud those who continue to put in the hard work and show the courage to go up against significant forces.

In my day, our focus was meeting the clean air health-based standards for criteria and toxic air contaminants. It wasn't an easy task then. But in today's world, you face even greater challenges of stricter health-based standards, designing new strategies, and carrying out a whole new regulatory realm of global climate change, emission reductions.

However, given its history and record to date, I have no doubt that the California Air Resources is up to the task and will continue to provide the leadership that it has so well been recognized as having. I feel privileged to have been able to play a part in helping to provide a healthy environment to the citizens of the state. And I will continue to support and advocate in any way I can toward California reaching the ultimate goal of clean air and health lungs for every man, woman, and child in the state. Thank you.

(Applause)

CHAIRPERSON NICHOLS: I'm going to ask if the award recipients can make their way up to the platform here. I think it's doable for everybody. And if we could

have a picture with all the Board members with the flags there. That will hopefully be a memento for everyone. There is a ramp up here. It should be doable.

No one has signed up for public comment, so we will be adjourned for our lunch break. And we will be back here -- we are adjourned. There is a public session this afternoon on use of revenue from auctioning of cap and trade analysis. That will be at 1:30. Thank you.

(Whereupon the Air Resources Board adjourned at 11:56 a.m.)

CERTIFICATE OF REPORTER

I, TIFFANY C. KRAFT, a Certified Shorthand Reporter of the State of California, and Registered Professional Reporter, do hereby certify:

That I am a disinterested person herein; that the foregoing hearing was reported in shorthand by me, Tiffany C. Kraft, a Certified Shorthand Reporter of the State of California, and thereafter transcribed into typewriting.

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

IN WITNESS WHEREOF, I have hereunto set my hand this 8th day of June, 2012.

_____

TIFFANY C. KRAFT, CSR, RPR
Certified Shorthand Reporter
License No. 12277