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CALIFORNIA ENERGY COMMISSION

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Achieving Zero Emission)
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Buildings)
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WORKSHOP

CALIFORNIA ENERGY COMMISSION

1516 NINTH STREET

FIRST FLOOR, ART ROSENFELD HEARING ROOM

SACRAMENTO, CALIFORNIA

THURSDAY, JUNE 14, 2018

10:00 A.M.

Reported by:

Peter Petty

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PRESENTERS

Presentation on the Current Landscape of Multifamily Sector

Zack Subin, Energy and Environmental Economics

Presentation on Current and Projected Fuel Use in Buildings and Associated Greenhouse Gas Content

Martha Brook, Advisor to Commissioner McAllister, California Energy Commission,

Presentation on the Berkeley Energy and Resources Model and Building Decarbonization

David Roland-Holst, University of California at Berkeley

Presentation on Building Decarbonization Research

Laurie ten Hope, California Energy Commission

Presentation by California Air Resources Board Staff on Building-Related Emissions

Dana Papke Waters, California Air Resources Board
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Panel 1
Moderator: Brian Samuleson, California Energy Commission
Panelists:
Jonathan Abendschein, City of Palo Alto Utilities
Rebecca Andreassen, City of Los Angeles- Vie WebEx
Barry Hooper, City and County of San Francisco Department of the Environment
Owen Howlett, Sacramento Municipal Utility District
Rachel Kuykendall, Sonoma Clean Power
Erin Brooks, Southern California Gas Company
Kevin Wood, Southern California Edison

Panel 2
Moderator: Heriberto Rosales, California Energy Commission
Panelists:
Sean Armstrong, Redwood Energy
David Lis, Northeast Energy Efficiency Partnership- Via WebEx
Ed Murray, for California Solar & Solar Storage Association
Scott Shell, EHDD
Ted Tiffany, Guttman & Blaevoet
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Jim Lutz, HWR

Mindy Craig, Blue Point Planning

Dan Aas, Energy and Environmental Economics

Alice Sung (via WebEx written question)

Jim McMahon (via WebEx written question)

Tom Kabat (via WebEx written question)

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P R O C E E D I N G S

10:02 A.M.

SACRAMENTO, CALIFORNIA, THURSDAY, JUNE 14, 20

MS. RAITT: Welcome to today's IEPR Workshop. So like I said, so we're going to start on this workshop on Achieving Zero Emission Vehicles -- good morning. Excuse me.

I'm Heather Raitt, and I'm the Program Manager of the IEPR. And I'll just go over a few housekeeping items.

If there's an emergency, please follow staff through the doors, across the street to Roosevelt Park.

The meeting is being broadcast through our WebEx conferencing system, so it's being recorded. And we have folks participating remotely. The recording will be posted on our website in about a week. And we'll also have a written transcript in about a month.

We do have a very full agenda today, so I'd like to remind our speakers to please stay within our allotted times. And we are going to have a ten-minute opportunity for clarifying questions before the noon break, but it's going to eat into our lunch hour, so we'll do a little

bit shorter than our one-hour lunch hour if people do have clarifying questions that they need to raise before that break.

And so folks on WebEx, you could raise your hand using the chat function to let our WebEx coordinator know if you have a question or comment.

And for folks in the room, go ahead and fill out a blue card and give it to me and that will let us know that you have a question or a comment.

And written comments on this workshop are welcome and they are due on June 28th. The notice provides all the information you need for submitting written comments. And all the materials for this workshop are posted on our website and available at the entrance to the hearing room.

So with that, I'll turn it over to the Commissioners. Thank you.

COMMISSIONER HOCHSCHILD: Well, good morning and welcome. And special thanks to staff for putting together a terrific and very full agenda. We've got a lot to get through today, so I won't belabor that, but just to say that,

obviously, this is a topic that has been a focus, both of our R&D activities and of a lot of policy making, including the Residential Housing Program that was just adopted, and a lot of discussion around this in other states, as well. So I'm very pleased to join Commissioner McAllister this morning for this day.

COMMISSIONER MCALLISTER: All right. Thank you, Commissioner Hochschild.

And just, I'll have brief comments, maybe a little more than Mr. Hochschild's, but --

COMMISSIONER HOCHSCHILD: That's fine.

COMMISSIONER MCALLISTER: So, you know, this is a topic whose time has come. I mean, this is -- decarbonization is where -- is really the essence of our state energy policy, at all levels. And so we're talking about buildings now as a piece of our overall kind of puzzle, you know, landscape of how we decrease emissions.

I guess, you know, Heather's initially said -- I think it talks a lot about zero-emission vehicles. You know, we have that whole thing going on, too, but that's sort of -- that snafu or whatever, that misstatement, actually is very apropos because our buildings and our cars

actually are increasingly interacting on the same platforms, and in real-time across the electric grid.

And, you know, in fact, in a lot of ways, we know more about a used car that we're looking to buy than we do about a home that we're looking to buy. You know, you get the VIN number and you've got the whole history of that car. Well, we don't have anything equivalent for our buildings. And so, you know, we need to understand the building sector more, so that we can guide it with policy that is judicious and makes sense and is cost effective, and all the things that's statutory that we have to do.

And finally, I just want to put a little bit of context around the building standards that we recently adopted. You know, as we move -- as we've moved towards, you know, RPS with, you know, higher percentages of renewables, and also looked at how to improve and optimize our building stock with our new construction and our existing buildings, you know, over time, over the last decade or so it's become clear that the paths of emissions, per se, and energy are diverging; right?

So if you do the numbers, you know, a zero-energy building, a net-zero building, as we've sort of been talking about since 2007, is not a zero-net carbon building. It really depends on the time of generation. It depends on a lot of different factors. And so netting out energy over the course of a year really isn't -- it's not the thing anymore. It doesn't get us where we need to go.

And from a policy perspective, it's a little bit of a diversion, of a distraction. Now, certainly, I'm not going to criticize zero-net energy buildings, I think they're great, and I admire people who do them. I'm doing one of those myself, actually. But I think as a matter of policy, we need to sort of go for the jugular, which is emissions; right?

And so that's why the Building Standards do what they do. They're looking for flexibility in the application of technologies that both allow decreased emissions, but then also allow for flexibility and grid responsiveness and all that kind of stuff. So the topics are -- they're related to buildings, but they're also related to our larger policy environment.

So anyway, I hate to get -- I don't want to get too broad here, but I want to put this context in, this workshop in context. Look, decarbonization is the name of the game and it's hard. You know, building a zero-carbon building is harder than building a net-zero-energy building. So as we move forward, we need to really try to rise to that challenge and look for creative ways to do it. Because the grid, you know, as all these EVs come on the grid, as loads increase on our existing distribution grid, the distributed realm has to come to the service of the distribution grid. You know, we can't just count on deus machina, a transmission line, a theoretical transmission line bringing utility-scale power into Downtown Oakland, let's say, if we have all this new load. And, you know, that's -- we have to have a -- we have to sort of consider all options.

And so one of our best options is to have our buildings become part of the solution and be a platform for those distributed technologies that are going to let us solve this problem at the same time we go to low emissions.

So anyway, that's a little bit of the

vision. I hope most of you share it, because I think we really are going to depend on actions, on millions of actions across California by Californians, by property owners, homeowners and business owners to get our existing buildings highly optimized, and also new construction where it needs to be, so that it doesn't keep contributing to sort of the emissions growth.

And with that, I will pass it off back to Heather to get started with our opening or with our first presentation from Martha Brook, but I want to thank you all for coming. I want to thank staff, as well, for organizing what's going to be an action-packed workshop and just a really substantive workshop and one that's really important for California for the long term, so thanks.

Back to Heather.

MS. RAITT: Sorry, we just had a little snafu with the slides, so we'll get back to Martha.

But I'd like to move to Zack Subin quickly, if Zach could join me? Thank you. You can come up here.

MR. SUBIN: Are the cameras on today or

is that just for the room?

MS. RAITT: No.

MR. SUBIN: No? Okay. Good.

MS. RAITT: No cameras today.

MR. SUBIN: My name is Zach Subin. I'm going to be presenting some work that a bunch of us have been working on at E3, Energy and Environmental Economics in San Francisco. And the work was led by Amber Mahone, who unfortunately couldn't make it today,I'm going to be talking about long-term energy scenarios in California and focusing on applications for building decarbonization.

So we recently finished a set of economy-wide scenarios for 2050, looking at the costs and risks of different pathways to reaching the 2050 emissions targets. We used the Pathways Model, which is an infrastructure, an economic infrastructure model, energy infrastructure that covers all sources of GHG emissions across the economy, including demand, different kinds of energy supply, as well as non-combustion emissions. And this is the model that was previously used for some of our work on the statewide long-term emission scenarios for the

CEC back in 2014, along with some other state agencies. And I'm going to focus today on implications from these scenarios for building decarbonization specifically.

We also have a follow-on study underway to take a deeper dive on implications for the natural gas system and building decarbonization. So I'll conclude by discussing our planned focus for that study.

We, for our economy-wide analysis, developed three kinds of scenarios. We had a counter factual reference scenario, a turn policy scenario, and then ten different mitigation scenarios that each met the 2030 and 2050 climate goals for the state.

So I'll focus on two of those scenarios that had relevance for building decarbonization. And these two scenarios can be thought of as bookend building decarbonization strategies. Both of the scenarios include high electrification of transportation, high levels of renewables, and limited biofuels.

In addition, the high electrification scenario includes near-complete electrification of buildings by 2050, while the new building

electrification scenario with power to gas excluded all forms of building electrification and instead included synthetic methane and renewable hydrogen in the gas pipeline, as well as deeper emission reductions in other sectors to help meet the overall economy-wide fossil carbon budget.

And we really want to think of these two scenarios as bookends along a continuum. For this study that we recently completed, we didn't evaluate any hybrid scenarios that included both new heat pumps and new sources of renewable natural gas, but that could also be something of interest. We also didn't evaluate for this study using high biofuels as a source of renewable natural gas for buildings.

So what we see in the economy-wide analysis is that all of the sectors have to make a large degree of progress to meet the 2050 goals. And we're showing here the emissions by sector over time. And you can see the remaining 2050 emissions are really dominated by a few challenging sectors, including off-road transportation, jet fuel, industry gas, and agricultural methane. So that means that some

other sectors, like electric vehicles and building might have to actually reduce greater than 80 percent, of their emissions, to meet the economy-wide target.

And it's also important to remember that we're not stopping in 2050. This is supposed to help us be on a trajectory to eventually zero emissions, which is what we need to do globally to stabilize climate. So deep decarbonization strategies for buildings are critical.

We tended to talk about four pillars of deep decarbonization in our analysis; energy efficiency, electrification, low-carbon fuels, and non-combustion emissions. Each of these four pillars have corresponding strategies in buildings. And the strategies need to be broader in scope than, you know, is often thought about. So in energy efficiency, we're talking about whole home retrofits and, potentially, natural gas heat pumps, as well as conventional heat.

The middle two strategies comprise our strategies for decarbonization of the energy in buildings in electrification and low-carbon fuels, specifically renewable natural gas. So some combination of these two strategies are

critical, but they need a long time to have their full impact because of the challenges of stock rollover and scaling up technology.

So most existing buildings in our scenarios will need to be -- to have their heaters replaced with electric heat pumps or very high-efficiency natural gas furnaces and heat pumps by 2050. And to retrofit existing buildings for heat pumps likely entails incremental costs relative to electric heat pumps in new buildings. But nevertheless, that might be necessary to meet the GHG goals.

So one of the advantages of the Pathways Model is that we can see how changes in sales propagate through to changes in the building stock. So the chart on the bottom left shows the percent of new sales, including, you know, replacing existing appliances on burnout in buildings, in existing buildings for residential space heating in the high-electrification scenario. And you can see the majority of new heaters in this scenario by 2030 are the pumps, electric heat pumps. And 100 percent of new sales are electric by 2040. Nevertheless, if you look at the bottom right at the space heating

stocks, we still have a small fraction of gas heaters remaining in 2050, and that uses some of the biofuel, as well as fossil fuel budget for the economy.

Any delay in transforming the building stock could lead to additional costs later by forcing the need for additional retrofits or early retirements. So we need to reduce natural gas use in buildings, both by efficiency, as well as substitution with electricity, bio methane, or power-to-gas.

So in these two charts we're showing the building energy, total building energy consumption from the two scenarios, the two bookend scenarios. And both scenarios through 2030, you can see that efficiency reduces the total building energy demands. But after 2030 the story is dominated by fuel switching. So in the top panel, which is the high-electrification scenario, nearly all the building energy is electric by 2050. With less building electrification, we have to add in some combination of higher biofuels, very aggressive energy efficiency, or power-to-gas.

In the scenario we're showing here we

included power-to-gas, as well as reallocating some of the biofuels from transportation in the high-electrification scenario to buildings to meet the economy-wide GHG budget. So the biomethane supply is a critical constraint for these scenarios. So I'd like to talk some more about the biomethane supply.

Biomethane is a form of renewable natural gas, along with climate-neutral hydrogen or synthetic methane, meaning that it's produced with renewable electricity or CO2 derived from a climate-neutral source, like atmospheric CO2.

To guide the conversation about biofuels, I'd like to distinguish four tranches of biomethane potential.

So the first tranche, it consists of waste products, like landfill gas and methane from manure. And this is the tranche that can be relatively inexpensive and also has co-benefits in the form of avoided methane emissions to the atmosphere. However, estimates of this potential are at least in order of magnitudes smaller than statewide natural gas demand. And I'll also note that only a fraction of manure can necessarily be efficiently, cost effectively centrally

processed.

The second tranche consists of agricultural and forest residues in general from in-state sources that can be basically gasified to produce biomethane.

And the third tranche consists of similar resources from out of state within the U.S.

And then the final tranche includes more speculative sources, including purpose-grown crops and forest plantations, potentially algal biofuels. And it's important to realize that this -- while this tranche could be the largest in potential, it's also associated with large sustainability concerns.

So we assessed the likely sustainable biomethane supply in California and compared it with natural gas demand in 2050. So this is shown as two supply curves to the left and contrasted with natural gas in the vertical lines to the right. So in 2015 the economy-wide natural gas demand, excluding electricity generation, was about 1.6 quads. And then we think by 2050, with very aggressive industry efficiency, as well as high-efficiency natural gas furnaces in buildings, the gas demand might

come down to about one quad, a little bit more than one quad, without building electrification.

However, the population-weighted share of U.S. biomethane potential from non-purpose grown resources is only about half this quantity. So we need some combination of electrification or additional sources of RNG to fill this gap.

Because of the limited supply of inexpensive RNG, the high-electrification scenario appears to be a lower cost in our scenarios on an economy-wide cost metric by avoiding dependence on reach technologies, like power-to-gas.

I'm showing an abatement cost curve, showing the dollars per time for different measures for a 2050 snapshot in the high-electrification scenario.

The blue measures to the left include efficiency, electrification and renewables. And this includes electric heat pumps which are found to have no incremental cost by 2050, although we did not have data available to include the incremental cost of retrofits for this study. And we think that could modestly increase the cost of heat pumps on the scale of this metric.

The grey measures to the right include reach technologies that might be needed to meet the target if other measures fall short. And we need to rely on some of these measures in the no-building electrification scenario. And it's possible that innovation could reduce the costs of these reach technologies, compared to what we're showing here.

But the total economy-wide costs are not the whole story. There's really two sets of contrasting challenges and risks for these two different strategies for building energy decarbonization.

So building electrification might be the lower cost option if it could be feasibly executed, but it is a consumer-facing strategy, so we need successful policy. We need to overcome the consumer barriers of the cost and hassle of retrofits, the increased up-front capital costs of heat pumps in general, potentially, and the lower consumer acceptance of electric stoves compared to gas stoves, although induction stoves could be an alternative.

There are also a number of concerns if gas throughput were to decline substantially with

stranded assets and equity concerns further remaining natural gas customers.

In contrast, renewable natural gas has the advantage of being a drop-in fuel, so it has little direct consumer impacts, other than costs.

It is a supply-side approach, and thus all the risks and challenges are on the supply side associated with whether the technologies are ready, whether there's enough resource potential, whether it's cost effective and sustainable. And we're really talking here about advanced approaches like growing, you know, miscanthus (phonetic) or switchgrass in the Midwest, gasifying it and sending it in the pipelines to California, or using direct air capture to get climate-neutral CO2 to make synthetic methane.

So because of these ongoing, unresolved questions, we have -- our next project with the CEC that is now underway focuses on the future of natural gas in California in the context of decarbonization.

So in this project, we're going to focus a little bit more deeply than in the just-completed projects on several areas, including updating our forecasts of RNG technologies with

partners at UC Irvine, including costs for building retrofits and costs associated with any phase down of a gas pipeline in high-electrification scenarios, as well as moving from just a kind of an economy-wide total resource cost metric to looking more closely at participating in utility cost perspectives to look at distributional impacts. And then finally, we're including an environmental justice component that will examine impacts, both in terms of cost and air quality for disadvantaged communities. We expect the results will be available next year.

Thank you for your attention. And our full presentation on the CEC EPIC Project is available on our website.

(Applause.)

MS. RAITT: Thanks. And I apologize for the change of order, but we'll go to Martha Brook next.

COMMISSIONER HOCHSCHILD: While we're waiting, you know, I thank you for the presentation. You know it's a good presentation when you get a round of applause. We never get a round of applause here. But let me just make one

point, which is the *Wall Street Journal* came out this week with what is basically globally, $297 billion was spent now on renewables, all coal, all nuclear and fossil capacity at $143 billion. So we're basically spending double on renewables than we are on fossil and nuclear capacity.

And looking ahead, the role of those that retrofit, to be able to assist with renewable information, I think is really important. I know it's not the main focus of your work, but I do think we need to be looking carefully at the ability of buildings that are fully electrified to help with that integration. And to what degrees we adopt higher and higher portions of renewables on the grid, what is the role of buildings in that?

But thanks for a terrific presentation.

MS. BROOK: Thank you. I'm Martha Brook. I'm an Advisor to Commissioner McAllister. And the topic of this brief presentation is really just kind of just to remind everybody what the baseline is for fuel use in California buildings and talk a little bit about why we think building decarbonization is achievable and also, you know, just kind of to just to lightly touch on the

issues that the rest of the agenda participants will be diving into in much more detail.

So this is the California emissions inventory, kind of refigured so that buildings have its own little chunk instead of being separated into the classical electricity buildings in there, and then there's also fuel use in buildings, and they are separately carved out in the Air Resources Board version of the inventory. So what this does is it takes the California Air Resources Board inventory, uses our Electricity Demand Forecast to share out the electricity sector into buildings and industry and agriculture. And then, basically, the result is about, you know, a quarter of the emissions is due to energy use in buildings, and refrigerant emissions that are related to buildings.

So if you think about -- you know, Zack talked about, you know, buildings doing maybe potentially a lot more than their share of the 40 percent below 1990. If you just look at the 40 percent below 1990 levels, by 2030 the blue, you know, quarter there would have to -- if there was no growth in demand, then it would have to be, you know, 40 percent of that number, of that,

basically, blue section. But because there is growth expected by 2020 -- 2030 in the Demand Forecast, it turns out to be about 60 percent of that blue quarter would have to be reduced to meet the 40 percent below 1990 levels. Makes sense; right? Because you have to account for the demand, and you also have a fixed reduction of the 1990 level.

It was interesting, when I looked at the inventory trend between 1990 and 2015, it's basically the same for buildings. And the reason is that residential gas use goes up, but commercial gas drops a little bit between 1990 and 2015. And then although electricity use increases for buildings, the emissions from electricity are significantly better now than in 1990. And so the result of all that is in 2015, we were about the same number in emissions in the building sector than we were in 1990.

So why else is it a good idea to think about limiting fossil fuels in buildings? Besides the emissions, which we've talked about being -- the fossil fuel component of building use turns out to be about ten percent of the California emissions. And other issues with

fossil fuels is that they produce NOx and carbon monoxide and other hazardous pollutants. And also, that we live in very constrained, you know, air basins for most -- most of us do; 93 percent of Californians live in ozone non-attainment areas. And because NOx is a precursor to ozone, we have to worry about fossil fuel use burned in the state.

So the Pacific Coast Collaborative -- so the point of the next two slides is just to say that we're, and David mentioned this, too, we're not the only ones thinking about this. And, in fact, the whole, you know, North American West Coast has been talking about it and working on this. And the Pacific Coast Collaborative represents the world's fifth largest economy. So between British Columbia, Washington, Oregon and California, we have 55 million people and a combined $3 trillion GDP.

So Pacific Coast Collaborative is made up of the Province of British Columbia, and then Washington, Oregon and California State, so then the cities of Vancouver, Seattle, Portland, San Francisco, Oakland and Los Angeles. In 2016 the Pacific Coast Collaborative committed to lower

the carbon intensity of heating fuels in residential and commercial buildings. And we're calling this thermal decarbonization.

So the pathways that we've identified in the working group for thermal decarbonization in the Pacific Coast Collaborative, very similar to what Zack mentioned. We had three of the four, you know, colors, electrification, renewable natural gas, and energy efficiency. So this is a big chunk of what we're talking about today and in the IEPR chapter in terms of building zero-emission buildings, but's narrower. So the Pacific Coast Collaborative work is really focused on water heating and space heating, so the thermal fuels used in buildings.

And when we talk about zero-emission buildings, and we've invited Air Resources Board specifically to talk about refrigerant emissions, and that turns out to be quite significant and an area we really need to focus on, to not ignore the fact that as we potentially use more heat pumps and they use refrigerant that have a very high global warming potential, well, guess what, refrigerant leaks. We know that and we have -- and ARB has programs to try to deal with that,

but we can't ignore that issue.

(Sneeze from audience member.)

MS. BROOK: Bless you.

So I'm going to dive down into the building sector now in California, just to set the baseline for how big of a challenge we have. And basically, it's 50-50. Commercial and residential buildings is a little bit more electricity than gas, but it's pretty closely split even-Steven. What is dominated here is that 70 percent of the gas use is in residential; right? So it's not 50-50. It's really dominated by space and water heating in California homes. And then the rest of it's made up in commercial buildings.

So this is the end-use breakdown for gas use in California homes. And at first, it looks like there's a lot going on here, but in reality, so, basically, you know, a little less than half of space heating. And then water heating, although shown here to be only about a quarter, it also -- water heating, also, is what is driving the clothes washing wedge and the dish washing wedge. So basically what you have is about 44 percent and about another 41 or

something for water heating, and then cooking and drying and cool/heating, which is also water heating. And so most of this is space heating and water heating. That's the point of this slide.

And this slide takes a little bit of time to digest. I, on purpose, didn't want you to read the percentages, so that's why they're relatively small. I think you just -- visually, there's two things going on here. This is the whole commercial sector gas use. So it's not only how much gas specific building types use, but it's also, how many of those building types are in California; right?

So if you take a large office, for example, it's showing up as the second biggest gas use in commercial buildings. Well, large offices by themselves typically use less. Like around 20 percent or so, of the emissions from large offices is due to water heating and space heating gas use. But because there's so -- there's quite a bit of large offices in the state and they use a lot of energy, they're kind of ramping up and getting closer to, you know, things we need -- a building type we need to focus on if we want to deal with gas use in

California buildings.

The other end of that example is that on this chart, schools and colleges are less than ten percent each, eight percent and seven percent. But if you looked at the percentage of gas used in schools and colleges, they're our biggest -- in terms of all of the energy that a school or college use in the state, more than half is gas use. So they actually rank high on the percentage of gas use used. But because they don't -- there's not that many of them in relation to other building types and they don't use as much energy overall as other building types, they kind of fall down on this ranked order of gas use in the state.

So another look at gas use in homes, basically, a different way to summarize what I just said. So what this is that -- so you take all the energy use in California homes and then you say how much of that overall energy use is gas by end use? Ninety-six percent of our space heating is gas. Ninety-five percent of our water heating is gas. Seventy-five percent of our cooking is gas. And over half of our clothes drying is gas. So, you know, just a little bit.

That's a big challenge. And it's good to have these baselines, so that we can understand the challenges and address them head on.

Similarly, in commercial buildings, space heating and water heating, most of it's, you know, close to 90 percent. And cooking, obviously, for commercial cooking is gas. And then miscellaneous, which is probably, you know, processed gas in commercial buildings. And then cooling and refrigeration or kind of on the lower end of the spectrum.

COMMISSIONER HOCHSCHILD: Martha, sorry. Can we go back a couple slides to the residential? Keep going. Keep going. There. Just I want to just make sure I'm understanding this.

Just on the water heating, okay, because, obviously, clothes washing and dish washing are using hot water, but they're also using electricity.

MS. BROOK: Yeah.

COMMISSIONER HOCHSCHILD: So is the -- what portion of the water heating is captured by the -- I mean --

MS. BROOK: It's all, so it's all of it.

COMMISSIONER MCALLISTER: This is all of it.

MS. BROOK: So this is how our -- this data is from our Demand Forecast.

COMMISSIONER HOCHSCHILD: Right.

MS. BROOK: And what we do on the Demand Forecast, and I probably should have simplified this and just threw it all into water heating, but because dishwashers also use hot water and clothes washers also use hot water, our end-use forecast breaks those out as separate end uses, but it's all hot water.

COMMISSIONER HOCHSCHILD: Right. So let me ask it a different way.

Like if we were to max out all water heaters with heat pumps, in other words, how much -- what portion of the residential natural gas use is being displaced? Is that 23 percent?

MS. BROOK: No.

COMMISSIONER HOCHSCHILD: Is that --

MS. BROOK: It's over 40.

COMMISSIONER HOCHSCHILD: -- over 50?

MS. BROOK: It's over 40.

COMMISSIONER HOCHSCHILD: Plus 11 plus 7?

MS. BROOK: Yeah. Yes.

COMMISSIONER HOCHSCHILD: Okay. So we're not counting -- I mean, in that 7 and 11, we're not counting the electric use of the dishwasher?

MS. BROOK: That's right.

ADMINISTRATIVE LAW JUDGE MCCARRICK: Got it.

MS. BROOK: This is just gas.

COMMISSIONER HOCHSCHILD: Got it.

MS. BROOK: And so like for -- and what I was thinking for our chapter is that we would either combine those into all one water heating or just have an indication on the chart that that's all water heating. Thank you. Okay.

So why do we think it's a good idea to electrify to reduce emissions? So this is, basically, a statewide average emission intensity summary. And it looks at the forecast period of 2019 to 2030. This is from our Supply Analysis Office here at the Energy Commission. They do a production cost model and the do post-processing to calculate emission intensities. So green is good. Red is not so good. And as you can see over time, we have less dark red and more green. And definitely, it shows the difference at time of the day. We're still using gas and other

emission, you know, high-emission generation in the evenings and in the mornings, but it gets -- it's getting better over time.

So this is just taking the two end points, 2019 and 2030, just to show the contrast. And, you know, basically, this is -- well, the next two slides is basically why we think it's a good idea to focus on electrification in buildings.

So this is the building's perspective. Now one thing I'll have to say as a caveat and one of the things we mentioned in last week's workshop is these are average emission intensities. And we know when we start thinking about reducing emissions through -- or either way, changing the emission profile, that we need to look at marginal emissions, and we're in the process of doing this, so this will change. I don't know how much it will change. But the point of this slide is it's relative to natural gas, so it's the electricity emission intensities relative to the emission intensity of natural gas. And so if it's really, really light pink or really, really light green, it's close to natural gas. And if it's -- if it's greener, it's better

than natural gas. And if it's redder, it's worse than natural gas.

This is 2019. And --

COMMISSIONER MCALLISTER: So I want to just make sure, I'm not sure everybody in the audience will have seen visuals like this, so just maybe explain. So there's a little square for every hour of the year, right, and model for a given year; right?

So the -- backing up, the point here is so that folks can understand and appreciate the time varying nature of carbon emissions.

MS. BROOK: Uh-huh.

COMMISSIONER MCALLISTER: And so hopefully that's clear to you. I just wanted to be --

MS. BROOK: Absolutely.

COMMISSIONER MCALLISTER: -- completely (indiscernible).

MS. BROOK: Sorry. Sorry. And I'm sorry that you can't read it. Across the top are the months of the year. And then across the vertical are the hours of the year. So the mornings are at the top. The evenings are at the bottom. And then it goes from the beginning of the year to

the end of the year from left to right.

And Andrew is right, this is the -- oh, the other thing that's important to note here is this is a building's perspective. And so the electricity emission intensities are bumped up to be a little higher to account for the transmission distribution losses. We're assuming no losses on the gas side. And so -- and that's because of our uncertainty year-round fugitive emissions, so we don't have a good handle on that right now, and that's certainly an area that we know we need to discuss. So you can see that this would change significantly if we included fugitive emissions in the gas distribution system.

So 2019, 2030, it looks pretty darn good; right? I mean, you see a lot of green. So the summary of these two slides is that from the building's perspective, which is what we're talking about today, electricity is cleaner than natural gas 40 percent of the time now. Forty percent of the hours in those charts, electricity is cleaner than gas. But by 2030, 70 percent of those hours are cleaner than natural gas emissions. So, you know, that's really why we're

thinking of, you know, discussing all these high-electrification scenarios.

Okay, so this is just an example of -- and I know we're not talking in detail today about building energy code, but this is just an example of -- and we will be in our chapter about where decisions will be made going forward. And Andrew mentioned it this morning as if you focus on emissions, then we have some work to do in our building standards.

And what you see here is two areas of the state, Sacramento and Los Angeles, so inland and coastal. Sacramento is at the top. Los Angeles is at the bottom. Our new home building standard that will go into effect in 2020 on the left has gas water heating, gas appliances and gas space heating. And on the right it's they're all electric homes. They have much different emission profiles.

So these are emissions, using the hourly emission intensities I just showed you in 2019, so this is just looking at 2019. The difference between these two is going to be significantly different in 2030 because the emission intensities are different, just as I showed you.

But what you see is that either inland or coastal, there's about a one ton per home difference in emissions between homes that use gas and homes that use electricity. Both of these homes are built to the just-adopted building standard, so they what we assume to be relatively equal energy costs because that was the metric in our building standards, but they don't have equal emission profiles.

So to summarize the differences between those graphs, this chart is just to try to summarize the difference, okay? So on the left, again, Sacramento and Los Angeles, the emission reductions going from left to right on the previous chart, inland, 65 percent of those reductions come from space heating and 20 percent come from water heating. On the coast where there is hardly any heating, 55 percent comes from water heating reductions and 32 percent comes from space heating. So roughly the same flip; right?

So I think that, to me, that means that potentially we don't have a one-size-fits-all kind of building standard. We might have to focus and have different requirements. Like we

do now sometimes in our efficiency standards, based on cost effectiveness and, you know, how measures apply with different climate conditions, we might have a more stricter standard inland for space heating, for example, and a more stricter requirement for water heating on the coast because of these emission reduction potentials.

And then to the right, this is just sort of to introduce the concept that we're also talking about refrigerants and leakage from refrigerants. So if you just take the remaining emissions if you went all electric, so you just got rid of the gas space heating and the gas water heating and the gas cooking and clothes drying, and what's left, based on, you know, typical assumptions that ARB uses in their Refrigerant Program for leakage of heat pumps and air conditioners, the dominating emission is now refrigerants; right? So you've electrified, but you're not done. We haven't gotten to zero. So this is just to indicate that refrigerants is very significant. And if you're thinking about zero emissions, we have to acknowledge that if we're putting all our eggs in the heat pump basket, heat pumps can leak.

Okay, and the other things are pretty self-evident, so I'm going to keep going.

So this is just an example of -- the next two slides are just two different commercial building examples. Again, just to acknowledge that once you electrify, you're not done in terms of getting to zero for building emissions. So large offices, you remember, they were the second biggest total gas use in commercial buildings, but they only use 15 to 20 percent -- only 15 to 20 percent of these emissions comes from gas space and water heating, so we -- so we're going to depend more and more on a renewable grid. And again, this is 2019. So in 2030, everything except for heating and water heating will shrink. And in proportion, water heating and heating emissions will get a little bigger, right, because the electricity sector is getting cleaner. And so it will change over time. But again, just to emphasize the fact that we're not done once we electrify.

Here's a retail store with refrigeration, so like a Walmart or a Target that has some food store elements. Refrigerant leakage, if you're commercial building has significant

refrigeration, then over half of your emissions comes from refrigeration, either the energy use of the refrigeration or the leakage of refrigerants, and ARB is going to talk much more about that.

And let me see if there's anything else I wanted to mention? Oh, I think that is it. That's it for me. Thanks.

(Applause.)

MS. RAITT: Thanks, Martha.

So next is David Roland-Holst from UC Berkeley.

MR. ROLAND-HOLST: Good morning and thank you to Commissioners McAllister and Hochschild and all of you for letting us share our assessment results. These were done for the overall program, the long-term managing of -- let me introduce myself. I'm David Roland-Holst. I'm an Economics Professor at Cal and a partner in Berkeley Economic Advising and Research, which is, essentially, a small academic-based consultancy.

In any case, we did an assessment for the Chairman's Office of the overall package of long-term energy scenarios. And we can talk about how

to tease out the buildings component of this intuitively, but we haven't done a dedicated study of the building decarbonization, although I think given the complexity that we've just heard about from Martha, that would certainly be a good idea. We can see the role of buildings, I think, in the aggregate results, but let me summarize for you. And I'm going -- time is quite limited, so I'll go relatively quickly. Maybe we can have -- I don't know, we have a question period later in the program; right? Okay. But, of course, interjections from the Commissioners is always welcome.

There are four main drivers from the point of view of the economics of this very large commitment to restructuring the energy system that goes on the supply and the energy use side.

The first one is investments in the energy system, and that including both the energy production and energy use investments in that category.

The second is large-scale adoption of the technologies that will determine future energy use patterns, and that includes vehicles. It also includes building; heating and cooling,

HVAC, you know the whole menu, I think, by now.

The third component, which is a really important driver from the economic side, is the result of technology, but it's a pure economic effect, and that is the direct benefits of energy savings in terms of liberating economic resources for households and enterprises to use for other things, and I'll go over all of that in a minute, but it is a potent driver of growth for the California economy in the long term.

And finally, a category which we introduced for the first time. This wasn't actually in our original terms of reference for the Chairman's Office, but I've been wondering for a while whether or not the state was taking enough credit for its climate policies. It turns out that the public health benefits are very substantial. And we were pleased to see that those benefits are coming directly from these programs, and I'll talk about that piece in a minute or two in more detail.

But the overall macro-economic impacts looking out to 2030 and to 2050, our estimates of these are based on our own model of the state economy, which we've been using since the run up

from AB 32 to -- for a whole alphabet soup of state agencies that helped them get better visibility about long-term growth prospects. The bare model (phonetic) was used in the original scoping plan and carried forward in lots of other studies, but this time we were fortunate to be able to calibrate it to cost data which came directly from E3's very authoritative works on the technologies of the energy system. They've created really, really solid evidence on the technical side. And we can incorporate that and cross the information into our model and then, basically, it gives us more detail of the economic impacts.

But here are the salient ones, the overarching economic effects. First of all, investments in the energy system are a potent catalyst for growth in the state. This is what you might call shovel-ready job creation, a very attractive source of short-, medium- and long-term employment and income.

Secondly, technology adoption itself, as the State of California knows very well, can lead to benefits that far exceed their direct costs. If you want to look at and if you want to

understand California's superior growth over the last three generations is the state economy and knowledge-intensive industries are really the driver behind it. And this is just another example of knowledge-intensive industries and new technology adoption accelerating California's gross trajectory.

Also, energy savings, as I mentioned, are a significant source of job creation through the indirect shifting of expenditure away from energy towards more job intensive economic activities.

And finally, savings from averted mortality and morbidity as a result of mitigation. Really the jugular, I guess, of these policies, as Commissioner McAllister said, really reducing emissions will have a significant fringe benefit in terms of public health effects. And there's a very clear causal relationship between those things. But we estimate the economic value of those things, usually in actuarial techniques.

In terms of numbers, I don't want to belabor them too much. There's a very detailed version of this study which is available on the website that's on the title page of these slides,

or you can contact us through that website for more detailed information, if you're interested, but I'll simply summarize it today.

The long-term, meaning 2050, impacts of these commitments to a new energy system will be very substantial. Our estimates are that gross state product in real terms would be almost nine percent higher as a result of these programs. Employment would be over seven percent higher than it otherwise would be in the baseline situation. And the employment impact, as you know, jobs are sort of the gold standard for a lot of policy, but that translates in California into over 3 million additional jobs. So this would be a very potent stimulus for sustained growth in the California economy. Even though we know technology adoption costs money and it imposes new costs that might not otherwise be incurred, the expenditures, let's remind ourselves, are a significant source of income for other actors in the economy. And so promoting innovation and technology adoption, a I've said before, has been a significant driver of California's growth. And that will continue in applications of the energy sector.

If the programs are adopted as they've been set forth in the strategic vision of this LETS -- LTES package, benefits would be uniform across the economy basically, not every single individual household, but on average, looking at households by tax bracket the benefits would be significant and not uniform, but they'd be widespread across the economy. The main beneficiaries in relative terms would be the middle class, as you can see here, but significant benefits with an average of over 15 percent increase in real incomes. Now real incomes also discount for cost savings due to lower-than-baseline prices. And we actually do see some prices coming down in the forward scenarios.

We did a similar project, collaborating with E3, again, for the CAISO, the Independent System Operator that delivers electricity to California ratepayers. And in those scenarios, we saw lower rates as a result of the renewables buildout in some of our scenarios.

So the benefits are primarily from job creation and new income. They don't accrue to every single household in the same amount.

Unfortunately, it's not like a check that comes in equal amounts to every household. But the effects of new jobs and rising wages from a tired labor market will benefit the authority of the state.

In terms of sectoral benefits, everything but agriculture is going to be a winner to some degree. The biggest benefits will go to the construction sector because of their role in building out the supply side and the energy use side of these programs. But again, it's very widespread, but not in each sector for the same reasons. The four sources of -- the four drivers will affect different sectors in different ways. I'll elaborate a little bit on that but, again, time is short.

Let me talk about the economics of the health benefits because, as I said, this is new. The state, I don't feel, has given enough attention to the -- has taken enough credit for this benefit but it's -- actually, we were startled when we got these results. And they're based on very authoritative national data on the morbidity and mortality impacts. We use California-specific statistical value of human

life and medical costs. So it's been tailored to the state itself, but it's based on a very spatially detailed assessment of mitigation and the public health consequences of that.

And what we discovered is that in terms of evaluating the morbidity and mortality is by 2030 we'd be seeing a $2.4 billion a year in savings annually because of mitigation. We'd also be seeing a $3.6 billion reduction in direct averted health costs. Now there's no -- this isn't where we start arguing about how much is a human life worth. These are direct medical costs from clinical evidence, so that's real money. It isn't speculative money. That's sometimes the estimate, the statistical value of human life estimates are.

But in any case, we were startled because this is the same order of magnitude as the cost of building out the renewable portfolio. Which means, of course, you could imagine justifying the buildout on the grounds of public health benefits alone, without having to talk about climate change, without having to talk about all the other effects that have entered the policy dialogue. This was startling to us. And if it

continues in terms of being comparable, so we're getting very substantial direct benefits from --

COMMISSIONER MCALLISTER: If you want to --

MR. ROLAND-HOLST: -- (indiscernible).

COMMISSIONER MCALLISTER: I don't know if you're going to talk about this, but the --

MR. ROLAND-HOLST: Yeah.

COMMISSIONER MCALLISTER: -- the inequity, sort of that piece, is great that it's positive for everybody. But, you know, it's kind of notable that the lowest people on the --

MR. ROLAND-HOLST: That's right. And I will --

COMMISSIONER MCALLISTER: -- even on a percentage --

MR. ROLAND-HOLST: Yes.

COMMISSIONER MCALLISTER: -- so -- and I'm wondering how that plays with today --

MR. ROLAND-HOLST: Thank you.

COMMISSIONER MCALLISTER: -- (indiscernible)?

MR. ROLAND-HOLST: I will talk about it, because one of the things that we've been doing more recently because of the state's awareness

and the need to engage more diverse stakeholder groups is we've been looking very carefully at the disadvantaged community category, and what we're going to be looking at more now. So we built out a spatial dimension to what we're doing, and I'll give you an example --

COMMISSIONER MCALLISTER: Yeah.

MR. ROLAND-HOLST: -- in just a moment. And the results that are even more affirmative, if you want to put it that way.

Anyway, what we see is that these health benefits are basically of an order of magnitude that themselves could justify this kind of investment commitment, before we talk about all the job creation and everything else.

But, all right, let's look at social economic impacts a little bit more closely. And I'll do that, Commissioner McAllister anticipated this perfectly, from the point of view of the disadvantaged community category.

Most of you probably know, this is a definition that combines characteristics of income. You have to be in the lowest quartile of income distribution, so it's the bottom 25 percent in terms of household incomes. And also

it reflects a higher than average burden of pollution exposure. So these are disadvantaged people that will never (indiscernible) economically in a pure economic income sense, but also in terms of their exposure to health hazards.

In any case, when we disaggregate these things, and we've been able to do this now because we can -- we can downscale our results to the census tract level. And the census tract is the added -- the atomic unit of the disadvantaged community analysis, so we were able to basically map that directly. And we begin to see some really interesting effects.

These are, obviously, really, kind of too specific, but just to give you an idea, about 75 percent of the disadvantaged communities in California are in either L.A. County or the Central Valley. So those are two areas where we want to pay close attention to this. We disaggregated it for all the regions in the overall report, so you can see it more -- in more detail, but this is job creation. And what we found is that the job creation effects, actually, are proportionately more favorable to

disadvantaged communities, that is the number of jobs. Of course, their wages are lower than highly skilled workers, but they'll get a larger percentage of the jobs than their percentage of the population, meaning they make up 25 percent but they're getting almost 30 percent of the jobs created.

So this is what the economists call a pro-forward policy. And I don't think that people have made that clear enough. I mean, it really is a policy that will readdress income and equality in the state, and opportunity, the evolving opportunities. The main reason for this, of course, is the focus on construction and buildout. So those commitments are going to be very, very affirmative in terms of correcting for inequalities, particularly in opportunities. And again, I think the sectors that commit to those costs deserve recognition for that, just like the agencies that are creating the policies.

If we focus on one county alone, the county that happens to represent almost half of gross state product, Los Angeles, we see that there the share of job creation for disadvantaged communities rises to 50 percent. So there's a

real emphasis on lower income opportunity, which is built into these policies. Even though it's not stated verbally, there are no affirmative -- I haven't seen any affirmative action wording directly in these policies. Here's the result. It actually is very affirmative because it creates a higher proportion of jobs for these groups.

COMMISSIONER MCALLISTER: You know what, I want to just point out generally.

MR. ROLAND-HOLST: Yeah.

COMMISSIONER MCALLISTER: So this is, you know, I mean, it's compelling, but it's also pretty high level. So, you know, in terms of policies that we're going to be doing a lot of disadvantaged communities and low-income, you know, per SB 350 and other pieces of legislation. And I think there's just a broad acknowledgement that if we don't -- if we're unsuccessful at making sure that jobs are distributed throughout the economy and focusing on low income, that we won't have succeeded; right? I mean, even if we kind of reach our emissions goals, it won't have been a fair way to go about it.

So I guess I'm going to just express a

little bit of doubt here, or at least kind of -- you know, the devil is in the details, really, on this; right?

MR. ROLAND-HOLST: Oh, yes. Yes.

COMMISSIONER MCALLISTER: So, you know, we have such a diverse state. And these disadvantaged communities are probably more so. You know, they're the most diverse, probably, pieces of the state. And so, you know, where those jobs land and who they land with I think could go a lot of different ways, even though -- even if they sort of concentrate on the low income.

And so I guess, you know, appreciation of that is just what I wanted to express, but then also I think it would be critical to push solutions to even inequities within the low-income populations of disadvantaged communities as part of our policies in a very proactive way. So making those linkages up and down the chain is pretty critical, even if it's starting with, you know, robust analysis, like yours, so --

MR. ROLAND-HOLST: You're absolutely right, you know, and we don't want to over claim in this context because, like all forecasting

models, what we're projecting is based on history. So this is a result of what the hiring patterns and economic responses of the past have been and we're, essentially, extrapolating that. But by adding or incorporating standards and incentives, it should be possible to increase the likelihood that these kinds of outcomes will happen. And you might even be able to take it further. I think things like training programs --

COMMISSIONER MCALLISTER: Yeah.

MR. ROLAND-HOLST: -- we're not modeling anything like that. But there are specific initiatives for that in the state that could be -- if you get the right kind of policy coherence between climate policy and the EdD and these --

COMMISSIONER MCALLISTER: And the Workforce Investment Board and all that --

MR. ROLAND-HOLST: Right. Right.

COMMISSIONER MCALLISTER: -- you know, we're going to need quality in construction, and so how do you make that really inclusive. And I think there are a lot of ways that could take place, but I think we just need to be very

intentional about that. And so I'd advise us all to think along those lines too.

MR. ROLAND-HOLST: I think that's a great idea, yeah, to basically increase the likelihood that we get these -- that these results will be fulfilled. But I still intend to take credit for them.

COMMISSIONER MCALLISTER: Sure.

MR. ROLAND-HOLST: All right. Anyway, let's look at another component. We did a number of other indicators, like income, household income, and even we took a shot at electric vehicle adoption which is a fool's errand, but we did report this, but it's in the more extensive report. In any case, let's look at these health costs because here the results are even more arresting. It turns out that not only disproportionate benefits for lower income households, but the disadvantaged communities get higher absolute benefits. They're saving more money in absolute terms than higher income households. And the reason, of course, is because in the initial conditions they have a higher burden of health risks, so they're spending a higher proportion of their incomes

anyway on medical care.

But we had to make a heroic assumption in this context, which is that the mitigation is relatively uniform across the state because we don't really have the detailed spatial characteristics of these programs yet. But to me, that's kind of an invitation, actually, just as Commissioner McAllister suggested, to zero in and target these policies, especially the mitigation elements, because if this is on an average basis with uniform mitigation, we could get even better results by targeting the mitigation towards those areas where we have the highest public health risks and the highest burden of emissions.

And, of course, you can expect the EJ community and other groups to be advocating for that going forward. But what we're simply trying to deliver here is a framework which can be responsive to that, so we can answer questions and improve visibility from policymakers at this level of spatial detail so that there can be a constructive dialogue, rather than we want it all for this category or we want it all for these stakeholders. There should be ways to target

policies a little bit more carefully and get the results.

Here's L.A., the same thing. The disadvantaged communities are enjoying -- they avoid $677 on average per household, while the non-disadvantaged communities which have higher incomes are avoiding $511 per household on average. Of course, it varies from household to household. But this is a really startling result because, of course, that's a much higher percentage of the incomes for the lowest quartile. And so for them the relative benefit is very substantial.

Okay, in terms of contributions in the building sector, we have to go fly on intuition here because, as I said, this particular study was not dedicated to this component of the package, the LTES package. We looked at all of the programs combined. But clearly, construction is going to be a significant actor. And so a substantial amount of the job creation, about 25 percent of the total adoption costs for compliance with the overall scenario is coming from building decarbonization. So we could, just as a rule of thumb, assume about a quarter of the

benefits are going to accrue there. But to be honest, I think that there will be more benefits in certain categories, and construction will certainly be one of those. So again, the equity effects of that could be very substantial.

The locations of things, that matters a lot because it determines what kinds of buildings we're talking about. So the differences between the residential sector and the commercial sector will depend on urbanization patterns. And in that area, things like distance to work and so on may be significant.

Here are the conclusions. I'm not going to just read the whole thing through to you. You've got copies of this available to you. But I've already gone through the main findings of this report and they are that, number one, the adoption of both new energy supply and new energy use technologies will be a substantial stimulus to the economy in the classical way of just new expenditures and new technologies driving growth.

Number two, we see that the energy savings will be also a potent catalyst for growth, and the reason is very simple. Think of a household who saves a dollar at the gas pump

because of the fuel efficient vehicle. If you take a dollar out of the gas pump and spend it on the stuff you really want, that's going to be services. And in my line of work, we have something we call the 70-70 rule. In the high-income economies, like California, at OACD, you know, U.S., Europe, Japan, 70 percent of demand GDP is services -- sorry, household spending, consumption. Consumers drive the economies. They drive the economy in California. Seventy percent of GSP is consumer spending. Seventy percent of consumer spending is services, so half of total demand is going for haircuts and espresso drinks. You know, that's the way we -- that's how we create jobs, with most of our expenditure.

So if you can take a dollar out of the gas pump, the energy fuel supply chain is one of the least job-intensive supply chains in the economy, and you spend it on what you really want, which is basically services, 70 percent of that money is going to go into services, we create many more jobs. And we see a potent job stimulus from energy savings that results from expenditure shifting. Give people that money

back, they don't have to spend it on energy which is, as I said, very low job content and a significant import content too. And they take that money and they spend it on in-state goods and services, those are jobs that can not be outsourced because they're not tradable; right? Those services aren't traded goods. And it creates a really significant multiplying effect.

And finally, the public health angle is something that I think we should give more emphasis to and more credit to climate policies for what they're accomplishing. There is a very significant savings for California and any high-income society which spends a lot of money on medical care.

And finally, from disadvantaged communities, the conclusions that I've already been through are really favorable. This is not only a pro per set of policies, but it's also something that can help to rectify quality of opportunity.

Finally, the priorities for where we'd like to take this work, obviously, more detail would be helpful. It will improve targeting. It

will make policy more adaptive and responsive to other actors in the policy dialogue, especially stakeholder groups that may feel that they're not getting -- they haven't gotten enough attention in the past.

Decomposition of the LTES into components like energy -- like building decarbonization would make a lot of sense because they are complex. And the macro economics, the numbers can hide some of the costs and benefits.

Also, I think disaggregating the building characteristics costs and benefits by scale and type of industry is going to be quite important because the adoption patterns are going to vary tremendously, depending on the size, especially with these firms. Some firms borrow their money in London and New York. And small enterprises, I mean, small enterprises in California make -- they create half the jobs in the state. Many of them finance their investments with credit cards, so their costs of capital are very different. And if you want to get the incentives right and promote adoption without discouraging business practices or threatening California's competitiveness and entrepreneurship, it's

probably a good idea to be able to get down to this and identify the diversity of the adjustment needs and compliance costs.

That will create more opportunities to enrich these policies with incentives, and maybe standards. California has many ways of being persuasive in terms of regulatory compliance. But the technology initiative, you know, it's just, it's part of the core of California's economic success. So I'm very upbeat about this program as an opportunity to renew knowledge-intensive development for the state.

Thank you.

(Applause.)

MS. RAITT: Thank you. And next we have Laurie ten Hope from the Energy Commission.

COMMISSIONER MCALLISTER: This is really the star-studded event. We have applause and balloons.

MS. TEN HOPE: Hi, good morning. Laurie ten Hope, Director of Research and I really the framing of this morning. I think we've heard from E3 and from Martha what it is we need to do. And then from David, what are the economic benefits of achieving these goals. And what I'm

going to talk about is can we innovate our way to these goals? And just kind of do a quick flyover of some of the research that we're doing that's building connected to help us achieve these goals.

So I mean we heard from E3 several of the things that we need to achieve to get to the goals in terms of energy efficiency, electrification. We need R&D for hard to electrify end uses like heat pumps, industrial sector and others. We need to increase our renewable power generation, diversify renewable energy systems and bring on more electric vehicles.

And also, I think one of the important focuses is to really come up with tools and strategies that align with customer behavior. So in the R&D Program, all of the research is connected to decarbonization. But the highlighted ones on this chart are connected to decarbonization in buildings onsite, either energy efficiency or onsite renewables, storage and integration, electric vehicle integration and on the gas side, again energy efficiency, renewable energy and understanding and reducing

methane leakage to and in buildings.

So everyone's mentioned the importance of electrification in buildings and electrifying heating and water heating is key. So I just want to point out a couple of projects that we're working on right now in the electric heat pump area.

The one on the upper left, A, is a retrofit project we're doing for heat pumps in multifamily retrofits. This is basically taking cutting edge commercially available heat pumps and doing M&V on what the prior energy use is and what the new energy use is.

The second one is really re-imagining heat pumps (indiscernible). It's in every project with multiple partners working with Daikin to really come up with a best-in-class heat pump and including new components and alterative refrigerants.

The Project C is a Build It Green project looking at central heat pumps, completely different configuration needed in the larger built-up heat pump systems that are suited to multifamily. We have a couple of installations right now and collecting energy savings and

performance information.

On the lower left is a project with California Home Building Foundation, which is the nonprofit connected to the building industry. And they're installing heat pump water heaters in many homes and remotely monitoring what the performance, what the usage and performance is of the hot water heat pumps. So I think that'll give us some really good performance and usage information.

We need, as already mentioned low global warming refrigerant alternatives for cooling. And we have several projects testing alternative refrigerants in what's their performance and cost.

And finally, most of the focus here is on electrification, but we do have a couple of projects improving the efficiency of gas-fired heat pumps for providing both hot water and air conditioning.

But I'm going to call out a couple of cool projects that are combining solar thermal in different applications. So we have a project with Chromasun developing solar thermal combined with absorption chillers, to provide both hot

water and cooling at a hotel. And IRKSOL, which is using a different solar thermal technology, evacuated tubes, for producing hot water at an industrial facility.

And the lower left I think is kind of cool. It's an induction cooking project for food service. I think we're looking at induction cooking for residential. It's just behavioral challenges that people are just really attached to their gas stoves, but in food service when you've got better performance it's cheaper and it's faster, it's more even cooking. This is, I think a good entry market, for induction cooking and we'll be gathering the performance information and really trying to reduce the cost. Cost is still a barrier for induction cooking replacements.

We're also with the California Builders testing residential heat pump dryers and this is again being remotely monitored to collect usage and performance information on heat pump clothes dryers.

And finally, is focused on UC Davis work on ground source heat pumps using different configurations and coiled heat exchangers that

reduce the installation costs about a third. So these are all active projects that are trying to move us in the low no carbon direction. This next project is a really innovative project that UC Merced is working on. It's using both PV solar panels and solar thermal collectors in a configuration to provide solar thermal for CHP applications and a PV panel for electricity generation. And combine them in a way that takes up a lot less roof space and provides dual function.

This one, I'm going to save for another presentation. I wanted to talk quickly about a couple of projects we're doing around DC buildings. And as I think everyone knows going from DC to AC and back to DC you have a lot of conversion losses and we have a couple of projects to look at applications of using DC directly and typically in hybrid applications. So you have one project with LPL doing analysis and modeling on the best applications for DC and residential buildings. We have a DC microgrid in Chino at a Honda plant and what they're doing is using the DC microgrid for lighting and battery and forklift applications directly and AC for

other loads in the building.

And we have another project using DC directly for parking lot lighting and I think these are all going to provide some good insights into what kinds of applications DC makes the most sense.

In these areas, efficiency in buildings, so those are our current projects where we're gathering a lot of information that is going to help inform future deployments. In our new investment plan on the electric side, there's a lot more work planned in HVAC and water heating, continuing to test and develop California-appropriate advanced HVAC systems and water heaters that are really designed for our climate including electrochemical compression systems and improved heat exchangers.

We're planning to do more analysis in demos in the DC building distribution systems and starting some new research in hybrid AC/DC appliances.

On the gas side it's a much smaller program, but still in the areas particularly that are hard to electrify, focused on efficiency improvements. And one of the big challenges

ahead is really how do you improve your building envelope in a cost-effective way with new add-on materials or 3D printing or other novel approaches to improving the building envelope. Moving from the building components itself, one of the things that E3 emphasized was integration. As we bring EVs into the market and renewables, smarter strategies for integrating the renewable resources with building controls is important to really reduce the natural gas load following that might be required from power plants.

So a couple of the focused areas in building integration is smart inverters. We've done a fair amount of research on smart inverters to improve the functionality and the ability for the smart inverter to provide some grid resources whether that's the voltage following or assist or islanding or reconnecting. These functions allow a higher throughput of solar on the distribution system.

We worked closely with the SunSpec Alliance to develop the open testing protocols and coordinate with the CPUC on what the needs are for smart inverters and the Smart Inverter Working Group. And then take some of the

research challenges that are coming up in that forum and incorporate those into future research objectives.

Vehicle grid integration is an area where we're seeing some really great improvements in improving the smart charging that takes into consideration what the driver profile and needs are for charging, what the price signals are for charging and then what the renewable resources that are available. And the potential cost savings for the consumer are considerable.

We're testing several different strategies to really incorporate renewable storage and electric vehicles into the energy management systems, so these projects are commercially based energy management systems. Energy management systems, you know, have been around for a long time, but being able to incorporate in price profiles and the renewable resources and the charging profiles bring additional complexity into the picture.

I wanted to talk just for a minute about demand response and customer empowerment. And I think this one project from OhmConnect is kind of a different strategy for us using social media

platforms to connect with a large number of customers making small demand reductions. They have been able to connect close to 300,000 customers in California. They send out signals for demand response events and then provide points to customers who take some action. And then they can cash in their points for either giving to charity, by a smart thermostat or bank the points. I think their strategy is very interactive and they're growing in leaps and bounds in their customer participation. These are CIEE and ZNE Alliance are taking different approaches focused on demand response for the commercial market whereas OhmConnect is focused on the residential market. Again, incorporating being able to tie in multiple appliances and vendors and more of an open protocol strategy for controlling loads and onsite renewables.

And finally, in addition to the more technology-oriented research, one of the areas that we have researched already in planning to do some ongoing research, and this is very much in collaboration with the Air Board, is better understanding of fugitive methane emissions in

buildings. And so we've tested about 75 residential buildings and find that the leakage rates in buildings varies substantially. A few buildings are responsible for a large amount of the methane and the largest percentage of that comes from pilot lights in combustion appliances, which isn't really surprising. But it does give a potential opportunity for retrofit and perhaps a particular focus for low-income, disadvantaged communities that may still have some pilot driven water heaters.

In the commercial sector, we're testing about 70 buildings right now focused on food service and healthcare facilities that have a large natural gas usage and looking forward to the results in that study. And we're about ready to kick off a large field study to look comprehensively at additions across residential, commercial and industrial, it'llmuch more scaled up than what we've been able to do so far. So that was just really a quick kind of flyover of some of the type of projects that we're engaged in right now. All of our projects on the electricity side are available on our showcase and we're starting to add in our natural gas

programs.

And I just want to close to say I think what we're trying to do is to develop tests and evaluate approaches to technology development that people are going to want to buy. And that they have the technology and the information needed to make smart choices of emerging technology and help with what technologies are successful. What are their attributes and be ready for scale up in utility incentive programs or building standards efforts.

Thank you.

(Applause.)

MS. RAITT: Thanks, Laurie.

So next is a series of presentations from ARB. And we're going to go flip the order from the meeting schedule to hear from Dana Papke Waters first.

MS. WATERS: Good morning, Commissioners and everyone here today. I'm very excited to provide an update on our zero carbon building related research.

Doubling energy savings from electricity and natural gas end uses as well as our 50 percent renewable portfolio standard are going to

contribute significantly to our 2030 climate target.

We've heard several times today that building electrification is also going to contribute to decarbonizing buildings. It's not counted in our 2030 climate goals, but it is recognized as an important contributor to reducing our long-term greenhouse gas emissions if it's optimized with energy efficiency as well as renewable energy and energy storage. Our Climate Change Scoping Plan does also recommend that we work together to establish target dates and a pathway for a zero carbon building state policy. So I'm really excited to be here today to begin that dialogue.

So Martha shared this demand side view where buildings are about one-quarter of our statewide emissions. That basically includes electricity, natural gas consumption and refrigerants.

My colleague, Aanchal, is going to talk about how we're reducing emissions from refrigerants. My colleague Andrew is going to talk about what we are doing in the area of leakage from the natural gas sector, which

includes that 1 percent, but also an additional percent that's buried in industrial that you can't see right now. But he'll get into more detail on that.

Our zero carbon building research really does take a more comprehensive view and is focused on reducing the carbon footprint from buildings that affect these additional 20 percent of wedges that impact water, waste and transportation emissions as well.

So this is a simplified view, and one example of what we're looking into in terms of transportation strategies that can be implemented at the building level to reduce those emissions. And what you can see here if we're looking at these preliminary estimates for hourly emission factors, that midday charging really is going to have the lowest emissions. We have our statewide target for 5 million zero emission vehicles on California roads by 2030. We expect that about 15 percent of those will be fuel cell vehicles, so the remaining 4.2 million passenger vehicles, if we looked at four different scenarios for how we would fuel those vehicles, that's the time of the day that would have the least amount of

emissions. Most electric vehicle charging is happening overnight, which has potentially doubled the emissions. Of course, all three scenarios are much lower than if all of those vehicles were fueled by gasoline as you can see in this display.

But I think hourly emission factors are critical and time of use charging is really important as we're thinking about zero emission buildings and transportation. And uses such as EV charging really should be considered in that framework when we're thinking about zero emission buildings.

So in addition to transportation, we're also looking at water strategies that can be implemented at the building level. And where our zero carbon building research is really refining, some of the estimates for electricity intensity for water pumping by region throughout California, in many parts we're finding that large reductions in outdoor water use, as well as indoor water use, can still be achieved and is cost effective. But because of this varying carbon intensity of water it is something that we also think should be considered in this zero

emission building framework.

And just looking out to 2030, the emissions associated, or I'm sorry, the electricity use associated with water pumping could represent between two to nearly a quarter of the electricity used in an all-electric home. So this is something that we should be thinking about as well, with zero emission buildings.

So I touched on transportation of water. We are also looking at waste-related strategies to reduce those emissions as well. We're looking at an energy component now as well that is looking at time of use, and how you can match the renewable energy supply with all of our dynamic end uses. Or save it and use it at a later time with battery storage.

We do also have a zero carbon community component to our research project as well, which is building on a low-income zero net energy project that was actually an Energy Commission advanced energy community funded project as well that's going to look at which strategies are better implemented at the community scale. And overall, this project is going to be looking at what are the realistic target dates that we

should be establishing for a state policy. And I'm really happy that we have CEC and CPUC on board with our advisory group as well as a number of stakeholders in this room that are participating in that project. And it's moving forward. We should have an interim report by the end of the year.

So in closing, CARB does support the Energy Commission's efforts to initially focus on the energy sector for achieving zero emission buildings.

This slide shows a case study for our new Southern California consolidation project where we originally had a design with a fuel cell. If we had gone with that original design and used grid electricity and standard refrigerants, we would have emitted on the order of 3,000 metric tons every year. We were able to achieve zero emissions by going with an all-electric zero net energy laboratory and we're using low-GWP refrigerants.

So the other piece that in addition to those aspects, we are also mitigating our construction-related emissions, which are on the order of about 4,000 metric tons. So it's

equivalent to this operational energy portion as well.

It's a one-time piece, but we are also mitigating that and recommend in addition to the water and transportation end uses that construction emissions should also be considered in part of the zero emission building framework. So with that, I just want to thank everybody for this important and interesting dialogue. And will look forward to staying up-to-date and informing you with what comes out of our research program for zero emission buildings. Thanks.

MS. RAITT: Thank you, Dana.

Next is Aanchal Kohli.

MS. KHOLI: Hi. Good morning everyone. I will be talking about the carbon footprint of clean equipment in buildings. So that Martha, and Laurie, and Dana mentioned refrigerants are really important. Refrigerants contribute a large part of the emissions, in addition to the energy consumption of the equipment. So, I'll be focusing on that.

Clean equipment is, I guess, not just clean, but also heating. So heat pumps, HVAC systems, refrigerators. That's any equipment

that uses refrigerant.

All of you have heard the term global warming potential several times today. Just as a quick refresher, one pound of a common refrigerant used in supermarkets, in industrial refrigeration, R-404A, has a GWP of about 4,000. This equals the emissions, the CO2 emissions from a car 4,000 miles driven by the passenger car. So it's a very, very significant in its impact. They tend to be very potent climate change pollutants.

The first thing that I want to talk about is changing the way we evaluate refrigerant technologies. Let's take a look at where emissions come from. So this is the piece that we're most familiar with, the energy consumption of a refrigerator or an HVAC system. So you plug in the system. It's using energy. That energy was generated using some sort of fossil fuels and that's where you get emissions from.

In addition to that, you also get emissions from refrigerant leakage. So this could be during service, operation of that equipment over its lifetime, any catastrophic releases. And also, at the end of its life it

will be that that equipment is disposed of.

Right now we see an emphasis on the indirect emissions from energy consumption because this is what people are paying for. And I want to talk about the importance of changing the way we look at this and evaluating it based on total equivalent warming index. So any time we analyze a new piece of refrigeration equipment, we should look at its total equivalent warming index rather than just the electricity consumption or the refrigerant.

So Martha already talked a little bit about this. Right now, global warming gases are about 4 percent of California's greenhouse gas emissions. So, say we do nothing about this, in 2030 this will -- this number is going to double, the percentage, but also the quantity of HFCs, in particular, which is a refrigerant category are going to double by 2030. They are the largest source, fastest growing source of greenhouse gas emissions in California.

So just making it very clear that we need to take action to reduce global warming potential, high global warming potential gases.

My analysis was focused on existing

buildings because they contribute 50 percent of total HFC emissions. Martha showed some figures talking about how important refrigerant emissions are within buildings.

So I'm going to look at five different case studies of common building types that we've got in a large part of California, the existing building stock. For the presentation I'm only going to focus on apartments and supermarkets. So again, this is something that Martha already talked about and just a different perspective to show you that HFCs, a category of refrigerants, contribute to a significant portion of greenhouse gas emissions from buildings. So in commercial building there's 17 percent and residential 6 percent.

And I also wanted to emphasize something that Martha already said. That as we move more towards cleaner electricity and higher electrification, this percentage is only going to grow larger.

So let's move on to a case study for a supermarket. This is a typical energy profile for the energy consumed in a supermarket. And it's very clear that refrigeration is the biggest

chunk of this. So it's a great -- the direction we're heading in improving the energy efficiency of refrigeration systems in supermarkets that's great. We need to go in that direction.

But this not a comprehensive picture of where emissions are coming from in a supermarket. If you look at a typical supermarket, its direct emissions are coming from refrigerant leakage on an annual basis and also at the end of its life.

So a large supermarket, like a Costco or a Wal-Mart has about 3,500 pounds of a common refrigerant, R-404A, with a global warming potential of almost 4,000. It leaks -- the system leaks about 18 percent of its total charge every single year. And I want to emphasize here this is a California-specific number. This number is much higher in other parts of the nation. So this is after we have measures put in place to reduce the leak rate. These systems tend to be very large and they tend to leak a lot.

There's lots of piping in a supermarket and it's very hard to control these leaks to bring them down. We could definitely do more, but it's not that easy to reduce refrigerant

leaks.

The way that refrigerant is disposed of at the end of its life, there's also a significant amount of leakage that occurs there.

In total, maintaining these refrigeration systems, recharging the refrigerant, operating them costs about $40 to $50 thousand dollars a year.

In contrast, if you look at the electricity use that's 2 to 3 million kilowatt hours a year, and ends up costing supermarket $250,000 to $350,000 a year. So you can see why they're really focused on improving the energy efficiency. And that's why historically we see a lot of discussion around the energy efficiency because the consumers are paying for that. That's such a big portion of their cost.

So what I went ahead and did is looked at the emission breakdown over a refrigerator in supermarket, over its entire lifetime.

So the first bar that you see and even the second are examples of two conventional refrigerants that are very common in supermarkets right now. I think about 40 to 50 percent of supermarkets use R-404A, the first bar, with a

GWP of almost 4,000. And I think 407 is maybe about 20 to 30 percent, with a GWP of 2,000. So pretty high global warming potential refrigerants being used right now.

And if you look at the breakdown of emissions, you see that energy is a pretty small portion of where the emissions are coming from.

If we move, if we transition to an alternative refrigerant, like CO2, with a global warming potential of 1, you can almost eliminate a hundred percent of the direct emissions coming from refrigerant leakage over its lifetime and at the end of its life.

So this makes a very compelling case that switching to a lower global warming potential refrigerant can have a huge impact on emission reduction. So we get 85 percent reductions, greenhouse gas reductions over the lifetime of the equipment. This is about 18,000 metric tons just for one supermarket.

If you take into account all large supermarkets, in California that's 2 million metric tons.

If you start taking into account smaller grocery stores, like Trader Joe's, and

convenience stores like 7-Eleven, this number just gets higher and higher.

And I also want to point out something that I didn't mention before is the CO2 system is between 2 to 5 percent more energy efficient. So it is also saving consumers energy, and in energy bills, but it's also reducing emissions significantly.

And another point I want to emphasize is that this technology is available now. It's used in I think -- I was at a conference just this weekend, they said there's about 400 stores in the U.S. that use CO2 technology, and maybe 14,000 in Europe. So it's widely available. There's many manufacturers that provide this technology.

So moving on to an apartment, the story's a little bit different, but also clear in that we should reduce energy -- we should improve energy efficiency, but also switch to better refrigerant.

So again, in an apartment you see that HVAC systems and refrigerators make up the biggest chunk of energy use in an apartment.

For an HVAC system, a common refrigerant

is 410A, with a GWP of almost 2000. And once again it's pretty clear, even though the leak rates for these systems are relatively lower than supermarkets, I think about 5 percent a year, over the lifetime of this equipment the emissions from the refrigerant are a lot higher just because the refrigerant is so much more potent in the impact than CO2.

If you switch to a refrigerant like R-32, with a global warming potential of 675, about a third of the conventional refrigerant, you get 55 percent reductions over the lifetime of the system. So once again, very significant emission reductions for each HVAC system, about 4 metric tons. If you multiply that with the 14 million homes that are in California or the 4 and a half million apartments, this is very significant savings.

For a refrigerator, the story's a little bit different. Here energy consumption is the biggest portion because refrigerators, luckily, don't tend to leak a lot. But you can still improve its energy efficiency and switch to a better refrigerant, R-600A, which is isobutene, with a global warming potential of 3, you still

get a reduction of .25 metric tons for each refrigerator.

In California right now, in 2017 or maybe 2016, there's 18 million refrigerators. So you can see that we can have significant impact if we start transitioning to lower global warming refrigerants.

I want to emphasize here that this technology is not quite available in the U.S., yet. There's millions of units being used in Europe, in Australia, in Japan, in different parts of Asia. But for a number of reasons, the codes and standards process has been very slow and USEPA's SNAP approval has also not been obtained for some of these refrigerants because they're flammable.

So what I -- as I'm coming towards the conclusion, what I want to emphasize is that switching to lower global warming refrigerants can be one of the most impactful steps we can take to reduce emissions.

This is not the only step, however. We can continue to improve the energy efficiency of systems. We can design smaller systems, with a smaller initial charge of refrigerant, so they're

in practice lower.

We can also reduce annual leak rates and strengthen end-of-life recovery and reclaim programs so that not -- large amounts of refrigerant are not lost at the end of their life.

So it's very clear that we can have a big impact by doing this. So why aren't more people doing it? Why aren't grocery stores switching right away? Why aren't building owners switching to better technologies? Because there are some barriers that we need to address.

The first one is just really changing the way we evaluate emissions. If we're completely focused on providing incentives for energy efficiency or just for HFC reductions that's not a fair comparison. We need to switch to a holistic approach where we look at total equivalent warming index.

There's also a lack of knowledge and unfamiliarity that can be overcome if we have more case studies, successful case studies demonstrating that these systems work well. Guidance documents from manufacturers. Connecting supermarket owners, for example, to

different manufacturers so that they have confidence in adopting these technologies.

The codes and standards process is lagging behind technology significantly in the HVAC area. And there has been discussion that this process is old and needs to be revamped. So that would definitely give a boost to refrigerants that are being used worldwide and have been used for a decade, that are still not permitted in the U.S.

There's a higher upfront cost which can be overcome with incentive funding. There's been some movement already here. The CEC recently launched the Food Production Investment Program which provides funding for industrial refrigeration processes. And looking at global warming refrigerants is one of their criteria.

There's also the California Cooling Act, SB 1013, which is undergoing the legislative process. And if it does pass, there will be a pot of money being given to incentive funding for supermarkets, other food retail establishments.

And then another thing that we can work towards is having a stronger workforce that's certified, that is well-trained in these new

technologies so that consumers are less hesitant about adopting them.

And at the end, I just want to emphasize once again that it is not possible to transition to zero carbon building if we don't switch to lower global warming refrigerants. Thank you.

(Applause)

MS. RAITT: Okay, next is Andrew Mrowka.

MR. MROWKA: Hello Commissioners. My name is Andrew Mrowka. I'm an Air Resources Engineer for CARB.

I'd like to change the focus from Aanchal's speech where she looked at in-house emissions to the methane leaks in the natural gas system. This does include that some of these are before buildings and residences.

To begin this presentation, I'd like to start with the lifecycle analysis of natural gas. On the right you can see a diagram of the lifecycle analysis of natural gas. I'd like to focus more on the first four items shown here.

Ninety percent of natural gas used in California is imported. It comes to us from the Rocky Mountains and from the southwest. These out-of-state emissions are not included in our

in-state emission inventory. However, a model is currently being developed by Stanford to consider emissions associated with in-state and out-of-state natural gas emissions.

On this slide you see a diagram of the equipment on the natural gas system. The production and processing is referred to as the upstream emissions. And the downstream emissions are the next few segments, the natural gas transmission and storage, and distribution.

I'd like to point on the distribution line you can see these little rectangles, and those are the meter set assemblies, and those are a significant source of emissions in our inventory.

Focusing on the upstream emissions, in 2017 CARB's Board did approve the Oil and Gas Methane Regulation. This regulation reduces fugitive emitted methane emissions from the following sources: oil and gas production, processing, and storage, gathering in boosting stations, underground storage facilities and natural gas transmission compressor stations.

Here you see a table of some numbers for the upstream oil and gas emissions. On the left

are the different system categories. And in the middle you see the 2016 inventory and that's converted to metric tons carbon dioxide equivalent. And on the right you see the emission reductions.

Looking along the bottom row you see the change -- you see the inventory, as well as the reduction total. And that's about a 40 percent reduction of in-state emissions. The goal was to achieve that by 2030.

Switching from upstream to downstream here is the downstream emissions. And this was -- this inventory was developed in collaboration with CARB and CPUC, and that's for Senate Bill 1371.

On the left again you see the system categories. You'll see the 2015 category total in the middle. And on the right you'll also the 2016 category total.

Looking along the bottom row for the total emissions there's a decrease there, and that's about a 5 percent decrease.

I'd like to share, though, that CARB staff will begin working on the 2017 inventory shortly. We are receiving information from the

utilities and that's actually due tomorrow.

After the inventories were developed, CPUC Commissioners met, and had a decision on June 2017. And their decision D.17-06-105 achieves the following.

It requires utilities to fulfill their reporting method for methane emissions. The utilities must submit a biennial compliance plan and that has already begun in 2018. The utilities must use 26 best practices. The decision also says a soft target methane reduction.

The end goal is to achieve a 40 percent reduction from the 2015 baseline by the year 2030. As well, this decision implements a cost recovery process.

In both the upstream and the downstream emission inventories, in some cases CARB could use direct measures as an accurate reporting, as it is with the flow down emissions.

However, in other cases emission factors need to be used. Some of those emissions factors are 20 years old, so they're a little bit out of date. And also, they were developed from national studies.

So to address this issue to have more current risk factors from California-specific inventory, CARB has contracted with GTI, or Gas Technology Institute, to do two studies.

And the Pipeline Study looked at plastic pipelines and unprotected steel pipelines and that was completed in 2016.

And the Residential Gas Meter Study was completed in 2018. And as mentioned earlier in a presentation, residential gas meters are a significant source of emissions and those are right before buildings or homes.

In both of these studies, randomly selected samples were taken from PG&E, SoCal Gas, and San Diego Gas & Electric.

I'd also like to share that in addition to CARB's contract for studies with GTI, the utilities have done their own pilot projects to look at in-house emissions, and they've shared them with us pursuant to Senate Bill 1371, best practice compliance plans.

In addition, CARB is aware of CEC contracts and I believe Laurie ten Hope shared on this one right here, a Survey of Methane Emissions from the California Natural Gas System.

And I think it was on her slide, as well, that their results indicate that natural gas leaks from single-family homes were about -- oh, here, it's 0.2 percent of natural gas consumption.

In conclusion, here are CARB contacts.

COMMISSIONER MCALLISTER: Thanks so much.

(Applause)

COMMISSIONER MCALLISTER: Thank you so much.

So let's see, we have just a couple minutes until our official -- I think it was five after was our anticipated break time, so we have just a couple minutes. I have two blue cards, and we have a few people on WebEx who want to ask questions. So the price of getting your comment out before lunch is that you have one minute instead of three minutes, if you wait until the end of the day. So we're going to put the time up. And I hope to get, more or less, the full hour for lunch. So I have two blue cards and you can choose whether you want to do it now or do it later.

Jim Lutz.

MR. LUTZ: I'll wait until the end.

COMMISSIONER MCALLISTER: Okay. So Mindy

Craig?

MS. CRAIG: I'll do it now.

COMMISSIONER MCALLISTER: All right.

MS. CRAIG: I'll keep to one minute. I'll talk fast.

COMMISSIONER MCALLISTER: All right. Good.

MS. CRAIG: Hi. Thanks everyone. Mindy Craig with Blue Point Planning. And I've had the opportunity to work on the Existing Buildings Action Plan, the Residential and New Residential Zero-Net Energy Action Plan, and working now on the Commercial Zero-Net Action Plan, so this is really true to my heart. And I think this is a great opportunity, because all of the ZEN zealots out there really know that it's an electrification strategy, but we've kind of kept that under the wraps.

But one thing I really wanted to comment on today was a lack of more integrated, sort of the built environment approaches. We really looked at this building-by-building approach, which is great. But the massive buildings we have to transform is overwhelming. To think about talking to every single house owner about

changing these things is really challenging.

So I challenge all of us to take a larger perspective to think about the built environment. The benefits that were talked about from UC Berkeley can be magnified even more so, thinking about the infrastructure and thinking what would change that, resiliency and health.

So that's it. Is that my one minute?

COMMISSIONER MCALLISTER: Thanks, Mindy.

MS. CRAIG: All right. Thank you.

COMMISSIONER MCALLISTER: All right.

(Applause.)

COMMISSIONER MCALLISTER: Mindy deserves some applause.

Okay, I think we have a few people on WebEx; is that right?

MS. RAITT: So I'm just going to read a few questions on WebEx that are to our presenters. So let's see, bear with me. Okay.

A question to the presenter from E3. "Why gas heat pumps, as opposed to all-electric heat pumps?"

So if Zack, if you're still here, if you wouldn't mind, would you be able to address that?

MR. SUBIN: Sure.

MS. RAITT: If you could just stand at the podium right there and answer this.

MR. AAS: Hi. Dan Aas. Different E3 person. Can you hear me?

COMMISSIONER MCALLISTER: Yeah. Right into the mic.

MR. AAS: Here, I'll just talk this way.

So natural gas heat pumps are just an alternative driver of the refrigeration cycle.

MS. RAITT: Talk in the microphone, please.

COMMISSIONER MCALLISTER: Talk in the mike, yeah.

MR. AAS: -- a different driver of the refrigeration cycle.

COMMISSIONER MCALLISTER: I think you turned it off.

MR. AAS: Now?

COMMISSIONER MCALLISTER: Yes.

MR. AAS: Sorry. Natural gas can be used as an alternative driver of the refrigeration cycle and a heat pump. The advantage of it is you can use the existing gas infrastructure and achieve a COP of about 1.5. That's less than the COP you would get out of an electric heat pump of

about three. But again, you're using the existing gas infrastructure. You're getting energy efficiency. And it decreases potentially, we didn't model it in this project, but it could decrease that gap between the supply curve of available biomethane and the demand for gas in buildout.

COMMISSIONER MCALLISTER: Do we have one more question from WebEx?

MS. RAITT: Next, we're going to put Martha on the spot here. This is a question from Alice Sung.

"Thank you. In Martha's last slide showing impacts from retail buildings with refrigeration, what were the assumptions in the definition of refrigeration and refrigeration leakage? What portions were due to building air conditioning, the leakage from electric heat pumps, in typical HVAC and rooftop? And what was the actual refrigeration and leakage from refrigerants from those refrigerators, freezers and commercial or retail walk-in refrigerators, grocery stores, et cetera?"

That's a lot.

COMMISSIONER MCALLISTER: Maybe you will

treat us for another day.

MS. BROOK: Okay. So the -- can you hear me? Because the green light's not on. It won't go on.

(Colloquy)

MS. BROOK: Okay, so these -- this data here that I charted was modeled. It was not actual. So to answer the question about actual, I don't know. Hopefully, it's somewhat equivalent to our model. Otherwise we're, you know, in a world of hurt.

COMMISSIONER MCALLISTER: Well, that's why we do research, so we can try to figure Out --

MS. BROOK: Sure.

COMMISSIONER MCALLISTER: -- what the reality is.

MS. BROOK: Sure. And the leakage is from the refrigeration system. So the refrigeration, the big chunk is from the energy used to refrigerate the display cases and the units that need to refrigerate food goods. And the leakage is from that refrigeration system. So I'd say that it's a little bit conservative because it didn't include the refrigerant leakage

from the air conditioning system, and that's because I didn't go into the -- there's a lot of decisions that you have to make about what kind of air conditioning system, and therefore was it -- is it self-contained or distributed refrigerant, and so I didn't go there. So what's there is just the refrigeration system.

I hope that answers the question.

COMMISSIONER MCALLISTER: Okay. Thanks.

Is that it, Heather?

MS. RAITT: No, sorry, we've got a couple more.

COMMISSIONER MCALLISTER: Okay. Sorry. Go ahead.

MS. RAITT: So next is Jim McMahon, excuse me, for David Roland-Holst. "Slide four showed real income in 2050 as increasing 5.6 percent. And slide five shows average household income in 2015 increasing 15 percent. Please explain the apparent inconsistency."

So 5.6 percent on slide five and 15 percent on slide five. Sorry. Yeah.

MR. ROLAND-HOLST: I'll give the answer in two parts for the sake of the audience.

Number one, all the details are in the

more detailed document. But the basic justification for that difference, which is not a discrepancy, is that GSP and real housing income are very different economic indices. Households benefit from below-baseline costs, not lower costs but below-baseline costs. And those benefits translate into higher real incomes.

Thanks.

MS. RAITT: Okay. Thank you.

Next is from Alice Sung, just a comment to Dana from ARB. "Great to take embedded -- embodied carbon and construction one-time emissions into account."

And from Tom Kabat, "Can CARB total equivalent warming index method that includes (indiscernible) potential gases also be applied to natural gas devices?"

So I don't know if somebody from CARB could address that briefly?

MS. KOHLI: Most natural gas systems do not use refrigerants. If they do use refrigerants, then you could use the same method.

UNIDENTIFIED MALE: (Off mike.) (Indiscernible.)

MS. KOHLI: No, I'm not sure if it could

be used for method leaks in the same way.

(Colloquy)

MS. KOHLI: Should I answer again? Okay.

So what I said earlier is natural gas systems do not use refrigerants, so you cannot apply the same methodology that you would apply for global warming refrigerants. But I think I may have misunderstood the question to being that could you use total equivalent warming index for methane leaks, and I'm not sure. But it does seem like a good method to use because all it is, is really quantifying everything to CO2 equivalent and then comparing apples to apples, but taking emissions from the entire system. So I do think that a similar methodology could be developed for natural gas systems.

MS. RAITT: And the last one is another question for ARB, perhaps Andrew Mrowka. "Another -- the best estimated range of fugitive natural gas emissions in terms of the factor in the indirect emissions. So what is the ballpark for best estimated range of fugitive natural gas emissions in terms of factor of direct emissions?"

MR. MROWKA: If you want to look at

emission factors, I highly recommend going to the slide on the downstream emissions. And if you click on that link, you'll see that CARB has worked with CPUC to develop a whole table of emission factors. It's Appendix 9 on our report, and you'll see emission factors in there. You'll see the whole range. I believe metering and regulating stations with above 300 psi inlet pressure have the highest lowering potential. And residences, as I said, a residence would be quite low. So there's quite a range on there. And also, we try to use direct measurements when possible. That's the highly accurate accounting. But then if we don't have that, we use emission factors.

COMMISSIONER MCALLISTER: Okay. Thanks. Thanks very much.

And I want to just -- it's clear that there's a lot of research going on this. I mean, the agencies are working together to really get a handle on not only, you know, the methane emissions and the various greenhouse gas potential gases and emissions, and as well as the emissions factors of our electricity system. And so this network is actually -- we're in way past

our elbows on this. And it's critical that we be using consistent numbers across the agency or across the agencies so that we really are getting to the gist of these various matters. So that's -- a lot of work is going on those fronts.

MS. RAITT: So that's all the comments from WebEx.

COMMISSIONER MCALLISTER: Okay. Great. Well, so thank you for sticking that out. I'm going to still hold us to our, yeah, 1:05 lunch, so have a good lunch and we'll see you at five after 1:00.

(Off the record at 12:14 p.m.)

(On the record at 1:10 p.m.

MS. RAITT: Thank you. Welcome back to our Workshop on Zero Emission Buildings, and -- hi -- welcome back to our Workshop on Zero Emission Buildings, and our first speaker in the afternoon is Rory Cox, for the CPUC.

MR. COX: Well, thank you, and thank you for the invitation to come, and I hope everybody had a good lunch and everyone's energized and didn't eat too much. And so my name Rory, like she said, from the Energy Division of the California Public Utilities Commission.

I have -- I am the Zero Net Energy Program Lead, but we're not going to talk about Zero Net Energy, we are going to talk about decarbonization.

(Laughter)

And you know, some of my slides are -- if you were here this morning you don't really need to sit through them. And I just realized this was the wrong presentation.

COMMISSIONER McALLISTER: Do you need another set of slides teed up?

MR. COX: I think I -- yeah, I think I might. I think these versions --

MS. RAITT: Now, building *16:17:16

MR. COX: I think Chuck's the one that's probably got them, when I sent you all corrections. I think that'll be better at this point. Do you have that? Do you want to flip places with the panel?

COMMISSIONER McALLISTER: That's fine.

MS. RAITT: I'm sorry. We'll take the time to correct this and we'll go ahead into Brian Samuelson's panel and then come back to you, Rory.

COMMISSIONER McALLISTER: Okay.

MS. RAITT: Thanks.

COMMISSIONER McALLISTER: Sorry about that.

MS. RAITT: So Brian, do you want to go ahead and start the panel?

*MR. SAMUELSON: Yes. We'll go ahead and start our panel. This is Brian Samuelson in the Demand Analysis Office at the Energy Assessments Division, moderating for the panel, Panel 1. And we're going to go ahead and go down in order today with Jonathan, followed by Rebecca, who is joining us on the phone.

We've confirmed that she's here, since we're starting earlier, to do your introduction and a little brief talk about the topic. And then Jonathan does have slides, but they're *16:19:09.

MS. RAITT: Yep.

*MR. ABENDSCHEIN: So good afternoon, Commissioners. It's great to be here. Thanks for inviting us. This is a real interesting panel to be able to sit on. Before I get started, I just want to recognize Christine Tam from my staff, sitting in the audience.

Everything that I'm presenting here today

is really thanks to her creative work. I know a lot of you know her, and hopefully, I can do justice to the work of her and her staff.

COMMISSIONER McALLISTER: Hey, Jon, could you maybe just get your microphone a little bit closer so it's clear for everybody who's listening in.

MR. ABENDSCHEIN: You got it. Is this a little better?

COMMISSIONER McALLISTER: If you're not used to these things, it takes a while to get used to.

MR. ABENDSCHEIN: Oh, no. I understand. This is my first time in that ring. So excuse any mistakes here.

COMMISSIONER McALLISTER: It's no worries.

MR. ABENDSCHEIN: Excuse any mistakes. Can I get the next slide, please? So I want people to have a little something, a little background on Palo Alto. We are a full service municipal utility. We have -- and I think that includes being one of the only gas and electric utilities in the state.

That puts us in a really, I think,

particularly interesting position for this whole conversation. There are about 68,000 people in Palo Alto, about 25,000 housing units with about two-thirds single-family.

Interestingly, for a small utility we have about 80 percent commercial load versus 20 percent residential. But on the gas side it's about 50/50. And so there are actually a lot of opportunities for residents to get involved in emissions reduction through both gas efficiency and decarbonization.

Can I get the next slide? So I wanted to share this chart. This is Palo Alto's emissions over time, and I think this is the way we're representing it right now. We're looking at some different ways of representing it.

But the main thing I wanted to call out is our transition to our carbon-neutral electric supply back in 2013. That policy was adopted, fully implemented in 2017. And what that means is, we're buying all of our energy from carbon-free, hydro-electric and renewable sources under long-term contracts sited in California, new renewables.

And I think there's a lot of conversation

right now about exactly how to count the emissions from -- you know -- a portfolio like this, and we're having our own internal discussions. But I think no matter what -- no matter how you count it, Palo Alto does have a very low emissions electric portfolio.

And so that's led to us to start thinking about the next steps around both transportation, which is the largest next step in our emissions, and then building decarbonization, which is the blue bar.

Can I get the next slide? So we got some formal direction from our City Council to focus on sustainability -- in our Sustainability and Climate Action Plan that was adopted in 2017, a clear direction to work on building electrification.

I was asked to talk a little bit about how our community -- what sort of feedback we get from our community around electrification, and I want to acknowledge that we have a really strong group, core group of advocates that work with us.

A lot of these folks have heat pump water heaters in their homes. Many have actually helped others in the community get heat pump

water heaters installed in their homes, and they bring us a lot of really good program ideas and help make our programs better.

I'd say in the community generally we actually have fairly low awareness. So we're trying to change that by doing a little bit more publicity. And we do have -- you know -- and there are -- and I don't want to say that support is unconditional or unqualified.

So we do have some folks who are pretty comfortable with their understanding of electrification and they raise a range of issues, including the issue of resiliency; that is, always having all Palo Alto transportation and heating uses coming from one energy source.

There are also questions about the impacts on our gas infrastructure, and by extension, as the universe of gas customers drops over time, whether the heating bills for the remaining customers will rise excessively.

And then lastly, there are definitely questions about whether decarbonization is actually a net carbon reduction. We get -- I think the intuition is that people question where the energy's coming from when a heat pump space

heater is running on a dark winter night.

And I think some of the answer to that comes in being able to explain how efficient these heat pumps are, and that you can actually see emission savings, even if it's being run from a gas plant.

Can I get the next slide? So I'm not going to go over all this. We have -- I know there's a lot of Q and A. We have opportunities to talk about what we're doing in the area of electrification, and I just wanted to have a slide that we could share -- that I could share with people that -- to talk about some of the things that we're doing.

We've had some early successes, but I think the main insight that we've had is that we really need a lot more action on a regional level, that it's very hard for one small utility to make a major change in the regional heat pump, water heater or electrification market. So I'll just stop there.

COMMISSIONER McALLISTER: What's your definition of regional? Like what does that mean?

MR. ABENDSCHEIN: Well, we're thinking

Bay Area right now.

COMMISSIONER McALLISTER: Okay.

MR. SAMUELSON: All right. We'll go ahead and go to Rebecca, who's on the phone.

*MS. ANDREASSEN: Hi. Probably (indiscernible) need slides. But a little quick overview. So my name's Rebecca Andreassen and I come from Los Angeles. I am in the Mayor's Office, Mayor Garcetti's Office. I am the Associate Director of Infrastructure here.

So I'm here to talk about City Objectives, as well as a little bit of what our utilities are doing. So we get our energy from the Los Angeles Department of Water and Power. There's about also 5 million power customers of *16:25:50 formally residents.

We have about 5,500 power customers also in the Holmes (phonetic) Valley. LADWP operations are financed solely through our sales. So we don't get in a bit of funding through sales bonds. So all of our programming we have to be cautious of, because it's ratepayers, all the letters that are coming in and that kind of feeds into the partnering we're allowed to do.

And we have 7,888 Megawatts in our

system, and about 20 percent of that right now is renewables. So it's kind of what our baseline is. So we're looking at zero emission buildings. First, we're kind of looking at long-term carbon objectives.

So last week Mayor Garcetti announced that he's trying to get to is zero -- net zero carbon emissions by 2050; it's up from our 80 percent carbon reduction by 2050 previously set out. So there's going to be some additional goals on our end of looking at when we release our next Sustainable Study Plan of how do we expedite or expand on the existing goals to meet these objectives.

One of the main things is going to be improving the carbon footprint of buildings. Obviously, this is where 70 percent of our emissions currently coming from, is our building stock and commercial and industrially specifically are some of the biggest energy users, as well. So that's kind of where we kind of see our initial target.

So we want to first -- you know -- reduce the energy consumed by the buildings and then look at, how do we fix the energy that's going

into the buildings. We worked recently with Seamens to analyze what steps we need to take to achieve carbon reduction goals.

One of the big things was our transition to 100 percent generation of renewable electricity. This is one of the bigger initiatives that we're working on right now in Los Angeles. So mid-last year by the request of the mayor and the City Council we're going to launch 100 percent renewable study to determine what assessments to make to be -- to achieve 100 percent renewable energy supply.

There is an advisory group that's been really key to determining definitions of renewable energies and what types of scenarios that we need to have analyzed by our other external partners, NREL, the group that we partnered with to help us run the model simulation of our power system to determine feasibility.

And so that we recently finalized what those eight scenarios are. I'm happy to talk about the study if someone is interested. But we expect to the initial results of what is feasible in Q4 of this year and then the study will be

done in early 2020.

So in addition to just looking at our power supply coming in, we also want to look at what technologies are being used by buildings, as well as how do we maybe adjust designs or building codes to try and make them more efficient, hopefully.

So we've partnered also -- so the Siemens Study also looked at the performance technologies that are key to GHG, Greenhouse Gas Reductions. Air -- they looked at air quality costs, job creation. And some of the main things were electric heat pumps, and then rooftop PV panels.

So we wanted to look beyond those, as well, to straight-on energy efficiency within the buildings as we look to electrification. So let's see. So one of the main things we did was our Building Forward Design Initiative.

That's looking at how buildings can be more resilient and sustainable by looking at how they're designed in construction in the first place. There's a -- this report's going to come out later this year, but there's a lot of recommendations related to the design and build process, especially within cities and how to make

it easier for alternative designs to -- and alternative technologies to enter into our building construction format. It's an exciting scenario that we're working in, as well.

And then lastly, for energy efficiency we have our own existing building, energy and water efficiency ordinance within the city that beyond AB 802 in terms of 20,000 square foot and above buildings are required to benchmark, and then all buildings are required to take some sort of efficiency action every five years.

We're looking at that as an opportunity to help us reach energy efficiency, but we're not needing to bring as much energy into the city, but at the same time also help load -- balance load as we are increasing electrification of buildings and transportation.

So we have -- there's a lot of programs within GWP related to on-site generation. I'm happy to go into those if there's questions about what types of programs we are going into, but the main thought on that is, can you offer any programs that hit different customer groups, not just homeowners that put can put some on their house, but renters and low-income, and then maybe

people who would love to purchase solar or solar system, but they can't put on their house for structural reasons or shade; so looking beyond that. So that's kind of where I'll stop for now.

MR. SAMUELSON: Okay. Thank you, Rebecca. We'll move on to Barry.

*MR. HOOPER: Good afternoon, Commissioner McAllister and Commissioner Hochschild. Thanks for hosting today's Workshop. I'm honored to be here representing the City and County of San Francisco. I work for the Department of the Environment as a Senior Green Build Environment Coordinator.

And I also wanted to mention that apropos today's meeting and the subject matter, we're also looking forward to hosting the Governor's Climate Action Summit in September. And San Francisco's currently reviewing and contributing to a number of opportunities to make additional commitments to strengthen our share engagement in progress in climate action, and we're definitely hopeful to see similar -- what similar commitments may come from the State of California.

In the meantime, I just wanted to

highlight one recent public commitment toward the World Green Building Council announced earlier this week, which -- where they challenged private sector leaders to accept the Net Zero Carbon Buildings Commitment in advance of the Summit, any one of three substantive companies, including one Bay Area engineering firm, that have signed onto that.

But of course, that's a milestone in efforts that we've all been working on for some time, and our goal as a city is carbon neutrality citywide for both public and private sector no later than 2050. We have milestone goals along the way, and through sustained efforts of many parties, definitely including this Commission, our own staff, utilities, private sector expertise, we actually have been meeting those milestones.

Since 1990, San Francisco's emissions have been down -- have been reduced 29 percent, while the population has grown 20 percent and the economy has more than doubled. So our GDP is about 111% of what it was in 1990.

So the choice between environment and economy is not -- not been borne out. It's a

both/and. My focus is projects, programs, policies that relate to the built environment and contributing to meeting those goals.

And I should really point out that those goals are adopted in the context of responsibility, that we really acknowledge that that's the threshold that science says we need to meet. And the question then, as Rebecca alluded to, is what's feasible.

And so in 2016 we also worked with Siemens, and looked at exactly how we could come -- we could get to those 80 percent -- then 80 percent emissions goals, reduction goals that have now been updated to 100 percent goal.

And in a nutshell, the finding was we do need to continue to make progress together to cleaning up the utility grid, partly through compliance with the Renewable Portfolio Standard laws in effect today.

We really expect the net effect of those laws, unless they happen to change, as basically offsetting growth and emissions, that the city will grow and the new renewables coming online, if we're conservative about our expectations about them, should not get us where we need to

go, but definitely contribute to things not getting any more difficult.

A Building Efficiency and Transportation, of course, are major areas where efficiency can yield emissions cuts, and we found opportunities for about a 63 percent additional cut, and that that is beneficial to reduction criteria, air emissions and employment it would support about 420,000 full-time equivalent person years of work between now and 2050.

That's just a gross number, so it's -- I really appreciated the economic analysis earlier, because a lot of those person years would be invested simply in maintaining the status quo, since most of these appliances and building systems will wear out and need replacement between now and 2050, whether we replace them with a clean and efficient option or not.

And so what do we need to do to actually get to 80 percent or 100 percent reduction? And the answer became pretty clear. Today, 95 percent of thermal appliances serving primarily domestic hot water and space heating are served by on-site fossil fuel consumption.

And the only means that we could find to

get to the 80 percent or even 100 percent emission reduction was widespread transition of those end uses to use of renewable electricity primarily with on the shelf technology, such as particularly including efficient heat pumps.

And that -- it transitioned to heat pumps was the single most impactful measure that we could analyze, contributing at least 13 percent in overall emission reduction. To support that transition our team is engaging on a number of levels, particularly on education, collaborating with other cities within the state through the Bay Area Regional Energy Network, or BAREN, among other collaborations, as well as communities outside the state that operate in different regulatory environments that are at the same time not as advanced as California in certain respects, but often offer a little more flexibility to help meet these goals at the same time.

And of course, we're among the many communities participating in our own efforts to clean up the utility grid by -- through partnership with PG&E, running the Clean Power SF Community Choice Aggregation Program, through the

-- hosted by the San Francisco Public Utilities Commission, by requiring new buildings to install solar, new building up to 10 floors and a little bit in advance of the Commission's recent similar decision, by requiring these new buildings to also be prepared for the transition to electrification of transportation, because it's all really one system from our point of view.

So we're requiring electrical infrastructure to build support up to an entirely electric fleet in a manner that provides some flexibility for the -- and cost minimization for the developer at the time of construction.

We're collaborating with other local officials to track the progress in developing the energy standards so that the state's rule set is, first, continues the progress that you've committed to and staff have committed to and have made so much progress toward in reducing the disincentive to use electric appliances for these end uses, and then ultimately, you know, help -- that'll set the playing field for us to be able to credibly encourage their use in buildings moving forward.

We've been certainly hosting workshops to

understand the market development and market transformation and workforce development needs, and begin some planning in that direction. We're currently developing a comprehensive strategy to, again, roll out the transition, because we do -- we see it as necessary to do the type of consumer engagement that was acknowledged as difficult.

But it's the part of the system that we have a special relationship with, is the local government, and we have the confidence that we can actually affect. And then last, we're observing and participating in a number of experiments.

And just as a comment, you know, one of our lessons learned, and an opportunity for better alignment between the -- where the Commission is currently going and its -- some of the intellectual infrastructure currently in place, is that a critical lesson learned in a recent project that we happen to be observing was that the structure, specifically the Electric Program Investment Charge has a limitation for supporting this type of outcome, because in the particular project it had its own issues, but one of the major challenges was they're aiming for

taking a historic, multi-family building serving affordable housing, taking that to ZNE, and of course, it's a mixed-fuel building today.

And so inherently, that transition to deeper efficiency and being able to meet their thermal loads with electric end uses involved either a slight reduction in electric use or a possible slight increase in electric use, concurrent with a radical increase in what fraction of the building's energy would be supplied by renewable energy.

And that was -- that's not compatible with the electricity reduction goal inherent in the Electric Program Investment Charge research at the moment. So I just wanted to highlight that, that we both enjoy working with the Commission and want to keep getting good feedback about where we really need to improve, and also, to give feedback to the Commission about where there's opportunity align goals with rules and with requirements. Thank you.

*MR. HOWLETT: Okay. Good afternoon. I'm Owen Howlett. I work for Sacramento Municipal Utility District, SMUD, and I'm in the R&D group there where we've been working for a

while on justifying SMUD's new electrification programs.

I want to recognize my colleague, Scott Blunk, who's over here in the audience, and my colleague, Obadiah Bartholomy, in the back, who have done a ton of work on this stuff and collectively we're all trying to bring this to -- but we have already brung this to fruition.

So I want to talk to the question today about the Cost Impact of these Electrification Measures on Customers, because this is one of the big, important, unanswered questions, is if we move to these electrified technologies, will customers be paying more for the privilege of reducing their greenhouse gas emissions.

So what I'm sharing today is the results of several studies that we have already done on that topic. So sorry for all the numbers in the slide. I just wanted to get this on the record with the Energy Commission.

What this slide's intended to show is the results of a study that TRC Energy did for us, looking at existing homes and what the impact on customer bills is of electrifying the space heating in existing homes.

So we've broken it down across the columns by the vintage of the home. These homes were modeled in CBECC-Res, with the appropriate grid insulation and characteristics of homes from those code years. And then the rows are different sizes of home.

We've used the standard Energy Commission home sizing bands there. The lowest savings are at top right. Those are small, modern homes, which have, you know, good insulation, don't use very much heating.

In those homes we model a 14, what is it, MMBtu reduction in source energy, which nobody knows what MMBtu is. So we put that in percentage terms. That's a 39 percent reduction in the source energy use of the HVAC of the home.

Bottom left is the highest savings, the largest home, the largest, oldest homes. Customers are saving about 280 bucks a year by moving to a heat pump for their heating instead of having their gas furnace.

And in those homes we're saving a similar percentage, 36 percent of the source energy, and therefore, the greenhouse gases, and saving about 16 percent of the HVAC bill. So the take-home

from this slide is across all the vintages we looked at and across all the home sizes we looked at there is a bill reduction for all those customers when they move to heat pump heating from gas furnaces.

And of course, there's a very significant greenhouse gas and source energy reduction.

COMMISSIONER McALLISTER: Can I -- I want to have one clarification, just a clarifying question.

MR. HOWLETT: Yes.

COMMISSIONER McALLISTER: So does the -- how big of an impediment is the -- particularly for older buildings -- but really, for all buildings, is the firing issue where you have to get into wire to be able to install a heat pump, where before, you know, that wire didn't exist. Is that included in your upfront cost? Is that built in --

MR. HOWLETT: No. That's not -- these are just annual running costs --

COMMISSIONER McALLISTER: Okay.

MR. HOWLETT: -- of the systems. This isn't a total cost -- analysis.

COMMISSIONER McALLISTER: Oh, okay so

that's not life cycle.

MR. HOWLETT: So we have to throw in here what we believe is about a $2,000 increment currently on the cost of a heat pump over a gas equivalent.

COMMISSIONER McALLISTER: Upon replacement.

MR. HOWLETT: Upon replacement, right. Right. And there may be wiring, additional wiring requiring. It's simply we haven't looked into it in detail. So we're still -- we're still --

COMMISSIONER McALLISTER: Yeah. I mean, these are programmatic issues, but they are -- they do impact.

MR. HOWLETT: Oh, absolutely, yeah. We --

COMMISSIONER McALLISTER: (Indiscernible) some of this stuff, too.

MR. HOWLETT: We're committed to looking at all this stuff. We just haven't -- we haven't finished it yet. We're still working on it.

COMMISSIONER McALLISTER: Great. Thanks.

MR. HOWLETT: So next slide. Oh, sorry. I wanted to just say -- let's go back to the

previous slide. Sorry. We ran the bill savings not assuming SMUD's electric -- sorry. These bill savings assume SMUD's electricity rates, which we know are lower than other utilities in the state.

So we ran the same analysis with a hypothetical 20 percent higher rate for electricity, and the savings declined by about half. So instead of saving the amounts of money shown here, customers would save around half that much, but it would still be a savings.

Then in terms of water heating we've looked at three, there are three, really, options that customers currently have, which is a gas storage tank type heater, a gas tankless heater and a heat pump water heater.

The second column there shows the annual operating costs of those options, again, in SMUD territory. We'd have to add a little bit more to the electricity for other utilities. And the second column there shows the annual greenhouse gas emissions in pounds.

And you can see, that's a -- there's a very dramatic difference there between the two gas options and the heat pump. The big question

here with the heat pump water heaters is the installation cost. And we've analyzed the customers who have come through our program so far who've converted from gas to electric water heating.

Our best estimate, and it's a little complicated to figure out because there are a lot of moving parts, is that it's around $2800 as a base cost to have a heat pump water heater installed, of which the water heater itself is about 1300 and the remainder is labor for installation.

Now, as I said, that's a base cost. That's assuming that people have an amenable site to install the thing. It's assuming that they don't have to upgrade their panel and it's assuming that the condensate drain can be run inexpensively.

We have seen costs up to four a half thousand for installation of the heat pump water heater. Those -- we're pretty sure those are exceptional based on some -- I'm going to choose my word here -- some overpricing from plumbers who are factoring in a high degree of risk into their pricing, and may be choosing their

customers carefully.

So that's our best estimate of the current cost. Now, it's important, we think, when you look at the cost effectiveness of these electrification measures to understand that there is often a high incremental cost for the electrification when it's first done.

But once that house is electrified and the heat pump water heater is in place or the heat pump space heater is in place, the replacement cost of that device is not as great. It's 2,800 bucks to install it the first time, or maybe it's even 4,000 to install it the first time, but when you come to replace it, it's cheap, because all the infrastructure's already there.

The wiring is done. The condensate drain is run. Everything's done. So when we looked at the cost-effectiveness of these measures in terms of the -- for instance, in code or in the CPUC in terms of program cost effectiveness, we want to make sure we're looking at a long enough horizon in the future that we include that less expensive replacement cost when it comes around in 15 years or whenever it gets to be replaced.

COMMISSIONER McALLISTER: Is there a difference in the lifetime?

MR. HOWLETT: The lifetimes of these are really hard to judge, because we don't have enough experience with the heat pump water heaters to know what their effective useful life is. So that's a hard analysis to conduct, but we're assuming it's around 15 years.

There is a bit of an issue here with TDV. This may not be the right place to raise it. Well, no, I'll save that for later. Sorry. Okay. Next slide.

COMMISSIONER McALLISTER: Do we -- Brian, how long do we have? Like, when are we supposed to be wrapping up?

MR. SAMUELSON: We have an hour and a half. So we have till 2:35.

COMMISSIONER McALLISTER: 2:35. We had originally planned till 3:05, but then we had to put Rory in. Is that right?

MR. SAMUELSON: Correct.

COMMISSIONER McALLISTER: Okay. So 2:35. All right. I'm just keeping an eye on things.

MR. HOWLETT: So this slide is a summary of the current electrification programs that SMUD

has underway. These are fully fledged programs. They're not pilots anymore. The All Electric New Homes Program at the top, we're providing incentive up to $5,000 per new home, and it breaks down, as I'm showing there with the bullets.

We've got a fixed amount for each element of the electrification with a minimum pre-wiring requirement for the home with it. Even if it has gas appliances, there are electric wires behind the walls ready to -- for those to be electrified.

We're currently under discussion and probably will be for a while about whether we will require buildings to have absolutely no gas to site, or whether we're allow people into the program if they still have a gas element or something. We're still figuring that out.

Then the second row there is our retrofit program, existing homes. It's called the Home Performance Program. In theory, people are able to get up to $13,750, which nobody actually, probably will, to electrify their home. It breaks down in the way I've shown.

It's unlikely would be able to utilize

all those incentives in a home, but it is theoretically possible. So what we've done here is integrate the -- integrate our existing Energy Efficiency Program, which is the Home Performance Program.

We've brought electrification measures into that program so it's an integrated program that allows customers to both electrify and make their home more efficient at the same time, from a common set of incentive amounts.

Okay. Next slide. So SMUD's pushing very hard on the program side. There's a high degree of urgency in what we are trying to achieve. There are a lot of market barriers to overcome, perception barriers, awareness barriers.

So obviously, the faster we address those, the faster we get through that difficult phase. One of the places we're looking for support is obviously Title 24. But also, we're looking for cities and counties to be able to support this effort, because they have a lot more leverage than we can have in terms of passing local code and requiring people to do things.

What we want to suggest here, or

demonstrate, is a new approach that we're taking to working with cities and countries, because typically, the understanding incentive programs is if a measure is requirement by a state code or a local code, then utilities don't incentivize that measure, because it's already mandatory. So we're not changing anyone's behavior.

We have thought of that here, tried to flip the horse and the cart around, so that what we're suggesting to one another for the municipalities is that we will commit to fund the -- those measures. We'll commit to provide program incentives, even though they will be mandatory under the local code.

And the approach there is to say, this local code would never have been passed if we didn't provide the incentives, because the costs imposed on customers are too high. So we're taking care of those costs in order for the code to be passed.

Now, it works out somewhat neatly for us because we wouldn't commit indefinitely to provide incentives, indefinitely into the future, but we can permit -- we can commit to provide incentives for let's say two or three years,

which is, coincidentally, the amount of time that a local ordinance lasts before it expires with the next statewide code cycle.

So it's a pretty neat fit between our needs and the statewide system. So I don't want to go spend all the time going through the words there, but this is a new approach. We think it makes a lot of sense. We think we've got local municipalities interested in this.

So to summarize. We -- obviously, electrification provides a magnitude of reduction in GHGs that we can't come close to with regular efficiency measures. We have a lot of studies, including E3's most recent study calling for dramatic increases in the market for heat pumps.

And the urgency on this is something I want to try to convey. When we install gas infrastructure for modern homes, when we put gas infrastructure in new homes, we know that we're going to have to take that out at some point.

So putting gas pipes in the ground in 2018 doesn't make any sense, and so we're trying to push hard to bring us to a point where we no longer have that happening. One of the other benefits that we get from electrification is that

it's not only greenhouse gas reduction. It's also thermal storage.

So a heat pump water heater, even a small one, a 50-gallon, regular, residential heat pump water heater is equivalent to about a one-kilowatt hour battery, if you can put in a thermostatic mixing valve and control that water heater as a thermal storage unit.

So that's -- and of course, that comes at a cost that's dramatically less than the actual cost of one-kilowatt hour conventional chemical battery. There are several things that we are -- we would like the state to do --

COMMISSIONER McALLISTER: Can you --

MR. HOWLETT: -- to help us along this path.

COMMISSIONER McALLISTER: -- can I ask a question. Are you taking into account the sort of dispatch, you know, the sort of time, the temporal aspect of that, when you turn it on and off and when it's needed.

MR. HOWLETT: Right.

COMMISSIONER McALLISTER: And whether it even has any load to be shifted at any given time.

MR. HOWLETT: So its characteristics are definitely different from a chemical battery. It can't provide power back to the grid at all. But so we're just looking here at its ability to absorb power from the grid. In those terms it's about equivalent to that size battery.

COMMISSIONER McALLISTER: Okay.

MR. HOWLETT: That's all. Thank you very much.

(Applause)

*MS. KUYKENDALL: Good afternoon. My name is Rachel Kuykendall, and I am our Programs Manager with Sonoma Clean Power. Try to get pretty quickly through this so we can catch up a little bit, and you can go to the next slide.

So Sonoma Clean Power, we are the Community Choice Aggregator, or CCA, for Sonoma and for Mendocino Counties, and really thrilled to be there. Decarbonization is something that's near and dear to us, because when SCP was set up, really right in our mandates is the goal of reducing greenhouse gas emissions for our customers and for our member cities and counties.

I'm here today to talk a little bit about a program that we have -- are about two months

into at this point, which is called Advance Energy Rebuild, and is a direct response to the fires that really devastated our community last year and left with about 5,000 homes that we need to rebuild.

You guys can go to the next slide. Oh, this is very small. Okay. So I'm going to do a couple minutes just on the program structure and what makes it unique, because there are some really interesting aspects to this.

On the left-hand side in about a size two font, that's our Dual Fuel Option for homes participating. On the right-hand side is our All Electric Pathway for Participation. That top row is a performance-based option for homes, which is asking them to be 20 percent better than current energy code.

And on the bottom is a prescriptive option for participation. And that prescriptive option was really important to us for really two reasons, the first of which is it became this really engaging learning tool for engaging with our customers, and they can visualize this home in a way that they couldn't visualize 20 percent better than code.

The second reason that this was very important is all these homes are getting permitted under the current 2016 standards. So it can be really difficult for an all-electric home to get 10, 15, 20 percent better than Energy Code, which is what current incentive programs are currently offering rebates on.

So we wanted to include a prescriptive option that was very rigorous for these homes, but didn't penalize homeowners for rebuilding in a way that was ultimately energy efficient, more carbon neutral and, yeah, very, very efficient.

So the other thing I wanted to really highlight here is that we've made an effort to unsilo traditional utility program offerings, and really think about holistic options to help people rebuild. So you'll see things like water efficiency, electric vehicle charging stations, solar PV, DR capability for our heat pump water heaters, which we think is a great potential resource down the line.

And we also do have a pre-wiring requirement for the program. So any dual fuel homes that do participate do need to wire to any gas appliances for an eventual switch to

electrification. And we think that's important because this is really the most cost-effective time to do that pre-wiring, so that we're not causing customers to have to invest thousands down the line when they do want to make that switch.

And then, yeah, we can go to the next slide. So our program partners, this is another thing that really makes, I think, this program unique. We have three very strange bedfellows funding this. So the first of which is PG&E, and frankly, we could not have set this program up as quickly as did without their participation.

We're leveraging their existing California Advanced Homes Program and we are pretty blatantly stealing their great program implementer, a lot of their processes, and of course, their program funds. What is important to note about those PG&E funds is they are fuel agnostic, because they are CPUC funds.

So PG&E is funding both that dual fuel home and that all electric home at the same incentive level. And where that difference the consumer ultimately sees this coming from is from Sonoma Clean Power and the Bay Area Air Quality

Management District.

We're more aligned in terms of valuing the GHG reduction, rather than just kilowatt hours and therms. And why I really want to highlight this is I think this is one solution near term for how we can potentially offer programs that value decarbonization while we work towards long-term policy and legislative solutions. And with that, I think I am done. Thank you.

(Applause)

*MS. BROOKS: Good afternoon, Commissioners. I'm Erin Brooks, the Regulatory Policy Manager for SoCalGas, and Customer Programs Commission and Assistance Departments for our Energy Efficiency Programs and our Low Income Programs.

Thank you for allowing us to participate in the discussion today. We really do appreciate being engaged in the conversations about how to reduce emissions in buildings, and to achieve our SP 350 goals.

There's been a lot of discussion about a specific path this morning, and this discussion today, but I'm here to offer an additional

perspective on a broader and more comprehensive approach. Even this morning Commissioner McAllister said that we need to consider all options.

And so since California has been a leader in environmental and energy policy, there's a need for a mixed and balanced approach in order to meet our climate goals, air quality goals and public health goals.

So SoCalGas supports our efforts to curb greenhouse gas emissions and other emissions. We've been a long-standing leader in developing energy efficient technologies and delivering energy efficiency programs that in term deliver meaningful emissions reductions.

Since 1990, our Energy Efficiency Programs have delivered what equates to removing 700,000 vehicles from the road. Our Emerging Technologies Program identifies, assesses and demonstrates new, efficient technologies for buildings so they can be offered in our Energy Efficiency Portfolio and adopted by customers in order to transform the market.

Some of these technologies are drain water heat recovery, advance solar water heating,

advanced boiler controls and a combination of water and space heating systems. But our work has not stopped there. Right now, we're working with a leading manufacturer on an advanced natural gas furnace, which reduces NOx emissions by 65 percent, and is one of several models that now meets the state's highest air quality standards.

So while we are proud of the advances we've achieved so far, we know that there's a big challenge ahead of us to get to our 2030 greenhouse gas targets, and we know that that's going to take new approaches.

As Dana mentioned this morning, CARB's scoping plan did not include building electrification as a pathway to achieve our 2030 goals, but it does include renewable gas. So decarbonizing our gas supply is going to be incredibly important, as well as we -- at the same time as we decarbonize our electricity supply.

So in mentioning what Martha Brook talked about earlier with our supply side strategy, this decarbonization of the gas in the pipelines is really a lower cost and more consumer friendly

approach that achieves our emission reduction goals while enabling consumer choice.

So an integrated energy grid, which comprises of both electricity and gas delivery systems that are increasingly renewable and lower carbon can insure reliability and can help society adapt and become more resilient to the impacts of climate change.

Today there's strong demand for renewable gas in the transportation sector in California, and tomorrow that gas can be delivered to buildings in order to meet our end uses and meet our greenhouse gas reduction targets.

So right now, SoCalGas is working on legislation that will support procurement of renewable gas for our pipelines. This program would ramp up to five percent of core throughput by 2030, which in this approach it would avoid the need for massive infrastructure change out, massive -- a high cost in purchase and installation and equipment, and long-term operating costs.

Further, if we capture the productive use of organic sources of methane, that re-uses California's waste stream as energy. Last year,

in CARB's 2017 Climate Change Scoping Plan, reducing methane emissions from organic sources was a major part of the strategy.

So while there are several efforts by the CPUC, the Air Resources Board and other policymakers to create opportunities to increase the production of in-state renewable gas, like dairy pilot projects, financial mechanisms and interconnection policy, as well as in the transportation sector, as the low carbon fuel standard, we need policies to support the broader use of renewable gas in buildings.

As we know, 2030 is approaching very quickly, and we need to look at all alternatives to reduce emissions. Policy should retain a focus on energy savings in alignment with greenhouse gas reduction, but does not predetermine a singular technology path to attaining those savings and reductions.

As the Air Resources Board presenters noted earlier this morning, energy efficiency plays a critical role in meeting our targets, as does decarbonizing the fuel we use in buildings. We need to take a look at how to decarbonize the natural gas and not just electrified end uses.

Consumers deserve and prefer a choice in how they heat their homes and cook their food, and we need policies that preserve that choice while meeting our emissions reduction goals. Thank you.

(Applause)

*MS. WOOD: Good afternoon, Commissioners and other Workshop Participants. I'm Kevin Wood with Southern California Edison, and I'm very happy to be here, and thank you for inviting us to participate on the panel and participate in the Workshop.

It's very interesting and informative, and great to hear this conversation going on. I love all the different perspectives. Southern California Edison is committed to reducing greenhouse gas emissions and creating a clean energy future.

We know, we've heard, that the -- or we know the state's ambitious goals of getting to a 40 percent reduction in emissions from 1990 levels by 2030, 80 percent reduction by 2050, are very ambitious.

As Erin pointed out, even though 12 years seems like a long time away, we know we have to

act with a sense of urgency for sure. In October, Edison released Clean Power and Electrification Pathway, and this is a proposal that lays out a clear, cost-effective path to reducing California's greenhouse gas emissions, and improving the air quality.

By 2030, the Pathway calls for an electric grid that's supplied by 80 percent carbon-free energy, more than 7 million electric vehicles on California roads and about -- or up to about a third of space and water heating in buildings supplied or powered by electricity.

So we've seen a lot of presentations today that talk about the amount of space in water heating. We clearly know that's the bulk of what's going on in residential and commercial buildings. We believe, and what our Pathways Analysis tells us, is that by using highly efficient heat pumps for space and water heating, we can reduce across the state about 12 million metric tons of GHG emissions.

So one of the key considerations in our Pathways Analysis was that installing electric appliances today, they actually get greener as the grid gets cleaner over time. Current state

policies call for 50 percent renewables by 2030.

Our Clean Power Pathways Analysis calls for 80 percent carbon free by 2030. And so we know we have to work with policymakers and all the stakeholders, builders, designers, manufacturers, customers, communities and others to raise awareness.

That's been touched on multiple times here this morning. We need to update some policies and we need to continue to sort of increase the availability of clean technologies and continue to sort of mature the technologies in this area.

As has been touched upon, some of the policies that we would like to see evolve are the fuel neutrality in the Building Code and some of the cost effectiveness tests, because we know that this is going to require some incentives and some cost support for customers to switch.

So on that note, we know that affordability is top of mind for our customers. We're not calling for a wholesale replacement of home gas appliances with electric. I think that's been in the media a bit, but that's not practical.

But we know that new construction and some kinds of retrofits, for example, customers that already have the appropriate electrical infrastructure, these can be affordable candidates for electrification.

So we're working on these innovative solutions with several of the parties, even here, and others, and we also believe that customer choice is very important and we want to help customers decarbonize in the most affordable and practical way.

(Applause)

MR. SAMUELSON: All right. I'd like to thank all the panelists for introducing themselves and their organizations, all the work that's being done. We'll go ahead and move onto the questions that we have for Panel Discussion.

And then Rebecca, who's on the phone, after I read the questions, if you hear a space of quiet, go ahead and step on in if you have something to share.

Go on, on the first question, what are the key steps you are taking to reduce emissions in government buildings? It's open to anyone.

MS. ANDREASSEN: I guess I can start in

Los Angeles. So we did not exempt city buildings from any of our efficiency requirements, and we actually lowered the requirement of building square footage, just compared to the private sector.

Effective there, is we want to make sure that if we're asking private sector to do something, that we understand what the process is ourselves, and that, you know, if there's challenges that we can kind of aid in at least the energy reduction side of the thing and water reduction.

So any city building that's 15,000 square feet or above is required to do -- to show an energy or water savings of 15 percent, and 20 percent respectively over five years, or show that they are the best performing buildings in their category according to Energy Star.

So that's what they were doing at least in terms of trying to adjust locally, and then we're also trying use city buildings as pilot testing capabilities. We do test new HVAC systems where we can, and we -- as city employees we do get a lot of vendors coming through wanting us to try or test or do things through new

technologies.

And where we can, we're happy to do it so that we're not, you know, if we're going to introduce Buildings Codes that are related to a certain part of the Energy Code that we want to effectuate, we at least want to know what the technology is or the extent of the potential buyer before we start encouraging grassroots regulations or new policy in that area.

MR. HOOPER: This is Barry in San Francisco. I would echo Rebecca's comments that we certainly start and commit to leadership by example (coughing) in our own facilities at the city. Those efforts are led by our counterpart to the San Francisco Public Utilities Commission, which happens to be the electricity service provider for municipal facilities in San Francisco, among some other customer types.

And so at first -- not a first, but a major step has been, of course, San Francisco adopted citywide benchmark and then disclosure requirements for both private sector and its own facilities in 2011. And in municipal facilities, the carbon footprint in municipal facilities has been reduced about 29 percent since the tracking

began, and the baseline there is 2009, just because tracking's always -- tracking started in 2011, but took into account a couple years beforehand.

At the same time, since the San Francisco Public Utilities Commission is the electricity service provider for those facilities and its primary source -- its sources of electricity in general are large hydro and some solar electric generation resources developed, essentially all of the operating greenhouse gas emissions in municipal facilities is through the combustion of natural gas on site.

And that's a current topic of discussion in exactly this sort of issue where our first objective had been supporting the Commission in insuring that because we're in a coastal climate zone, or the very mild climate, that it was as straightforward as possible, and we had high confidence that the buildings could remain very efficient and adopt those electric end uses.

And I will -- I'd expect to see further action from there in the near future, but we -- that certainly is a focus of where we're managing our (indiscernible).

MR. ABENDSCHEIN: Jonathan Abendschein, Palo Alto. I would just echo a lot of what L.A. and San Francisco are saying. We -- you know -- we're trying to take as much of a lead as we can in our own buildings.

Our focus has been on reducing the emissions in our electric supply up until now, and also, pushing to have our government buildings as efficient as possible. In the last few years we completed a main library that achieved leed platinum status, and our new Public Safety Building is designed to CALGreen Tier 2 Standards, with a target of leed gold.

But like San Francisco, we're just starting the discussion about how to reduce gas use in those buildings, as well, or talking about fuel switching in those buildings, as well. We're just starting that discussion.

MS. BROOKS: This is Erin from SoCalGas. I'll just add from the investor-owned utility's perspective, they're -- at least in our Energy Efficiency Portfolios, when our systems for our government customers is focused on this new public sector that we've created in our New Ruling Portfolio we have specific metrics to

measure the greenhouse gas emissions reductions associated with our program delivery, which is the first time we've ever tracked and reported on this, which is a really positive path.

And looking at the public sector, specifically separate from our traditional approach, to treating it as our general commercial sector is going to afford special focus in addressing the specific barriers that these kinds of customers and buildings often face.

For example, the different fiscal years, the different kinds of financing requirements that government customers often have, as well as the different split incentives that they face, rather than typical commercial customers.

So we're excited about tailoring our Energy Efficiency Programs to our government and public sector customers in a really targeted way as we move forward.

MR. HOWLETT: This is Owen Howlett, from SMUD. I think it's fair to say we're doing a lot of similar things that the other utilities are doing, we have account advisors that are dedicated to local state government customers,

and trying to meet their specific needs.

So within the context of overall energy efficiency, correct. So we also have some (indiscernible) but we have over the years run several pilots with local governments to improve the energy efficiency of their own buildings. So we're going to continue to do that.

MS. WOOD: This is Kevin Wood, with Edison. The only other thing I'll add in addition to some of the things that we're doing, as well as the other utilities, is we are helping some local jurisdictions develop reach codes, and we're working on a low-carbon reach code. So some of the work we're doing.

COMMISSIONER HOCHSCHILD: Not everybody has to answer every question.

MS. RAITT: If we're going to get through all these --

COMMISSIONER HOCHSCHILD: So let's try to keep it -- you can clip it all --

MR. SAMUELSON: Yeah. Okay. Well, really, in our question two, what are the actions you are taking to help consumers reduce emissions in their buildings?

MR. ABENDSCHEIN: So I think like some

other utilities, we've started on a downstream -- started with a Downstream Rebate Program. I think one of the other advantages of having -- being under the same roof as our Building Division is we've been able to sit down with them and focus on the permitting process.

So we've gotten an efficient, over-the-counter permitting process. We developed some inspection checklists and other materials that I think we'd be enthusiastic to share if others are interested.

And we've also pulled manufacturers together for workshops on heat pump water heaters. And I'll say all these are really applicable to heat pump water heating, rather than space heating or whole building electrification.

We've pulled together workshops with manufacturing reps -- manufacturers' reps to speak with contractors, our building inspectors and consumers. And I think one of the things that we've found a little bit challenging is that there are -- it's really difficult for homeowners to find maybe two things.

It's difficult for homeowners, number

one, to figure out how to retrofit their homes. It's really challenging. It's a really challenging thought experiment for them, and finding a contractor to help with that is a little bit difficult.

So one thing we're doing is expanding our Advisory Program, our -- what we call our Home Energy Genie Program, and we're going to expand that to provide electrification advisory services. But the tougher nut to crack, I think, is actually finding a contractor who can do both the plumbing and electrical work for these things.

And we're not sure entirely how to tackle that one, but any sort of guidance or help on that front would be -- would definitely be appreciated.

MS. KUYKENDALL: So we're doing a lot in this space, but as I started to write them all down I figured out that, really, you can sort what we're doing into two buckets, education and incentives. And on the education front, I think just getting technologies in front of customers has been really powerful for us.

For Advance Energy Rebuild, right off the

bat we knew; or we thought we knew; induction cooking was going to be a sticking point. So we actually invested in these little portable induction cookers that customers can come check out and cook on for two to three weeks. And the response to that has been phenomenal.

I will say induction cooking has not been the sticking point we found, interestingly enough. It seems to be fireplaces, which is a big learning point for us that we were not expecting. We're also investing in, thanks to the Energy Commission and an EPIC grant, a physical storefront where customers can come see and test these technologies.

And on the contractor front, one of the big pieces that we're working on there is an actual tool where customers can walk in and get connected with a contractor that can install those technologies, working really closely with the vendor partners for each of those technologies.

And then on the incentives, we are trying a whole bunch of really sort of off the wall things to complement existing PG&E programs, including midstream incentives. We've really

seen, I think across the country, real success there that we'd like to experiment, as well as pairing that with on-bill financing, and we think that can be really compelling for, especially our low-income customers, and reducing that upfront cost as low as we can.

And in addition, we're actually pairing that with a back-end incentive for participating in our Demand Response Programs, especially for things like water heaters, HVAC, vehicles. So we offer currently a $5 per month incentive for folks to connect their technologies to the grid.

But yeah, I think in terms of how we can help our customers, just education nonstop, and then giving them money to do the things that we value and to push the technology further.

MR. HOOPER: I think it might be important for me to answer the opposite of the question. So one thing we're not doing in San Francisco is providing incentives for specifically carbon minimization at scale.

And we've been partnered with PG&E through running our Energy Watch Program and a few other programs before that for going on 17 years. So we are a program implementer. We are

effective at giving out incentives and delivering energy efficiency savings to small and hard to reach customers.

In particular, we have relationships with them that others may not. But CPUC rules do not allow us to advise those customers or to systematically enable them to make this type of switch on a GHG basis.

And so we only see a very limited number of projects that have been -- where it's either entirely a customer's motivation or other exceptional circumstances where we've been able to support the type of complete switch that we're talking about today.

MR. HOWLETT: And since I'm responding on the opposite end of the scale, we are not held back by any CEC rules thanks to the regulatory diversity that we enjoy in California. So SMUD has been, obviously, extremely generous with incentive money to encourage customers to switch to electrified end uses.

There are some other things that we have done at the same time. We are moving to time of day rates. Time of day rates are obviously a way for customers to reduce their bill, but also,

generally to reduce their greenhouse gas impacts, because they're shifting to times which have low margin of greenhouse gas emissions.

Because that time of day rate exists, that creates an opportunity for the utility or a utility subcontractor to come in and automatically shift either the heating or the water heating or both to low cost times of day to low emissions times of day.

So we have a small number of customers right now who are on a pilot with heat pump water heaters where there's an artificial intelligence algorithm running in the background, predicting their anticipated daily water draw, and charging their water heater up in the morning in cheap power to hopefully ride out the evening water draw without having to recharge. That's a live program that we are hoping to scaling up soon.

We've also moved to a midstream or are moving to a midstream incentive for our Heat Pump Water Heater Program. That midstream incentive means that the incentive's provided to the distributor rather than to the customer directly.

That sounds like it might be less good for the customer, but it's actually better for

the customer because what it means is, because the distributor and potentially the installer are given that incentive payment, it reduces the initial outlay that the customer has to make to install the technology. So it actually lessens the financial burden on the customer, makes it easier for them.

We've also thrown out the idea of a price guarantee. So one of issues especially with heat pump water heaters, and to some extent with the heat pump space heating, is that there is a lot of variation in the cost to each individual customer.

Some of them are much cheaper than others. Some are much more expensive. Individual customers don't know how expensive that home is going to be to retrofit until they've gotten three price quotes from three different plumbers or HVAC providers.

So what we have considered, we may end up going ahead with it, is that we would provide -- we'd provide that installation and guaranteed costs. It might be, you know, $750 or $1,000 that we will charge, and whatever it actually costs, the customer doesn't pay any more than

that.

So that's something that might help in terms of the -- for the helping customers who are low down the socioeconomic scale and helping all customers to overcome that price volatility.

MS. WOOD: One quick comment, which I haven't heard talked about today. California obviously offers a fairly substantial scale of these units, and so we're hoping that we can attract and engage manufacturers to kind of come to California and, you know, that would help lower the price.

COMMISSIONER HOCHSCHILD: So I just want to jump in here. First, just let me just congratulate Southern California Edison on that Pathways Report last fall, really bold and inspiring vision. And it's almost unprecedented to actually have a investor-owned utility go out that far ahead and adopt a goal of 80 percent decarbonization by 2030.

And the same goes for SMUD, by the way, with your incentives to convert. I had a question around heat pumps in particular. I just actually myself swapped out my gas-fired water heater with electric heat pump. It works great.

It's obviously lower cost to operate on a monthly basis. But you know, in football you don't throw the ball to where the receiver is. You throw it to where the receiver's going, and we know what's coming.

We're going to a high renewables penetration grid. We're going to get to 50 percent renewables ahead of schedule and we'll be beyond that. And every device that's connected to the grid needs to be a good citizen of the grid.

And one thing I'm looking at doing right now here at the Energy Commission is even removing inverters that don't have telemetry and voltage regulation from our eligible equipment list, which is used by almost 20 states around the United States today, because we want to insure smart burners.

And with respect to heat pumps, I'm just curious your thoughts about how we make sure telemetry is part of that, and what else the state ought to be doing, we ought to be, and what are you seeing happening at the local level to insure the heat pumps that are going in are going to be in a position to actually help integrate

renewables, because it does seem to me that among the different suites of technologies we're looking at is particularly well-suited.

You can be flexible wind during the day, and we want electric vehicles, right, a big electric vehicle happy hour. They're plugging in at the time of the day we have surplus renewables, and the same goes for heat pumps.

Anyone want to comment on what we need to be doing to insure we're doing that intelligently.

MR. HOWLETT: Well, it's funny you should ask. We have a pilot that we're just rolling out which will aim to get 100 customers onto what we're calling an integrated distributed energy resources control system.

So those customers will be people who are over-generating with their photovoltaics, and are therefore at risk of pushing too much energy back into the grid, more than we can really cope with. So we're offering those customers a combination tailored to them of a residential battery, a heat pump water heater and a smart thermostat.

And we are about to contract for companies that will control those three

controllable items in a synchronized way so that it will try and insure that if power is pushed back onto the grid in too great an amount at any given time of day, and then the customer's bill is also optimized by shifting those thermal loads to the time of day that's best for the customer, and to the extent possible, to shifting the thermal loads to the time of day that's best for the grid, as well.

So there's a pretty complex optimization algorithm in there to make sure that we're not shortchanging our customer, but at the same time we're able to get some of those benefits for the grid, i.e., when we say the grid we mean all customers. So that's a pilot that we have currently underway.

COMMISSIONER McALLISTER: I want to push that one step further and actually ask the whole group something. You know, one of my frustrations, frankly, since I sat down at the Energy Commission is the under-performance of demand response.

And you know, all these technologies we're talking about and this -- you know -- this -- Commissioner Hochschild's question and your

answer, and some of the conversations have alluded to this through the course of the day, you know, all of these technologies are perfectly adapted to be automated and to work together in an integrated way.

And you know, if we want markets to be encouraged, then it seems like the most direct way to do that is through rates that transmit the right incentives. And actually, we could -- you know -- they could express what the grid needs at any given moment, you know, within some bounds that protect equity and things like that.

So I guess my question is, what are the prospects for developing the kind of rates that we need to do what I just described? Maybe Rory can answer this, since he's from the PUC.

MR. COX: I will talk a little bit about this.

COMMISSIONER McALLISTER: Okay. Okay, great. Oh, there you are. Thanks.

MR. HOWLETT: Okay. So the rest of -- if nobody else -- Owen, from SMUD. I am not speaking for SMUD on this topic. I'm speaking from -- this is a speculative point of view. This is not SMUD policy.

My understanding of the tension that you're describing is that residential customers especially don't want a new burden with the complexity of going to a real time rate that will reflect more accurately the utility and society's cost of providing power.

So the idea if we could have every customer looking at their phone and adjusting their energy consumption in response to changing rates and the future predictions of changing rates, but realistically they are not going to do that.

So and a lot of customers don't want to be exposed to the downside of this, of using power at times when they didn't realize that it's going to be exceptionally expensive. So what we're looking at, at least in the R&D group and others, is money to get the things done (indiscernible) so this is not -- like I said, this is not SMUD policy-setting.

But we're looking at whether we can provide what we're calling a price publishing server, which would be a background application where we communicate to aggregators and we provide to those aggregators our real time price.

And those aggregators would then operate the end-use devices like the water heaters, and the space heaters, in the customers' interest to minimize their bill, but also to minimize SMUD's costs. So we'd effectively be outsourcing the optimization of our own real time rates, but we'd be insulating the customer from the volatility of those rates, and insulating the customer from the need to then be constantly analyzing and adjusting their own energy use.

COMMISSIONER McALLISTER: I think everybody recognizes that that's not a tenable future and third parties are going to have to get in the middle of that somewhere. So that's compelling. Anybody else?

MR. ABENDSCHEIN: The only thing that I'd just add to that is that I think you have the same chicken and egg problem that you have with other issues around heat pump water heater manufacturers that you need to get the volume going for them to be willing to make changes and adapt their technologies to work with the kind of automation that we're talking about.

MR. HOOPER: So I don't work for utility, so I can't comment on rate design. But you know,

speaking directly to Commissioner Hochschild's question, there is the -- I would recommend that the Commission look more closely at CTA 2045 as the appliance standardized interface for compliant appliance controlling, because sending signal through the appliance standards, through incentives, and maybe through the Code itself supporting a standardization, could have a, you know, serious effect; that you also alluded to how once California, through our incentive programs maintains lists and inspects, we actually influence products available in other states, it's kind of -- it works both ways.

So if we jumped on the bandwagon of the industry developed controller standard, that could seriously lower the cost of adding the systematic data and the type of control that we're looking for to be widely available.

COMMISSIONER McALLISTER: Yeah. It seems like there are a lot of chickens and eggs hanging around, right.

(Laughter)

COMMISSIONER McALLISTER: We have -- in order to do a standard through Title 20, for example, the Appliance Sufficiency Standards, we

have to show cost-effectiveness. Yet there's no rate incentive that provides some kind of traction for that calculation, that shows, okay, if you can participate in demand/response, there is a value proposition that saves the customer X over the lifetime of that device, then there is no cost effectiveness because there's no savings.

And so you know, so the -- anyway, I think -- I'm sure there are solutions to this, but a lot of it boils down to having the customer see something that allows -- that provides an incentive.

MR. HOOPER: Clearly, I'm also not a -- I'm not an appliance manufacture, but in looking at this specific issue the marginal cost of a device compliant with that standard is on the order of $5 today, and is -- could be, you know, basically negligible if it were actually widely sold.

COMMISSIONER McALLISTER: Yeah.

MR. HOOPER: I think that is a surmountable problem.

MR. SAMUELSON: Okay. We'll go ahead and move onto question three. We have a little time left. So question three, what are the

opportunities for local governments and/or utilities to leverage what your organizations are developing.

MR. ABENDSCHEIN: Well, one of the things that we're really excited about was a grant that was approved for BayREN this last week, for a variety of things to -- in part to expand their educational and outreach programs to contractors, building officials and consumers, to include heat pump water heaters.

But also, there's been some -- it's also going to include a midstream incentive program, and I thought Owen gave a great overview of why those are compelling. And like I said, it's going to be hard for us to make a lot of progress without some regional action in the Bay Area.

And so we're participating in funding those midstream incentives and we're looking for a lot more Bay Area regional partners and utilities and CCAs to participate. And I maybe would second, you know, to the extent that there is guidance out there that would enable other IOUs and -- or CCAs to participate by clarifying some of the guidance on the use of those EPIC funds. That could help expand this program all

the way.

MS. ANDREASSEN: I agree I'm coming from our perspective. One thing that we really want to leverage is our own city training, or it's (indiscernible) but an option that we want to look into is -- the educational staff solution. A lot of technologies obviously come into the city that are aimed at machine productions or, you know, energy reductions and energy savings and whatnot, and they're new.

We need to see how they incorporate into our grid and into -- how they sit with the building and safety standards and fire safety standards. And so we're trying to figure out what's the best way to open up communications so that we don't slow anyone down when technologies come in.

We've seen that with batteries. We've seen that with certain groups that want to come in and they get stuck in other safety requirement areas. So one area that we have there that we're going to try to focus on is not to hinder innovation, but it's something -- you know -- so there's new ideas coming in. How do we, you know, expedite that process in a safe way is a

really key area for us, and you know, it's our own training.

So if someone's looking at a building plan that's, you know, not for -- and it's not a prescriptive building code, how do they make sure that the -- to allow the design and what educations are they needing -- do they need to be more informed on the new code developments and whatnot.

MS. WOOD: In May Southern California Edison filed a pilot program we're calling the Clean Energy Optimization Pilot, which is a partnership with the University of California Office of the President, and we'll be using this pilot to test this very thing of incenting and encouraging GHG abatement strategies on campuses. So we'll see. It's currently under review at the CPUC.

MR. HOOPER: This is Barry in San Francisco. I think it's a great question. We definitely have benefitted from the standardized products that the statewide Codes and Standards Program has provided, such as some of the cost effectiveness studies they've been able to fund -- ratepayer funds.

And we've also definitely benefitted from the formation and the communication facilitated and engagement through Regional Energy Networks, particularly BayREN, which we're a participant in, of course, in disseminating those studies.

And sometimes providing specific technical guidance and project support that is additional to what could be provided through other people, it's always additional through what could be provided through other channels, but it's specifically tailored to our requests and it's very timely.

And we also appreciate learning from peer networks elsewhere. So I've definitely gained from the activities that SoCal ran.

MR. HOWLETT: This is Owen with SMUD. The -- I think it's going to be critical to achieve these goals that the utilities and others in this phase work together to achieve market transformations conservation that we need to achieve.

Some are pretty obvious, a lot of technology improvements. So we first want to have heat pump water heaters that offer 120 volts, 240 volts, because that dramatically

reduces the wiring costs and it reduces the chances that the panel has to be upgraded, which is a big cost variable in these upgrades.

So but we as the utility that has five percent of California's electric market, we don't have the clout to work with national manufacturers and say, hey, you should change your product spec, or we'll develop a new skew.

So working with other utilities and collectively asking for those things from manufacturers is much, much more powerful than having utilities acting on their own. And of course, that's the same for customer awareness barriers as it is for manufacturer barriers.

There are lots of things -- lots of product improvements that we want to see, inverse driven HVAC, heat pump, space heating that doesn't blow cold air on people. To get those kinds of standardizations, to get those better products so the customers don't experience poor comfort performance is super important.

But then in terms of local government leveraging what we're doing, I already mentioned that we want to work with local government on passing local Building Code ordinances that would

require electrification in existing homes and for new homes.

That is -- that's mostly critical to achieving the sort of widespread markets that we need for these technologies.

MR. SAMUELSON: Okay. We're going to -- that brings us basically to the end of the panel 1. So I just wanted to thank everyone for participating in our panel today. We know your time's valuable. We appreciate you coming here and sharing what's going on with your organizations. Thank you.

(Applause)

MS. RAITT: So we'll go with -- and we're ready now for Rory Cox, from the California Public Utilities Commission. Thanks, Rory.

*MR. COX: Well, thank you for your patience during my little PowerPoint snafu, and thank you, especially to the panelists who just jumped in 90 minutes early, to their panel to accommodate my PowerPoint snafu.

So we'll pick up from where we left off, with the right set of slides. And if you've been here all day, and of course, some of you have been working here for -- or working on this topic

for a long time, some of this is pretty old news.

And I'm going to go past what I think is pretty old news pretty quickly, starting with this slide. We just saw something like this from E3 this morning, but this just demonstrates the importance of decarbonizing the building sector.

This is some legislation that we haven't really talked about today that I wanted to bring up. There are three bills that are floating around the Legislature around the corner that would consider building decarbonization in different ways.

The first one that at Bonta bill is not really advancing, but it would have changed the Building and Public Utilities Codes to encourage all flexit-buildings *17:41:55. The number two and number three are advancing.

The Friedman bill is -- would require the CEC and other agencies to develop a plan to reduce building emissions by 40 percent by 2030. That is advancing, and the Stern bill would create a zero emission heating market.

Actually, I think it changes the market development fund, instead of market -- market transformation fund at the State Treasury.

That's also advanced. So there's some exciting things happening at the Legislature in this space.

And this is just a slide that covers what the various agencies are doing. The first two I don't think I need to talk about, because it's been presented today. The third one you might not be aware of, which is the Department of Community Services and Development.

They are the administrators of the Low-Income Weatherization Program, and they are -- they have been calculating per building -- this is for, you know, disadvantaged communities with the low income customers.

But they have been calculating per building energy and GHG savings, and working on -- they've been kind of getting to doing home retrofits for low income customers that are -- that include solar panels and are using GHG revenues for that, the Cap and Trade revenues. So that's something that's an agency and a program that is certainly worth watching.

And I'm going to go over these more in detail, but these are some of the things that are current are discussing the definitions of fuel

switching versus fuel substitution, which I'll get into, the three-pronged tests, which I'm also going to get into, Integrated Resource Planning, which is the -- sort of the master plan, if you will, for our future utility programs and what they will do and their part in SB 350.

In future PUC policy activity are -- we're looking at and discussing some possible policy approaches to electrification, including tariff, all electric tariffs, resource acquisition programs, which is incentives, financing and emergent technology and market transformation, which again, I'm going to get into all of these.

So first of all, on definitions, I've heard even today these two things used interchangeably, and sometimes not in a way that we've understood them, anyway. Fuel switching is when we're referring to using a PUC-regulated fuel to replace a fuel outside of the CPUC jurisdiction, or the other way around, such as electric cars, which is switching gasoline for electric vehicles.

And that's not really much of what this presentation is about. It's more about fuel

substitution, which is more building focused, because it's talking about a PUC regulated to other PUC regulated.

So for instance, natural gas to electricity is mostly what we're talking about. So that is the difference between fuel switching and fuel substitution. I won't go into why those -- why it's important that we have those two definitions, but we do. And these are just examples of, you know, what we're talking about when we talk about fuel substitution.

We are talking about replacing the natural gas version of space heating with the electric version of space heating, the natural gas version -- the replacing the natural gas version of water heating with the electric version of water heating, electric water heater.

Cooking ranges, natural gas versus could be electric, but induction is more of the highly efficient model. And this is something that I just learned about that is interesting. In industrial processes there are all kinds of opportunities for electrification.

Pasteurization is one good example. Currently, the -- what's mostly done is natural

gas powered, but there is UV-based pasteurization that is electric. And so that is another example of -- and quite a bit of natural gas is used in the industrial sector.

So I think there's a lot of opportunity here. So the three-pronged test, and I think this is what Mr. Hooper was running into when he was talking about not being able to get incentive for electric appliances.

A three-pronged test is something that we've had with the PUC since 1992, and the purpose of this test was to determine whether energy efficiency funding can be used for fuel substitution. And so the -- there are, you know, three different prongs that have -- that any measure has to overcome, which is that it cannot increase source BTU consumption.

That's -- shouldn't really have a problem. It's the second one that becomes the problem, because then it must be cost-effective, which is to say it must have a total resource cost, and the participant -- PUC benefit cost ratio of one or greater.

And the Interveners filed a motion in last year to refine the three-pronged test in the

Energy Efficiency Proceeding. This slide is a little bit outdated in that it is not -- no longer under consideration, but it is now scoped into the Energy Efficiency Proceeding.

So that just happened a couple of days ago. So that's sort of some late-breaking news on the three-pronged test. So we are looking at it, certainly. And here is the IRP, what we're doing with the IRP.

We have, you know, looked at the IRPs, what the impacts of future electricity growth are on the grid, and according to our research, if we -- the more -- as we become more dependent on renewables and -- I'm sorry -- on electricity and renewable electricity, the demand for storage goes up, especially if you look at that last bar there, 2038, that purple block is energy storage.

So that's where the things, as we think long term, is that this is going to be a heavy lift for energy storage, is something that we're looking at. So future decarbonization activities. One of the things that we're considering and kicking around a little bit, and again, this is just sort of an outline so we can talk about, all electric tariffs.

So this is something, we actually have an all-electric tariff for all electric homes already in place. The reason we have this is because back in the '50s and '60s there was this big -- a big push in this country to electrify buildings and electrify homes and they built entire developments of all electric homes.

So it's kind of like what's new is -- what's old is new again, or something like that. And then that ad there is from that year. But there are several communities, you know, especially in Southern California, that were built to be all electric, and those customers have a -- it's a tariff which allows them a baseline usage that's higher than those of dual fuel homes.

And this is an example of something that we can look into, to -- I mean, it's already there, but it's not there for commercial industrial customers. It's -- but also, it may need to be updated or looked at in terms of this concept of, you know, going -- of electrification, but it's something that we're looking at it in the toolbox of things that we could possibly do to push electrification.

Number two is incentive. This is something that we do a lot of, especially in energy efficiency and the California Solar Initiative. And this is some -- an example, of an incentive structure could be something like the California Solar Initiative, where it's a -- it's offered at a certain rate and the rate declines over time as the market uptake increases, and that did a lot to triple the -- grease the skids for solar in this state and it's something that we could do with electric appliances.

Incentives can also be scaled to the amount of GHGs the appliance will reduce over its life cycle, and you know, could be offered for a panel -- for solar panel upgrades or rewiring to accommodate an all-electric building. So another thing that we're -- another concept that we're thinking about.

Number -- another idea is financing, on-bill financing to provide low or no interest loans for electric appliances; could have a dedicated financing program for customers that have – or wish to have all electric homes or businesses, and we could targete financing in

disadvantaged communities; another item that's another tool that we could possibly use.

Another one is emerging technology. Right now, we work with the utilities on Emerging Technologies Program that's funded by the Energy Efficiency funds. This could develop a technology priority maps to prioritize all electric appliances.

This would provide a pipeline for products to go from the development stage to market adoption, and as an example of this, Commissioner, you mentioned that appliances can be grid interactive, and you know, water -- grid interactive electric water heater is something that is, you know, certainly something we could think about for something like this.

But right now it's not part of the demand response programs, and they're pretty expensive right now. And then there's market transformation. So these are typically strategies that are aimed at reducing barriers, and moving technologies into standard practice or into code.

And this usually happens -- after it goes to the Emerging Technology Program it could then

go through Market Transformation Intervention. So for example, we could have a marketing campaign that addresses that customer concerns are inadequate for cold climates, was one example.

Market Transformation we could have a marketing campaign that could, you know, sell the benefits of induction cooking, is another one. I've always thought that one -- give you one good way to get induction cooking to be popular is to get celebrity chefs to start doing induction cooking on their TV shows.

So you know, there are things like that, and the things like that, that I think could really -- really helps for this market. So here, this is the sort of one concept to think about of how to combine, you know, all the different programs that we oversee.

And you know, one of the things that we always have to think about is, you know, as it is we've siloed our programs off and it could be very confusing for customers and fairly overwhelming. But you know, how do we -- how can we put what we have together into something that will really, really not just serve the consumer,

but also serve the grid.

So here's an example that we've thought about. You know, as you know, net energy meter reading you get credits for some excess energy to the grid. You know, we could provide -- we could develop a program that could combine wholesale NEM compensation for that, for the solar, with an extra incentive for folks with heat pump water heaters and who subscribe to a demand response program.

And by doing some -- and you know -- maybe have a grid interactive water heater. So by doing that, that's a better incentive for the customer to accept all these technologies, but it also then, then the customer becomes a better grid citizen, so to speak, and by, you know, being in demand response and by having them interact -- by having interactive appliances, it can be valuable grid assets instead of a concern for the grid management.

So that's the kind of -- along the lines of what we're thinking about, and just thinking about right now. And so these are some of our next steps. We're considering some possible policy approaches, tracking the legislation that

I just mentioned, working with and tracking the work at our sister agencies.

And you know, monitoring some of the progress and overseeing some of these programs, some of which were - we played a pretty big role in developing. Now, one of them is the San Joaquin Affordable Energy Rule-Making.

That's a proceeding that we have that is addressing some of these small towns in the San Joaquin Valley that currently do not have access to natural gas at all. And we're developing different scenarios by which we can take care of their energy needs.

A lot of them are using wood or propane to heat and cook with. So we're trying to -- we're looking at the possibility of solving that problem with all electric, as opposed to building new natural gas pipelines.

Southern California Edison, you just heard them present about their plan. You heard SMUD present about what they're doing and then you heard Sonoma Clean Power and PG&E's partnership in the North Bay Area. So some of these we've gone over a few things here all day.

And that's -- those are the end of my

slides. I guess we're going to do the discussion after this. Is that right?

COMMISSIONER McALLISTER: We have one more panel. So we have one more panel, and then I think we'll hold questions, public comments after that.

MR. COX: Okay. Thanks.

COMMISSIONER McALLISTER: Yeah. Thanks a lot. We're --

(Applause)

MS. RAITT: So we're ready to go into our second panel. So the folks in the panel can go ahead and we have seats for you at the tables in front here. I'll just take a moment to transition.

(On the record at 2:52 p.m.)

MS. RAITT: All right, so the moderator is Heriberto from the Energy Commission, Heriberto Rosales.

MR. ROSALES: Good afternoon. Is the mic working? Great.

This is Panel 2. We're going to be talking about design practices, Technology Solutions Panel.

So we're going to do self-introductions and we have -- just real quick we have representation here from experienced building designers and engineers, and we also have representation from the clean energy industry here.

So I'm going to start with my right. We'll do quick intros. And then, when we complete that we'll get into the questioning part of the panel discussion.

MR. ARMSTRONG: Hello. I'm Sean Armstrong. I'm a Principal with Redwood Energy and we're specialists in the electrification of buildings and pairing it with solar. So we've done 2,500 all-electric solar-powered homes, and another 3,000 that are solarized, but not all-electric. And I'm here to share construction and technical details.

COMMITTEE MEMBER MURPHY: Good afternoon. Thanks. You saved the best for last. I just want to thank Commissioner McAllister and Hochschild.

My name's Ed Murray and I'm with the California Solar and Storage Association. The 500 member companies throughout California that

represent the manufacturers, the installers, the financiers of solar products throughout California.

I'm also, as a side job I have a company in Sacramento called Aztec Solar and I install solar water heating, pool heating and electricity. Thank you.

MR. SHELL: Good afternoon. I'm Scott Shell, a Principal with EHDD Architecture in San Francisco. We're a 60-person firm. The project that people know of ours is the Monterey Bay Aquarium. We've been designing zero energy buildings for about 15 years. And last year we were doing some carbon calculations and realized that we were kind of using the wrong metric. We needed to shift to zero emissions buildings.

So we've been trying to figure that out and I'll be talking a little bit about that.

MR. TIFFANY: Ted Tiffany. I'm the Director of Sustainability for Tuggman & Blaevoet Consulting Engineers. We're mechanical, electric, plumbing, telecom, and our building performance team covers energy modeling, simulation, commissioning and sustainability. But my background is really around the energy

standards. I've been involved since the 1995 standards and, you know, was here in 2013, the standards with that challenge.

And I just wanted to thank your staff for being so responsive and thoughtful about that challenge and coming to this challenge for electrification and decarbonization with the same responsiveness. So thank you for that.

The other efforts we're working on right now is the Building Decarbonization Coalition and trying to build education around that. And another one for New Buildings Institute for the Grid Optimal Initiative. So if we're going to have electrification, it has to come with healthy, responsible grid design. So --

MR. WICKES: Good afternoon, Geoff Wicks with NEEA. I'm the Senior Product Manager in our Emerging Tech area. And I focus mostly on heat pump water heaters, demand response with heat pump water heaters, and then also scanning on intelligent pumps, fans, and anything electrically driven within a commercial building shell.

MR. ROSALES: I believe David's on the phone.

MR. LIS: Hi, can folks hear me?

MR. ROSALES: Yeah, we can hear you. Go ahead, David.

MR. LIS: Hi, good afternoon. This is Dave Lis from Northeast Energy Efficiency Partnerships. Like Geoff, we're a regional energy efficiency organization, but we're out in the northeast. It's a pleasure to join today.

I've been with NEEP for 12 years. My current focus is on a couple of market transformation initiatives. One involving air source heat pumps specifically. And more recently on a broader initiative around strategic electrification. So look forward to being on the panel this afternoon.

MR. ROSALES: Thank you. So we'll start with some of the panel discussion questions that we've prepared. And again to remind everyone, the panel's going to be speaking directly to promising and innovative design practice for buildings of different types.

But also we're going to be talking about new and overlooked technology options that can help us solve some of the lag in energy efficiency, barriers across multiple sectors.

So, they're going to be acting as tour guides for us, help us understand the landscape between energy efficiency use and a better building design. And we'll hold questions until the end.

Each panelist will have a PowerPoint presentation and a few minutes to go through that.

So okay, let's get started. We'll start with question one. Question one: What types of new construction projects are the best suited to all-electric designs? Are there certainly building types or locations that are prohibitive?

And Sean Armstrong will lead us on this one.

MR. ARMSTRONG: Okay, you can bring up my slides. So the quick answer is all building types can be made all-electric. The easiest ones are the ones that are low temperature buildings that can use heat pumps that only need to get to, say, 180 degrees maximum for heating and water. And if you have temperature needs that are below 180, you can meet them with heat pumps.

So residences, and offices, restaurants, schools, all of these are easy with the

technologies that are available.

And I want to show -- on the last -- there's three pictures. Wolfgang Puck is in the middle on an induction stove. To the left of that you can see a map of the United States. In yellow are all counties, which is most of them, where all-electric construction has gained the market share since 2010. This is a gauge of market share change. It's not the market share itself, it's the change in market share.

So what we've seen is that since 2010 most of the United States is continuing to grow in all-electric construction which is a trend that at least began in 1993, according to the Energy Information Administration, with our federal government.

So we are now not only in a 23-year-long trend of electrification, since 2010 it has accelerated. Particularly because of inverter driven heat pumps, where you can take one compression but run it faster or slower depending upon the outside temperature. So it doesn't have an on/off switch. It can go into any climate, into Antarctica. It can go really, really cold now with an inverter.

So in the middle I want to talk about restaurants. Anthony Bourdain, in Rest in Peace, on the right-hand side, he's showing off his induction stove. In the middle we have Tomas Keller's French Laundry that was just converted to an all-electric restaurant. And you can see it's wonderful to cook on induction in restaurants because it's faster and safer.

The people who cook on induction in restaurants will show you usually about a dozen burns all the way up and down their arms where they've touched 3,400 degree metal, and it's an instant three-degree burn. It's an instant scar. And they have a dozen, usually, professional chefs within the first ten years, and it hurts.

So when you talk with a chef about why they convert it's frequently around pain and safety, as well as air pollution inside the kitchen.

I want to speak to what's more difficult, though, recycled glass dishware. Glass cooks at, say, 2,000 degrees, somewhere between 1,500 and 2,000 degrees. In the middle you're seeing a blow torch that we use to make cement. That long cement tube has a flame inside of it and it's

burning about 3,400 degrees in the flame and it's trying to deliver about 1,500 degree Fahrenheit temperatures to make cement.

And then, canned foods which sterilize at say 400 to 600 degrees Fahrenheit. All three of those can be accomplished with electric resistance. So aluminum smelts at about 1,500 degrees with a lack of resistance. There is no material that can't be heated to the appropriate temperature with electric resistance. It's obviously energy-intensive, but if for a wind turbine down the road, so to speak there's -- it's an efficient use of renewable energy. But it doesn't lend itself well to heat pumps, to they're collecting atmospheric warmth. But it's still there.

The next slide, if I could. So I was asked to speak about barriers and solutions. The first is going to say low-power buildings can require panel upgrades, as has been spoken to. So the panel, the electric panel in your mechanical room or something, laundry room, $600 to $3,000.

There's the interior wiring. So if you're going to put in a 220 volt device and

you're 120 volt electricity, you have to put in a new wire. And that's going to cost $200 to $400 per wire. So it might be $800 to $1,000 per house to rewire. It's a challenge.

Mechanical engineers and contractors unfamiliar with heat pump equipment that's a way bigger challenge. It's unfortunate but it's just fundamental most people don't have much familiarity, and are scared, and over-priced, or just refuse to do the work.

But let's go to Japan, a country that has very limited grid supply of energy. They don't have fossil fuel resources. They run a third of their power is nuclear power. It's very constrained. People have 20 amp packages, where your house turns off if you're using more than 20 amps at any given moment. We have 100 to 200 amp panels that allows you to use whatever we want. But you can constrain all of your energy consumption in a house to under 20 amps, fairly straight forward. So that's how they have actual programs with the utility. I pay for that rate, the 20 amp rate where my house turns off if I mess up, and that's how people live.

So in Japan they also have nine

manufacturers of carbon dioxide heat pumps that are 40 to 50 percent more efficient than the best products. So COP is 6 to 7 is what you'll find in Japanese heat pumps, at the close to the theoretical maximum efficiency.

Now, they've moved over to like comfort as the issue, as far as meeting all the efficiency thresholds with carbon dioxide. Those nine manufacturers are all big names. Notice the Panasonic. That's the picture of the 2014 heat pump with a COP of 5.1. 2014, it's by Panasonic. Many of us have Panasonic in our homes. We don't have access to this heat pump. What it lacks is a UL listing in the United States and a cargo ship. That's the barriers a UL testing and a boat. And there's nine products over there at are over there that use CLO of 5.

So what I'm saying a solution is bring in products from Japan that have already gone through all the design thresholds that we have, only worse, and they've already solved the problems. They're an advanced society like us. You know, they're not different. We can just use their products.

We can address the costs with programs.

And I think, as mentioned earlier that midstream are ideal for reducing the downstream cost adds a profit. People add usually 20 to 30 percent profit every time they resell something, sometimes other percent. So, dealing with the economics of where prices go up.

And then the last one is to provide best practices guides and classes. As I said, again I think the worst challenge is the lack of knowledge, not the lack of products. So those are my thoughts.

MR. ROSALES: Right on time, thanks.

MR. ARMSTRONG: Did my two, three minutes.

MR. ROSALES: Scott, you want to follow up?

MR. SHELL: Sure. I have a few slides, I believe, so and then the next slide. As I mentioned, we came at the electrification via zero energy. And we started out with our first zero energy building in 2003 and it was a small building. It was a little nature center and then another small office a few years later, in 2007. And it was hard at the time. And there were not many products. We didn't know if we could do it.

Solar was expensive.

And so we learned a lot doing those and then we scaled it up to these projects; so a 50,000-square-foot office building for the Packard Foundation, and a 200,000-square-foot pretty energy-intensive science museum, the Exploratorium.

And a lot of the things that we used to do on these buildings and that we used to brag about, Title 24 now requires those things. You know, so continuous exterior insulation, advanced lighting and controls, and on, and on, and on. So the code has really raised the floor. And it's now gotten almost routine for us to do these all-electric zero energy buildings.

We have about eight others that are either recently completed or are in construction now, and it's a pretty straight forward thing. It's shocking to me how simple it has gotten in such a short period of time.

And so I was wondering if this was just the strange little niche that our firm lived in or if it was more widespread. And so, I reached out to seven of the top mechanical engineering firms in the State, two of which are sitting up

here with me, and I asked them these same questions you're asking us. You know, are we ready to shift to all-electric buildings?

And I wrote down all the answers and I put in a bunch of pictures of their buildings, and they're of all different types of sizes, and here's kind of what they said. So Integral Group said, yes, we're ready for all-energy buildings. We have dozens of electric buildings recently complete, in construction, in design. It's a big C change in recent years.

Interface said almost all of our projects are all-electric, even one in Minnesota.

Point Energy Innovation, heat pumps are already making significant inroads in California. We're seeing a lot of developers on our projects go all-electric.

P2S, new buildings are easy to get to all-electric because you can do integrated design and tradeoff strategies. Residential buildings are easy, small and midsized commercial buildings are really straight forward.

And I'll let Sean and Ted speak for themselves.

And so as you -- you know, I asked about

the costs. They said the costs were competitive. I asked about maintenance, I asked about all these things that my clients worry about and then I have to answer to. And I got thumbs up almost all the way around, with the exception of some specialized buildings like hospitals, or a building that has to generate steam, or commercial restaurants, things of that sort.

So, that's what we're finding when we asked these questions.

MR. ROSALES: Thank you, Scott.

And David, just for your benefit since you're on the phone, we're going to come to you on question four, so if you can just hang tight.

So we'll move on to question two. What are the key barriers to electrifying existing buildings? How can these be overcome, e.g. codes, technology readiness, infrastructure, et cetera.

So Ted Tiffany's going to lead us on question two.

MR. TIFFANY: Yeah, I didn't bring those slides so I've got to see which slide's got up there.

So, you know, like Scott said, you know,

a lot of the drivers between electrification are already happening. Any time we're designing a zero net energy building it's almost a given fact that we're going to an all-electric application.

So those technological barriers are not there. Even on these large-scale commercial buildings the driver being, you know, trying to put solar on the building drives that choice.

Like Sean was talking about, the technologies being available on the market is one of those things we need to overcome real quickly.

Can you advance a couple slides? No, this is the truncated one. So really what I need to talk about are some of the things that are barriers in the code right now between, you know, alternative compliance method, manual barriers, a lot of those have been solved in the 2019 for residential. There's still some large barriers for electrified applications in the nonresidential barrier that we need to talk about, and we will in a different forum.

COMMISSIONER MCALLISTER: We are focusing on nonres and multi-family in the 2022 update, so your change will come.

MR. TIFFANY: Yeah, and we need to move

there a little bit faster for the 2019 so we can enable those buildings now.

And I'll give you one example for that. I have a 375,000-square-foot dormitory building right now that has an all-electrified solution and shows a payback of about ten years. We're not eligible for incentives because we can't meet compliance through the performance approach.

We have to take a myriad of approaches with a prescriptive path, with domestic hot water for an electrified solution and an electrified path for HVAC. So we're using two prescriptive applications and performance for architectural and lighting to even approach compliance. And incentives are off the table.

And that is a challenge for, if we talked about the three-prong test being able to show cost effectiveness in retrofit applications. The technology's there, the willingness is there to decarbonize. The incentive from an existing building baseline and the three-prong application for electrified applications is a real barrier in the market right now. So I think those things need to be really thoughtfully redesigned.

And one thing, you know, that you brought

up, both Commissioners talked about was grid optimization. And having those incentives, both in rate structures that are enabled and incentives through public goods charges need to be enabled to have grid-optimized solutions.

And you talked about demand response, and the demand response programs and those utility programs are the wholly unused incentive programs, and I think just because of the name. Because we asked the people to demand response, and if we maybe just changed the name to grid harmonization and put that on a rate structure name, we might get more participation.

But favoring something like, you know --

COMMISSIONER MCALLISTER: Grid harmony.

MR. TIFFANY: Grid harmony, grid harmonization, being a good grid citizen all of those languages that I've heard here today that make my heart warm could be used in a rate structure name.

But those barriers need to be changed, you know, with a thought process around demand responsive technologies like thermal energy storage. PG&E's thermal energy storage program is down off their website right now. And if you

look at NYSERDA's demand responsive -- or thermal energy storage and demand battery storage applications, they're program's way more robust than what we've ever had, so those technologies need to be enabled.

COMMISSIONER MCALLISTER: Thanks.

MR. ROSALES: Thank you, Ted.

Sean, Scott, I'm going to give you an opportunity if you guys want to add some brief remarks to the question.

MR. ARMSTRONG: Yeah. I'd like to add that the power available -- to expand what I was saying earlier, people can get by with a 20 amp panel, but we don't. Like that's not the way we're even approaching using power in homes.

But we have two options, essentially. We either go in and retrofit people's homes with new wiring and panels, which is a real option, or we have products that fit within their existing power supply. And I think that we should be focusing on finding the right products as opposed to gutting people's homes, or futzing around with their panels. There are all sorts of other problem approaches to it that trigger the next thing, and the next thing, and the next thing.

Any construction project has unexpected consequences of upgrades that are attached to it. It's just almost a rule that you don't know what you don't know.

So I keep wanting to -- I want to focus people's attention on the solutions that exist and just make sure that we have them here so that we don't have to do an expensive retrofit of our State, which I think is not the right approach to it.

COMMISSIONER MCALLISTER: Can I -- I just want to make sure we cover, expand where it might be helpful. So in order to do that, so we're talking about policies and certainly, you know, the code presents a process that, you know, obviously it's best that we optimize. And then the program requirement, just like the visual you use in the PUC, you know, I want to talk to those ideas.

I guess, if you could paint a little bit of a picture of what a success like engagement with the market actors like look like, like meeting importers of these devices, the manufactures, the whole supply chain. You know, how might we go about engaging productively with

those folks and, you know, it might even go as far back as design, even original design. I mean we were talking about earlier it's five bucks to have -- you know, to add some telemetry or some communications devices attached to like an HVAC system or whatever, a heat pump.

You know, what does that convening look like to you guys?

MR. ARMSTRONG: Okay. So I've talked with Mitsubishi and Daikin. Daikin's a large manufacturer. Like personally, just hanging out with them, asking them the same question. Their answer is we don't think that Americans want what we have. So first, we have to ask them, make a request. They're convinced that only maybe California's interested in it and that probably not. Actually, no, they're not interested. That's what they said; we are not interested, according to them.

So starting there, just I think that it means having a demand, a program from the City of San Francisco, or L.A., or some significant purchaser that guarantees them sales.

And then there's an incentive that is the third nice thing, for the midstream incentive and

it lowers the cost at the right spot.

And then on your guys' side make sure that the products that are coming in can be modeled. That's a continual struggle that we have where the products can't be modeled, even when they're there. So have an integrated like we promise you'll be able to get a building permit, we promise it won't be very expensive, and it will sell.

That's a process that would get them to bring over container loads. Does that answer your question?

MR. LIS: This is Dave. Can I jump in quickly?

MR. ARMSTRONG: Yes.

MR. ROSALES: Yes, go ahead, David.

MR. LIS: All right. So one of the pieces, one of the involvements in the market that we have been active in is around a specification that a lot of the programs that Northeast point to, as part of their incentive programs. And I'll tell you, when we're talking about revisions to that specification that gets a lot of attention from manufacturers and there's a lot of -- basically, there's a lot of dollars

rolled into meeting that specification. Very much like an energy star specification.

But California's probably big enough, but if California were to coordinate with other regions, and other states, and built that into the specification, and put real dollars in terms of the incentives behind that, you could really drive design and changes from manufacturers. So, a quick one on that.

MR. ROSALES: Thank you.

Go ahead.

MR. TIFFANY: Really quickly, a huge amount of education. If it's not specified, it's not going to get into the design. I run into a lot of mechanical engineers that design simplified school buildings that are, you know, split heat pumps with gas furnaces. And it's like can you not just do a heat pump and simplify the equipment? And it's just knowledge base. It's what they're used to doing. And there's a huge educational uplift that needs to happen with the engineering world and the owners.

And I think Scott's gone through that with some of his school projects. It's just educating about the all-electric options and that

hasn't been done industry-wide.

MR. ROSALES: Thank you.

So question three, Geoff Wickes. The question is what are the barriers realizing highly efficient electric water heating? How can these be overcome?

MR. WICKES: Thank you. To touch on that last question, what is an example of how do you get some of that product here, we actually -- some of these products are actually created here. And NEEA has been working in the heat pump water heater world, now, for well over 20 years. And we have what is called the advance water heating specification. We're currently on version 6.0. All the manufacturers are following that and that helps drive their efficiency level.

When we first came out with the tiers higher than what they were currently producing they about -- you know, my phone started ringing off the hook saying, what are you doing? We can't do this. And I said, no, no, we're giving you a runway. A big calm came into the room and they were fine with that.

And I think this would echo what David was saying. Once people start getting behind the

specification, a testing methodology and a qualified products list then you'll see that market uptake for technology, and then you'll see products showing up, regularly.

COMMISSIONER MCALLISTER: Do you have any issues with federal preemption in that approach?

MR. WICKES: So we don't try to contradict the DOE. We try to have the DOE and Energy Star as a minimum. But these are stretch performance standards so we don't view it as a problem. And we actually apply our incentives over and above those.

So to talk about --

MR. LIS: It's a voluntary program.

MR. WICKES: Yes, exactly. Thank you. Yeah, good point, David.

So, why don't you go to the next slide? So as I said, we've been working in heat pump water heaters for quite some time now and we are pretty familiar with some of the barriers.

And there are a couple pretty obvious ones, consumers are just not aware of it. And I would say that most of the time people think about their water heaters when they don't have it. So we view that as about 85 percent of the

time, so it's kind of the step on the rake moment. And they all of a sudden I need a water heater. They didn't budget for it, they don't have the money sitting around, and so they're going to pick the lowest cost solution which happens to be an underwater toaster.

(Laughter)

MR. WICKES: The other solution or the other barrier that we see quite often is plumbers are not familiar with it. So we find that that's a big barrier. Somebody calls up in a panic, I need water to shower tomorrow morning and the plumber says, well, we can replace like for like. It's going to an electric resistance or a gas. It will be the low-cost solution, the six-year warranty. They don't enter into the conversation of a total cost of ownership and how much that's going to save you over a ten-year lifespan.

And that's one of the reasons why in our specification we say you must have a ten-year warranty. So that gives that peace of mind and confidence where the customer is going to say, wow, it's not new, it's not going to break on me, and I'm comfortable with it.

So I would also say that products are not

sufficiently stocked. Well, that's shifting here up on the northwest quite a bit. Last year we moved roughly seven percent of all-electric water heaters were heat pumps. We're still not above much more than about one and a half total saturation. We moved somewhere between 170 and 200 hundred thousand electric water heaters per year, in our region.

But it's having them there is important because when a plumber calls up and says I've got somebody who needs one right away, and they say, well, it will be two or three days. It's coming from a warehouse in Denver. That's not going to fly. So, stocking it is important.

I would say there are some installation challenges, although most of the products now that's not so much an issue, and we can talk more about that.

And believe it or not, code officials can actually be a barrier, too. We have to have a way of disposing of the condensate. And in some jurisdictions people say, well, it's a condensate pump. It must be acidic, so you've got to take that to drain. Well, the reality is it's probably cleaner water than some people are

drinking these days. So that's not an issue but we do need to educate the code system.

COMMISSIONER MCALLISTER: A question on -- you just rattled off a bunch of data, you know, volume and stuff like that. Are you tracking and how much detail are tracking sort of the distributer level, the retailor, sales of different models? Creating serial numbers, maybe, huh?

MR. WICKES: Yeah, so we don't get down to the serial number, necessarily, but we were working upstream so we were incenting the manufacturer, who would then ship it at distribution, whether it was retail or through the plumbing supply channel. So we knew exactly how much was coming into our region, into our four-state region.

And what was interesting is we worked upstream and some of the utilities were working downstream, and their success rate -- we could tell them that they weren't capturing a good 70 to 80 percent of them because we knew how many were coming into the region and that downstream incentive wasn't getting to the customer. They didn't know about it.

COMMISSIONER MCALLISTER: Did you true that up with permit data?

MR. WICKES: Well, that's an interesting one. And permit data is not necessarily the best data because not everybody gets a permit.

COMMISSIONER MCALLISTER: Well, that's exactly my question. How many -- did you see the discrepancy between the volume imported to the region and sold in the region --

MR. WICKES: Yeah, we haven't gotten down -- because we have so many jurisdictions, you know, with Portland, Seattle, and Boise is our main markets. But there's 140 utilities and there are, you know, probably a thousand municipalities that would track that, but good point.

So there are great opportunities out here, though. The products are solid now. We feel, you know, there was some rough starts with early days and with the Rheem product, with the Air Generate. I can tell you the horror stories.

But now, the three big manufacturers. AO Smith, which owns about 44 percent of the market, Rheem at about 35 percent, and Bradford White at 15 percent, they're all making a great product.

And they're all above a COP of about 3 or 3.3. So there's great products out there.

The supply chain is greased. They know how to promote this. I would say that that's one area where if we're looking to decarbonize a grid we need to leverage that supply chain. We don't want to try to do it, enforce them to do it. Use their channel, they know how to move a -- and it's a commodity. Remember, these things just -- they sell for as little as $300 to $400. And we're now asking them to sell a $900 or $1,000, or $2,000 installation.

So California has a great building stock. This is a phenomenal environment for these things. They're in garages, they're in utility rooms. You couldn't ask for -- in the Northwest, we see temperatures down to the low 30s sometimes in the garage. You do not want to be adding more cold air into that garage. So most cutoffs for heat pump water heaters is right around 37 degrees.

But a garage in California, we can see up to 95. And in fact, we're adding that into our test just so people in California can see a COP of maybe even close to 5 in certain applications,

in certain times in the Central Valley.

One of the other things that I would say is that demand response is a great solution for these. There are already electronics in there because these are compression systems and they've got electronic controls to them. So DR is an easy lift. We're currently doing a major study with that. Great results, both electric resistance, but also for heat pumps and we see savings in both of those.

New construction market. That happens to be our biggest market in the Northwest. And I think there's a bit of new construction going on in California. When I flew in I saw a few sticks on the ground.

Some of the solutions that I want to point to are work with the market channels, both distribution and retail. Home Depot, Lowe's and some of the smaller retails, great programs. You can push a lot of product that way. But your distribution channel is where a lot of the emergency replacement is happening. You need to work with the major manufacturers, their account reps, and then through people like Ferguson, Consolidated, and others.

One of the things that we recommend our utilities to do is go to midstream. Don't do downstream. Go midstream. Get that price reduction to the plumber. Don't have the individual have to go out and scrounge up that money and send in the application and all that. It's another barrier. And the plumbers will say don't screw with it. I'm not going to mess with it. Just get this cheap product.

The other thing is that we talked about stock and flow incentives, so work with the distribution to make sure that there's plenty of stock on hand. One little intervention that's getting some traction is called the Prodio (phonetic). We have the distribution channel give the plumbers a heat pump water heater. Let them live with it. They become the advocate and then pretty soon they're selling and promoting it.

So there's another couple of projects we're working on which are what we call the proactive replacement. And that's an important market because we don't want them to get to a failure state. We want them to be thinking this thing should be replaced if the payback on it is

-- on its own, it's just in great shape.

So we can go to the next slide. Maybe. I thought there was another slide. So click it one more time.

So in California I can talk about this, NEEA is a fuel-neutral organization. But in California I wanted to point out this is put on -- - this is a slide I was given permission to use from Bradford White. And they talk about the economics of what does it cost to run a regular electric resistance at $455 a year? These are national numbers. So California, these numbers would actually be higher.

The cost of running a heat pump water heater is $155. Savings for electric to heat pump is a $300 savings. But it's still cheaper than a gas, too. So you'd be foolish not to be replacing it.

So go to the next slide. So installation consideration, I don't want to bore anybody, but it's doable. This is not a problem. If you really -- if you want it in a tight closet, in a tight house, you still can vent it in and out, if you want to. All the manufacturers are making venting kits.

So go to the next slide. I think actually this is to another topic area. It just got thrown in there, so you can pull that off. Thanks.

MR. ROSALES: Are you done?

MR. WICKES: That's all I have.

MR. ROSALES: Thank you that was really good.

And we're going to give it over to Ed because he's going to take a different approach on this. Ed, your slides will be up.

MR. MURRAY: Thanks. Again, Ed Murray with the California Solar and Storage Association, formerly CALSEIA. CALSEIA was the California Solar Energy Industry Association, a 40-year company representing solar thermal to begin with, and then solar photovoltaic thereafter.

In order to get a picture of what is going on, you know, we ask about solutions that already exist. Solar thermal does exist. It's been in existence, like I said, for 40 years in this State, and it's a proven technology.

The basics of solar thermal, just because it's sometimes considered the other white meat,

most people think of solar and think solar photovoltaic.

Solar thermal techniques capture heat energy from the sun and use it to pre-heat hot water and air for homes, businesses, industrial uses such as crop and process drying.

Solar thermal works in combination with the existing water systems in the home and it can reduce a significant portion of the energy use for heating water, 50 to 80 percent on average for residential solar water heating.

We also help residential, commercial, industrial buildings become more energy efficient, helping consumers and businesses save money and support manufacturing and installation jobs. We don't have to put them in ships as we have -- in the room we have two manufacturers of solar panels, one from Fontana, SunEarth and one from Richmond, Heliodyne. There's also a representative from Heliocol in the back.

So this stuff is readily available and it's been tried and true. And when I started installing solar water heating at my company, in 1980, there's been an amazing amount of transition with certifications for the equipment,

certification for installers, and also streamlining for permits that we've worked with the Governor's Office. So we've made this state of the art.

The solar thermal also helps reduce gas emissions. I'll discuss further in Q&A, but according to the National Renewable Energy Lab, or NREL, solar thermal is the best available technology for reducing greenhouse impacts of solar of heating water.

Can I have the next slide, please? This pie chart shows the potential greenhouse gas emissions reductions for the heating sector. So for example, 6 percent of the light blue one there is residential. California greenhouse gas emission comes from residential sector, mostly from heating and equivalent to 26 million metric tons per year.

There is great potential for solar water heating to help reduce those emissions, including up to two percent of these emissions from the residential sector, alone. That's one-third of this wedge of the pie.

So solar water heating can be used for industrial, commercial and AG sectors. We've

talked about pasteurization. We have some of that with solar water heating.

I don't know if anybody wants to go through the exact calculations, but if you need to, I can go through these calcs for you.

The next slide, please. This chart, which was produced by Tim Merrigan and Jay Maguire, two scientists at NREL, show the potential for solar water heating. They ran an analysis in 2016, comparing the greenhouse gas impacts of heating water from different technologies, in three locations in California, Sacramento, San Jose, and Los Angeles.

And as you can see, the very best technology you can have is a solar water heat and tankless gas heater in California, which reduce -- the GHG impact is 294 kilogram CO2 equivalent.

The conclusion was that it is the best available technology for reducing greenhouse gas impacts of heating water. In fact, solar thermal's is twice as good at reducing greenhouse gas emissions than heat pumps.

Solar water heating with a heat pump backup was not run, but that can easily be added to this table.

So in effect, solar water heating is an existing market in California. We have a knowledgeable and trained workforce within California. Because of the California Solar Initiative, which was formed in 2007 through AB 1479, and I think a lot of it written by Commissioner McAllister, we were able to get rebates for solar water heating systems throughout California.

We have systems that are easy to install, easy to service, and no refrigerants to leak. So the installed therms saved in the multi-families housing sector doubled between 2016 and 2017 because of the CSI, or California Solar Initiative Rebate Program. So this sector is growing.

There are opportunities, because of the existing rebates within the California rebate but this, unfortunately, ends in 2019 so we're looking for the next vehicle to incentivize solar water heating throughout the State. We can build on the existing CPUC's CSI Thermal Program to strengthen the requirements through the energy efficiency.

And we look forward to working with the

CEC and the stakeholders.

And we also want to thank, again, the 2020 Title 24 Solar PV on old homes. That is another way to electrify homes.

Slide three, please. So the natural gas is 85 percent of all water heating fuel consumption in California. It's very difficult to transition to a heat pump. As you know, you have to get a plumber and an electrician, and it's very difficult to get two trades into your house. It's hard enough to get one trade into your house. But get two and to try to do both of those.

Unfortunately, natural gas prices are low and it makes for a low priority for a household budget. So there's a lack of awareness and culture for using solar water heating in California. We need to change that.

The other aspect is that when a system or a water heater breaks they aren't -- the customers are told that they have the option to do solar water heating and installing solar water heating. So we'd like that to be maybe marketed by the Energy Commission to help us get these out there.

Then we need programs and policies in place to present more solar options, when they are replacing their water heaters.

I just wanted to touch on a couple of other things. The pictures that you see up there are residential on the top and there's a couple of commercial systems down below there. But there are also -- there's a new technology called PVT, made in Chico at the FAFCO headquarters. And they integrate a solar water heating panel with a solar PV panel. So the PV panel is more efficient because of the cooling effect of the solar water heating on the back of it. And so this is a technology that will do both water heating and electricity.

And because the solar electric panel is cooled, the PVT is between 2 and 20 percent more effective producing electricity than just a simple PV panel.

There is also a solar wall, which is a wall that's put on the side of a building that would hold -- they have some perforations in it and they blow a fan across it, and they heat the commercial building with this solar wall. So that's another technology, a simple technology

that works.

So thank you.

MR. ROSALES: Ed thanks. It's great to consider that the market has different options, with different players. Thank you.

Commissioner, if you don't have questions, I'll go to number four.

COMMISSIONER MCALLISTER: Yeah, go ahead.

MR. ROSALES: Okay. So David, are you ready?

MR. LIS: I'm here.

MR. ROSALES: Great. Question four: What are barriers to realizing higher efficient electric space heating? How can these be overcome? Codes, technology readiness, product cost and availability, et cetera.

David, when you're ready?

MR. LIS: Great. And I want to sort of couch my remarks with the next couple of slides around the fact that the regional initiative that we've been managing for a number of years in the Northeast has to date been mainly focused on smaller scale systems, 5 tons and less.

So while I would say a lot of these barriers and strategies are likely to be very

relevant to larger commercial electrification of space heating, this is -- I'm pulling a lot of this from a two-year-old regional market transformation strategy report that we developed around air source heat pumps and, again, residentially scaled.

So it sounds like a lot of these barriers have been repeated throughout the portion that I've been on. So I'm going to go through the barriers pretty quickly and spend a little bit more time on some of the strategies.

But one word on the development of how we put this strategy report together. We pulled stakeholders from across sort of the market together to -- we brought them a market assessment and then we talked about key barriers in the market, and developed the strategies around how to address the barriers in the market. So I think this is a good model to follow, both, you know, obviously you want market strategies and interventions to be relevant to address the barriers. But also, the process of bringing a lot of different stakeholders, whether it's the manufacturers, the distributers, the sellers, all the way up to policymakers, you know, is to have

them all thinking about their roles in a market because it is powerful.

So barriers, we've heard about the consumer issues just in terms of lack of awareness about a lot of these technologies. And again, I'm talking about air source, but there's certainly ground source heat pumps that are available in the market, solar hot water.

This number two is around obviously when installers, and architects, and designers are not aware and confident in a technology, they're certainly not going to be selling it to their customers and they're really the front line to be selling these systems.

So, obviously, just building that market and building the confidence in that sector is crucial.

The issues of affordability with these new, low-carbon systems is an issue. I'll hit on the saving uncertainty in the next slide.

The metrics piece, particularly on the air source heat pump side, the DOE metrics are really not designed for the latest generation of air source heat pump technology. So the issue of being able to differentiate the highest

performing products from sort of the middle-of-the-road products is difficult. And particularly in colder climates, when you're looking for performance information, low temperatures that is very difficult to pick out of the existing metric.

One issue that may be more specific to the Northeast, but a lot of the heat pumps, 90 percent of the market in the Northeast are ductless mini-splits going into homes that have existing central systems. And the ability to automate and maximize the use of the ductless heat pumps to displace as much of the use of the central system today requires some consumer awareness and O&M wisdom. And so, how do we get over that barrier of simple consumer operation and then maximizing that?

And then certainly, from a top down perspective, at the policy level policymakers feeling really confident around or having questions about grid impacts from if we were actually successful in deploying large numbers of these systems what would that do to peak or how would that shift seasonally?

And a lot of policymakers, like the CEC,

wants to be sure that that is going to be managed in a responsible way and potentially a beneficial way.

So those are the barriers. And then I'll jump over to the next slide. This is a little image of the report. You're certainly welcome to go onto NEEP's website and look at all the details.

So a lot of the strategies here, the market intervention strategies are left at a very high level, and there are sort of some sub-strategies underneath these. But I'll hit on a couple of, I think, strategies that have been effective in the Northeast.

In terms of consumer education and awareness, a lot of states are starting to support community-based programs in a solarized model, whereas communities are coming together whether it's bulk purchasing, or simply educating their fellow consumers and neighbors about these technologies.

At the community level there's a real opportunity, particularly with new technologies. If you're hearing about a new technology from your neighbor and they've had a good experience

with it there's a lot of power to that. We've seen the local programs, you know, in a couple of states in the Northeast have a lot of success with that.

In terms of this greater awareness and confidence in the installer community, you know, there's a lot of efficiency programs that have large installer networks. So we're looking at the efficiency network as an opportunity to -- the efficiency program network as an opportunity to not just train on the more traditional systems, but to really bring air source heat pump -- you know, raise the specter of air source heat pumps to them.

And then costs, we've heard a lot about that in the Northeast. There's both efficiency programs and climate programs that have been -- that have come to the market and provided certain kinds of rebates. I would second the shift to moving to midstream. This has been effective in the Northeast and I think that is, as programs mature it's a really effective way of getting to some of these costs. Obviously, as a market, you know, if we can just drive volume, volume, volume on this, we're going to see cost reductions as

well.

The piece on mobilizing the state and local policymakers, this kind of materialized itself in the Northeast in a lot of -- right now, in the thinking through how to leverage existing energy efficiency programs and are there ways to evolve those programs to include proactive fuel switching through those programs. And that's a conversation that is happening in a number of states in the Northeast and it sounds like it's happening in California.

So in terms of the vehicle that the efficiency have kind of created with customers is a good opportunity.

I touched a little bit on the advanced controls. That may be a particular area that the Northeast sees as an opportunity, so I'll gloss over that one.

This issue of the case that brought this up earlier, particular when you get to some of the colder climate areas in California you're going to want to be able to identify those products that are going to operate at low temperatures and operate efficiently. And this is an area that NEEP has become involved with.

We have a cold climate air source heat pump specification and product list that a number of programs in the Northeast have leveraged in different ways.

But, you know, we are certainly trying to make this specification as relevant across regions as possible to really give this kind of market, market traction and market impact. And I think there are some ongoing efforts to actually -- so there are some deficiencies with the specification that I could go into, but there's also efforts to create a new voluntary test procedure for air source heat pumps that I think will do a much better job of characterizing performance. And I think that is in the long term where we need to move because that will be an industry -- a consistent industry standard that, again, will do a better job of characterizing systems.

And then, lastly, in terms of developing more confidence around performance, there has been a couple of pretty large-scale field studies that have been going on in the Northeast that suggest that performance is good. They were mainly focused on ductless air source heat pumps.

I think there are -- so I think that the results are very positive. For the most part the systems are performing as manufacturers are suggesting. And as the market moves towards more multi-zone systems, and centrally-ducted systems in our region we need to do more -- we certainly need to look into those systems with more research, more in-field research to confirm their performance. But I'd say that the initial research that's been going on is positive for these systems.

So I'll leave it at that. Thanks.

MR. ROSALES: Thanks David.

COMMISSIONER MCALLISTER: I have a quick question. This is Commissioner McAllister. You mentioned that people were putting in ductless mini-splits in buildings where they already have central systems. Could you sort of describe a typical scenario there for what would drive that? Is it an addition or just comfort in one room, or what's the deal?

MR. LIS: Yeah, I think it's definitely a -- there's definitely a range of reasons why that market has -- or why people with existing systems are looking for ductless systems. I would definitely say the cooling -- that the cooling

piece is actually one of the initial large drivers in the Northeast. You know, a lot of hydronic systems, so a lot of -- there are a lot of significant homes that don't have the central ducts or central AC. So in order to get a more centralized cooling system the heat pump is a good opportunity for that.

And then you have a lot of fuel oil in the Northeast. And three or four years ago oil was very expensive and there was a big spike in adoption of ductless heat pumps to go into those homes and displace some of that expensive heating.

And we've really been able to maintain that momentum ever since that market growth three or four years ago.

COMMISSIONER MCALLISTER: Thanks.

MR. ROSALES: Thanks, David. I'm going to go ahead and launch question five. Question five: What is needed to minimize the potential for refrigerant leakage in heat pump technologies? For example, product design, installation and expertise, et cetera.

And Geoff, can you get us started on this?

MR. WICKES: Sure. There was a slide in the last slide of my earlier deck that I was going to speak to. But I also think David was going to weigh in on this whole topic, as well.

This conversation has been going on all day. I don't want to belabor it too much. I think there's the issue of current sources, what you're shifting to. And then I want to leave you with a couple thoughts.

We need to just improve the efficiency level of the existing technology, much like what Sean has been talking about. Japan, China offer some great products. We need to break those barriers to bring them in here as quickly as possible.

And then as we transition from existing refrigerants to more greenhouse gas-friendly refrigerants, 1234YF, or CO2, or even propanes or butanes, or even going back to some ammonia technologies we need to get a little more flexible.

This chart just represents what the future will be. This was generated by a paper that will be published at ACEEE, by my colleague Christopher Dymond. David Lis is one of the

authors and has had some weigh-in on some of this, as well.

But I think there's a bright future and I think California's going the right way. I would say build a specification, create sufficient market demand, and then follow through with sufficient long-term support of it.

MR. ROSALES: Thanks Geoff.

We're near the end, so I want to give anyone an opportunity to either add to this question, question five, or if you have something on reserve, on hold for any of the previous questions you didn't get to participate on, we can start now.

And then just to be orderly, we can start with Sean and then we can move down the row. And then, David, just let us know if you want to jump in. Go ahead, Sean.

MR. ARMSTRONG: Thank you. So there are two items I want to respond to. The first is leakage. So the last time I was in this room I had Yanda Zhang sitting next to me, and he's a leading researcher in domestic hot water. We looked up the rates of thermal, like therms of gas use each year. We applied a three percent

leakage rate, which is conservative since leakage rates of methane are likely closer to five percent in the system, and might be significantly higher. But you said three percent.

Three percent, we applied the global warming potential of methane, which is in the environment for about nine years, so we put a ten-year GWP on it. We did some modifications to the incorrect 100-year horizon for methane. That's not a true thing.

And found that it took about three years of a natural gas water heater just being used to equal all the refrigerant that could be leaked out of a heat pump water tank. So you have a disaster, your tank fails, all refrigerant leaks and that equals just three years of using a gas tank water heater, just normal. Not it leaking, the system leaking.

So I think that the emphasis on the GWP potential of refrigerants is not being scaled to the GWP potential of using methane and the leakage rate associated with it, which is profound.

The second comment I'd like to make, I service developers as a cost-effectiveness

consultant. So solar hot water I think is the old school heat pump. It's like a heat pump that doesn't work at night. Heat pumps work at night. And what heat pumps are, like solar hot water they have a refrigerant in them that circulates around to collect heat. Thermal heat, specifically, either more air, or the sunshine hitting it, but there's a refrigerant that turns it around and collects the heat.

When you go to a heat pump you have phase change as the heat absorption process. A really powerful way to suck in five, six times more energy. You get huge efficiencies out of using specific refrigerants.

So a solar thermal panel, which is a collecting surface. Just like in a compressor there's a collecting metal surface. It has refrigerants. Both of them have refrigerants. One uses phase change and one doesn't. Heat pumps use phase change and they work at night.

And so the consequence is you have a solar thermal panel, with a couple accelerators on it and it you get a much more cost-effective way of getting the heat into the system that are used in phase change and refrigerants.

So that is an important part to think about. And solar thermal, unfortunately because heat pumps work best when there's a cold temperature and a hot temperature, and a large delta T between the two, if you deliver warm water from a solar thermal panel to a heat pump water heater you dramatically reduce its efficiency.

Whereas if you deliver PV electricity to a heat pump, you continue to operate at maximum efficiency.

So I think solar thermal has specific applications, but it is not a cost-effective strategy if you have a heat pump in the mix is my technical, professional opinion on the topic.

And I mean no offense because I know you represent PV. And I just think that you guys should include heat pumps as your solar thermal collector representation. I honestly think you might want to consider expanding that a little bit.

Because in Europe, heat pumps are considered solar thermal collectors. They actually have a renewable energy definition applied to a heat pump. And I think we could

consider the product that way more effectively in the United States, too.

MR. ROSALES: Yeah, on a quick time check we have about seven minutes total.

MR. ARMSTRONG: That was all I have time to say, yeah.

MR. ROSALES: Thanks.

MR. MURRAY: We have a couple -- like I said, we have a couple of manufacturers that didn't get to weigh in on this, too. But I can tell you that we have solar thermal that heats up during the day, but stores at night. So we have the solar storage, which is in the garage. So we're the first storage beyond battery, now that they say solar storage. Actually, solar water heating was the first storage. And so we store that heat that's gained during the day at night.

We wouldn't want to -- and I'm kind of confused if you wanted to compress the Freon to go through the collectors?

MR. ARMSTRONG: No, I'm not really suggesting that we increase the amount of refrigerant circulating. I actually think that compressors should be closed so we don't have leakage opportunity. So generally, I would not

favor recycling the panels with new refrigerants. But I haven't thought that deeply on it.

MR. MURRAY: Just to be clear, though, there aren't refrigerants in solar thermal panels, there's --

MR. ARMSTRONG: Well, propylene glycol is a refrigerant.

MR. MURRAY: It's not a gas. If it leaked, you're not going to --

MR. ARMSTRONG: True.

MR. MURRAY: We're not going to hurt the ozone.

MR. ARMSTRONG: No, it has no global warming potential.

MR. MURRAY: Right, right. That's what I just wanted to be clear about.

MR. ARMSTRONG: Yeah.

MR. MURRAY: Thank you.

MR. SHELL: So as I mentioned, we're focused on how do we get our buildings more in harmony with our grid needs. And I think one of the biggest loads in our buildings is our heating and cooling. So we're focused on having to design our envelope to help with that.

Seven years ago I retrofit a 100-year-old

cabin to be a passive house. And I recently went and had lunch with the family that was living there and they just talked about how stable the temperature is and how slow it changes over time.

The new insulation standards and the exterior continuous insulation standards in Title 24 are approaching passive house levels. The two things we're missing are air sealing and a heat recovery ventilator.

We've been doing air sealing on a number of our projects. We've looked at it in both residential and commercial scales and it's happening very successfully. The State of Washington, the Army Corps of Engineers, lots of places are doing it very successfully. And I think we're ready for that. It's not that hard. There's a learning curve, but it's not that hard once you understand the concepts.

There's two other pieces to that envelope that I think we could really use. Lawrence Berkeley Labs and Anderson Windows are working on a thin triple glazing. And it's a drop-in replacement, the same thickness as our current double-glazed IGUs, so manufacturers don't have to change any of their frames. It's just a drop-

in glazing replacement.

It would be a huge help for existing buildings, every time when you upgrade your windows your whole envelope score will go way up.

And the second thing is we really need some innovation on how we insulate and air seal our existing buildings. It's challenging. You know, we've all crawled into our crawl space in our attics with a can of foam. It's hard to do. We need some research on how do we -- can we blow in insulation that has enough density or some sort of layer on it that will get an adequate level of air sealing.

We don't need the passive house level. The 50 pascals, I don't think is a realistic pressure number, but we don't know what the right number is. How do we cost-optimize that for the California climate? Thank you.

MR. ROSALES: And for those in the audience, let's see, that was Scott Shell making those remarks. And we're transferring over to Ted.

MR. TIFFANY: Yeah, this is Ted Tiffany. I think one of the things that Scott pointed out right now is really optimizing envelope to bring

down loads. And there's a particular building type in a couple of coastal climates where we've got this situation where we could design our architectural systems to really drop down the loads like in a high-rise residential application or dormitory, where we can really almost eliminate cooling. And eliminate the, you know, vertical pack achieve pumps, whatever you want to talk about heating and cooling systems, and go to a very efficient, low-wattage technology in a radiant panel, electric panel.

And we're not able to do that in the code right now. And that would be one way to really eliminate refrigerant technologies in the building. And if you pair those with, you know, heat recovery, dedicated outside air units, you're really getting down to a load that even if you were to put the smallest available heat pump, it would still be three or four times oversized for that load.

And then you can effectively heat with a radiant panel and zonally controlled. Very effectively and way more cost effectively.

COMMISSIONER MCALLISTER: So I assume you are talking with staff about this?

MR. SHELL: I'll show you a couple examples.

COMMISSIONER MCALLISTER: Okay.

MR. ROSALES: That was Ted Tiffany.

Geoff, before I get to you, I'm going to give David an opportunity and then we'll wrap up with you.

David, you've got a minute or two if you want to make any closing remarks? David Lis, can you hear me? I'm going to take that as a No.

Geoff, you're up.

MR. WICKES: Yeah, so I can't speak to California so much because I just represent Oregon, Washington, Idaho and Montana. But I would say I do talk to the major manufacturers regularly, and I've talked to them about the idea of helping California go from what they currently have of about 85 percent gas to a higher percentage of electric or electric heat pump.

And they said we're very interested in doing that, but they would like to have a clear number and direction of where that's going. So I'm working with them on a 120-volt, 40-gallon heat pump system.

But if California could say, yep, we're

going to be replacing this over the next ten years and we need that help, I think you would have product in distribution very quickly.

COMMISSIONER MCALLISTER: I think one of the issues you're going to hear people talking about pretty quickly is if it's a small tank, and we are looking to use off-peak energy, then that morning surge of power use is going to have to wait until the evening to get recharged. At least that's a possibility.

So like the load shape issues are real, I think in California, and they're going to be different from probably the Northwest.

MR. WICKES: I agree. And there are solutions. There are mixing valves and demand response for storage for shifting. So the technology's here. It's not -- we just need to show the demand and the product will appear. And their R&D is ready to go.

COMMISSIONER MCALLISTER: Yeah. We'd we appreciate -- we haven't actually said anything about comments, yet. Maybe Heather, you're going to tell us at the end when comments are due, since this is an IEPR workshop.

But there have been a lot of ideas

throughout the course of the day and, you know, I want to get them on the record in more depth, if you can at all bring yourself to write written comments. And, you know put some links in there -- and in attached documents, you know, whatever the backup is. That's really important for us and I think it will be helpful along a number of different axes, including the conversations as we get into it for the 2022 Building Code.

MR. ROSALES: Thank you, Commissioner.

Just to close this panel, I thank all of you for your participation with your comments. You guys were great tour guides. That concludes Panel Two.

(Applause)

COMMISSIONER MCALLISTER: So we have a few blue cards, for public comment, right Heather, that's --

MS. RAITT: Right, we have.

COMMISSIONER MCALLISTER: Okay. So Jim Lutz.

MR. LUTZ: Thank you. I want to talk about the heat pump water heaters and some sort of my experiences with water heating. I do a lot of research on hot water use, residential hot

water use and have about 30 years of experience with it.

A lot of that was funded by the Energy Commission. For those of you who don't know, the Bradford White heat pump, the original field tests on the concepts were paid for or some of them were paid for by the Energy Commission.

I also want to draw your attention to a report, about a decade ago: Super-Efficient Gas Water Heating Appliance Initiative. It's got a cute acronym, which fit with the times. The SEGWHAI was an idea of trying to boost the efficiency of gas water heaters.

That initiative did not really succeed, but a lot of the messages in that are still applicable. They're sort of repeats of what Geoff was saying.

That part of the problem is the programs or building codes depend on a cost-effective product, and it's not there. The manufacturers could do it, but they need to see a large enough market that it justifies them spending that R&D money.

From the SEGWHAI study and looking at what's happened in the heat pump water heater

market in the past few years, from the numbers Geoff was talking about, in the SEGWHAI study we talked to the manufacturers. And they were saying they were looking for a market of about 50,000 units a year, for about five years. It had to be long enough and big enough for them to justify the spending on it.

What Geoff just said makes it sound like it may not be that large anymore.

So I want to bring up a couple of things I was thinking about why I think the heat pump water heater initiative in California might be a different position than the SEGWHAI was about ten years ago, trying to get a super-efficient gas water heater appliance.

COMMISSIONER MCALLISTER: Try to be pretty quick about that because you're going to run out of time.

MR. LUTZ: Well, then I'll -- well, okay.

COMMISSIONER MCALLISTER: Yeah.

MR. LUTZ: Two things. One is the -- you need to get a product that's targeted to the gas replacement market and the 120 volts is a big issue. And I think California has a big enough market, we probably have more than half-a-million

product a year.

And then the other one is there's a new set of motivation, a new set of resources behind the people that could run the programs. And that's the greenhouse emission policies. It's also the adoption of the CCAs. And so there's a lot more resources there now than there were for the gas ones.

COMMISSIONER MCALLISTER: Okay, thanks.

MR. LUTZ: What I would suggest is that we call a workshop for the CCAs and the muni's that want to run these programs and to get the manufacturers that Geoff was talking about together, and do it. And if the CEC could host that, that would be great. I suspect we could do it within a month or two.

COMMISSIONER MCALLISTER: Thanks for your time, Jim. Appreciate it.

Pierre Delforge.

MR. DELFORGE: Good afternoon, Commissioner. Thank you so much for hosting, convening this workshop. It's been a remarkable day, both on the substance and the energy, but the thermal energy and the human energy in the room I think today.

We appreciate the Commission's willingness and determination to take this on. This is a challenging topic, but one which is essential to help us achieve our climate goal.

I'd like to step back a little bit and put this in the context of some of the clean energy revolutions that we are witnessing today. You know, in power generation 20 years ago we had very little renewable energy. It was expensive. And now it's a growing, rapidly growing and it's cost-competitive with gas generation.

On transportation, you know, ten years ago there was virtually no electric cars on the road. Now, we have the choice between electric cars, hybrids, even natural gas, gasoline and fuel cells. So we have a whole host of choices, clean energy choices.

And I think we can achieve the same thing with clean heating technology. We have, you know we heard today the technology exists that it can be used. You know, whether it's air source heat pumps, geothermal, solar thermal, this is the next -- potentially, the next clean energy revolution in California and nationwide. We've got the potential to dramatically reduce GHGs,

especially as we clean up our grid. It can lower costs for people, especially for -- you know, with the housing affordability crisis, if you have solar and heat pumps, you can cut your bills in more than half.

It's got a potential to help integrate renewable energy on the grid. So it's a huge potential and I think we -- unfortunately, we have market barriers. But if we can give ourselves the choice by developing this market and ensuring that people who want to switch to heat pumps have -- you know, have them available, affordable and, you know, heat pumps can compete on their merits with existing technologies.

So this is going to require forward-thinking qualities and we think that the IEPR and the work in this proceeding is going to be essential to some of the open questions that we have. First, how do we do it at the scale and pace needed to meet our goals? How do we establish investments, innovation to be able to bring these products to the market at scale? How do we do it in an equitable and cost-effective manner so we can address the housing affordability crisis?

And as I said all along, I think heat pumps have a real potential to help do that significantly.

How to integrate them into the grid? I mean, you raised this question early on. There was some good discussion about the potential to do this and how we do this.

How do we manage the existing gas infrastructure in a way that makes sense for taxpayers and utility customers as we ramp up clean energy electric heating?

How do we have the right greenhouse gas emissions accounting? And it's critical that we have the right accounting to inform our policies, like both the Building Code incentive programs, and we use to need marginal emissions. And we don't yet have the right type of emissions accounting that really factor in the -- what's happening with the grid as we go forward.

So I was going to close it as I'm over time. And thank you so much for taking the lead on this issue in California. And, hopefully, that will leverage across the nation.

COMMISSIONER MCALLISTER: You bet. Thanks.

(Applause)

COMMISSIONER MCALLISTER: Tim Carmichael from SoCalGas.

MR. CARMICHAEL: Good afternoon, Commissioner. Tim Carmichael of Southern California Gas Company. Though I wasn't able to be here for most of the day, I was listening to most of it.

And let me start by saying that you made some very good comments this morning to kick off the discussion, including the point that decarbonization is harder than building a net zero energy building.

Internationally, the UN Climate Change Council and the World Green Building Council have come to a similar conclusion. They have recently set goals for buildings to achieve net zero carbon, not net zero energy or zero emissions, by 2050.

In Europe, countries are looking at renewable electricity and renewable gas to deliver energy needs to the building sector.

California is a national and international leader in addressing climate change and reducing GHG emissions. We are leaders in

setting targets, leaders in spurring technology development and leaders in setting new standards for buildings. For decades many, if not most, of the strategies that we have developed in California in the energy and environmental arena have had a ripple benefit across the country and beyond.

But the question arises, if California continues to go all in on electrification are we limiting our State's ability to lead across the energy spectrum and thus our strategy may have less of a ripple benefit beyond our borders.

A recent *Forbes* article, earlier this month noted that there are many unique characteristics about California that make it challenging for other states to replicate our activities. They noted that Californians use less energy than the average American. California has a higher GGP than most of the country.

The article also discussed the advantages California has with the availability of solar and other renewables, noting other regions have not adopted renewable portfolio standards in part due to the lack of available renewable resources in

parts of the country.

If other states cannot achieve the same level of renewables in the electric sector, then focusing only on electrification of buildings is not likely to have -- is not likely to be as an effective a strategy in other parts of the country.

Over 90 percent of customers in Southern California use natural gas for space and water heating. The American Gas Association estimates that over 60 percent of homes nationally are using natural gas.

The Commission should consider that continuing to encourage efficiency improvements in gas appliances and a reduction in the carbon intensity of natural gas in California could have a greater benefit in reducing GHG emissions in buildings across the nation.

California's unique circumstances, solar PV, high renewable portfolio standards cannot always be replicated in other states.

In short, by continuing to develop a variety of renewable technologies and high-efficiency appliance alternatives that can be adopted by consumers across the country, our

leadership will have a bigger impact.

Thank you.

COMMISSIONER MCALLISTER: Thanks.

Let's see, North Lennox from Greenbanc.

MR. LENNOX: Hi. Thank you for the time. I'm North Lennox. I founded Greenbanc, with a "c".

And building energy scorecards are required in the 28-member states of the European Union, and have been since 2009. They are required because they educate people that building energy performance impacts climate change. And they provide data to policymakers to provide incentives for people to do things like replacing gas water heaters with heat pump water heaters.

In the United States, we have a methodology that's similar to the one that was developed in Europe. It's called the Home Energy Score. It was actually created in California at the Berkeley Lab. Billy, who's here, created the first ordinance that required Home Energy scores at time of sale for homes.

And in Portland, Oregon they actually have an even more robust program for home energy

scores.

Massachusetts has legislation to require Home Energy scores statewide starting in 2021.

And my question really, for the Commission and for the other people in the room is really why doesn't California have a building energy scorecard policy in place? And is there somebody who's working on it? Because I've tried to find people who are working on it and have had trouble doing so.

COMMISSIONER MCALLISTER: That's a long answer. But, yeah, I think maybe a little archeology after this over is good. But Martha can probably help you after the session.

Obadiah Bartholomy.

MR. BARTHOLOMY: Hi. Obadiah Bartholomy with SMUD. Thank you for the opportunity to make comments and expand on our comments from the earlier panel.

One of the questions that wasn't reached by the panel was: What are the critical areas you need help from the State government? So I wanted to expand on a couple of those areas.

First off, we appreciate the positive movement, and direction, and support towards all-

electric buildings in the Title 24 2019 version. However, we think in preparation for the next round some further changes could be made.

So in terms of Title 24 changes for utilities applying for a case study cost justification should be able to include the cost avoidance of natural gas infrastructure in that cost justification. That would make a huge difference.

As well, in thinking about the TDV complement, there's currently a retail adder complement dealing with fixed costs for things like call centers, which currently has a much higher waiting factor for electricity than natural gas.

Those costs typically don't expand with the addition of electric loads and so we would suggest they be removed to avoid that barrier that exists in TDV today.

And then lastly, considering the deep de-carbonization goals that we have for the State, we feel that Title 24 should consider the cost of switching or getting to zero in buildings, as well as the cost of stranded gas infrastructure in the future as it's thinking about the cost

effectiveness of gas versus electric.

In short, as Title 24 is influencing new construction, we really feel like expanding the gas infrastructure beyond what we have today is really just digging a deeper hole for ourselves and it's going to be an expensive hole to climb out of. So we really encourage Title 24 to do everything possible in the next round to push for an all-electric mandate.

For SB 350, we've been in discussion with staff on the fuel substitution framework and certainly applaud the Commission for inclusion of that, as well as the authors of SB 350 for inclusion of that.

However, we feel like maybe there's more focus and motivation that needs to happen somehow to drive that to a faster conclusion. You know, it's certainly a barrier for us internally in seeking approval for our electrification programs. And we expect for the utilities that will be a barrier, as well. So really encourage the CEC to do everything they can to try and accelerate that fuel substitution rule development.

And then, finally, to the extent you're

interfacing with the CPUC, we really feel like there can be some encouragement to think about an equivalent of a distribution resource plan for natural gas. There's been a tremendous focus on that for electricity, which is great.

We feel like a similar focus on that for natural gas to look at avoiding future investments, which are going to potentially face stranded asset risks is equally important. And so, I'd encourage you to comment on that fashion to your colleagues.

Thank you very much.

COMMISSIONER MCALLISTER: Thank you. Right on time, appreciate it.

(Applause)

COMMISSIONER MCALLISTER: Rachel Golden from Sierra Club.

MS. GOLDEN: Thank you. This is Rachel Golden with the Sierra Club.

I just want to thank you Commissioners and staff for hosting this workshop, and thank you to all the leaders in the room who are charting a course to zero emission buildings and a fossil-free future. So thank you to everyone.

And in listening to the presentations and

comments so far, I think that we can all agree that we need to deeply decarbonize the building sector and that this is, indeed, the next clean energy frontier.

We can debate over the exact percent of how much building electrification is needed. In the analysis that I've seen it lands at around 95 percent. But by and large, most of the building sector will need to be electrified to stay within our greenhouse gas budget. And we do need to be all in and support policies that are needed to leverage and scale this change.

We're seeing a lot of important activity locally, we heard about this today, to support building electrification. And these really provide the examples for the State to leverage, to lead to market transformation.

So we feel that building electrification really warrants a similar level of attention and funding as California has put in to supporting the growth of rooftop solar and as it does today to support transportation electrification.

And when we do this, it is critical that these policies to electrify buildings are centered in energy equity and ensure that low-

income families and environmental justice communities get access to these clean, zero emission buildings first, and they're not treated sort of as a trickledown effect to get these clean, zero emission buildings at the tail end.

And I want to quickly share two thoughts that I had while listening to the presentations today, and we're going to be following up with more detailed, written comments.

One is we heard from SoCalGas today that decarbonized fuels are the easiest and lowest cost pathway to decarbonizing the building sector. And I have not seeing any data showing that renewable natural gas at scale is either feasible, cost effective or sustainable, nor will it reduce hazardous criteria pollutants.

So two things I want to highlight on that. One is not enough supply. So NREL estimates that all of California's sources of waste can only produce biomethane to replace about two and a half percent of California's current demand for natural gas.

Even the American Gas Foundation found that supply could only serve two to four percent. Relying on biomethane credits from outside the

State is not compatible with California's greenhouse gas strategy and it's not an available to model for other states.

So that brings us to power to gas. And I'm running out of time. But I just want us to think about what power to gas is. Basically, it's creating synthetic methane using a clean energy source. Methane, a highly potent greenhouse gas. They're piping that through a leaky and aging pipe system.

So we do not think that using synthetic methane or power to the gas is a sufficient or scalable option for California.

And we also need to keep in mind that when we talk about renewable natural gas it has the same air quality impacts and safety impacts as fossil gas.

So there's a lot more to say on this and we'll be following up with written comments. Thank you.

COMMISSIONER MCALLISTER: I'm looking forward to reading them.

(Applause)

COMMISSIONER MCALLISTER: Adam Chrisman, SunEarth.

MR. CHRISMAN: So thank you. So I'm with SunEarth. We manufacture solar hot water heating equipment in California. Thank you for the time to talk. I didn't have much time to prepare anything, but I wanted to make a couple of statements about solar water heating and its ability to help in decarbonization of California.

It's applicable not only to electric or gas water heating. It can supplement both and helps both. You know, with onsite storage and onsite generation that goes a long ways to helping our carbon neutral goals. And solar water heating in itself being maybe an order technology has been well-proven and around for a long time. Some of it is 40 years old, with equipment aging to 30, 40 years old in some applications. So it's really a proven technology that lasts.

And I wanted to make sure that that was clear. Just like maybe heat pumps or some other sources of equipment, solar water heating there's not a knowledge around it. It's longevity, how it works, the actual types of systems. And so that we also ask for help in that education as we try to reach a carbon neutral future it will

involve a lot of learning. And even the technology as old as solar water heating still needs education. And we hope to have your help on that. Thank you.

COMMISSIONER MCALLISTER: Thanks very much.

The last card, Jonathan Changus, NCPA. And then we'll go to WebEx and I think we have two or three people on WebEx.

MR. CHANGUS: Great. Thank you. Jonathan Changus with the Northern California Power Agency. And in the progress, we'll get into a little more detail in written comments but just in general want to -- appreciate the progress that's being made through the Title 24 process with 2019. There have been some key steps taken in response to concerns that have been previously raised.

I think, you know, there's additional progress that we can continue to make, but do want to recognize that steps are going in the right direction and we do appreciate that.

Secondly, NCPA supports some of the comments earlier about the important of a regional effort. CCAs and TOUs working together,

especially in the heat pump space, and that's very much we'd very much like to be supportive of and work with your staff, if there's any way. I think it was mentioned by an earlier speaking about working together to try and bring the forces together with manufacturers. We absolutely want to be a part of that.

And thirdly, a small issue, I don't know if it's come up previously, we've raised it. In certain communities, one of the main decarbonization efforts is actually transitioning away from propone and wood-burning fuels. Understand and appreciate that wasn't in the letter of the law in what was passed in SB 350, with regards to the doubling goal. But as we're talking decarbonization on a statewide basis, especially for some of those more rural and low-income places, being able to transition away from propone and wood-burning can have transformative effects, both for a cost perspective as well as from a comfort and health perspective.

So want to make sure we keep that on the table as well, recognizing some of the legislative limitations with that doubling goal, in particular. It's near and dear to some POUs

in particular. So thank you very much.

COMMISSIONER MCALLISTER: Thank you for those comments.

All right, anybody else in the room want to make comments that did not submit a blue card. All right, let's move on to WebEx.

MS. RAITT: Okay, so Claire Broome. Do you want to go ahead and open up your line? Claire, if you're there, please go ahead and start your comments.

MS. BROOME: Hello?

COMMISSIONER MCALLISTER: Go ahead, we can hear you.

MS. BROOME: Okay. I want to congratulate the CEC for an excellent program. I would like to ask the CEC and the CPUC for creative thinking.

As we heard from the E3, time is of the essence in accelerating the transition to all-electric buildings. And we also heard from multiple presenters that the current Title 24 standards and the three-prong tests are substantial barriers.

It seems to me it is time for something other than business as usual and that both

agencies should commit to an accelerated time table for removing those barriers so that building electrification can move ahead without these artificial constraints.

My second point is that only Southern California Gas argued for pursuing the renewable gas approach. And I think this is a very counterproductive strategy for the State to consider. It would be absolutely necessary for Southern California Gas to include that three percent leakage figure in any consideration of the greenhouse gas impact of their proposed strategy.

And I think as we heard from Sean Armstrong that that methane leakage in the distribution system would essentially wipe out the feasibility of that.

Finally, when you look at cost effectiveness it's really important that the externalities for gas costs are factored in. As we heard from UC Berkeley, the economic impact of the health effects of gas are real economic costs. And when you talk about cost effectiveness that needs to be factored into the equation so that there's a level playing field

between gas and renewable energy.

Thank you.

COMMISSIONER MCALLISTER: Thank you.

MS. RAITT: Okay. Next is Bruce Hodge. If he's on the line, go ahead.

MR. ANDERSON: Yes, can you hear us?

MS. RAITT: Yes.

MR. ANDESON: Yeah, so this is Fred Anderson and I'm speaking, and it's Bruce Hodge from Carbon Free Palo Alto. We've been watching from Palo Alto here.

And we're very encouraged to see a lot of those very similar strategies and views of the marketplace for electrification that we're seeing in Palo Alto.

A few of the barriers that came up from the very first presentation of the development of this market for beneficial electrification included customer acceptance, the up-front costs, the hassle and the complexity of installing heat pump water heaters, and heat pump space heaters. And also, the issue with the disadvantaged communities, where early replacement of their devices may mean trends, and also the up-front costs are difficult for them to handle.

So, Carbon Free Palo Alto put forth a proposal that's on the docket. It's called Be Smart. It's about beneficial electrification and it basically is a plan for mass market rollouts, so to address these barriers, such that everyone can adopt them on an economic basis.

And so what it is, is it's basically a package of inclusive financing, based on tariffs, on-bill financing. So we're hoping that's going to be looked at by the CEC going forward.

As well as a proactive service to replace these devices before failure. When they're replaced at failure it's always business as usual and it's all natural gas devices. So we really need to get out of that mode.

And then, finally, a concierge service that makes it very easy for the customers who basically check a box, yes, I'd like heat pump water heater with clean energy water heating, put that on my bill. It's a $5 charge, or whatever it's going to be. But it allows them to finance on an infrastructure basis for mass adoption, and includes all of those that have been traditionally disadvantaged.

So hopefully we'll get more exposure as

we go along and talk to others on the workshop agenda. But we'd like to put that forth as something to think about and invite anyone to contact us after they read the paper on the docket.

COMMISSIONER MCALLISTER: Thank you. You know, it appears to me there's a paper that's fairly recent from the (indiscernible) Project on beneficial electrification. You probably have to bring up the docket.

MS. RAITT: Okay, the next one is Sarah Wiltfong. Oh, okay, it sounds like she's off the line.

So we will go ahead and open up the phone lines, so if anyone's on the phones and wanted to make comments, we'll open up your line. So we'll just wait a moment.

MS. WILTFONG: This is Sarah Wiltfong, can you hear me?

MS. RAITT: Oh, go ahead. Yeah.

COMMISSIONER MCALLISTER: Yeah.

MS. WILTFONG: Okay, sorry about that. It didn't work.

My comment's really brief. My name is Sarah Wiltfong and I'm calling on behalf of the

Los Angeles County Business Federation, also known as BizFed. We're an alliance of over 170 business organizations, representing over 390,000 employers, with 3 and a half million employees in Los Angeles County.

As the United Federation, we advocate for policies and projects that strengthen our regional economy. And we just wanted to let you know that BizFed supports an all-electric solution for energy needs and recognize the importance electrification brings to reduce greenhouse emissions. But several of our members rely and prefer natural gas over electrification for supportability and reliability.

A diverse energy portfolio that includes multiple fuels and technology is needed to meet California's energy needs, economic needs, and climate change targets in a cost effective and timely manner.

It is important that the State of California seeks to find technology and fuel solutions that are quick to market and cost efficient so that we can reduce our emissions and meet our energy goals without impacting the economy.

It is our hope that the State does not prematurely advocate for positions that it is not ready for.

And just really appreciate you guys listening to our concerns and we look forward to working with you to find active solutions to our energy needs. Thank you.

COMMISSIONER MCALLISTER: Thanks for your comments.

MS. RAITT: I think that's everybody on WebEx and the phone lines.

COMMISSIONER MCALLISTER: Okay. Boy you guys are stellar. It looks like we've got almost a full room still with us and it's 4:30.

Well, I'm not going to comment much. I don't have anything to add to what's been said at the moment.

But I really want to thank staff for putting this together. I felt this was a really productive day and just a lot of substance there for us to chew on and a lot of things for us to pursue going forward. And just a lot of optimism in the room and a lot of creative thing, which is great, which is exactly what we need. That's our lifeblood here.

So with that, I'll again will thank the staff who put it together, but also all our presenters for being here. Really and clearly a group of very prepared presenters who have been thinking about this and really been working at this for a long while, with good faith. So I appreciate that and all of you who stuck it out to the very end. Thanks a lot.

So we're adjourned.

(Thereupon, the Workshop was adjourned at 4:33 p.m.)

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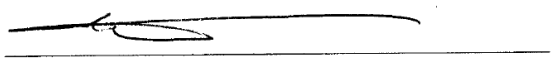

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