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BEFORE THE ENERGY RESOURCES CONSERVATION

AND DEVELOPMENT COMMISSION OF

THE STATE OF CALIFORNIA

In the Matter of:	)
	) Docket No.
2022 Energy Code Pre-Rulemaking	) 19-BSTD-03
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COMMITTEE CONFERENCE

CALIFORNIA ENERGY COMMISSION

THE WARREN-ALQUIST STATE ENERGY BUILDING

ART ROSENFELD HEARING ROOM - FIRST FLOOR

1516 NINTH STREET

SACRAMENTO, CALIFORNIA 95814

THURSDAY, OCTOBER 17, 2019

9:00 a.m.

Transcribed by: Cathy Kleinbart

eScribers, LLC

Phoenix, Arizona

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APPEARANCES

COMMISSIONERS

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PRESENTERS

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Danny Tam, Mechanical Engineer, BSO, CEC

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QUESTIONERS

Roger Hedrick

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George Nesbitt

Pierre Delforge

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PROCEEDINGS

October 17, 2019

MR. SHIRAKH: Good morning everyone. Welcome to the first workshop for the 2022 Cycle of the Standards. We have a full day today. This is a Lead Commissioner Workshop. Commissioner McAllister is here.

And so, it's a few rules. This workshop is being webcasted and recorded. So when you come up to the podium for comments, you need to identify yourselves. Give Payam a business card. And then you can make your comments. We ask your comments to be limited to three minutes.

We will use that recording to transcribe the workshop, which will be posted on the web.

A few words, and if there's a emergency of a fire drill, which does happen from time to time in this building, we'll follow Payam; he's hard to miss -- through the front doors and we'll meet in the Roosevelt Park (indiscernible).

Restrooms are outside the door. We do have a cafeteria that has vending machines. If you want decent coffee, you need to walk a couple of blocks to level.

So with that, I'm going to ask

Commissioner McAllister to make some opening comments.

MR. MCALLISTER: Yeah, thanks, Mazi. I want to just thank you and Payam and the rest of the staff for putting together this workshop. The -- I see from the folks in the room, this is just a little bit (indiscernible). Hopefully, we have some participation out there on the web as well.

Just to reiterate and put a finer point on Mazi's comment on process -- so we do not have a court reporter today. Which means that the WebEx is our lifeline for -- for the public interface for this workshop. And we'll depend on the WebEx for the transcription and for all the participation. And so we just have to have all that buttoned up because we don't have a backup like we normally would if we have a court reporter in the room.

So please speak clearly. Make sure we know who you are and we have your contact information when you speak.

So with that, I guess, you know, this is building blocks for -- for the building code. And this is super important. So you know, the life cycle costing, we're making some changes; the TDV, we're making some changes. The greenhouse gas metrics, we're really focusing on like never before. And weather files are super important. And I'm actually really interested in the perspectives of folks here on that. Including, you know, how we best represent the weather -- that we think is going to be happening in the future to understand the actual performance that we're likely to see out of our new buildings. That's a really important topic. You know, we need to anticipate where the weather's going to be because that's actually energy. That's going to dictate the energy that actually gets used in the buildings as they get constructed.

And I'm real excited about the GHG metrics work and the -- the sort of, two-tier, ER (phonetic) approach that we're -- that we're adopting this next cycle. It'll allow us to focus on greenhouse gas reduction more explicitly. Obviously, we can't base the energy code itself on carbon reductions directly, but I think we've figured out a way to -- to allow the marketplace to embrace carbon reductions at the same time we still use energy or energy costs -- and energy costs to actually -- as the operative metrics for code compliance -- development and compliance.

But as we all know, you know, green -- the greenhouses gases aren't the same. So we need to -- we need to make sure that folks can understand the impacts on greenhouse gases as they design buildings to comply with code and go beyond code.

So with that, I think I'll just let the events unfold and listen along with the rest of you and with a great interest. So thank you.

Back to you, Molly -- Mazi.

MR. SHIRAKH: Thank you, Commissioner McAllister. So on the screen, I have the agenda for today. I'm going to have a brief presentation for introductions. Following me, is going to Danny Tam. He's going to present the 2022 weather files we're going through and what the recommendations are.

And then, after that, I think Snuller of E3 is going to basically present the -- the heart of the matter for today. It's the life cycle costing methodology, the natural gas and electricity, TDVs, and you know, what we're recommending for -- for this code cycle.

Then, after that, I will describe what the two EDR approaches that we've come up with. And this is the approach that, you know, we think we can use to move towards building decarbonization while maintaining a resilient building envelope.

We'll break for lunch and after we come

back, then Bruce Wilcox is going to show the results of his measure analysis for residential low-rise residential buildings. Following that, NORESCO, will do the same thing for non-res.

And then we'll have a public commentating and we'll adjourn. These times will change depending on how much public comment we'll get. And we try to get as much public comment as possible. We'll respond to some of them here and some of it, you know, we may respond later.

MR. SHIRAKH: Again, I'm Mazi Shirakh. I'm the Commission's Building Decarbonization Lead. And I work very closely with my colleagues at Christopher Meyer, Bill Pennington, Payam Bozorgchami, and Danny Tam, on all aspects of ZNE and building decarbonization.

A little bit of background, you know, the recently-adopted 2019 standards was the last code cycle that primarily focused on zero net energy. But for the 2022 and the subsequent workshop, you know, our missions has changed. And we're going to be pursuing building decarbonization as our primary goal.

ZNE has actually served us well. And I have a slide, you know, to show that even though we were primarily focused on saving energy, you know, we were able to achieve significant CO_2 reduction. You know, the measures that were developed as a result of ZNE, such as high-performance attics, high-performance walls, better windows, renewables, and -- and some of the others, not only save energy. They also save CO_2. But you know, our focus will shift in the future to make that event better.

So to pursue a decarbonization goal, we need to develop a new metric or metrics to align buildings with decarbonization goals without having adverse consequences. And we'll describe what these adverse consequences might be and how, you know, we attempted to resolve them.

The new approach must afford building decarbonization, resilient building envelope, and strong demand response signal, all at the same time. This was our biggest challenge, that third bullet. And then to come up with an approach that would do all three of them at the same time. And I think, you know, we have an approach that will achieve that.

We're also updating our new weather files. And changing weather files reflecting the -- the planet's warming trends, having climate zones that are warmer than the existing weather files will -- will have an impact on building trade-off measures within --

with on -- within our software.

So this is just pausing for a moment and looking back and see what we've achieved over the -- the past several code cycles. And again, even though ZNE was primarily aimed as reducing energy or EDR, energy design rating, of the building, it also, as shown here, reduced CO2 emissions from the home significantly.

So this first line, even an existing home, maybe eighteen-, nineteen-years-old, 2000-compliant building with no PV, and that house, today, emits around 6-1/2 metric tons. With the 2016 standards, we brought that down to about 3.3. And again, these are for mixed-fuel homes. For -- with the 2019 standards, with the prescriptive amount of PV system, 3.1, that emission dropped down to around 2.3. So we're about a third of what an existing building will do. And if we add battery storage to the standard 2019 home, the emissions go down to around 2, 2.1 metric tons per year.

But the major savings comes when we switch to all electric. And in the most aggressive case where, you know, we've got 6-kilowatt PV system, with batteries, we're almost down to zero. The prescriptive house is down to 1. So that is a major reduction. What ZNE doesn't do, it does not encourage mixed-fuel homes to switch to all electric. So that's the -- that's the trick is to basically encourage these scenarios down here and have additional measures.

The purpose of today's workshop is to introduce the new weather files, reflecting the warming climate zones and introducing the life cycle costing methodology, including the updated natural gas and electricity TDVs, introducing the new source energy metric that, you know, we've come up with to align buildings with decarbonization goals, introduce the two EDR approach; how the two EDR approach; how is it different than the current approach and -- and its rules. And also present the simulation results to demonstrate the implications of these changes.

So this is basically the agenda that you've already seen and with that, I'm going to ask E3 to come up -- I'm sorry, Danny Tam.

MR. TAM: Hi, I'm Danny Tam from the Building Standards Office. I'll be present -- presenting the changes -- the post-changes to the 2022 weather files.

So why are weather files important? Well, they're used for all entry calculations, both for compliance and standards development. They're also an important part of TDV develop -- developments. Some history, on weather files, before 2013, they were based on observed data from 1950 to 1980. So by that time, the -- they were pretty old and this old data was calculated versus observed. Another issue, if they weren't synchronized, each location has their own typical weather month. So not entirely compatible with TDV.

So in 2013, we, at the time, made a giant leap as the first -- it's the first time we used satellite solar data to develop the weather files. Also we -- this is the first time we used the statewide typical months, so all the months are -- all the locations are synchronized and it's more compatible with TDV.

And Joe Huang, from White Box Technologies, helped us develop these original 2013 files. He's a weather expert.

So our goals for 2022, now that we have additional eight years of weather data, we propose to incorporate the latest available data to better reflect changing climate conditions. Also some of the original data was proprietary. So we want to move to publicly available data from the NREL NSRDB database.

So also this whole project originated as a PG&E-led project to update weather files for our new incentive program. So they're actually able to expand their work scope to support the 2022 standards. So this will be -- allow us to have better alignment with IOU programs.

So we used the TMY method developed by NREL for weather file selections. It's basically, a multiyear dataset is analyzed, and twelve months is selected, what's considered typical for -- for that month. Some elements of the selection includes global radiation, direct radiation, and dry bulb temperature, dew point and windspeed. For our analysis, we convert TMY from the latest twenty years, fifteen, twelve, ten, and seven. We also have data from the global climate models. There's four priority models that California has selected for policy analysis. We cannot use these directly for weather files because we don't have all the parameters, but it's useful for comparison.

So for 2022 stats recommending to continue to use the statewide TMY methodology, it will provide us with hourly data necessary for CBECC, and also it's compatible with TDV. We recommend using the full maximum dataset, twenty years, it's the, you know, maximum and latest amount of data. And these results, we think, are the most technically solid and most resilient buildings of all the scenarios.

So this is an example of what changes we might be seeing. So this is a graph of the dry bulb temperature for Climate Zone 8, Fullerton. So the -- the blue graph is the current weather files, that's the labels, CTZ2016. The orange is the new proposed weather files. So you can see, January, February, and December, there's not much changes. But between March and November, there's a definite increase in temperature. And when you're looking at just the cooling load, this is the cooling load for a 2700-square-feet prototype.

So the graph on the left is Climate Zone 8, Fullerton. Climb on the -- graph on the right is Climate Zone 12, Sacramento. The green bar is the current weather files. And the rest are the cooling load from using TMY from twenty, fifteen, twelve, and seven. So in general, there is an increase in cooling load and the biggest changes is transitional climate zone, like Climate Zone 8, a pretty dramatic increase. And some increase with Sacramento, but not as much. And between the different datasets, it's pretty similar results. (Indiscernible) there's some more difference with 7.

And looking at the heating load, in

general, there's some decrease in heating load. For Fullerton, again, a bigger decrease, almost fifty percent.

And between the different scenarios, kind of similar, but the magnitude is actually bigger for Sacramento. The percent difference is bigger for Climate Zone 8, but the magnitude is actually bigger in Sacramento.

So this is a table showing all the percent difference compared to the current weather files. So I just want to point out, when you go to a really small dataset like the 7, we start to see some anomalies. For example, Climate Zone 16, using the seven-year dataset, actually started with a decrease of fifty percent in cooling load, versus increase of thirty-five percent using the twenty. You see some really dramatic increase for 2 and 7. That's because, currently, the -- these climates don't have very little cooling and just, you know, increased by a little bit, but a -- the percent is a dramatic increase in percent.

Looking at the heating load, general decrease in heating loads for all scenarios, for all 16 climate zones.

So we mentioned, we did some comparisons to the global climate model. Like we mentioned before, we cannot do a direct comparison, but we can compare it to maximum temperature.

So this is the graph of the distribution of all the data points in that dataset. So let me explain. It's a box and whisker graph, so this represents all the data for January. So the box represents fifty percent of the data, and the bar inside is the medium. And the whiskers is the other fifty percent, which represents the highest and lowest daily maximum temperature. So this particular graph is the daily temperature maximum.

So let's focus on the two bars on the left and right, the blue bar and the red bar. So the blue bars are all the data from -- observed data from 2000 to 2017. And the red is from the four climate models. So as we can see, in general, the box is moving higher. The blue and the red is -- the global climate model is, you know, is -- the trend is getting warmer. Additionally, the whiskers, the more extremes are getting more extremes.

Okay. So now let's move to the middle two. These are the typical weather months that was picked. And this one is picked for January. So they're the months that's picked from the larger observed dataset. That's why it's -- it's smaller. So the orange is the current weather files and the green is the proposed weather files. So what we're seeing the new weather files, it's trending warmer. It's -- it's in line with what the global climate model is predicting.

So this graph is the daily temperature maximum for Fullerton. This one is minimum temperature. Same thing for Fullerton. Again, it's -- it's the same trend. It's getting warmer and the temperature is more extremes.

So based on this, the weather file that we evaluated, it indicates that it's becoming more important for the standard to encourage building that's more resilient, not only for higher average temperature, but resilient against the extreme hot and the extreme cold.

So in summary, in all scenarios, the average temperature is getting warmer. Cooling load is going up and heating load is going down. Less changes, so climate zone that's already hot and cold, for example, their cooling load didn't change that much. The biggest change is transitional climate zone, like Climate Zone 8, and staff recommend the full-twenty sets of data because it's the most technically solid, resulting in the most resilient buildings. And it would avoid introducing data anomalies that we mentioned before from using a small dataset.

With that, I just want to thank Joe Huang and Bruce Wilcox and his team, who did most of the grunt work. And PG&E for funding this project.

So now, we're opening the floor for questions.

MR. STRAIT: Just to start things off, there are two questions that we received while the presentation was going on. The first was from Mike Moore (phonetic), who asks, what format will the weather files be in, and can they be used with ENERGY/PLUS simulations?

MR. TAM: The thing is TMY 3 -- Joe (phonetic), are you online with Bruce? (phonetic) Can you answer that?

MR. STRAIT: I will -- I'll have to unmute them --

MR. TAM: Okay.

MR. STRAIT: -- just a moment.

UNIDENTIFIED SPEAKER: TMY 3?

MR. STRAIT: Um-hum. What are we looking for?

MR. TAM: T -- TMY 3.

UNIDENTIFIED SPEAKER: (Indiscernible) --

UNIDENTIFIED SPEAKER: And we're already using it with ENERGY/PLUS, the (indiscernible). Yes, so (indiscernible) --

MR. SHIRAKH: Yeah, could you come up to the --

MR. STRAIT: Anybody who says anything, needs to be in front of a mic and needs to say who they are.

Also who are we unmuting for -- you said you were -- I don't see a Bruce Wilcox.

MR. HEDRICK: Yeah, I'm -- I'm Roger Hedrick from NORESCO. We're already using them in our Energy Plus simulations as with CBECC-Com they're EPW files. Yeah.

MR. STRAIT: Thank you. Mike Moore also asks, are the new weather files available now for use in CBECC?

MR. HEDRICK: I believe they are.

MR. TAM: We are using them in our research version.

MR. TIFFANY: Tedd Tiffany, Guttmann & Blaevoet Consulting Engineers. Danny, thanks for your hard work on this. Since you've done the work on the future weather files, may I suggest that you include these in CBECC as an option for folks looking to utilize those, because they're hard to access. And if you have those available and for public use, that would be a benefit to the community as looking for, an instance, we use those for planning for buildings we're not providing cooling in. And we can see the maximum temperatures in spaces with those weather files. So it helps us plan for future cooling. So if you have that dataset available for the public, it's -- make its accessible, so I would encourage including that in CBECC.

MR. TAM: Yeah, if you mean the global climate model, like I mentioned, it doesn't have everything we need for building simulation, so we can't really use it directly.

MR. TIFFANY: Okay. Thank you.

MR. TAM: Yeah.

MR. NESBITT: George Nesbitt, (indiscernible). Are we building buildings for the weather of the past or for the weather of the future? I -- I think, as we all know, that there is a trend in the change of weather and it's going to continue. So -- so you know, updating the more recent weather makes a change, but that weather's going to keep changing. So should we be looking out ten years or twenty years?

MR. DELFORGE: Pierre Delforge, (Indiscernible), I want to thank the commission for the work on (indiscernible) updating these files. I think it's really important and I strongly support it. I have, but along the lines of those comments, you know, I think when we look at the very complicated box and whiskers chart that you showed, that showed that the climate models -- global climate models are significantly higher and more spread apart than the proposed. And I wonder if you have examined or explored the feasibility of considering the trend and, you know, maybe not using this particular data if it's not, you know, sufficient, but finding, I believe there are some forecasts of weather files, ARAP, amongst others, has some data on this. I wonder if you have exact notes (indiscernible) using that and whether it would make a difference -- a significant difference, as it seems to, you know, to indicate on these charts.

MR. TAM: So yeah, so to answer your questions, we actually have looked at it. We -- experimenting with (indiscernible) trending to the future years. So what had happened is, there was a lot of months that actually overshot the climate model. In this graph, the hotter the months are the months where the medium actually overshot what the climate model had for, you know, 2050. I mean, in the future, there could be some additional work to be done, but for this round, we kind of stopped where we're at because we kind of, you know, ran out of time. But we can definitely consider that for the future.

MR. DELFORGE: Thank you.

MR. SHIRAKH: Any other questions in the room or on the WebEx?

MR. STRAIT: All folks, on the WebEx, if you'd like to ask a question, either type into the chat box or raise your hand and I can unmute your line.

MR. SHIRAKH: Go ahead if you're hearing us and you want to ask a question. We're not hearing your question. Feel free to use the chat box to type in your question and we'll respond to it. Any other questions or comments?

So we'll have plenty of opportunities for other questions and answers.

So I'm going to ask that we --

MR. STRAIT: I'm sorry. Bill Dakin just raised their hand.

MR. SHIRAKH: Okay. All right, Bill.

MR. DAKIN: I (indiscernible) --

MR. SHIRAKH: We can barely hear you. I don't know if you can move closer to your mic?

MR. DAKIN: Can you hear me better?

MR. SHIRAKH: Much better, yes.

MR. DAKIN: Okay. So the question I was -- had is can you expand on how the twenty-year dataset provides more resilient buildings?

MR. STRAIT: You want to answer that, Mazi?

MR. SHIRAKH: It has more extremes on both summer and winter, whereas some of the other choices had more extreme in the summer, but very moderate temperatures in the winter. So that was the basic difference.

MR. DAKIN: Thank you.

MR. SHIRAKH: Any other questions online?

MR. STRAIT: I am not seeing any other questions and no one else has raised their hand to speak.

MR. SHIRAKH: Okay. We're going to switch to E3. Thank you, Dan.

MR. PRICE: Okay. Good morning everybody. My name is Snuller Price. I'm a partner here at E3. And I think this might be my fifth or so code cycle. And looking out at the room, you know, that's not very many. There are some in the audience who have been here for more. I -- I am going to start us off on our presentation today, but I'm also -- have the pleasure of introducing two E3 colleagues. Younger faces behind the microphone to talk about some of the work that we've been doing. And I encourage you to ask them all the hard questions. And yeah, no, just a pleasure to be here. And excited to tell you the work that we've done behind this code cycle, which is actually, I think, quite a bit more significant than prior code cycles because of all the weather that changes that we've seen. So happy to walk through it.

We're going to do a little bit of background. I know there's a lot of pros in the audience. But I'm still going to start, just to make sure we have everybody in the room know what TDV is and what it does, so that we've bringing everybody along.

I want to spend a fair amount of time talking about the policy framework because what we're trying to do is think about, when we build a new building, starting -- remember, in 2023, we're talking about, what is that energy system going to look like in California? And what is the weather going to look like in California? And is that building going to be a good citizen for the type of electricity grid that we have, for our climate goals, for our refrigerant gases? You'll see, our non- non-combustion emissions; what --

what can we do now, thinking about -- projecting the future? And as you will see, it's quite a bit of interactions that happen between buildings and all the energy systems that supply energy to those buildings.

We have two scenarios I'm going to queue up. And we'll talk about that.

Then we will present what the values are in comparison to 2019. And I think, in some cases, back to 2016. As Mazi mentioned, this is the first code cycle where we're introducing a new metric, a source energy metric. And we're going to present the draft of those. One way to think about the source energy metric is really as the buildings GHG footprint. Okay? So it's not the same -- it's not just one dimension going forward, in terms of just the TDV energy kBtu. There's sort of two dimensions, potentially, in the standard. And so that provides a better tool, less course tool, to really push down the GHG content of our new buildings in this energy future. So very excited about that. I think it's a pretty interesting innovation, and I'm looking forward to what the comments are. As I mentioned, we're also taking a shot at the non-combustion emissions. So as Mazi mentioned, we're looking at a lot of electrification. Heat pumps, as everyone knows, have refrigerants, and those are high global warming potential gases. So we want to take a look at, well, how much new climate burden are we putting in in our electric buildings to -- in order to reduce GHGs and -- and how do we account for that balance? So -- so that's also something that we've been working hard on with the commission staff and with the air resources board staff, as well to -- to try to characterize what that looks like. Both on the methane side, you know, if we're switching off of natural gas, that -- natural gas leaks also have a high global warming potential and non -- and refrigerant gases have theirs. So how do we -- how do we wrangle with that balance?

So the background, first of all, what are TDVs? So TDVs, time -- are time-dependent values. And they're a long term forecast of the hourly electricity, natural gas, and propane cost to building owners. And so this is was a cost metric. And they're used for cost effectiveness, activities, and Title 24. And they really answer the question of what is cost effective, you know, per the Warren-Alquist Act, which was passed in the 70s. I think it was one of the founding legislation here that established the commission.

And this chart on the slide shows what a sample for Climate Zone 12 looks like. For electricity, these are the averages by hour. And it just shows that, first of all, this is Climate Zone 12, so there is also TDVs for all the other climate zones. So it's got an area differentiation. And -- and all those areas have been aligned on every aspect with the weather that Danny presented. And then it's also got a time differentiation. So when is it expensive to deliver electricity to a building from a utility, from a -- from a social perspective?

And you'll see -- and this is going to be a theme that when is it -- it is expensive is in the evening, right after sundown because solar is low-cost and getting ever lower. And so -- and we've got solar on the buildings as well. So it's really after dark that our system is starting to provide -- or having to drive up a lot of costs. And so that's going to be a theme. And that's why we want to have a time dependence in our building code so that we can provide a signal for buildings, if they can, to get off of that evening. Okay? And you can get credit for that in your designs.

So what are they used for? People forget that TDVs are used for two things; probably not the people in this room, actually. But the first thing is the cost effectiveness analysis in the codes and standards enhancement studies. So after this workshop, as these TDVs get put out into the world, we think that these TDVs are good framework for looking at what's cost effective in terms of new measures and new features to be considered. And those are -- that's done in every code cycle. And that's measuring dollars. Okay. So what would this do form a dollar TDV standpoint.

The other thing that it's used for is code compliance. And so this is the currency for all the tradeoffs in your building features, right? So if you want to add more windows then the prescriptive standard, you might take an energy penalty. You could do another feature in the building to bring that back. And then you could have flexibility on the design valued at the currency that's area and time differentiated.

And so that way, we can really have all our new buildings in sync with the costs of providing energy to the buildings, decarbonizing the buildings out over into the future.

So a few frequently asked questions, and I'm going to pick up speed a little bit. Why do we use statewide average electricity and natural gas retail rate levels? I always get this question. And the reason why is so that we have an overall similar level of stringency in the building code. You know, how high the rate levels are, are directly proportional to how hard we're pushing on the building efficiency system. And so by creating an average, we're -- we're having buildings that look similar across the state. There are differences by climate zone, but the overall stringency is similar.

I also get the question, why don't we use the actual retail rates? And the reason for that is that these buildings are going to be there for a very long time. Rates change constantly. And there are even options for customers to be on different rates and so on. So what we've done is, we've taken the sort of underlying fundamentals of the delivering costs -- delivered costs of electricity and gas, and use that to drive what an ideal rate would look like that really matched what we thought the utilities costs of service were.

That's also why, when we translate TDVs, we translate them from dollars to kBtus just with a straight factor. And it's not really designed to predict a customer's exact billed savings, sort of the long-term, over-time billed savings -- related to their billed savings. But we don't want anybody to confuse that.

Let's see if I can actually, oh -- oh, yeah. So why are they in kBtu?

So I added a new FAQ; what are the source energy factors used for? And this is, I think, Mazi's going to present this next. On the EDR2, a 2-D EDR system, it just gives another metric. And this metric is -- is related and directly proportional to the greenhouse gas emissions.

So you know, if you're a believer in you get what you measure and you really want to reduce GHG footprints of buildings, this metric gives you something that is exactly on that topic. You know, the ZNE movement and the numbers that Mazi presented are sort of along that line, but they're a little bit orthogonal. And so this is just a direct lever right on what we care about most right now.

And why include non-combustion emissions? That's probably pretty obvious. We're thinking about a world with tons of heat pumps, et cetera. We should be accounting for that and be a -- you know, and -- and understanding that. We should also -- and Gabe's going to present this -- you know, our proposal creates an incentive to -- to use lower GHG -- GWP refrigerants in the buildings. And with -- unless we measure, we can't provide any mechanism to credit. So that's -- that's why -- that's why it's in here.

So I want to talk a little bit about the framework. And then I'm going to turn it over to Brian Conlon at E3 to -- to walk through the -- exactly how we did it. But I had mentioned that what we're trying to do is -- for new buildings, what energy future are they going to live in. And so what we've done is we've constructed a scenario, a future world, that hits our climate goals. So by 2050, we have eighty percent below 1990 levels, economy-wide in the state. Okay? That's an economy-wide target. You can see on my graph, it's a -- it's a dramatic reduction.

We didn't go all the way to Governor Jerry Brown's executive order of carbon neutrality by 2045. And there might be some in the audience who thought we should be even more aggressive than eighty below 1990. I think that just the research is -- is still out on how we're going to achieve a carbon neutrality. And also it is an executive order, not statute. But I would not be surprised if someone is standing here in three years telling you that we've now gone to a carbon neutrality by 2045. And you know, the code development process is a three-year cycle. So it's pretty clear where we're going, but we didn't go there yet, I think, is one way to say it. And many decisions to be made between now and then.

So how are we going to meet this -- meet the carbonization future? It affects a lot of different aspects of our future, not just buildings, right? So when we break this down from our work, we -- we really identify four pillars of energy decarbonization. There's energy efficiency and conservation, not just in buildings and appliances, but also in transportation and other aspects, even, you know, denser housing, et cetera, transportation mode shifts. The other demand side is electrification. We're going to be talking about that quite a bit. But not just buildings, but also cars and trucks, and industry -- all -- all types of fossil fuels that are easily switched to electricity are potential demand changes that help us meet our goals.

And so one implication of that, and I think Brian will show you, is that when we look at the costs of delivering electricity into the future, what we've done is we've layered on, well, what -- what load shift do we expect the cars and trucks and other transportation systems to add, and how will our future electricity system deliver that energy. And is that going to move the peak around?

Electrification of buildings, really, one of the most dominant pieces of that is potentially space heating. So in California, for my whole career, we've had that summer air conditioning peak load. And you'll see, we're starting to see, oh, if we're going to heat all our buildings with electricity, we're going to start to shift a little bit more and see some winter loads on the coldest days.

On the energy supply, really our approach is renewables. We've passed SB-100, which requires a sixty percent RPS by 2030, with interim goals. And then a hundred percent decarbonized electricity system by 2045. So the buildings that we're building, the electricity that's supplying them are going to be increasingly decarbonized, all the way down to as far as we can go.

We've also got low carbon fuels as a possibility. And you'll see our scenario includes biofuels in the natural gas pipeline, includes hydrogen in our pipeline, and also for other -- other end uses.

So it's not just buildings, but what building -- what system is the building in and what are all the different aspects of our decarbonization strategy that affect them.

And we've tried to capture that in the

standards. So I think I've gone through this mostly. We've tried to really make sure that our future complies with all of our statutes and our -- and our aggressive climate goals. So that our buildings can be working in harmony with those. And so what does it look like if you break down the sectors emissions in our model of this? Over time, it looks something like this. And -- and I think the thing to point out is, really, that there's, you know, agriculture is a little bit difficult, but mostly every sector has to move. You know, it's not like we've got a transportation just sitting there without any increasing GAC reductions or what have you.

Industry is hard to move; agriculture is hard to move. So in our model of the future, we -- where are we getting our emissions if we're going to try to hit an overall eighty percent in the other sectors, is the answer, including in buildings. So while we expect an eighty percent overall economy wide, we're doing more than that in buildings.

So to drill down on buildings a little bit, in our future scenario, we've tried to define a -- a Pathways case, using our model called Pathways, that's a -- we think is a balance. So it's got natural gas in the buildings, but only very high-efficiency natural gas appliances are only installed by 2025. We've got some renewable natural gas blended into the pipeline, up to ten percent by 2030, nineteen percent by 2050. We've got hydrogen in the pipeline, too, up to the levels that the gas companies say that they can safely deliver. We've got a lot more details of this future in a forthcoming publication and I've linked on this slide for the -- the last publication in case you want to know more about the Pathways modeling.

The other things is, many folks in this room might have heard of the Energy Futures Initiative study from Stanford. And just a quick comparison, their study, they were looking at 2030 with the forty-percent goal, and they were doing forty percent in every sector, so -- including hard-to-do sectors. So it's not exactly comparable to forty percent overall, where we went higher on sectors that are easier, in our mind, to get reductions. But they have a similar amount of renewable natural gas in the pipeline. They actually have much more aggressive assumptions around electrification. They do all new electric buildings starting in 2020 in order to hit their goals in the building sector which is, you know, obviously, right around the corner.

And the purpose of the future that we're trying to do here is to show that there's these increasingly aggressive goals, but we're still providing choices between fuels for buildings. You'll see, as these TDVs come out, that more and more, you get more credit if you can find efficient electric use, but it's still a -- a world where there's choice.

And an example of this -- so the selected scenario, and just to zoom right in on residential space heating, what does the trajectory of that look like over time? And this is not just new buildings, this is our entire building staff, okay? What's electric, and we've got a fairly, what we would say is a moderate increase in the share of electric residential. Contrasting that, we also have -- we've been working on a high electrification scenario, which is much faster. So we've got a -- what we would say is a moderate version.

So I had mentioned that we have two scenarios. So let me walk you through those. And I -- I think that the results that Bruce Wilcox and the NORESCO team are going to present after lunch, chew up how do the -- those answers come out for both of the scenarios. And the commission will decide which scenario to use based on folks' comments and the, you know, how they're formed. So I want to kind of explain them since they'll be with us all day. Okay?

So the first scenario what -- is what we're calling our policy scenario or policy compliant. And it's fully consistent with our eighty percent by 2050 scenario. And one of the big implications of being fully compliant is that there are retail rate implications.

If, in our policy compliant scenario, I mentioned that we have biofuel in our gas pipeline. So in the policy complaint case, we've -- I've got the costs of bio -- those biofuels in there. We also have a source energy metric. So our source energy assumption for renewable energy of all types is zero. In other words, we're not measuring source energy from non-depletable resources. So what that means is that the source energy for our natural gas in our policy compliant case is also going down. Okay? So it's more expensive, but we're -- we're -- we're taking on less source energy. All right? So that's -- that's a world that's all consistent.

Traditionally, the TDVs have been all based on an IEPR -- the IEPR's retail rate forecast. So we also have a world where, what we're calling the mid IEPR case, where, instead of this interaction on the gas and the decarbonizing the gas world, we have continued a hundred-percent fossil natural gas in the pipeline and the CEC has a retail rate forecast of the mid IEPR that goes out at least eight years, and we just trend that.

So the source energy factor is 1 in that scenario and there's no biofuel in that scenario. And the retail rates of natural gas are lower in that scenario. And -- and those are the -- and -- and you'll see. It sound -- having explained it, it sounds like, oh, my goodness; this is two different worlds and how are we ever going to choose? I think, when you see the results, the -- the implications of this are actually fairly mild.

So we'll wait and, you know, you'll -- when you see the -- the answers and the -- and the implications of this, you know, this is a little bit of shift, but it's -- it's up to ten percent renewable gas. It's -- it's a mild choice. It's not a -- it's not a night and day type of choice. But nonetheless, we wanted to take the time to show everybody a little bit around, you know, the development of these and -- and what the tradeoffs are.

Okay. So I'm going to introduce Brian Conlon from E3, who's going to talk us through how we took that vision of the future and turned it into TDVs.

And then I'm going to come back and -- and present what the actual TDVs were. So, Brian.

MR. CONLON: Hey. Thanks, Snu.

Yes, as -- as Snu mentioned, there's been a lot of work that has gone into this round of updates. This is a -- an overview of the modeling framework that we had to produce the TDVs, but this is really just a greatest hits or high-level overview just to remind everyone that the TDVs are consisting of, you know, stacked components that represent the marginal costs of electricity and natural gas and propane. And so most of what I'm going to discuss here is the electricity portion of that. And how each of those component was created.

So as Snu overviewed, we have -- start off with the big picture, Pathways, GHD targets, and economy goals, to meet our statewide policy targets. That really establishes a lot of the -- the annual loads that will sort of pass onto our resolve model, which does capacity expansion and renewable procurement to identify what the, you know, optimal package of, you know, generation and transmission resources are for the state to meet its carbon goals.

Those generation resources are then passed onto the PLEXOS production simulation model, which has been developed by the CEC's IEPR team to model hourly energy for the entire western interconnection, focusing mainly on California, but capturing the interregional dynamics there. The important update here is taking in both the resolved marginal generation mix for the additional renewables, as well as including weather match loads, including the EV and building electrification loads, as Snu eluded to.

These, along with a few other large suite of models coalesces into this TDV spreadsheet, which produces the final hourly regional TDVs by climate zone.

Just to start at -- at the Pathways level, looking at the annual load forecast, we see the stack of our different load components. Traditionally, what we've done in past code cycles is really focus on -- on that load baseline and not necessarily differentiate between these new electrified load types. And so you've had a weather match load, but you know, as -- as we add more and more building electrification using -- and vehicle electrification, using historical shapes, isn't as appropriate as it once was. So we're adding a lot of granulatory and sophistication with -- with this process.

One of those loads is the -- the building electrification loads that we got from parametric runs from NORESCO and Bruce Wilcox. The -- these are marginal loads, so our -- we have sort of a baseline building electric -- electricity forecast for, you know, all other types of loads, but for water heating, space heating, cooking, and clothes drying, loads that would be, you know, electrified moving away from natural gas. We have a different hourly load shape that we scaled up based on the Pathways forecast. And added in incremental annual amounts matched to our new CTZ 22 weather that was discussed earlier.

You can see that in 2050, there's quite a bit of building electrification load. Looking at, you know, as we're looking at -- these are mostly heat pump shapes here -- produces a winter peak for just this load shape alone.

And then, shifting over to the generation side, once we feed those loads into Resolve, we're setting Resolve to meet our optimal portfolio; it's minimizing generation procurement costs to meet these emissions goals. And you can see, on the left-hand chart, what that emissions reduction looks like over time. On the right-side chart, you can see the increase in effective RPS. Note that these -- the RPS level exceeds our early-term benchmark goals that the state has set forth because of early procurement by the model. But note that this is only including bio, geo, small hydro, solar, and wind. So it doesn't include large hydro. So by 2045, we're at about ninety-three percent of retail sales from those sources alone.

And this is -- a -- a sample of what -- what the generation resources are made up of. This is pretty evidence by the large, bright yellow bars and -- and the area, that a lot of the incremental generation resources are coming from solar. This is both from rooftop PV, which is sort of the paler yellow. But, you know, largely, since we're looking at an optimized view, we're getting a heavy amount of solar. And so to match that and balance that, especially in later years, we're adding a pretty significant amount of battery storage to that mix.

So once we have our -- our loads and our generation resources, we feed that into the PLEXOS model, and the CEC ran. And again, this reflects the entire western interconnection, so each one of these regions in the west is modeled separately with its unique generation resources, transmission reserves, loads, et cetera. Important to note that, while the weather year was created for, you know, a -- a typical climate change reflecting year for California, we took that same historical weather -- the historical weather that makes up that weather year and applied that throughout the west.

Important to note that while the weather year was created for, you know, a typical climate-change reflecting year for California, we took that same historical weather -- the historical weather that makes up that weather year, and applied that throughout the West so that we have a synchronized coincident weather happening across the entire western interconnection. So if you have, say, a sunny day in L.A., that would correspond with, you know, whatever that's doing out in Salt Lake City. So you have -- properly reflecting the trade dynamics between those -- those areas.

So here's a little preview of what the outputs from the PLEXOS modeling looked like. These heat -- heat map charts show the month hourly averages in the years that we modeled. So it's modeled 2023 through 2030, so that's a -- hourly annual models for those periods. In previous code cycles, we've done just, I think, the first six or seven years, and then used that last year as a trend for -- for the remaining, you know, twenty-some years that are in the -- that factor into the net present value TDVs.

This -- we thought, was really important to reflect the early dynamics in all of the years, but also model a year farther out, where, you know, we're really turning up the building electrification, vehicle electrification, and the -- the renewable portfolio to match that. So what we did was we modeled 2023 through '30 and then 2045, trending those shapes in between.

And as you can see from these sample years, the energy prices have -- have changed in some pretty interesting but important ways. So 2023, you have what we consider more traditional with, you know, low prices in the middle of the day, especially in low load spring, as well as your summer evening peak, and that sort of concentration of red. Moving to 2030, we see, you know, even more low prices, that summer evening peak disappearing a bit. And moving on to 2045, you see that the peak is now -- peak prices are now more focused on the -- the winter morning and evening, due to higher solar, higher storage throughout the high renewable periods, essentially being zero cost generation.

So here's a quick sample of how that looks like coming directly out of the model. This is for average seasonal month in the Southern California

Edison region for the year 2030. You can see that during those high hours, the solar penetration really pushes down the price of energy, especially in the spring where it goes negative in some cases.

This is a better look at what our TDVs look like. So this reflects the net present value of the -- that entire thirty-year time frame for those energy prices and comparing between this 2022 code cycle and the 2019 code cycle. A few really important things to -- to note from these charts is that, you know, obviously the belly of the duck, or that -- that large dip in the middle of the day, becomes very pronounced with the increased solar penetration on the system. You also see a lower overall peak right after that duck belly due to higher penetration of storage. And then you see more of a seasonal variation with -- with the addition of more renewables and loads that enable low-cost generation in -- in the springtime.

Moving on to generation capacity, which is, you know, another layer in the TDVs, it's pretty similar to what we saw in the energy heat map chart with the shifting away from the summer evening peak more to 2033, the mornings, when the batteries charged on solar are sort of exhausted overnight and then looking for actually adding generation capacity in the morning, which is something I don't think we've seen in previous code cycles.

T&D capacity, so transmission and distribution capacity, has stayed largely the same. Over -- over -- remains largely the same over the three -- these three sample years. The peaks and -- you know, constraints on the distribution system are largely unaffected, but change somewhat with the -- behind the meter solar penetration that we looked at, as well as looking at the annual updated dollar-per-kilowatt-year values from the avoid cost calculator.

So a few new changes. So a lot of the -- those were, you know, old favorite characters in the TDVs. Some maybe new faces that we're integrating into the TDVs, or at least putting a new spin on, are these three categories that reflect the handling of greenhouse gases.

So we have one, the Cap and Trade Emissions category, which reflects just the cap and trade carbon value that's inherent in the energy production -- in the energy prices. And that's -- that's equivalent to the emissions category that was in the previous code cycle. The GHG Adder is also equivalent to what was last known as the RPS Adder, but since we're moving towards an electricity sector greenhouse gas reduction goal, we are pegging it more to the generation -- the extra procurement cost for generation resources to meet our hundred percent carbon goal.

And then this last category as Snu mentioned, it sort of takes all different sectors to meet our statewide carbon goals, but the electricity sector often has some of the cheapest opportunities to decarbonize, so taking that even beyond the SB100 goals, adding sort of a flat GHG cost to reflect meeting our 80 x 50 GHG goals.

Similarly, with the natural gas TDVs, we have the Cap and Trade Emissions inherent to nonrenewable natural gas on the system, netting out any renewable natural gas from biogas or hydrogen that's included in -- in the scenario that we're looking at, either the mid-IEPR or the policy-compliant case. And then depending on the -- on the scenario again, looking at the ability of the natural gas sector to meet those additional 80 x 50 GHG goals.

So these are the emissions prices that we've inherently included from the RESOLVE case, so it's the abatement price or the price that the model determines is, you know, the marginal price of adopt, installing, and integrating the renewable resources to meet our SB100 goals, as well as the IEPR GHG emissions forecast price that isn't inherently included in the cap and trade portion.

As you can see, the retail rate forecast that we used for the residential and non-residential hasn't changed an awful lot between this code cycle and the last code cycle. We're seeing, you know, a steady increase in both cases due to, you know, higher procurement of, you know, basically zero -- zero-cost renewable resources.

So I think I'll now turn it back over to Snu to talk about what those actually look like.

MR. PRICE: How are we doing on time? Are we -- we're good?

MALE SPEAKER: We're okay. Yeah, we're good.

MR. PRICE: Okay, great. Thank you, Brian. I saw some -- some squinting at the -- this chart with arrows going up and down and sideways and so on, so I wanted to say, again, sort of what Brian went through, but just in my own words so that everybody understands what's going on. Because I think that was a really important part, and obviously we can take questions after. But we've tried to create our cost accounting for GHG emissions as we incur costs.

So there's three pieces. There's -- and this is true for both fuels; electricity and natural gas. So we've -- they come down a little bit differently, but the first is this number one, which is the direct emissions. So that's just if I took my existing system and I produced more electricity to meet the new load, the generators that are fossil generators will have to buy allowances. Right? So that goes into the energy price, and so that's the price that I've got in number one.

Over time, though, we're going to decarbonize, so as I've added load, I'm also going to trigger some renewable investment. Not just the renewables, but the storage to integrate it, and there's also some cost of solar curtailment. If I can't use all of my solar, and so on. That's number two; that's the cost. And that's specific to the electricity sector. That's just, you know, I'm trying to hit SB100, so if I add load, I've got to add renewables. And that decreases my overall emissions, right?

And then I have the residual. So those two things together don't get rid of all the emissions in the electricity sector. So how do I account for is there any cost of our residual emissions in the electricity sector? And since we're trying to meet an overall eighty percent climate target, we have -- we've attributed a cost to those residual emissions, and that's number three.

And that residual emissions is essentially our expectation of what the cost is of hitting -- of sort of marginal resource for our overall climate plan. And so, a like --

MS. BROOK: So number three is the final amount? It's not one plus two for --

MR. PRICE: No, no, it's one plus two plus three.

MS. BROOK: I thought you said it was residual --

FEMALE SPEAKER: This is Martha --

MR. PRICE: Yeah, yeah.

FEMALE SPEAKER: -- from the energy commission.

MR. PRICE: So I can repeat your question, I think.

MS. BROOK: Okay.

MR. PRICE: You're asking is it -- so number three is the emissions that I end up with --

MS. BROOK: Okay.

MR. PRICE: -- at the end of the day.

MS. BROOK: Okay.

MR. PRICE: So that is right. The tonnes going into the air is the emissions at number three.

MS. BROOK: Okay.

MR. PRICE: What were the costs of getting there? I've got a couple things. I've got allowances and I've got renewable investment. So that's how I get there.

MS. BROOK: So what --

MR. PRICE: So the costs are the sum of one, two, and three, but the actual tonnes are three.

MS. BROOK: Oh, my goodness. Okay.

MR. PRICE: Okay.

MS. BROOK: I'll try and figure that out later.

MR. PRICE: Okay. And not -- and also for natural gas, it's the same thing. Okay? It's the same thing for natural gas.

So I've got my direct emissions from burning natural gas. In this case, I've introduced biofuel, so those won't trigger allowances. So I've got allowances in the natural gas system for the net of the fossil minus the biogas. And then there's residual emissions in the natural gas system as well that are valued at the same cost as the residual emissions on the electricity side. Okay? So it's a parallel structure. And we can talk more about that.

But I want to kind of jump to the conclusions so that everybody can see what this looks like, and then we'll talk about source energy. So here's an example for the Residential Climate Zone 12 TDV component. And they're just sort of stacked up here. We wanted to show everybody the shape. And all of these have been updated, as Brian walked through. So -- and you can sort of see the relative magnitude of all these components. So the retail adjustment factor to get from marginal cost to what we would expect a customer's cost and the retail rate is still the largest piece -- has been for a while, or forever.

And then I've got my energy price. I mean, this is an annual average on this one chart, so you know, as Brian said, it's going to be very low or negative in some hours and positive in other hours. But it's got this pretty big dip. And then I've got my Cap and Trade Emissions piece. Those are the allowances. The GHG Adder, which for electricity is the cost of my renewable that I'm triggering to reduce emissions. I've got the residual emissions.

Transmission and distribution costs are all in the evening. And that's because the storage on the system is largely integrated with our supply side, so we're not necessarily doing distributed storage everywhere, which could help alleviate that evening peak. And when you take storage and you put it on the system, it's lower cost, which is why we do it. But it still leaves -- it ends up with a peak on the T&D system is in the evening out in the time, but for the supply side, the peak -- which is in this yellow -- the peak is in the evening a little, but it's also starts to pop in the morning. Okay?

And it turns out that when you add lithium-ion storage, you know, in a four-hour, it's easier to take care of this sort of evening peak. And the winter mornings, especially on cold snaps, start to -- you start to run your batteries down, and you start to look at different types of technologies, and it's going to be, you know, the problem our children can work on in a couple decades maybe as we -- as we work through this. But it gets a little more perplexing than just what the technology is that we have. And it starts to think of seasonal storage opportunities and those types of things.

So this is the shape -- to compare to the 2019 TDVs, which is probably why everybody is here; how are things changing? If we just map it over, we see a dip in the middle of the day, so you know, energy efficiency in the middle of the day is less valuable under this system than it was, and that's just because of the low cost of energy. But obviously, we haven't taken the retail rate or -- rate adder. So there's still value in efficiency no matter when. Okay?

The other thing is that the peak in the evening is a little bit more spread out, and it's popping a little bit in this winter morning. So I think -- I think the performance of buildings in the -- in the winter morning have never been a thing, ever, as far as I know in California, but as we start to look at buildings we're going to build now and into the future, that kind of starts to pop up a little bit.

Our costs of managing this peak in the evening have come down. So I don't know if folks have been following what storage costs are, but every time you ask how much it costs, you get a lower number. And so that's why, you know, this is starting to mitigate this -- this red is not -- and this -- I'm sorry, this yellow is not what it once was.

You know, so that was Climate Zone 12. There's differences between different zones, so here's 12, here's 7. They have different shapes. We don't -- we're not going to go through all the different shapes.

It's still the dominant trend of solar in the middle of the day, but some weather in more mild climates spreads the capacity over more hours, so you have less concentrated value. And so if you're doing things like battery storage, that could be important in terms of how much value you get per battery. But it's, you know, the general trend. And when everybody gets the numbers, they can go and look at has much disaggregation.

There's also some differences in terms of residential and non-residential. Not in shape. It's -- electricity is electricity, whether you're, you know, residential or non-residential. But the rates are different, so the retail rate adder affects the overall level of the code just to reflect cost-effectiveness of a -- owners.

Let's see. So inputs to natural gas -- and remember we have two scenarios on natural gas -- so this is what the TDVs look like for natural gas on the policy-compliant case. There's a same kind of buildup, the retail adjustment. The commodity cost for natural gas policy case includes the biofuel cost and the hydrogen cost. Then there's the allowance prices and then the cost of the residual emissions and then the pipeline cost. And we still have the pipeline peak cost in the winter for heating.

And then in the mid-IEPR case, there's the other scenario. It's similar, though the retail rate adder is less, because of the mid-IEPR forecast there's no renewables in the commodity, but the emissions are higher. So you know, that kind of dampens out a little bit those in particular --

MR. PENNINGTON: (Indiscernible).

MALE SPEAKER: Mr. Pennington, you should know better.

MR. PENNINGTON: I was going to (indiscernible) --

MALE SPEAKER: You can try (indiscernible) --

MR. PRICE: I was going to, for the record.

MR. PENNINGTON: Sorry for cheating. Yes, Bill Pennington with the Energy Commission. So could you -- so the difference here between the two cases is mostly the magnitudes, right? The shape is very, very similar?

MR. PRICE: That's correct.

MR. PENNINGTON: But it's kind of hard as you're jumping from one slide to the next to see what the magnitude difference is, so could you --

MR. PRICE: Okay. Yeah, yeah. So let's -- so this is a mid-IEPR case. Let's just take July -- pick on July. It's 275. If I jump over to here, it's 325. So fifty out of three -- so it's ten percent higher or something like that.

MS. BROOK: Martha Brook, Energy Commission. And do you have a comparison to what our current 2019 (indiscernible)?

MR. PRICE: Thank you for asking. So yes, I do.

So here is how the comparison looks like -- and I can go back and show the propane -- but here is the comparison of what the natural gas TDVs look like to prior code cycles, and probably the chart speaks for itself, but they've gone up.

The 2016 line is -- this similar shape on the top line for all of the last couple code cycles. But we've got much stronger, a much higher cost of allowances forecast based on this most recent IEPR, which drives up the cost quite a bit.

We've got -- the retail adjustment is higher, and the cost of our residual emissions is higher. So those are the three factors that are really pushing this up in the world.

MALE SPEAKER: Can I ask you a question?

MR. PRICE: Of course.

MALE SPEAKER: So with the new natural gas TDVs and electricity TDVs, would you say that heat pump technologies would actually perform better than standard natural gas appliances?

MR. PRICE: Yes, and I think we're going to see that. There's a few things, I think, going in the favor of heat pumps. The first was just the weather that Danny showed. Like, the world is kind of warming, and the problem spots for heat pumps are in the coldest times, so we have more warm weather means higher efficiencies on heat pumps, so just less use. It's one thing that's kind of moving that direction.

The other thing that's moving this direction is that the utilities for natural gas have been asking for a significant amount of money for safety upgrades. So that's starting to factor into the cost of natural gas deliveries. SoCalGas just got their rate increase approved, which is over thirty percent, a rate increase over the next few years.

So the relative cost -- there's uncertainty, I will admit, for the future of what's going to happen to the electricity rates and wildfires and so on, so you know, this business is full of -- you know, we're doing thirty-year forecasts, so we do have uncertainties, but the -- from what we can see on the ground right now, it seems like things are tilting towards heat pumps from our perspective. And I think we're going to see some results from that in the simulation, too, to play it all the way out and then multiply by these factors, and everybody can see.

Okay. I want to get to the source energy metric because it's new. And this is an additional metric, completely independent of the first one, although all of the underlying assumptions and the modeling that Brian described to get there, is all coordinated. So it's, you know, it's the same dataset, but we're measuring a different thing, which is the source energy.

And we've defined the source energy as depletable fuels. Okay? So we're not, in our source energy metric, counting rays of sunshine that hit on a solar panel somewhere and thinking that we get a credit for saving how much. It's just really depletable fuels, which in our energy system and buildings really means natural gas, okay?

So how much -- whether you're using natural gas in the powerplant to generate the fuel or generate the electricity to deliver to the house or whether you're using natural gas directly in the building.

And I guess the important thing that we've done to develop the source energy metric is that we want to look at this from a long-run perspective. So if we have our renewable generation system for electricity supply, we want to account for that so that if we add load from building electrification, we're also going to add some renewables to the system. So our factors for the source energy metric account for that. And I'll show you sort of how we calculate it.

So Brian mentioned that the Energy Supply Office has been running PLEXOS throughout the years and then in the future. And what that does is it gives us this heat map, the short-run source energy heat map, which is just; if I were to produce another kilowatt-hour in any of these hours, how much more emissions -- or how much source energy would be used up? And if I have a thermal powerplant on the margin, I calculate its heat rate plus the losses, and I get a number. That's the short-run source energy.

But if I add load, I'm also going to add renewables, so we account for that. So I've got my marginal renewable generation profile that is mostly solar but not all. It's got wind and it's got a diversity of solar and wind across the WECC. Times the short energy -- short-run energy factors for the renewable output shape, and it gives me the, well, what's the emission's response from my supply-side investment in renewables.

And I sum that up so that for every kilowatt-hour of additional load I'm going to trigger some amount of emissions reductions from my new renewable supply to meet that. And I can take that off of the short-run energy, and I end up with an hourly long-run source energy. Okay? And what it shows is that the source energy is much, you know, is much more like a fossil plant outside of the solar hours. Okay? But with this credit that I trigger some additional renewables if I add load, even in the evening or after dark.

And the long-run source energy factors are hourly because of the way we've structured this. So we have, in effect, assumed that we're going to hit an RPS target over time. So like a sixty percent by 2030, forty, you know, and out to SB100.

For those following, the PUC also has a rule making on building decarbonization. And they have a long-run source energy factors as well for their fuel substitution test. And the proposed test there is a little bit different. It's we assume that we're going to hit a carbon target for the electricity sector no matter what. And when you do that, the hourly variation all goes away. So I just wanted to mention that this factors look a little bit different than another agency's factors, but this preserves an hourly profile over time for the whole year. And we thought that for the purposes of the building standards and the idea about grid harmonization of our new buildings, that that was worth doing, although I will say, you know, from the PUC's perspective, they have their IRP doing planning -- the electricity sector to hit carbon targets, so for them it makes sense to do carbon targets, so.

Any more questions on that?

So what do you get at the end of the day? At the end of the day you get this heat map of -- and these are, essentially, the net heat rates for source energy by hour and month that you end up with for our source energy factors for electricity. And so, you know, if you think about a combined cycle plant might be about a 7,000, 69, 50, something like that if you're -- you got an efficient plant. And these are lower than that, even on the hours with thermal, and that's because it nets that renewable piece. So when I add load I'm going to have triggered some renewables.

But -- so this gives you a map, and it also shows you that if you're trying to optimize this new metric for source energy, if you can use and add load to soak up your -- the solar and stay off of the evenings and nighttime, then you're going to do better. Okay? So it's no mystery. It's just really the inverse of the solar profile.

I mentioned that we've got two scenarios for our natural gas. So while we have added the costs of biofuels in the pipeline for our policies compliance scenario, we have to also factor that into the source energy. And so the source energy factors for the biofuel look like -- if fossil gas is a one, a hundred percent would be just a sort of a straight line. And so on the IEPR policy it's a straight line, hundred percent.

But in the policy compliant scenario, we have source energy dropping down over time. And that's just the sheer mix. So the gas is a little more expensive. But you also take on a little less source energy, which is the whole point of putting decarbonized fuels in the pipeline.

So how do things turn out? And I know that we're going to have the experts this afternoon talking about the impacts in a lot more detail than this. But I just wanted to kind of show what happens when we look at source energy metrics to some buildings.

So this is climate zone 12. And we picked on 16, which is obviously the mountains in a cold zone. What happens if we do our fuel switch A. And what's the difference between our mid-IEPR case and our policy case?

And so if you take -- here's our source energy metric stacking up, our different end uses, you get the all-electric versus the mixed fuel. And I think this might be the 2,700 square foot prototype.

The source energy is about half the source energy for mixed fuel, the electricity is about half, all-electric is about half then. If we do the policy-compliant case, yeah, my natural gas is a little lower.

But you know, is it dramatic? No, not really dramatic. When I go to 16, where we've got a lot more space heating load, the same trend but really there's a lot more emissions -- or sorry, source energy associated with the buildings because it's just a lot colder. And if I have mixed fuel, I've got natural gas or pipeline gas space heating and then that's those driving those up.

So with this framework, we end up with, you know, again about half, roughly, the carbon footprint from an all-electric over its life. And that's before we tried to optimize around the source energy. This is just taking the profiles out of CBECC-Res and multiplying across.

So I'm going to turn it to Gabe to talk through the noncombustion. Hopefully, everybody remembers back when talked about introducing it. But obviously, we're talking a lot about heat pumps and electrification. So we've been working on our proposal on how to account for the noncombustion emissions, so -- and then I think we're going to have a time for questions overall for the whole thing, so --

MR. MANTEGNA: Thank you, Snu. My name is Gabe Mantegna. I'm going to be talking about the new noncombustion emissions addition to the TDV framework.

So just to -- if you grow what Snu was saying earlier, as we're having a lot more heat pumps in California, all heat pumps use refrigerants. And pretty much all refrigerants in use today are very high global warming potential gases, up to about 2,000 times more potent than CO2 is about what we're talking.

So these refrigerants, of course, only

cause emissions when they leak. But leakage is inevitable. So it's important to account for these emissions when we're looking at the life cycle emissions from an all-electric home.

And one important thing to keep in mind here is that air conditioners use refrigerants too. So these emissions are actually not too different between a mixed fuel and an all-electric home. But what we want to be able to do is incentivize the use of lower-GWP refrigerants, which are available. But there are some barriers to using them.

And it's also important to account for the potential for avoided methane leakage on the natural gas side. The natural gas system is pretty leaky. But the difficult question here is how much of the leakage in the natural gas system could we avoid through electrification of homes.

So I'm going to talk about this a bit and how we got to an estimate. And just to clarify, methane is a very high global warming potential gas. So leaking methane is a lot worse for global warming than burning that same methane and emitting CO2.

So just a bit about how this will be integrated into the TDV framework. What we're going to do is for a building calculate the lifecycle of CO2 equivalent of emissions from refrigerant and methane leakage. Okay? Multiply it by the GHG Abatement factor for TDV to get to a (indiscernible). So that's going to be converted to kBtu and then add it to the TDV score.

And then what this will allow is that if you can use a lower GWP refrigerant in a building, then you can use more energy in other places to meet that same baseline score. And so this is going to be included in the baseline homes also for both CBECC-Res and CBECC-Com, what those baseline emissions are.

And an important thing to keep in mind here is that for an all-electric home, these refrigerant emissions can be a pretty significant part of the overall emissions. It's about half. So it's pretty important to take these into consideration and take into consideration the potential for reducing these and incentivizing that.

So a bit about how this is going to work with refrigerants. The California Air Resources Board has standard data that they've compiled on the average leakage rates for refrigerant-using equipment currently in use. So there's both an annual leakage rate and an end-of-life leakage rate.

So if you want to look at the leakage

rate for one year, what we can do is just divide the end-of-life leakage over the lifetime, and then you get an annualized leakage rate. So you can then calculate either the annual or the lifecycle emissions from refrigerants for an all-electric home.

So a bit about the potential for lower-GWP refrigerants that are out there just to give some background on where this could go. There's a lot of options out there for lower-GWP refrigerants, but there's a lot of barriers to using them also.

The most promising lower-GWP refrigerants in the near-term is lower-GWP HFCs, which are pretty similar to the refrigerants in use today but just have a lower GWP. The main tradeoff with these is that they tend to be mildly flammable, which is not currently allowed in the fire code and the mechanical code.

So tradeoff there, although we also are piping other flammable gases into buildings now. So it's not like it's impossible to deal with. And this is being done in other places, too.

The sort of medium-term option is HFOs, which are similar to HFCs that are currently used, but just have a much lower GWP, which is still in development and currently said to be used in things like water heaters and those smaller systems.

MR. SHIRAKH: May I ask a question?

MR. MANTEGNA: Um-hum.

MR. SHIRAKH: This is Mazi Shirakh. Is there an energy penalty for using this alternative?

MR. MANTEGNA: Yeah. Not necessarily with the lower-GWP HFCs. With the HFOs, I think they tend to be slightly less efficient. But refrigerant manufacturers are actively working on this. And I think generally the consensus is that we can get there. They're just actively developing them.

You can also use hydrocarbons, such as propane. Obviously, very flammable, so you have to deal with the flammability there. But this is actually used pretty widely in places like Europe and India.

The last one -- this is sort of the longer-term decarbonization goal is you can actually use CO2 as a refrigerant. This can't currently be used in larger air source heat pumps because it requires a lot higher of a system pressure. But it is currently used in some water heaters. So if the home could use a CO2 heat pump water heater, then that could be a tradeoff in the TDV framework that it could help lower lifecycle emissions.

So now to methane leakage. This gets a little more difficult to estimate how much leakage we can actually avoid through electrification of homes. So just to talk a bit about where the leakage is and then natural gas system, I have a nice little diagram here.

The leakiest part of the natural gas system is generally considered to be production and storage. The difficult part is that most production of California natural gas occurs out of state.

So this is not quantified in the ARB inventory. There's a fair amount of leakage also behind the meter. This has recently been added to the ARB inventory.

The question here is how much do existing homes differ from new homes, and will new homes be less leaky anyways. But there is also a fair amount of leakage at the meter. And so basically, anything left of this left-most dotted line could definitely be avoided through an all-electric home, right?

So what we looked at is an attempt to try and estimate which leaks in the natural gas system could we avoid through an all-electric home. And the answer is definitely everything on the left, maybe some of the right.

So we looked at a broad range of studies on methane leakage to try and get out our question of how much leakage could we actually avoid through electrifying a home. So there's a few different estimates I can walk through. The first is just the behind-the-meter leakage in the ARB inventory. This is about 0.5 percent of consumption.

The difficult thing is that, as I said before, this includes both existing and new homes. So we're still investigating what the potential leakage is going to be for new homes because new homes don't have pilot lights anymore.

The second number is the ARB inventory, which is all of the leakage sources in California but doesn't include any of the out-of-state leakage. It's a bit high. It's about 0.7 percent.

There's also a study of the natural gas leakage in the L.A. Basin, which found a leakage rate of 1.4 percent. And there is production here in the L.A. Basin.

And the really interesting thing about this is that they found that natural gas leakage was pretty strongly correlated with consumption. So whether or not that was causal is unclear, but it was very strongly correlated. So they found an overall leakage rate for residential and commercial buildings of 1.4 percent in the L.A. Basin.

And then if we go to a U.S.-wide estimate of what the total natural gas system leakage is, there's a range of academic estimates that vary from one to ten percent. But a more-recent study is getting out a leakage of 2.3 percent.

And so it's once again the issue with this is that not all of this leakage is going to be able to avoid it through electrification. A lot of natural gas is associated gas. So it's going to be produced anyways if you're consuming oil, right?

So the answer for the leakage that we can avoid is probably somewhere in here. But what we're proposing as a starting point while we do more research into this is the 0.7 percent leakage rate.

So a sample calculation for how this looks if you add in that methane and refrigerant leakage for a mixed-fuel home versus an all-electric home -- as a I said before, the key thing here is that the mixed-fuel home has refrigerant leakage too. So an all-electric home still uses about half as much -- or still emits about half as much greenhouse gases over its life.

And this is using the long-run electricity emissions. The methane leakage is a pretty small component if we use that 0.7 percent but also keeping in mind that reducing emissions from refrigerants has a pretty large potential to produce emissions from an all-electric home.

So key takeaways here, all-electric homes are still a lot more low emitting. And there's a lot of potential to reduce emissions in an all-electric home if we use lower-GWP refrigerants or can get lower leakage. And we're still investigating how much leakage on the methane side we could actually avoid through electric homes.

So that's all I had. And I think we are on to questions for E3.

MALE SPEAKER: There is one question I was asked earlier by Jeff Stein (phonetic). He asks, "How can I get a copy of the slides?"

MR. SHIRAKH: We will post the slides right after the workshop today on our website. So any questions on -- please come up to the podium, identify yourself.

MR. MCALLISTER: Yeah. I've got a question. So --

MR. SKIRAKH: Commissioner McAllister.

MR. MCALLISTER: Yeah. So let's see, I guess -- yeah. So it's good that the shape of the TDV now kind of reflects -- you know, is a little more time dependent because we're actually looking at demand-side resources and you know, (indiscernible), the low flexibility, and marshalling all this potential we have out there.

So I guess, just from your perspective sort of working across the building commissions, instrumentally, how does that -- what conversations are happening to ensure that that perspective is conveyed to the end user to motivate behavior? Is that strictly in a rate-making context or is there an IRP conversation that's sort of trying to figure out a pathway to get there?

MR. MANTEGNA: Yeah, so I think the places where this conversation is coming up are few, Commissioner. There's the IRP, which is looking really at cost. So it's really translating the signal for active use of demand-side measures through the cost lens.

So in other words, if I can add more load during the middle of the day --

MR. MCALLISTER: Yeah.

MR. MANTEGNA: -- then I've got a low-cost sink for my solar and I have to buy less storage and so then that gives me the benefit in terms of the dollars.

MR. MCALLISTER: So I --

MR. MANTEGNA: Yeah.

MR. MCALLISTER: The preliminary question is how much of a distortion -- so as we try to translate and kind of link arms with the PUC --

MR. MANTEGNA: Um-hum.

MR. MCALLISTER: -- on putting the pieces in place and the ISO kind of putting this whole landscape in place so that it makes sense to anybody who's, you know, walking through it --

MR. MANTEGNA: Yeah.

MR. MCALLISTER: -- how -- what are the distortions between the different locations for this conversation? For example, we've got a -- what, it looks like about a fifteen-cent retail adder on TDV. So presumably that cost conversation over at the PUC is all about, you know, essentially, avoided cost or wholesale --

MR. MANTEGNA: That's right. Marginal, yeah.

MR. MCALLISTER: Marginal?

MR. MANTEGNA: Um-hum.

MR. MCALLISTER: Yeah. So you know, is that a problem? And is that going to get in the way of putting -- of aligning all these incentives?

MR. MANTEGNA: So I don't think it's a problem. I think that it's an answer to a different question, what we're doing with TDV versus what the PUC is doing with their distributive energy incentives. The reason we have the retail adder is because we want to make sure when we're -- what we're doing with the building code is understanding the impact on the cost of the building owners.

And so you know, think about this. If the marginal costs are super low, the people are still paying a significant rate in the middle of the day. The TDV will include that significant rate. And so what we'll be ensuring is that we're not making people do things in the code that don't pay off for them over the life.

And so I think it's really important to have a consumer lens in the building code when we think about mandates and what we're requiring in our buildings, as opposed to the PUC has -- you know, we're talking about all voluntary. And it's really where should the PUC allocate its money for incentive behavior.

MR. MCALLISTER: Um-hum.

MR. MANTEGNA: And so the participant -- you know, assuming that participants have good information of how what they're doing and what incentives they're taking, it's the right framework for the PUC to look at, okay, well, what's our socially best use of these incentive dollars. So I actually think that, while different, they're answering sort of slightly different questions --

MR. MCALLISTER: Yeah.

MR. MANTEGNA: -- and it's important to have the consumer protection and consumer lens on the building code, whereas the PUC has kind of got a different animal to wrestle with. So I guess that's what I would say.

MR. MCALLISTER: So I agree with that. And that's, you know, obviously, I'm all onboard with, you know, providing consumer benefit through the building code.

I guess the -- you know, maybe a finer point on the question is that if it's still worthwhile for the consumer, say, in the code environment or found, you know, the builder to build a building that invests heavily in efficiency that helps during the middle of the day or working hours, you know, if there's still significant value for measures that decrease consumption in the middle of the day when power is essentially going to be free at the wholesale level, is that a proper alignment of incentives?

MR. MANTEGNA: Yeah. Well, so what we're talking about is how in the rate design are we going to collect a fixed cost or embedded cost of the system. And that is a PUC decision. But if you look at the rate designs and the TOU rates, it's not like they're giving away the power for free in the middle of the day, even though we have negative prices in the wholesale market.

So you know, our best -- you know, I guess it's a little bit of Vaseline on the lens. But our best is just, okay, we're going to collect our fixed costs, the same amount, every hour. We're just going to spread it out, that per kilowatt hour in every hour as a rough cut at that. I don't think it's actually too bad. If you go and you look at the rates, I think that's not terrible a way to allocate those. You know, it's a pretty tricky 30 year forecast of rates and how are we going to collect embedded costs in the rate structures. The -- yeah. So --

MR. MCALLISTER: Okay.

MR. MANTEGNA: You know, I guess -- you know, we could think about that and could try to introduce demand charges or predictions of that. I think that the volumetric per kilowatt hour is better for the residential class as a proxy, where we've been reticent to put demand charges as opposed to the nonres, which a lot of those customers do have demand charges. And maybe it's not quite as good of a fit. So yeah.

MR. MCALLISTER: Okay. I won't beat that further.

MR. MANTEGNA: We can talk about that all day probably. So --

MR. ELEY: I'm Charles Eley. I'm a senior fellow with Architecture 2030. And I was speaking -- I've got several comments and questions.

The first question has to do with the time arising for global warming potential. You used a hundred years, I saw. Did you consider using twenty because, if you do, the methane emissions are about ten times greater?

And on Standard 189, which I'm a vice chair, we actually moved to twenty years to more properly --

MR. MANTEGNA: Okay. Yeah.

MR. ELEY: -- (indiscernible).

MR. MANTEGNA: So that would definitely increase those methane leakage emissions a lot, just as you said. We used a hundred years because that's the standard in the ARB inventory and generally in inventories everywhere. But if you could point us in the direction of standards and whatnot, that would point to what's using a twenty-year GWP, that would be --

MR. ELEY: Okay.

MR. MANTEGNA: -- very helpful.

MR. ELEY: I'm thinking John and I could help you with an argument there.

I like the -- I like that your new TDV curves have a little more curve to them. Before, they seemed to -- the only spikes were due to transmission distribution and capacity. You now have a dip in the middle of the day from energy and other things. But why not -- why is there no dip for the retail adder?

MR. MANTEGNA: Yeah. So this was the conversation that the Commissioner was asking, too. And it's, you know, really how are we going to charge customers for the embedded fixed cost of the system.

MR. ELEY: Okay.

MR. MANTEGNA: And you know, rate design is an art. You can put more embedded cost collection on some hours versus others. And they do that in the time of use rate designs. But there's definitely some collection of those fixed costs in the middle of the day, even in all of our existing time of use rate designs, even in the more extreme ones for EVs and so on.

So you know, how are we going to collect that money from customers? It's just an assumption. The reason why I like it flat -- I'll just tell you -- is that when we have it flat then the deltas, the differences between any hour -- so like if I'm doing battery storage or load shifting through precooling, those deltas are all reflective of what the societal value actually is of that action. So the deltas all work, right, when you put a flat adder.

And so I feel like then we get the right economic signal for battery storage operation. We get the right economical signal if we're going to reset our thermostats and do precooling and cooling during the middle of the day, not that people don't put a foot on the scale all the time in rate design, and it's a political and social tradeoffs and all of that. So I perfectly acknowledge that. But flat, to me, feels like at least we're preserving the deltas and not trying to, like, weigh in on and put even more leverage than we already are than the underlying marginal cost, basically.

MR. ELEY: I want to speak in support of the time-dependent source metric. That's what we used in the Architecture 2030 ZERO Code. And I believe that provides a really strong incentive towards more behind-the-meter storage and more consideration of buildings.

One other question. I didn't see that you considered ammonia as a refrigerant.

MR. MANTEGNA: That's also an option. I just didn't --

MR. ELEY: Oh, okay. You just didn't -- okay.

MR. MANTEGNA: I just didn't have --

MR. ELEY: And one other thing in the Standard 189, we found a -- for future to a gas -- or methane leaks -- we found a NETL report that gave us leakage rates of 1.4 at the power plant and 1.8 percent at the building. So I can provide that to you, and you can add it to your list there.

MR. MANTEGNA: Yeah.

MR. ELEY: And then one last point, which was not really on your topic, but if we want to encourage electrification moving to a metric-like, time-dependent source energy is a big step. But we also need to look at our baseline.

Right now, the residential baseline depends on what you're doing. So you have a gas --

it's gas if you've got gas in your proposed design. It's electric if you've got a heat pump in your proposed design. We should set the baseline to be the low carbon class.

MALE SPEAKER: That's what I've got in my --

MR. ELEY: Oh, good.

MALE SPEAKER: -- presentation that's coming up next.

MR. ELEY: Okay, good.

MR. PRICE: Thank you, Charles.

MS. BROOK: Hi. Martha Brook, staff of the energy commissioner. I have a question for each of the three E3'ers.

MR. PRICE: They get the hard ones, right, unless --

MS. BROOK: So my first one for you, Snu, is you talked about the difference between 2019 and 2020 to TDV. You know, the battery costs are coming down and gas safety costs are going up. But how much of that, of the differences in costs, especially the noticeable decline in TDV electricity costs, is because of the denominator of the metric?

We have so much more load on the system. So we're spreading the cost out.

MR. PRICE: Yeah.

MS. BROOK: Is that also a part of it?

MR. PRICE: That is a part of it. So the retail rate adder is lower because we are using our existing infrastructure to deliver more kilowatt hours. So that is part of it that's lower. But also our -- you know, it's a balance.

It's not only lower. It's also higher for other reasons because we're doing a lot of new investment in renewables and et cetera. So there's a balance --

MS. BROOK: Okay.

MR. PRICE: -- in the retail rate adder.

MS. BROOK: The thing that was the most shocking to me is that the T&D costs were lower because I've always thought that huge amounts of new load, there's going to be a ton of infrastructure cost. And you're basically saying that that's actually going to spread across more customers --

MR. PRICE: Yes.

MS. BROOK: -- just fine. Is that kind of what you're saying or --

MR. PRICE: We're not -- yeah. What we're saying is a lot of the new load is going to be able to be served over our existing T&D infrastructure.

MS. BROOK: Okay. Okay.

MR. PRICE: It's not like we have to build all new. Now, we have peaks. And those peaks show up as little spikes on our chart. And they'll show up in the building simulation as places to avoid.

You know, our ideal world is if we could not build any new T&D and just deliver a lot more. But it's not going to be like that. It's going to be some upgrade.

MS. BROOK: Okay.

MR. PRICE: And we have a cost factored in for that. But total T&D per total kilowatt hours, we should be able to manage.

MS. BROOK: Okay. That's fantastic. So quickly, I know other people want to ask you questions.

Gabe, if you could bring up one of your last slides where you showed the mixed fuel GHG with refrigerant. That one right there.

So I can't quite figure this one out because it looks like the refrigerant leakage is just a teeny bit more for all-electric.

MR. MANTEGNA: That's right.

MS. BROOK: Is that just the -- is that because heat pump water heaters don't have a relatively low leak compared to a heat pump or an air conditioner?

MR. MANTEGNA: It's actually less of a leak and more the amount of refrigerants --

MS. BROOK: Oh.

MR. MANTEGNA: -- that's in there.

MS. BROOK: Oh. Okay.

MR. MANTEGNA: Yeah.

MS. BROOK: Okay. Great.

MR. MANTEGNA: It's about, like, an order of magnitude lower refrigerant in a water heater.

MS. BROOK: Oh. Awesome. I didn't know that. That's great. Okay. So that's my question for you. Thank you.

And Brian, I'm going to make you way back.

MR. PRICE: I can scroll back for you.

MS. BROOK: There was an early slide where you talked about using CBECC heat pump load shapes. And then you applied that to your pathways model to get, like, a population level thing. And that's what confused me because you applied these CBECC load shapes to the whole stock.

That's what confused me because of do we just model new buildings and you applied it to all of the decarbonization that's going to go on in existing buildings, or do we give you existing building heat pump load shapes?

MR. CONLON: Yeah. So you know, the -- our load shape -- or forecasted load shapes, were, you know, a number of different components. We started off with, you know, the system-wide historical load shapes that were weather matched based on, you know, existing technology right now.

MS. BROOK: Um-hum.

MR. CONLON: And so we took the parametric runs from CBECC-Res and CBECC-Com. I'm not exactly sure on what, you know, different parameters we used for those.

MS. BROOK: Um-hum.

MR. CONLON: But it was a bunch of different building types and climate -- all the climate zones adjusted to the IEPR building forecasts and the PATHWAYS load forecasts --

MS. BROOK: Um-hum.

MR. CONLON: -- and then took those, sort of, incremental heat pump water heating, including clothes drying loads, and added them in their incremental nature to the existing system load forecast.

So these are only reflecting, say you have the inherent forecast for the system, you know, has mixed fuel buildings --

MS. BROOK: Uh-huh.

MR. CONLON: -- you know, the new buildings being built. This is adding the marginal load of what an electric building would be on top of that.

MS. BROOK: But it still is reflecting your deep decarbonization future, right? So you have huge heat pump penetration in existing buildings?

MR. CONLON: Uh-huh.

MS. BROOK: Is that true?

MR. CONLON: Uh-huh.

MS. BROOK: And do you use these load shapes for that heat pump penetration in existing buildings? That's what I'm asking --

MR. CONLON: Yeah.

MS. BROOK: -- all of us to think about is -- I would think, though, that heat pump load shape for a new home that hasn't been retrofitted is going to be different, and maybe significantly different, than our new buildings that have really good envelopes.

MR. PRICE: And --

MS. BROOK: So maybe we can work on that.

MR. PRICE: And I think that, Martha, there's even one more kind wrinkle in that. So I think these are the shapes. So there's the shape, and then there's the magnitude of the load.

MS. BROOK: Uh-huh.

MR. PRICE: And so I think we've used the shapes from CBECC simulation correlated with all the weather files, but I'm -- correct me if I'm wrong, Brian, but the -- how much we scale those shapes up and down, I think, is coming from --

MS. BROOK: Yeah, yeah.

MR. PRICE: -- our energy use.

MS. BROOK: Yeah.

MR. PRICE: So like an existing building might use more energy for space heating --

MS. BROOK: And I think --

MR. PRICE: -- than a new building.

MS. BROOK: -- the shape is probably a little different, too. Yeah.

MR. PRICE: The shape might be different, too, but --

MS. BROOK: Yeah.

MR. PRICE: -- I think we're at least --

MS. BROOK: Okay, okay.

MR. PRICE: -- capturing, like, the --

MS. BROOK: All right.

MR. PRICE: -- kilowatt hours, not -- if not the shape.

MS. BROOK: I was hoping I could ask Bruce and Roger for all of their existing building models. That's what I was hoping for.

MR. PRICE: Oh, okay. Well, you can. I won't stop you.

MR. DELFORGE: Here their floors and other things, for a while. That was then. But I think -- so I have a ton of -- a ton of questions and comments. I'm only going to going to go through some of the top ones in the short time that we have.

First, I think generally, I really appreciate and support the direction of really including building decarbonization as the central direction in these metrics, and I think generally, it seems to be in the right direction. So strongly, you know, we support the overall direction.

I do have some questions and a concern, and my main concern is actually related to the one that Commissioner McAllister raised early on, on the retail adjustment. I think the problem is that -- yes, thanks for bringing it up.

MR. PRICE: I'll pull it up so everybody can see how big it is.

MR. DELFORGE: So if you look at it right here, it seems to be around sixty percent of the entire price signal is retail adjustment, I mean, roughly, right?

MR. PRICE: Yeah.

MR. DELFORGE: And by making it flat, you are dampening, very strongly, the incentive for load flexibility and load shifting.

And this is purely under assumptions because, you know, as you said, it's an assumption around, you know, cost collection, energy revenue collection, it's not -- it doesn't have to be that way. It could be proportional to the other signals. And we spent a lot of time making a lot of assumptions around, you know, the amount of renewable gas and all of the other assumption I won't go into, which are basically, I assume, have very little impact compared to that major assumption it's going to be flat. And I would strongly encourage you to consider alternative that better value grid flexibility and load shifting, which are a key part of what we need for decarbonizing our buildings.

And you know, this doesn't even reflect the three-to-one ratio that we have on some of our retail rates today in effect with, you know, Atchison's PG&E's EV rate. So these retail rates are basically just -- I think is a major issue in terms of a price signal for load flexibility.

Next, I also question why we're not focusing on carbon neutrality by 2045 as a policy scenario. I have --

MR. PRICE: I thought you might.

MR. DELFORGE: You know, the eighty by '50 is our executive orders. So there's no difference between the two. They're all executive orders. We need to decarbonize buildings. We know that buildings are easier to decarbonize -- not easy, but they're easier to decarbonize than other sectors. So it's a big difference in trajectory by, you know, between aiming for eighty percent by '50 and aiming for zero by '45. It's a significant difference that we should at least consider what this means.

The other assumption around, you know, targeting a slower building electrification scenario, that seems, you know, cautious, probably not what we think we need to achieve to decarbonize our economy when we begin NRDC and many others.

On the other hand, assuming ten percent renewable gas by 2030 seems extremely ambitious compared -- now, given that we haven't had any at all today in our gas pipeline, and we don't have any policies in the RPS that are going to -- and it's extremely high cost. So how can we assume we're going to go from a fraction of one percent to ten percent and then, you know, twenty or more by 2050, when we hardly have anything today with -- you know, we already have building electrification policies?

So there seems to be a disconnect in terms of the ambition, the ambition that's involved between these two assumptions. And I would encourage you to take the high building electrification scenario as an assumption to underly all this work.

Last, on the nonconversion emission, I think it's a great improvement. So thank you for doing that. Two issues here, though. One is on the leakage rates. So if we assume that it's .5 percent behind the meter, and just another .2 percent to get to this .7 assumption, we're really saying we don't really have much impact at all on upstream emissions. And when you consider that, you know, you've referenced this 2.3 percent, not including behind the meter, so behind the meter, it will be 2.8 percent, I think we need to have something which is much -- you know, I don't think we'll be able to be able to avoid all this 2.8 percent, but something much closer to that, you know, less conservative than what has been assumed right now, which is almost -- you know, very little other than behind the meter.

And then I just want to encourage -- to support what Charles said. You know, hundred-year GWP is not relevant in the era of the climate crisis. We have, you know, ten years to turn things around, and we come -- I mean, it's important for the very long-term, but in the very short-term, twenty-year is really what we need to focus on. So I strongly encourage you to -- you know, not undervalue -- you know, a hundred years undervalues methane leakage by a factor of 3.5, roughly. And I think it's really important that we consider the urgency of the climate crisis and the underlying assumptions around it.

With that, thank you, and we'll be commenting on record.

MR. MCALLISTER: Yeah, great. Thanks, Pierre.

MR. DELFORGE: Thank you.

MR. MCALLISTER: I thank everybody for your comments, and we still have more.

But on that methane issue, it seems like -- so how are you dealing with the shorter-term residence of methane? I mean, a hundred years isn't really relevant because methane molecules just -- if you limit emissions --

MR. PRICE: Yeah.

MR. MCALLISTER: -- it's all done in ten years.

MR. PRICE: Yeah, so I guess we're not, really. Let me take a shot at this, and then Gabe, you can chime in, too.

Where's our chart?

So you notice that what we are recommending is really the ARB inventory. And so, you know, we kind of went fully aligned with ARB in our proposal. And that's where the hundred year comes.

And so, you know, it's -- we think, and probably, you know, Pierre would agree, like, it's a first step. We know we -- in order to really get looking at the refrigerant gasses, we need to also account for the methane change. So -- so we already know we're having to do a methane assumption, and the data -- and Gabe showed four studies. We actually looked through about twenty. But none of them, not a single one, really tells us or has a number that is, like, the one we want, which is, how much will methane leak change based on a change in load?

And so in the absence of information, what we wanted to propose was a first step that gets us going on being able to account for noncombustion emissions and that aligns with our other state agency that's focused on this issue exactly, recognizing we've got to start somewhere and move forward.

So -- so that's -- that's why -- that's why you see what you see. And you know, the -- and -- and -- you know, I -- the code cycles every three years, so the idea is, you know, I -- I understand the NRDC's position is to go farther faster, but we will have another bite of the apple in -- in three years. So the question is just how far to go.

I guess the other thing that I would say along that, if I -- if I may --

MR. MCALLISTER: Yeah.

MR. PRICE: -- just to go back to one of Pierre's comments as well, you know, why take this slower building electrification scenario? Sort of seems like a -- an unusual scenario. And the reason why is, again, this sort of incrementalism. So if we pick the high-electrification scenario, the natural gas rates are so high because of the throughput decline, that essentially, there's no more choice for natural gas versus electric.

So then, in this -- and we have some -- and we have some factors. But so incrementally, we're leaning the scale towards -- you know -- and benefits of higher electrification penetration, but the choice is a -- is an incremental step. And if we took the other step, it's really all the way there, and then we've -- we've eliminated fuel choice.

So -- so I'm -- you know. I know that's a very practical or just direct implication, but I might as well just tell everyone that's -- that's why we ended up with an incremental step, at least in our mind, as a -- as a recommendation.

MR. MCALLISTER: Okay. The reason I asked about methane is just earlier this week, I was down looking at dairy digesters, right? And just the massive amount of capture of methane that they're doing that used to go into the atmosphere. And they're building a ton of projects, and there's, like, a real pipeline full of projects.

MR. PRICE: Uh-huh.

MR. MCALLISTER: And you know, if you translate that avoided methane emissions to carbon equivalents, carbon dioxide equivalents, you really lose the temporal advantage of getting the methane --

MR. PRICE: Uh-huh.

MR. MCALLISTER: -- which is like, okay, well, you know, we're saying it's like carbon. But that's like, it's going to resident for a hundred years in the atmosphere, whereas methane is resident for just a few. And so it actually bends the curve faster than would be possible if you were only talking about CO2 to, in the near-term, control methane emissions. So it's got kind of a bigger benefit, a bang for the buck, early on, and that's kind of what we need in a lot of ways.

MR. PRICE: That's interesting. That effect that you're talking about, of we -- our counterfactual would have been release the biomethane into the atmosphere, is not in our case.

MR. MCALLISTER: Oh.

MR. PRICE: So -- so we're assuming, basically, we're going to capture and flare at the very worst.

MR. MCALLISTER: Right, okay.

MR. PRICE: We're not just going to let unabated methane go into the atmosphere. So we're not taking extra climate benefit for biofuel use in our pipeline for our buildings, based on the counterfactual of, we would have just put it up into the atmosphere.

MR. MCALLISTER: Although, the distribution grid, the gas distribution network, would be just losing methane.

MR. PRICE: Yeah.

MR. MCALLISTER: Right? So that's --

MR. PRICE: That's -- that's right. Yeah.

MR. MCALLISTER: So capturing that methane --

MR. PRICE: That's right.

MR. MCALLISTER: Okay.

MR. PRICE: So if it leaks in our delivery, then yes.

MR. MCALLISTER: Yeah.

MR. PRICE: And if we can change that, then -- then we take credit for that piece.

MR. MCALLISTER: Yeah.

MR. MANTEGNA: You're definitely right, it's not an apples-to-apples comparison at all between --

MR. MCALLISTER: Yeah.

MR. MANTEGNA: -- methane and -- and CO2. I think the idea of using a twenty-year GWP instead is definitely well-taken, and we'll definitely consider that.

MR. MCALLISTER: Okay. Okay, great.

MR. PRICE: I wanted to point out one other thing between the .5 percent and the .7 percent, since Pierre -- you know, the .5 percent is our existing -- was largely our existing homes, where there's a lot of pilot lights or what have you. So I don't think you -- you know, none of these -- like I said, none of these studies is exactly what we want, right?

So the .5 is a whole mix -- I think there was, like, one or two new homes in this study; maybe just one that gets us to .5 percent, the all leakage in California, .7, so -- yeah, sure, Pierre. Come one.

MR. DELFORGE: New homes also have tankless gas water heaters, which are a major source of leakage, so no pilot lights, but alternatives which may also be significant.

MR. PRICE: Yeah, we -- we have two studies on that, and they're wildly different in their conclusions about how much tankless water heaters leak. We have one study that says, you're right, like, it's a big source, and conjectures that, you know, every ignition cycle, there's a puff of methane that get -- and not all of it gets ignited.

Another study has pretty low, so you know, this is like we're trying to get at, like -- you -- you read these two studies and you explode, right? So we need a third study to be the tiebreaker, or maybe a tenth study.

So you know, that's -- we're in a -- we're in a second-best world in terms of what's available in the literature.

MR. DELFORGE: Going back to the retail ad, or -- when Wilcox will show his results, you see that the demand response signals get significantly weaker in 2000 -- well, the 2022 TDVs because of --

MR. PRICE: Yeah.

MR. DELFORGE: -- you know, it's not as peaking, and -- even though there's a dip. So --

MR. PRICE: Yeah.

MR. DELFORGE: -- again, I kind of want to add my voice to the people --

MR. PRICE: Yeah.

MR. DELFORGE: -- who want to reconsider the retail adder, perhaps, as a way of restoring some of that demand flexibility signal.

MR. PRICE: It's so interesting. I mean, if we zoom out, we're looking at an energy future that's almost all fixed-cost.

MR. DELFORGE: Yeah.

MR. PRICE: The cost of our solar farm is fixed; the cost of our battery is fixed. It's just all infrastructure, and we don't have any variable costs.

So like, when we come back here after three more Coates cycles, it's just going to be, like, a blue bar. You know.

MR. MCALLISTER: The thing, though -- the thing, though -- let -- I mean, I got to chime in here, though.

MR. PRICE: Yeah.

MR. MCALLISTER: How is that going to happen in practice if we don't have a stimulus for investments in the thing to allow that load shape to flatten? That's the thing.

If we can't figure out how to motivate investment behavior such that we optimize our infrastructure investment and don't just focus on the -- you know, on whatever that -- you know --

MR. PRICE: Uh-huh.

MR. MCALLISTER: -- the peak time is going to be and don't revolve around that but actually move energy around throughout the course of the day and all that.

MR. PRICE: Yeah.

MR. MCALLISTER: You know, if we don't have that incentive to behavior, then we're not going to get to that particular future. So like, it's a chicken/egg.

MR. PRICE: Yes, it is a chicken/egg.

MR. MCALLISTER: So anyway -- so --

MR. PRICE: I agree.

MR. MCALLISTER: But that depends -- I mean, in many people's view, certainly mine -- that depends on having time-dependent pricing that has a lot more teeth than what we're seeing today --

MR. PRICE: Yup.

MR. MCALLISTER: -- which is the standard TOU.

MR. PRICE: Uh-huh.

MR. MCALLISTER: So what are the -- you know, again, I guess, just what are the levers that we need to be trying to pull to make that happen? We don't do rainmaking here. The CCA's only presented a great opportunity to play in this field in a way that's more iterative in a time frame that matters.

MR. PRICE: Yeah.

MR. MCALLISTER: But you know, we need to work with the PUC on this.

And so I think that flat retail adder potentially creates a disconnect between the conversation we need to be having in terms of time-responsive pricing and the kind of long-term end state of, you know, all infrastructure and no commodity.

MR. PRICE: Yeah. This is a really interesting discussion. I think that in the 2005 Title 24 building update, when we introduced TDVs, it was a topic then. And we decided to go flat because of the signal it gave to energy efficiency in buildings.

MR. MCALLISTER: Yeah, absolutely.

MR. PRICE: And you know, maybe, you know, as we're changing our energy system from variable to all fixed-cost, we need to think about that and whether we -- what was right in 2005 is still the right thing. Clearly, you could make them proportional, and then you would have the same shape, and you could add the retail rate adder and still get the stringency.

So clearly, you know, that's not a hard math problem.

MR. MCALLISTER: Yeah.

MR. PRICE: What you will get, though, when you do that, is that the deltas for, like, battery storage or whatever -- we're going to be like -- it'll be supercharged. That difference in the money that it could make is bigger than it provides value to our society.

So that's -- that's what I had in my mind, at least. Thinking about, like, it's tricky. You know, this is a tricky problem that one solution may create another issue. So -- so I think it's -- it's not one where we would just say, okay, let's just do proportional. You know, I think we have to really think carefully about what signals we're sending to the buildings.

MR. MCALLISTER: Yeah. Thanks.

MR. TIFFANY: Tedd Tiffany of Blaevoet Consulting Engineers. Great point, Mr. McAllister. And I just wanted to thank you three and staff and everybody who's worked so hard on this. I'm continually learning from your reports. But thank you for all your hard work on this.

I'll just add to that electricity adder, if we're going to incentivize the, you know, nonwires behind-the-meter valuation of storage and behavioral aspects, we've got to change that retail adder and rate structures to align with carbon.

My focus really is -- and I want to bring this back to the natural gas sector and the impacts there. When we're talking about all these wonderful tools for looking at, you know, marginal impacts on the electric side, we really need to take the full marginal impact of -- of natural gas systems. And if you go back to the slide about the leakage rates --

MR. PRICE: Uh-huh.

MR. TIFFANY: -- leakage rate really only impacts what actually gets into the pipeline, and all these places where we're purchasing ninety percent of our natural gas supply out of state are currently flaring a third more of the natural gas that they're producing before it actually gets in the pipeline.

So this adder needs to be about 1.3 as far as energy multiplier for natural gas for those elements. And I'm going to encourage the Energy Commission and Air Resources Board to start including that marginal impact of all these natural gas impacts, because if we include all of that above the leakage rate, and we're accounting for all those purchases that we are taking our taxpayer dollars and investing in transportation systems and purchasing those fuels, those need to be included in both the cost equation and the time-dependent source for natural gas. So I would like to have your feedback on that and how we might be able to start to capture that.

MR. PRICE: Well, I would observe that you are right, that what we're doing with our source energy on gas is a 1.0. So we haven't tried to think about -- you know, and the production of natural gas is complicated, as Gabe mentioned. It's allowed within a coproduct with oil extraction. You know, we could, I'm sure, do a whole study on, like, what the right source energy factor is from a life cycle.

You know, when we start to go down the life-cycle path, there's -- there's life -- it's quite a -- quite a Pandora's box because I don't think it's fair to just single out just natural gas. Like, we should be probably thinking about, opens up building material, opens up, like, a -- my mind is, like, big.

MR. MCALLISTER: Well, focus on the energy sector.

MR. PRICE: So you know -- so yeah, even on the energy side, it starts to trace up through, you know, energy production and solar panels, all of this kind of stuff that's, like, you know, important. I'm not saying it's not important. I'm just -- you know, we have to draw the line -- I do think we have to draw the line somewhere.

And so, where -- you see where we -- where we came down. And I'm not saying it's not worth further exploration, either. But I don't think we can solve this problem by just doing the natural gas factor adjustment. I think we'd have to look at the broader set of energy generation components.

MR. TIFFANY: Commissioner McAllister, just to put this in perspective; the flare rates that were reported this spring were about 50,000 cars per day, driven for a year, twenty-one million cars each year that they're flaring off. That's twenty-five percent of all the cars in California. So that is a large impact. And the rate payers are paying for that -- and that's our infrastructure that's delivering it. It's not just this leakage rate. So we need to consider it and find a formula to consider it. So thank you.

MR. NESBITT: George Nesbitt. TDV is very complex. I think as a metric, it's done a pretty good job, I mean, being a cost metric in recognizing not just the value -- before TDV, it was source energy. So it was the value of energy versus energy, and it introduced an added value of when you use the energy is also as important as what energy you do use.

I haven't been completely convinced that's the best metric to use for decisions. To use it as determining cost effectiveness for the code, I think it works pretty good, although one could argue we shouldn't be using cost effectiveness.

So I'm wearing steel-toed boots today, and number one on my list is the fixed retail.

MR. PRICE: Okay. So to respond --

MR. NESBITT: I don't want to -- I don't want to beat it too, too dead. But TDV being a variable price, I mean, it is essentially a time-of-use sort of scale in the way it works. But I do think having the fixed retail at the base, it needs to also reflect that where we are going and should go and need to go is a variable retail price. So it should reflect it, maybe not, you know, to the same extend that it does anyway with all the other stuff.

One of your young ones there made a comment about accounting for the cost of the three solar energy. Remember, they used to say nuclear power would be so cheap that it wouldn't have to be metered. So we currently have enough TDV where we have excess. Even though those wholesale prices might go negative, there is actually a cost to that. The cost is that steep ramp. The cost is the batteries needed and all the other things we have to do to deal with that fact. And of course, as a policy, we're now going to ad PV to all new homes in California.

One comment on the refrigerant leaks was, are you going to use the service life of the equipment in that projection? Okay. And I don't know if it matters -- well, whether we use an average or put the end of life at the end of life, but --

MR. MANTEGNA: Yeah, so I think it would be the same either way if you were looking at --

MR. NESBITT: I suppose we can account for it upfront. The more we can account for it upfront, the better.

MR. MANTEGNA: Yeah.

MR. NESBITT: But anyway, so it looks like the TDVs for gas have gotten higher, and the TDVs for electricity have come down -- down a little bit at their peak --

MR. MANTEGNA: Oh, yeah.

MR. NESBITT: -- and the spread has gotten larger.

MR. MANTEGNA: Right.

MR. NESBITT: I think this is -- well, a signal, assuming it's the metric and that it is changing the balance between fuel and electricity.

And actually, I wanted to make a comment. Our goal is net carbon. So it's not that the electricity grid is a hundred percent carbon-free, but that it would be net carbon, and the likelihood is we're going to have carbon on the electric grid. Just --

MR. MCALLISTER: Uh-huh.

MR. NESBITT: -- reality. And then source energy, back to the future, I guess --

MR. MCALLISTER: Uh-huh.

MR. NESBITT: -- where we moved to TDV, it was one for natural gas --

MR. MANTEGNA: Like three?

MR. NESBITT: -- and three, yeah, a flat three for electricity, and I don't know what propane was, although it was higher than the one, I believe. Although the reality is the western grid, California is probably 1.05, 3.4; nationally, it's probably 3.4. The reality is most of our electrical generation in the world is fossil fuels.

So you didn't present it in what you did, but it looks like source energy for natural gas is, one, going down a little based on biofuels. What's it roughly end up for electricity?

MR. PRICE: Yeah, so as -- if you look at this chart -- so one Bt -- or one kilowatt hour of electricity is 34/12, I think. So if we want to pick -- pick on January at midnight, we're at 42/82. So what is that? That's like a 1.4-ish multiplier, 4,200 divided by 3,400 is like whatever that -- you know, so it's a 1 in change. And then it's almost zero here, in the middle of the day.

So -- so what this has got -- they didn't do it as SB100, right? So we're dramatically driving down our electricity grid. But you're right; on the margin, we still have thermal. So it's not -- it's not zero source energy for electricity, but it's much lower than the numbers we were talking about for, like, a national average or something like that. We're at, like, one and -- one and a half at most.

MR. MCALLISTER: Right.

MR. NESBITT: Yeah. It would -- it would be nice to see it in a form that gave you a sense of what it is.

MR. PRICE: Yeah, it --

MR. NESBITT: I mean, you know, it's pretty pictures and nice colors, and all.

MR. PRICE: We could have divided those through -- we could have divided those through by 34/12 and made it a lot easier for folks.

MR. MCALLISTER: John?

MR. MCCUE: John McCue (phonetic). So I've -- I've got a question about the T&D, you know, the allocation -- maybe you could go over to that slide. It would probably be kind of worthwhile.

The thing I'm trying to understand -- I understand how -- where you get your capacity charge, et cetera. I was thinking more if it showed the hour of the day or something like that.

MR. PRICE: Oh, that shows the evolution by hour --

MR. MCCUE: Yeah.

MR. PRICE: -- and month over time. And then we have this chart --

MR. MCCUE: Yeah.

MR. PRICE: -- that shows -- like, this is the average across the year.

MR. MCCUE: Right.

MR. PRICE: So it could happen at different days or different times, but --

MR. MCCUE: Sure. Yeah, I -- in any case, the thing that's kind of interesting to me is that, you know, it's reflecting that there's more solar on the grid, et cetera, but -- you know, when I think of T&D, I think of powerlines --

MR. MCALLISTER: Uh-huh.

MR. MCCUE: -- and transmission lines, et cetera. And now, with all the solar that's, you know, located in different places, and that the loads are still, you know, higher in the middle of the day, when we add a -- you know, an incremental building -- because this is what this is about. It's the incremental -- you know, how do we allocate costs towards T&D? When we add an additional building, et cetera, isn't the thing that's driving it is my capacity and my lines, and -- and aren't those still kind of in the middle of the day? Or is this actually reflecting that there's all this investment in batteries right now and things to shift it? So I'm just trying to understand, why is it not necessarily near the actual peak flow of electricity?

MR. PRICE: We have a lot of distributed solar that we're expecting because of rooftop mandate, what have you. So like, we're not expecting to drive new T&D peaks in the middle of the day. Our evening peak tends to be higher, you know, starting at about 4 o'clock anyway, just a natural. The thing that could mitigate this is if we did do a ton of embedded storage at the end use, right? Which we don't have assumptions --

MR. MCCUE: Right.

MR. PRICE: -- of. So we have solar, you know, located with our loads. But we don't necessarily have storage because of the cost. So you know, maybe we come back and find -- maybe, you know, the -- the batteries in the garage take off and we can shift this thing around. And then the T&D capacity bar would probably look more like the generation capacity bar that's on here, which is sort of spread out a little more, and -- and muted more.

But that's, you know, that's what's happening underneath this thing is that we've got higher loads in the -- this timeframe. You know, you see seventeen is -- is -- you know, sixteen hours, sixteen, seventeen. It really starts to kick up. Our solar is no longer helpful in this meeting the T&D peak, and we get this giant ramp. So -- so that's what's happening with that.

MR. MCCUE: The other question I have is, in terms of your model, looking forward, you know, the -- was it -- the water control board has this, you know, order out for -- and I know there's recently some interesting things going on. But you know, there's something like 20,000 -- yeah, 20,000 megawatts of generation that has to comply, one way or the other, and I'm assuming that some fraction of that's going to be discontinued, potentially. Some fraction of that's going to be replaced with, you know, combustion turbines, things that are more variable. So just kind of wondering how -- how you kind of look at that.

MR. PRICE: Yeah. So I think what you're talking about is the planned retirement for our once-through cooling power plants which are kind of up and down the California coast. And we factored those into our capacity development model. We didn't have time to talk on it, so I jumped to the appendix slide.

And you're absolutely right that that drives a capacity need for generation capacity, even as early as 2022. We're talking about shutting down Diablo 2, which is once-through cooling, and also nuclear, so that's a big chunk of capacity. So behind the scenes for what you've seen is -- is our capacity value chart that looks something like this. And it's got high-capacity value in the near term.

When these codes kick in, there's a high-capacity value. The -- the thing is, though, that under our SB100 high-solar penetration, we end up adding a ton of storage for integration. And so that's an integrative device for our renewables. And we can also use it for capacity.

So in the long term, essentially, we -- we have a short-term problem that gets resolved with our decarbonization strategy almost naturally. And then, you know, we kind of, overtime, are, you know, relying on our existing -- just keeping our existing fossil fleet for backup, essentially, as the cost that's driving capacity, once we get over that near-term need. So -- so that's what -- so this is the price behind that. And you're absolutely right that we're seeing in this coming decade, and you know, even in the year that this code cycle that we're talking about take -- kicks in having a capacity need.

MR. MCCUE: Great. Thanks. And then, you know, I think what you're showing is that the value of -- of electricity produced in the middle of the day is -- is declining. And so in your model, is it -- what -- why doesn't, for instance, wind actually is a decline in cost and the value of the -- of electricity in the middle of the day, just -- it -- it's just not enough to actually spur, you know, a mix -- you know, more of a mix of wind and solar?

MR. PRICE: Yeah. So it takes all the reasonable wind in California just right away. But over time, the combined cost of solar plus storage is beating our wind. Okay? So it just -- you know, it's just a head-to-head ruthless competition. And it's the least-cost planning.

And so solar plus storage looks like it's beating wind if you get into kind of any marginal cap factor or regime. I think maybe the wild card is the cost and feasibility of offshore wind. And I think that's an area of a lot of research. But you know, there's probably a lot of hearing room meetings like this before we get to new offshore wind off California.

So --

MR. MCALLISTER: And one last thing -- you know, about twenty years ago when, you know, TDV was being first developed, you know, there was a -- there was this same discussion about a fixed retail rate at or one that would, you know, essentially twist the dial and make it even more peaky than what TDV is currently. And the thing that I remember about this is that, you know, there was a concern that we'd actually start creating new peaks.

And you know, if you think about it, back then, you know, the -- you know, potential technology at the time -- the technology has changed because back when we were looking at this, our big concern was actually the middle of the day and we're worried about, you know, providing energy in the middle of the day. Now, it seems to be less of a -- an issue, right? But back then, you know, the technology at the time were, you know, essentially, electric resistance, water heating, and heat pumps, and basically creating spikes in the morning and in the late eve -- or you know, early evening.

So we might've actually ended up, you know, if we'd kind of taken that other route, we may have ended up with an even more sort of U-shaped load curve than we do now. So I just thought I'd -- you know, just a little historical perspective and some -- you know, times have changed. But you know, it's something to think about, being kind of cautious that we're not creating some kind of new peak like this.

MR. MCCUE: Thanks.

MR. PRICE: Thanks, John.

MALE SPEAKER: Thank you, John.

MR. MCALLISTER: So can I -- I just want to make another comment here. So I think there's a really valuable discussion that we should be having. We sort of are having it, but maybe not straight ahead which is what's the balance?

You know, all the energy efficiency advocates, myself included, we're all, like, afraid that, oh my gosh, if we focus too much on flexibility, and solar plus storage, and all this kind of stuff, and energy efficiency -- you know, oh, my gosh, it's devalued, and no one will invest in it, right? I don't think that's the case. But the incremental value, the temporal value of efficiency actually matters more and more.

So that's kind of a conversation that we need to have, is where do we come down? Like, how low? If we were going to have a time-dependent, you know, retail adder, how low would it go in the middle of the day? How much would we still want to keep it worthwhile, in the Building Code context, to invest in energy efficiency, no matter what hour, you know, across the board, with lighting, eight-track, and all that stuff.

I guess, at the same time, we're -- when we get highly -- having just built one of these, I can speak with some authority on this, now. We've got a -- well, if you built a passive house, you don't have a lot of load flexibility in some places, where before, you had it. Your heating loads go down. Your heat pump, when it comes on -- which isn't often -- it comes on -- it's small so it's not a lot of manipulable [sic] load, and it comes on for hours at a time because it just takes it that long to recover the couple of degrees that it lost, you know, of internal temperature.

And so you're, in a way -- so we need to quantify these things, like how much, you know, efficiency, how much flexibility? You know, if you're in the Midwest and you've got a whole bunch of electric-resistance water heaters, you've got a massive dump load, and you've got a massive, you know, flexible load more across the board.

And so that's not our future in California. We're not going to put that in. We're going to put in a bunch of heat pumps -- heat pump water heaters that may not as be -- be as flexible as we're thinking they might. You know, but they are.

So anyway, I think the time value of efficiency and flexibility is something we really need to dig into to understand where we're going. And I actually -- I kind of want to come down. My guts telling me that we do want some time dependence on the retail adder. But the details matter, right? So anyway. Like, I -- I'm -- I -- I'm going to encourage us to keep that thread alive and try to inform it.

MR. SHIRAKH: Yeah. So -- and it does sound like, you know, this is a topic of interest. I'm sorry, Snu, but you're outnumbered on this one.

MR. PRICE: No, no, I clearly -- I can read the room, too.

MR. SHIRAKH: So I think we should have a -- I suggest having a discussion --

MR. PRICE: Sure.

MR. SHIRAKH: -- after this (indiscernible).

MR. PRICE: No, absolutely. Clearly, we should. Can I add one more datapoint to your comment?

Which is that, actually, Brian Conlon here has done a lot of analysis on the daytime cooling.

So you know, for residential, if you run your air conditioner during the day, you'll have some losses through the thermal envelope and you'll actually use more energy. But if you value it, even in the 2019 TDVs, you get this huge TDV value, you know, because you can ride though the evening.

And so it's like -- and think about all the air conditioning in California. What a peak capacity resource that could be if we could just do daytime cool -- run our air conditioning during the day and then it's just comfortable in your house all day and you let it drift in the evening.

So it's -- to me, it's a very big question. It's efficiency versus timing. And in that example, I have negative efficiency, using a little bit more, but it's low-cost energy and I can really save a lot of capital in the evening. So it's --

MR. MCALLISTER: Well --

MR. PRICE: -- kind of an interesting --

MR. MCALLISTER: Well, I mean, so -- another spin --

MR. PRICE: Yeah.

MR. MCALLISTER: -- on that, if we're going to -- we're also trying to focus on equity, right?

MR. PRICE: Yeah.

MR. MCALLISTER: So if we have a whole bunch of low-income houses that are inefficient that don't have the ability to ride-out hours because they don't hold heat or hold cool --

MR. PRICE: Um-hum.

MR. MCALLISTER: -- so let's invest heavily in insulation, and performance, and ceiling of those building shells, right --

MALE SPEAKER: Yeah.

MR. MCALLISTER: -- windows, whatever. And then we -- if they're getting their HVAC replacement, I mean, we downsize the HVAC, right? And then we have the ability to ride through and do demand flexibility -- or do anticipatory demand, as you're talking about, you know, demand response of flexibility --

MALE SPEAKER: Yeah.

MR. MCALLISTER: -- whatever we're going to call it. So I mean, I do feel like the -- we need to get creative on program approaches and then quantify how much money it's going to cost. Like, you know, how -- it's going to cost a lot of money to retrofit, you know, a third of the buildings in the state, if that's what we're going to do for low-income. So we really have to sharpen our pencils.

MR. SHIRAKH: Go ahead, please.

MS. GOLDEN: Thanks. Hi, I'm Rachel Golden with the Sierra Club. Thanks so much to E3 and the CEC staff. I've found this presentation to be really helpful and really appreciate the updates you've done to the metrics and also introducing new metrics, so it feels like a very positive step. So thank you for that.

And I do agree with a lot of the comments made already by Charles, Pierre, Ted, and others. So in interest of time, I'm not going to, you know, repeat all those comments, but just mark me as a plus one, and I'll fill those out in my written comments. I do have a few questions that would just help me as I prepare to write written comments on this workshop.

The first is I'm thinking about hotter climate zones that are going to have cooling loads and are going to necessitate air conditioning. And in your assumption on GHC emissions from refrigerants, presumably, if you install a heat pump space heater, that is also going to provide cooling. So I'm wondering if that is included in your model, if there's other -- any sort of double counting there on the refrigerant side.

MR. PRICE: Yeah, so the difference in leakage rates between heat pumps and air conditioners is included. It's very slight. Yeah, there's -- I mean, yeah -- yeah, so the leakage from air conditioners is included, too, if that's your question. Is that your question or what?

MS. GOLDEN: Sorry. My question is, for -- in those -- in homes in those hotter climates --

MR. PRICE: Um-hum.

MS. GOLDEN: -- I'm assuming that the household would have a heat pump space heater that does both the heating and --

MR. PRICE: Yeah, yeah.

MS. GOLDEN: -- the cooling.

MR. PRICE: That's right.

MS. GOLDEN: So I just wanted to make sure that you weren't counting both --

MR. PRICE: Oh, no.

MS. GOLDEN: -- refrigerants from A/C and then a separate unit for heating.

MR. PRICE: Yeah, no, it's one heat pump that does both --

MS. GOLDEN: Okay.

MR. PRICE: -- heating and cooling. That's right.

MS. GOLDEN: Great, okay.

MR. PRICE: So you can see just the chart -- this is just one example for one climate zone, but the hashed tier is the refrigerant leakage for the all-electric home. But the mixed-fuel home has an air conditioner. And so that's the hashed area here on the mixed-fuel home. So there -- it's not double counting, but it's accounting for both -- you know, both sides of the ledger.

MS. GOLDEN: Okay. Thanks. That makes sense. And then, you were saying earlier that the refrigerants is based on the lifetime of one appliance?

MR. PRICE: Of the equipment, yeah.

MS. GOLDEN: Of the equipment. So I'm wondering, since these buildings are going to last thirty years or more, do you assume lower global warming potential equipment with time due to sort of market development and increased standards for refrigerants?

MR. PRICE: Yeah. So in the baseline, we're just assuming refrigerants that are available today. And then, building designers will have the option to -- if they want to design a building that will use a lower GWP using equipment that can reflect that --

MS. GOLDEN: And then get a credit or --

MR. PRICE: -- and then get a credit for that.

MS. GOLDEN: Great. Okay. And then, one comment on the leakage, I was in the IEPR, Building Decarb Efficiency Workshop in this room a few months ago and there was a great presentation on behind-the-meter leakage. And the presenter talked about leakage rates in restaurants being around one percent behind the meter. So I was wondering if --

MR. PRICE: Um-hum.

MS. GOLDEN: -- you looked at that study and if that's included in your --

MR. PRICE: That'd be --

MS. GOLDEN: -- literature review.

MR. PRICE: That'd be great if you could send us that study. I haven't seen that.

MS. GOLDEN: Okay, great. And then just sort of on the topic of methane leakage and aligning with carb, I understand the need to align with different state agencies, but my -- you know, my preference is that we really align with climate science. And if some agencies are slower to come around, I think that, you know, it's the role of E3 and the CEC to really lead here. And I trust carb will come around and start to use a lower time horizon for methane.

But I don't think that we should just base our numbers because carb -- that's what carb is doing. Like, I want us to be aligning with -- with climate science directly.

And then, on that note, you know, I understand there's a really large range in these leakage rates. We've looked at these, too, you know, from the Howarth studies that are extremely high, to some of these. And you know, what we're really talking about here is a climate crisis. And I don't think -- you know, if we use a bit higher of an -- of a percentage rate for leakage, I don't think come 2030 or 2045 we're going to be like, dang, this equipment didn't leak as much as I thought it was going to. You know, it's more the opposite is true.

So I just think that we need to be careful in our assumptions. And then, maybe we assume a slightly higher leakage rate because we know that's very possible and the literature shows that because, you know, when it comes to climate change, we need to get this right. And it's better that we assume a bit higher than a bit less in terms of, like, the tipping point for climate change. So I would just encourage us to think about that, instead of always being extremely conservative in sort of an academic research approach.

And on RNG, I do have concerns about the supply assumption in the pipeline. But at a higher -- and I'll put that into my comments -- but at a higher level, I'm curious, Snu, you said earlier how industry is a lot harder to decarbonize. And I assume that means we're willing to use a lot more RNG for industry --

MR. PRICE: Right.

MS. GOLDEN: -- instead of for buildings. So out of the total RNG supply that you're assuming we have in California, what percent are you assuming is going to go for buildings? So you noted if -- you know, a certain percent in the pipelines. What does that --

MR. PRICE: Yeah.

MS. GOLDEN: -- leave for industry?

MR. PRICE: Yeah. So the way our model works, it is allocating our available supplies. So if we put more in the pipeline, that means we do have less for industry. What it does -- and I don't have the specific number of, like -- on hand. I'm trying to find the slide while I talk here. Hold on.

But we start to do -- we do less, basically, in industry, and more in the pipeline, under this scenario. But you know, we also have some electrification opportunities in industry. And we have other opportunities in transportation, what have you.

So we push -- because we're doing this and putting some of our buyout fuel into the pipeline, we're pushing up costs in other sectors, or reducing a level of ambition in terms of total reductions. Absolutely. So if that's the effect that you're wondering whether it's going on --

MS. GOLDEN: Yeah.

MR. PRICE: -- yes, it is. The degree to which this matters, I could, you know, put that in your comments and we can dig that up --

MS. GOLDEN: Okay.

MR. PRICE: -- out of our modeling.

MS. GOLDEN: Great. I do think we want to sort of look into those percents a bit more in terms of --

MR. PRICE: Um-hum.

MS. GOLDEN: -- what the larger economy-wide effects are. And then, lastly, on the source energy metric, very encouraged to see that. And I'm just curious how this is going to be used, if it will be used as a compliance metric to comply with the code, or more just sort of as a credit. And I would definitely encourage us to be using this as a compliance metric.

MR. TAM: I'm going to be talking about that next presentation.

MS. GOLDEN: Okay, great. Thanks very much.

MR. MCALLISTER: I also want to point out that SB-49 became law a couple of weeks ago. And that's the Skinner bill that extends this load flexibility authority to our appliance efficiency standards. So we will, at some point, be moving forward with some kind of -- I mean, this -- part of the reason I'm digging into this time valuation, you know, issue is that we need to show some hysteresis. We need to show some reason, some value that gets generated by this flexibility, otherwise, we can't show cost effectiveness and we can't do anything with the regulations --

MR. PRICE: Yeah.

MR. MCALLISTER: -- you know, the way that we have. So you know, on the building, on the new buildings, and on the appliances, we -- yeah, it starts to kind of add up to some capacity that we could actually marshal if we could show cost effectiveness. But we have to have the right metrics to be able to do that.

So go to Nehemiah?

MR. STONE: Nehemiah Stone, Stone Energy Associates. First, I want to thank you -- all of you, for this. This is an extremely valuable workshop. I had two questions. One, to what extent have you -- in the value of the T&D that you put in here, have you included the prospective costs that the utilities are going to have incur to make their systems more resilient?

MR. PRICE: Um-hum.

MR. STONE: In addition to, you know, the fires that have been blamed on PG&E's line, a recent fire was just blamed on Edison's line. So they're all going to have to invest a lot more in making the T&D resilient. Have you included those additional costs?

MR. PRICE: No, we haven't. And nor do we know what they are. So you know, I think that that is -- and I tried to say that there's, like, this uncertainty about this piece of it and how -- how -- I don't think we know yet what our -- how we're going to deal with our new resiliency, you know, needs, you know, given the safety shutoffs recently, and how -- you know, I imagine that's going to trigger a lot of conversation about what can we do better and how much will that cost? But we don't have that included into this.

MR. STONE: Well, I recommend that some cost is better than zero cost there because there will be a cost. And so it ought to be included. And even if you just take a really conservative approach to the cost, there should be -- that should be included.

The second thing is probably more for you, Commissioner, than -- in the past couple decades, our healthcare costs in the United States have risen a lot more sharply than our electric -- our energy costs or our housing costs. And a recent study has shown a -- has given a cost per KWH avoided healthcare cost per KWH avoided that in California, it's reasonably low because of our -- of the cleanliness of our green, but it still ranged between .9 cents per KWH and 1.8 cents per KWH. Nationally, it's more between two and three.

I'm wondering at what point when we do the TDVs do we start including this other societal cost? The -- you know, and I would imagine that for natural gas the health costs are even higher because cooking with natural gas produces NOx in the kitchen which rivals the NOx levels in the worst days in L.A.'s air. So at what point do we want to start including the societal costs of health benefits?

MR. MCALLISTER: Yeah, I'm all for it. We brought this up earlier through the course of a number of IEPR workshops. And actually, I -- in the -- in another study that E3 did, they started to quantify these costs in a kind of episodic way, I think, looking at particular events.

But I've been talking with ARB and others about how we might actually get some data, you know, kind of deal with Kaiser or one of the big providers to actually show, you know, like, when you retrofit specific populations, what are the health outcomes, you know, the improved health outcomes that you can actually get, and measure, and try to put some numbers to this. I think that's hugely valuable. And there are probably a lot of pathways to get to some credible numbers at some level, like, at least an aggregate.

But I think, you know, the more we can look at this to actually quantify those numbers, the better. And then we, you know, have the condition to be able to include it in the actual --

MR. STONE: Um-hum.

MR. MCALLISTER: -- you know, as a wedge in there.

MR. STONE: Um-hum, thank you.

MR. PRICE: Yeah. And can I just --

MR. MCALLISTER: Yeah, please.

MR. PRICE: -- chime in on that last piece? So you know, I think that -- well, I guess, first, just so the whole room knows what we're looking at here, this is really driven a allocation of customers' electric bills. So what we've got in our cost-effectiveness framework here is are we mandating building features that will pay off, given the utility bills over time, best we project?

So that's been the way that -- when we started working on this at E3 in, like, 1989, 2000, there had been years of precedent for that's the view, and we've kept that. And I think if you go back and look at the statute -- and there's some experts in the room -- I think it just says cost effectiveness. So I think that there is a little bit of room to reconsider.

But we do have, I would say, forty, fifty years of precedent of looking at it from a -- okay, I'm going to make you put in that, you know, window because it saves energy and it's justified based on your change in bills. So that's what we have. And that's where we are.

MR. STONE: Well, in that context, perhaps I should be talking to the PUC, then, about it. That's charging the utilities for (indiscernible) costs in California.

MR. MCALLISTER: Well, it -- also, I mean, if we're really focused on equity, I mean, if we're really trying to figure out all the ways we can bring resources to, you know, the folks who cannot afford to be doing these things, then the avoided healthcare costs could be a significant leverage point to bring capital to that, right?

And it's sort of like a -- you know, we have airports, right? You know, they have these programs to retrofit buildings around airports and it's about noise abatement, right? But it's a similar kind of idea.

We can have -- there's actually generation of social value and you know, land use value and all that by improving the built environment. So let's look for -- let's be creative, right? That's what we need to do.

MR. NESBITT: George Nesbitt. So I think we pretty much know where we need to be by 2050 and that's a dramatic reduction of fossil fuel consumption. And of course, electrification's part of that. But one of the dilemmas with electrification is we're also talking about electrifying not just buildings, but transportation, parts of industrial sector.

So we're talking about adding more electrical consumption. And then we have goals for renewable energy or carbon-free. But we want to use more electricity which means more renewables or carbon-free.

So I think -- couple things, we need to think about the decisions we make today and the buildings we build and how they support the 2050. We may not be able to build those buildings exactly today, although technically, we can. So how do our decisions support that? But efficiency just plays an absolute role because we need to reduce the amount of energy we consume for what we need to consume it for in order to make room to electrify, and you know, whether it's passive house or whatever, a building that doesn't need a lot of energy.

But then, we also need the flexibility. So perhaps the heat pump water heaters, since we have an excess of PV, and we're over-reliant on it, and that's as cheap as batteries will get -- that doesn't mean it's a good idea -- we have to change when we use energy.

So we need to maybe think about heat pump water heaters. They usually have an electric-resistant element. So perhaps when we have excess PV, it should run in electric-only mode and run in heat pump mode. We could do the same thing with heating equipment, the heating side, not the cooling side. But so use as little as possible, and perhaps maybe we'll have to be less efficient in order to provide the flexibility and reliability and all that.

MR. SHIRAKH: Any questions online, Peter (phonetic)?

MR. STRAIT: Yes, I was just about to get to those. I'm just going to read them in the order that we've received them.

The first is from Michael Thompson (phonetic). Michael Thompson asks, how accurate do you believe your refrigerant leakage rate for existing homes and buildings is, given the code compliance is so low. And have you estimated how much leakage would be reduced by ninety percent compliance as projected by the CEC?

MR. PRICE: Yeah, so the leakage rates are what's estimated by the ARB, as far as what actually happens, not assuming, like, whether people are compliant with the code or not. It's based on actual observations. And so I think the idea is that we're using in the baseline what the current practices are, and then if there can be better practices that can be reflected in this framework.

MR. STRAIT: Sure. Dan Johnson (phonetic) had a comment of I support Pierre Delforge's critical comments about the arbitrary retail adder as dampening the price signal doesn't reflect even current 3-to-1 TOU pricing. RNG assumption is overly optimistic in terms of supply, use twenty-year GWP for refrigerants. It's game over in three years if we don't turn this thing around right now.

And then, last comment was just asking who was speaking, which is a little out of date.

Oh, there was one comment from earlier. I'm not sure if this got asked, about the format the weather files would be in. Did we answer that one?

MR. SHIRAKH: Yes.

MR. STRAIT: Okay, good. That was in two different windows. So thank you.

MR. SHIRAKH: Okay. So we -- the other thing that we're going to -- well, actually, we're right on time. We're going to move to the your presentation -- the EDR.

But Snu, I'm going to ask you to sit up

here because --

MR. PRICE: Okay.

MR. SHIRAKH: -- this kind of builds on your --

(Pause)

So this is Mazi Shirakh again. I'm going to attempt to describe how to -- the two-EDR system works to align us with the building decarbonization codes. And as we bid farewell to Z&E and refocus our attention on building decarbonization, you know, we had our certain goals and objectives, you know, we need to meet.

And one of them, the foremost is encourage building decarbonization by removing various to building electrification. There are several vehicles, you know, we can have at our disposal to do that.

Second is maintain and encourage thermal-resilient building envelope features that perform well, both in cooling and heating climate zones, even as the planet warms up. The third one is encourage self-utilization of on-site PV generation and demand-responsive measures. This is basically a simple way of saying maintaining strong demand response signals; not increasing the stringency of the residential low-rise for one code cycle.

And the fifth one was to avoid-preemption issues. So this took several months and you know, the staff, and the team, the consultants, the utilities, you know, we kept thinking, you know, what is the one magic metric that's going to allow us to meet all the goals and objectives that I outlined here.

So we had a pretty good idea what TDV looks like, but then we knew that TDV by itself is not going to do the job. So we started thinking about other metrics such as sourced energy and GHC metrics and a combination of some of these metrics. And some of them are outlined here.

There's nineteen different options here. I'm not going to go through each and every single one of them. It's just to say that there are -- there were cost metrics here that usually include a TDV.

We had energy metrics. That's source energy. We have GHG metrics that are here. And then we had metrics that were sort of combined, like metric 14 and 15 were -- we attempted to get the source energy and add features from TDV to it, like capacity, hoping that, you know, it will give us the shape that we want for both decarbonization and maintaining, you know, resilient building envelope and demand signal. And each and every one of them had an issue with them.

And then towards the end, you know, you see this two-step descriptions here. And each one of these made -- like, source energy, there was, like, four different flavors of them.

So you know, we looked at every one in long term, short term, average. And you know, we kind of kept going through to see which one might do that. And the combined metric, like 14 and 15 again, was an attempt to try to accomplish that. And that also fell short. And the two-step ones here are the ones that kind of pointed us towards the one where you ended up as a two EDR system.

So to select the metric that would give us the right signal, we set ourselves these eight goals. One was to facilitate fuel switching and building electrification. Number two was support demand flexibility and grid harmonization strategies. Number three was protect the building envelope measures, such as high-performance attics and walls, and efficient windows. We didn't want the buildings to end up with features that might save carbon but also increase the operating costs of the building, such as -- you know, an example is resistance heating for water heating, not increase the energy cost of the building for the occupants.

Number six was the result in long-term and sustainable GHG reduction in buildings by supporting items one through five above. We also wanted to avoid the federal pre-emption issues, which was associated with some of the GHG measures. You know, we cannot use, directly, a GHG measure as a -- for trade-offs. We could use source energy and the good thing is that the source energy, some of them actually track really well with the GHG metric.

And so we could use that as a proxy for a GHG metric. And that's actually the key point in our strategy. Instead of using a GHG, we can use a source energy and define a carbon budget -- or proxy carbon budget for the building.

And we also, at number eight, was trying to do all of the above without really have unusual limits -- trade-off limits in the software. For that exercise we went through a lot of different scenario analysis.

One example is here. You know, we had many, many more where we looked at fuel-switching signals. We looked at individual measures, like high-performance attics, high-performance walls. We had PVs -- standalone PVs plus storage, and on and on for all sixteen climate zones.

And you know, across the top here are the different metrics. And these are climate zones that we looked at to see how these metrics would handle the different measures that, you know, we were interested in.

So the results were as following: For single metrics, we could not find a single metric that emerged as a satisfactory option for this. Out of all that list and everything that we saw, there were none of them. And the problem is, you know, a metric that is really good at reducing carbon was not good at protecting the building envelope or maintaining DR signal -- and vice versa.

So the second choice that we had was the combined metrics like 14 and 15. This is where we took the source energy and we had it -- some elements of TDV, like the capacity factor. And again, the same thing. You know, it was a compromise between the two. And you know, it didn't give us a satisfactory answer for either decarbonization or maintaining. So it was like they both get diluted.

So what we came up with is what we call the do -- two EDR approach. So it's two independent metrics. EDR1 uses the source energy. And EDR2 uses

TDV.

So the hourly source energy, again, establish a carbon proxy budget for the building. The units are KBTU per square foot per year. And think of it as establishing a carbon budget for the building. And the one way you can do that is you start with your baseline building, like your 2019 standards, and see what the budget is.

And then we can slip end uses from natural gas to electricity. And this metric will define that budget. So when the builder builds the building, they must operate within the confines of EDR1.

EDR2 is the TDV base that Snu just introduced for 2022 with natural gas. And so what the TDV2 does is basically -- it protects the envelope and it maintains the demand response signals. But the key to this is that EDR1 and EDR2, they must operate independently -- in other words, no trade-offs between EDR1 and EDR2. You cannot put a better high-performance attic and compromise the carbon budget or vice versa.

So that's the key. The building must meet both EDR1 and EDR2 independently. So I'm not going to talk about time dependent valuation or hourly source energy. I think Snu did a good job.

So this table kind of summarizes this approach. In this column, you got the metric, the hourly source energy. What is it good at? It's very good at promoting electrification and efficient use of gas appliances and fuel switching. But it's not good at just protecting the envelope, such as high-performance attics, walls, efficient windows, low leakage envelope, and it has a weak grid harmonization signal.

TDV, on the other hand, is good at protecting the envelope and grid harmonization, but it's not good at encouraging electrification. When you put them both together, you actually have the best of both worlds. You can't have your cake and eat it, too.

So the recommended approach is for 2022 this cycle -- and I think this is what Charles was talking about -- having separate gas and electric baseline for this cycle, one baseline for mixed-fuel homes; one based on all-electric homes. We did this in the 2019 standards because under the 2019 TDVs, gas appliances are performing better than electric. So by separating the baselines, we basically remove the disadvantage for all-electric buildings. So this was a step in the right direction where, you know, we basically allowed the builders to build an all-electric package without having to compete with gas.

Now, the good news is actually under the 2022, you know, the TDV for electricity is actually lower than gas. So now we have potentially both EDR1 and EDR2 aligning, pointing both towards the same outcome. But for this cycle, 2022, we're going to stay with the two-baseline approach.

And then, we have EDR2 which is -- I'm sorry -- the EDR -- we started with two baseline: EDR1, the carbon proxy; and EDR2, TDV. No trade-offs between EDR1 and 2. And again, EDR1 is designed to align with decarbonization goals when EDR2 maintains envelope resiliency and demand response. And what EDR2 is actually is a very similar to the existing, you know, 2019 standards.

EDR -- we have EDR for efficiency, an EDR for PV and flexibility, and then a total EDR. So EDR2 is all of those three parameters. And I'll show that in a later slide.

So beyond 2022 standards, we are going to move to a single baseline, as Charles was suggesting. And we're going to couple that again with a 2-EDR approach. And a single baseline, together with a EDR approach, establish a carbon budget by switching natural gas end uses to heat pump, and then developing a carbon budget based on that.

This could be a space heater. It could be a heat pump water heater. Or we could be thinking about a clothes dryer that's switching from, you know, gas to electricity or cooking appliances, you know, going to, for instance, induction cooking. The good thing about this approach is that it could be either gradual or it could be sudden.

You know, we could, you know, start flipping end uses one at a time, or we can do them all at the same time. You know, we can -- we can decide that at the time. But it does give us that flexibility to dial in how much decarbonization we want for each cycle. And EDR1 ensures that there's no backsliding on carbon limits.

So again, you know, that hard stop that there's no trade-off. Once you establish that carbon cycle, you cannot backslide by doing things under TDV. And so I'm going to show a few slides on software and how it will change in 2020 to accomplish this.

And the good news was that the -- we didn't have to change the software dramatically. There are some changes, but you know, the interface will look pretty familiar.

So what I have here, this is the 2-EDR approach for CBECC grid. It says under the EDR tab, there are several tabs up here. So this is the middle tab here. So it says energy design rating. What I've outlined in the blue here on the right, this is the existing structure of the software, the tab under 2019. That's the efficiency EDR, PV/flexibility, and total.

So that is the same as what it is today. What we've added is this EDR one for standard design and proposed approach here. And if you notice, there's a line here between EDR1 and EDR2. And that's supposed to mean that, no trade-offs between these two.

So again, under the standard design, we will establish a carbon budget for this building. Your proposed budget must be equal or less. In this case, you know, this is a -- slightly less than that.

So you know, as we flip end uses, the standard design will go down. So the proposed design must match that accordingly. And the rest of it actually works the same as the 2019. You've got to have an efficiency EDR that's equal or less than that and then a total EDR that's equal or less than that. So that -- this piece of it is the same. We're adding this carbon budget.

And down here, there's obviously changes.

You know, anything that says an EDR1 is a new addition. So we have an EDR budget for both -- this is the reference design and this the proposed design. Under the energy use detail tab, where you actually get the individual measures and their contributions, you know, the same thing. You know, we added columns for EDR1. And the EDR2 is as it is today.

Same thing under the compliance summary tab. Previously, only these two columns appeared, both on the left and the right side. Now there's a source energy EDR1 column. And again, for a building to comply, it must pass all three of these, not just the two that we previously had.

Stole a slide from Wilcox. And I think that he's going to talk about this but the intention here is to show how the two EDRs work together to avoid the adverse consequences.

The first column here, that's the baseline. It's a 2019 mixed-fuel package. And so these are the -- basically they are used for reference. So for a building to pass, it must have a source energy score that's less than fifty-one and a total EDR that's less than thirty-four.

So I'm going to look at -- not describe all of them, but this one measure here, just Scenario

3. This is a mixed-fuel home where we removed the high-performance attics, and we removed the high-performance walls, and we added a condensing furnace.

So high-performance attic gone, high-performance walls. We are back to, I think, a 2013 shell, basically. And we added a condensing furnace. What happens is this building still passes source energy EDR1. So that's why, you know, we say there's an adverse consequence here. But TDV will capture it. So the final outcome is a fail.

So the builder now must go in there and add other features to make sure that the -- the TDV also passes. And there's several other examples here and they're all kind of meant to show the same thing that had the two EDRs work together.

So that basically concludes my presentation. I'll be happy to take any questions.

MR. MCALLISTER: So how are we doing? What's the schedule say we're supposed to do for lunch? I imagine people --

MR. SHIRAKH: So --

MR. MCALLISTER: -- people's stomachs are rumbling here.

MR. SHIRAKH: -- we're supposed to break at 12:30. We've got about ten minutes.

MR. MCALLISTER: Okay. So --

MALE SPEAKER: I can't speak fast, but I'll speak short. Two questions. Why are you having the two baseline strategies only apply to low-rise buildings? Why not high-rise multi-family as well?

MR. SHIRAKH: So high-rise multi-family will have -- we can switch that. The two baselines, it's supposed to be they're only for low-rise. Well, high-rise, non-res, all have two baselines for this cycle.

MALE SPEAKER: Yeah, well, I mean, for this cycle, we have to have a conversation. I mean, for last cycle, we focused on single-family, low-rise multi-family. And so any modifications we made to that -- we make to that this cycle are going to be -- we're going to try to minimize those because we asked a lot of that sector last round. But the conversation around multi-family and commercial, we have to -- we still have to have that. The intent is to -- well, yeah, we -- I don't want to presume how it's going to end up. Yeah.

MR. SHIRAKH: Yeah, like I mean, again, the answer was, you know, we've been focusing on low-rise residential for the past several cycles. And so we're going to give it a break and start focusing on non-residential buildings. And that was the reason why.

MALE SPEAKER: Well, what you just presented actually seems the opposite. I mean, you're focusing this big change on low-rise.

MR. SHIRAKH: No, no.

MALE SPEAKER: Okay.

MR. SHIRAKH: I think I -- no, again, well, in 2019, we went to --

MALE SPEAKER: Well, I under -- I know the --

MR. SHIRAKH: And we're going to --

MALE SPEAKER: -- history of that.

MR. SHIRAKH: We're going to stay course on that.

MALE SPEAKER: I was just going off of your slide. It said that applies to low-rise buildings. So --

MR. SHIRAKH: So maybe I --

MALE SPEAKER: Maybe we need a clarification of the definition of low-rise and high-rise (indiscernible).

MALE SPEAKER: Okay.

FEMALE SPEAKER: (Indiscernible) we'll talk about it.

MR. SHIRAKH: Yeah, okay.

MALE SPEAKER: Yeah.

FEMALE SPEAKER: (Indiscernible) talk about it (indiscernible).

MALE SPEAKER: Yeah, at the moment, we have two baselines for both sectors, right?

MR. SHIRAKH: Yeah.

MALE SPEAKER: So --

MALE SPEAKER: No, (indiscernible).

MR. SHIRAKH: No, no --

FEMALE SPEAKER: Oh, okay. I'm --

MR. SHIRAKH: -- (indiscernible). We have two baselines for low-rise.

MALE SPEAKER: Oh, right. Okay, yeah.

MR. SHIRAKH: And so what we're saying is we're going to keep that for one more cycle.

MALE SPEAKER: Yeah.

MR. SHIRAKH: Now, what we do with high-rise multi-family and non-res for 2022, we can't decide.

MALE SPEAKER: Yeah, we've got to have that discussion.

MR. WILCOX: And the --

MR. SHIRAKH: Yeah.

MR. WILCOX: And to make it clear, the current 2022 research software does not have two baselines for high-rise res or comm, as far as I know. So in low-rise, it's all two baselines. And high rise, it's not there. So -- but that doesn't mean it won't change. This is all just --

FEMALE SPEAKER: Metric (indiscernible) --

MR. WILCOX: -- drafts.

UNIDENTIFIED SPEAKER: Hopefully, it will change because I'm --

MR. MCALLISTER: Yeah, right. We -- we've not had that -- okay. So let me just clarify. So my bad. We have not had that conversation for commercial, high-rise multi-family that we had in the last cycle for low-rise and single-family. We will have that conversation and see where we end up. I'm not going to presume, if it ends up in a single or multiple.

MALE SPEAKER: Well, hopefully, that will change because I'm looking forward to a standard for multi-family buildings that applies to all multi-family buildings, regardless of the number of stories. Second question, well, it's not a question, it's a -- well, maybe it is a question. It -- the -- (indiscernible) back, the two EDR -- the, you know, proposal is obviously more complex than what was -- what's in the 2019 standards which is more complex than what was in the previous standards.

We already have a problem with compliance. And a lot of that, from my interviews with building departments, a lot of that results from building inspectors, plan checkers, throwing their hands up when it comes to multi-family and saying, you know, I just don't get this because you got two different things it has to go with.

Now, when we look at this, the additional effort, obviously, that's going to affect compliance even more. So I'd like to know if you've thought about having a relatively simple model checking software for building departments to use so they don't have to feel like their brain's going to explode looking at each individual compliance output.

And a part of it could be like your slide 25. But then it would also have to list measures that get you there. But you know, a simple tool for them, so they don't have to try to understand the whole tool that the compliance experts do.

MR. SHIRAKH: Okay. We did think about that compliance issues. But you know, we are making a big change, so there is going to have to be some changes here. And I -- this actually was more modest than some of the other alternatives.

MALE SPEAKER: Yeah, I'm not against any of the changes. I'm just saying --

MR. SHIRAKH: Yeah.

MALE SPEAKER: -- the -- to try and get greater compliance, let's make it a little easier on the building officials.

MR. SHIRAKH: I understand. And we'll work with you. Thank you.

Charles?

MR. ELEY: Thank you. I'm Charles Eley. I had some questions. You keep talking about EDR. Does that mean you're not planning on having the two separate metrics for non-residential?

MR. SHIRAKH: It's open to discussion. But I think we are going to have some -- a carbon metric and a TDV-type metric. It may not --

MR. ELEY: Well, why not? Why wouldn't you --

MR. SHIRAKH: -- be EDR.

MR. ELEY: -- do it -- do the same thing for both residential --

MR. SHIRAKH: We could.

MR. ELEY: -- and non-residential? I

don't see any reason why you wouldn't do that.

MR. SHIRAKH: We could.

MR. ELEY: And that's what we're doing in the zero (indiscernible).

MR. PENNINGTON: So pardon me for taking your space --

MR. ELEY: Oh, you'll -- I'll be all right.

MR. PENNINGTON: -- Charles.

So -- Bill Pennington. So sorry for the little confusion here. We definitely believe strongly in having a source energy metric and a TDV metric going forward. And we would apply that to all building types.

And so Mazi's presentation is kind of focused on EDRs and you know, we're not -- the question of whether we change to an EDR for non-res is kind of -- is still under discussion here. But in terms of baseline, we think that the best strategy is to go to a single baseline. And we think we should be doing that in the future. We need to do some cost effectiveness analysis here to try to figure out what our standard design might look like and how that would compare between fuel types.

And so we're kind of not -- we haven't

finished all that work. But definitely, we would be moving to having a HSC metric and a TDV metric. And whether we have only one baseline or two is sort of -- we need more discussion about that.

MR. MCALLISTER: We ended up in the -- in the residential, we ended up with two because we wanted to create -- we couldn't check all those boxes that Bill just --

MR. SHIRAKH: Right.

MR. MCALLISTER: -- referred to. So we -- but we wanted to create a parallel path that if you want to build electric, you could. And that gave you a unique baseline.

MR. ELEY: Well, I --

MR. MCALLISTER: So maybe we end up the same where --

MR. ELEY: Yeah.

MR. MCALLISTER: -- the same way in the non-res. But I don't know. I'm not going to judge that right now.

MR. ELEY: Well, I strongly recommend that you use both metrics for all buildings --

MR. SHIRAKH: So again --

MR. MCALLISTER: So that is already happening.

MR. ELEY: -- in the next version --
MR. MCALLISTER: That will happen.
MR. ELEY: -- (indiscernible) standard and not just go with low-rise residential. (
MR. MCALLISTER: So there's a confusion here. One is between whether there's one or two baselines. And the other is --
MR. ELEY: Well, yeah.
MR. MCALLISTER: -- whether there's one or two EDRs. There will be two EDRs.
MR. ELEY: Well, let's talk about the metric first, yeah.
MR. MCALLISTER: Yeah.
MR. ELEY: In terms of the baseline, I think, you know, moving to these dual metrics, I think, helps a lot, but not if we have a neutral baseline. I mean, you're not achieving anything if the baseline is neutral. So it's -- I don't get the point there.
MR. SHIRAKH: Uh-huh.
MR. ELEY: And the final thing, then I'll sit down, in -- there's a precedent for the double metrics. And in Standard 189, we have three metrics, actually.
MR. MCALLISTER: Um-hum.
MR. ELEY: We have costs, source energy,

and carbon. And maybe we're violating some rules by having a carbon metric. But it's been there since 2009 and nobody's complained yet. So there you go.

MR. SHIRAKH: So let me explain this one more time. For 2019, we have two baselines for low-rise residential. We're proposing to continue that through 2022. In the future, we can switch to a single baseline, like in 2025. So that's for the baselines.

And then on the non-res side, we actually have a choice to go to a single baseline in this cycle or in the future. That's a discussion we need to have.

For the two metrics, I thought your question was, are you using EDR for low-rise; are you going to use EDR for high-rise or for non-res? You know, we are having some discussions with the castings and we haven't decided, you know, if it's going to be EDR or something similar to that. But we are going to have the two metrics. We're going to have the source energy metric --

MR. ELEY: Okay.

MR. SHIRAKH: -- and the TDV metric.

MR. ELEY: Okay.

MR. SHIRAKH: Roger?

MR. HEDRICK: Yeah, Roger Hedrick, NORESCO. I think a lot of the questions that are being asked here are going to get addressed in my presentation later. And so let's hold off until then.

MR. SHIRAKH: Okay. Thank you.

MR. HEDRICK: I mean, you don't have this conversation grumpy.

MR. NESBITT: George Nesbitt. A few years back, the standard design, or the baseline, was somewhat reactive to what you put in your building. And then that was, I think, tightened up a little bit. Then you went to two baselines, one for electric, one for gas, which actually parallels the old package -- packages we used to have, one for gas, one for electric. You had to do more insulation and stuff for electric.

But regardless of one or two baselines, we have the problem of pre-emption. So we could put in our billion -- you know, the best windows, the best insulation, the best distribution system, the best assumption about where the ducts are, you know, various things. But we still have the problem of eighty percent AFUE furnace or a minimum energy factor water heater or the minimum SEER air conditioner or HDSS heater. So there's still a lot of room there to trade off that good envelope.

So in passive house, there's basically

two requirements. You first have to meet your heating and cooling budget and site energy. So it's -- it makes no judgment whether you use electric or fuel. But then, you have at total budget that's source energy. So you have to meet that, too.

Now, of course, your fuel choice in heating and cooling affect your total. And so ideally, what we need to decide is, what is an energy-efficient building? How you get there, we care a little less about, although we do care, and let you get there because we -- and I think this proposal still allows plenty of trade-off on the enclosure.

MR. SHIRAKH: It does, but it doesn't allow -- again, the way this is going to work is we'll go to -- if we basically go to a single baseline, we'll start with a mixed-fuel home, then we'll start flipping end uses -- maybe just water heating, maybe all of it. And based on that, on the EDR1, we use the source energy to define the carbon limit for that building. And when we ran our simulations, was actually no way that you could go back and put in a gas appliance or a gas water heater by, you know, putting more efficient envelope.

You have to meet EDR1 and 2 at the same time. So that EDR1 does really guard the decarbonization very effectively. And then EDR2 allows you to get to those goals in the most cost-effective way.

Go ahead.

MR. DELFORGE: Pierre Delforge, NRDC. On the 2EDR approach it's very thorough research and smart. I generally, you know, strongly support the general approach. The concern I have is around the two separate baselines. It was implemented in 2019 as a workaround for the performance pass.

Going forward, we want to make sure that we use this, you know, smarter metrics, better metrics that are better aligned with our current goals to make sure that we stop building with gas as soon as possible. We know, you know, where the future of gas studies that your drafts going to come out soon, clearly shows that, you know, we're going to have to try to access every new building and goes -- that's built is going to get stranded before the end of its lifetime.

We can't afford another six years of new construction in California with buildings built with gas and all the societal costs that will come with that. And you know, if there's one sector where we need to, you know, to switch a hundred percent as soon as possible is new construction. And there's no doubt about this.

So I don't think we can, you know, wait for another code cycle to move to a single baseline with a GHG line metric in the performance past. And across all sectors -- and I realize this -- you know, this agreement with the builders on, you know, single-family low-rise residential, I think that can be upheld on the electric side. I don't see an issue with that.

But I think, you know, you have leadership locally by local government who are -- there's always eleven local governments who have adopted codes that strongly encourage or require all-electric. We've got another thirty or forty in the pipeline. You know, that's sufficient to, I think, for the state to pave the way for the state to adopt this type of policy as soon as 2022.

The last argument I wanted to make about this is that beyond California -- I mean, California is, you know, obviously, a key priority -- but California is also showing an example, setting an example for the west of the worlds in new construction in particular. We have, I think, as Mazi has remarked, as of 2030 has the statistics that there's a new New York City worth of buildings built every month between now and 2060, and many in countries where they don't have building codes, and they're looking at California to say, well, what is the building code that we need to adopt?

So I think we need to look bigger than California and look at where we need to go in terms of building codes. And that requires, you know, 2022 to be the code cycle where we decarbonize new construction in California.

And the last point to close on this is on the cost effectiveness. So far, I believe we have not included cost of the -- the cost of utility connections in cost effectiveness. And as we move to a single baseline, that's a real cost that, you know, developers pay, customers pay, and it needs to be included. It's -- you know, it's a significant cost. That -- it has significant impact in terms of cost effectiveness. So we strongly believe that needs to be included going forward as soon as 2022. Thank you.

MR. SHIRAKH: Thank you. We are beginning to look at the -- to the cost of electrification and you know, the natural gas -- the infrastructure savings and all that. So that -- we've been looking at that and we will continue to look at that. And again, we do agree that the most effective way to go to electrification is a single baseline with a tight carbon budget. And that will really drive buildings towards that. Thank you.

Any other questions online, Peter?

MR. STRAIT: There's one question online. This is from Elizabeth McCullum (phonetic). Were there any trade-offs -- that is, deviations from standard design -- identified in the CBECC runs that resulted in passing both EDR1 and EDR2? And I think the context here is the slide was just there to illustrate how some configurations would pass one and not pass the other. I'm sure there are ones that would pass both.

MR. SHIRAKH: Yeah.

MR. MCALLISTER: But --

MR. SHIRAKH: Good question. The -- what -- the slide that I showed was supposed to be all adverse consequences. So we're hoping that they all would fail. That's why I'm showing it. Yeah, I mean, you can pass by having high-performance attics and walls and a heat pump water heater; you'll pass -- or even a standard tankless water heater.

MR. STRAIT: That's all that we've got online.

UNIDENTIFIED SPEAKER: Okay. So we're at the -- about ten minutes behind time. So why don't we meet back here at 1:45. And we'll start with Wilcox's presentation. Thank you.

(Pause)

MR. STRAIT: Oh, presentations will start again shortly. We're just waiting for people to return from lunch. For those in the room, our scheduled return time was 1:45 so we will be getting started shortly.

(Pause)

MR. SHIRAKH: Okay. Good afternoon. I think we're going to get started, but before we go, just wanted to introduce Commissioner McAllister's new second advisor. Is he here?

Fritz?

MR. MCALLISTER: Yeah, I don't think he was here right now, but he'll -- Martha was going to flag him and send him down when she had a chance. But so yeah, well, I should've announced this at the beginning.

So Martha actually has -- you all know and love Martha Brook. And she's a fabulous resource and continues to be so. She's sort of easing toward retirement at the Commission. If you could all talk to her individually and take her aside and tell her not to retire, that would be great.

But anyway, she has moved out of my office back to -- well, actually, over to the Energy Assessments Division, working with CEVA on some stuff a little bit more behind the scenes. And my new advisor is Fritz Foo who was here earlier and will be here again. But you should all introduce yourself to him.

And then you probably know my other advisor who's been with me for a long time, Bryan Early. And so Fritz and Bryan are my new awesome team. And yeah, so yeah, please introduce yourselves at some point. Thanks.

MR. SHIRAKH: Okay. Thank you. So we're going to go to residential simulation results.

Bruce?

MR. WILCOX: Thank you, Mazi.

MR. MCALLISTER: Also, actually, let me say one more thing. Sorry, Bruce.

Just -- I wanted to just point out the public advisors representative, Dorothy, who's right in the back there. She has her hands up. And you know, this workshop is, like I said, the beginning, sort of insider baseball, so not a whole lot of public -- members of the true public in here.

But if any of you go out into the world and have -- you know, encounter in your clients, or you know, the communities you work in -- maybe you work in low-income, maybe you're working in, you know, English as a second language type communities, or with developers who have those sorts of constituents, local governments -- the -- please do turn them on to the public advisor. If there are any issues with access to the Energy Commission, and our processes, and you know, our kind of sometimes Byzantine process -- I think, you know, it's not -- it's actually not that bad, generally, but it's not intuitive to regular people. So Dorothy and other members of the team can help you access the Energy Commission, help those folks access the Energy Commission. Thanks.

MALE SPEAKER: Before I forget, I am (indiscernible).

MR. SHIRAKH: The comment period for this workshop is November 13th, so we appreciate your comments by then -- your written comments. Thank you.

MR. WILCOX: Okay. So I'm going to present an explanation of the impact of the new weather and TDV and all of the associated stuff that you've heard so far on the residential standards in the context of the CBECC-Res program which is what's used for residential compliance and for standards development and so forth. And the basic thing -- the point of this presentation is to help you understand what all those numbers that have been presented earlier actually mean.

So we're essentially using the CBECC-Res program as a viewer of the integrated effect of weather and TDV and all of that stuff. And in spite of the fact that Charles Eley just proposed that I win an award for the worst slide ever presented at the Energy Commission, this is exciting compared to these results which are just mostly a lot of -- they're mostly a lot of trends. But I think -- you know, I think really it's what -- it's the guts of understanding what has changed here because that's what I think is really important is how things changed. And we'll see.

So I'm going to spend a little bit of time talking about the history of compliance and EDRs and TDVs and so forth, just to put this in perspective. And then I'm going to give a bunch of comparison examples where we look at the 2019 TDV analysis and how measures are rated compared to the proposed 2022 ratings for the same measures, same buildings. Everything's the same. The only thing that's different is weather and TDV.

And so we're going to look at, you know, overall savings from the 2019 update, water heating, space heating, natural gas. We're going to look at the two different natural gas scenarios and see how much effect that makes on the results. And then, we're going to look, single measure at a time, at high-performance walls, attics, windows, and doors, quality insulation, PV, and batteries.

And then I've got that, you know, one slide on the hourly source energy impact that we're going to -- we can talk about at the end. And I'm perfectly happy to be interrupted with questions as we go along, unless it gets too slow. Okay.

So looking at the recent history of compliance in the res standards, this is the compliance summary screen from the 2016 software which is the stuff that's still in effect right now and is about to be superseded at the end of this year when the 2019 standards go into effect. And it was, you know, basically very simple. There was a standard design and a proposed design here in these two buildings.

And then you calculate the TDV total -- the TDV energy use -- for the standard design and the proposed design. And if the proposed TDV was less than the standard, then you passed. That's it.

There was a compliance margin and it's all in TDV units. So -- and that was the old simple world. Then, for 2019 compliance, which is -- now that's -- it's a software that's on the street and people are using it for doing compliance forms for buildings to be built starting in January.

So this is the approved stuff that's the current things the compliance calculation is complicated by being done in EDR terms, not in TDV terms anymore. EDR is the energy design rating. And it's a ratio of the proposed -- to -- there's actually a -- oh, the compliance is done by comparing the EDR of the proposed design to the EDR of the standard design. And TDV is never mentioned in the compliance world in 2019.

EDR is a metric that you -- is calculated by comparing the results for the building in question to the results for 2006 IECC version of that same building, which we call the reference design. And there's a lot of political connections behind this and so forth, but it's -- you know, it's basically defined terms that one of the things we have to do for this is we have to run another simulation for that reference house, for every time we do an analysis. And we then calculate this EDR.

And it's -- you know, I think Mazi mentioned earlier, for 2019, we now have dual compliance criteria. There's an efficiency EDR which includes envelope, HVAC, DHW, and unregulated loads, and self-utilization credit for batteries. There's some fiddling around in the background there. But this is the protected efficiency metric that we were talking about earlier.

And then there's a final EDR in which you add in the results for the PV, the battery, the demand response, and so forth. And you have to actually comply with each of these separately to -- in order to comply.

So now, we have two compliance metrics. So the calculations are twice as complicated. I don't know what we're going to do. Wait until the next one.

So this is what the compliance summary page looks like. You have the standard design EDRs for efficiency and total, and you have the proposed design EDRs for efficiency total, and then we calculate this compliance margin by subtracting the standard -- or the proposed from the standard. And if these numbers are positive, as it says down here, building complies when all efficiency and total margins are greater than or equal to zero. It's pretty simple, but you have to do them both.

So now we're going to go -- the proposed

2022 compliance that we've talked about today is we're adding one more EDR criteria. And that's the EDR1 which is calculated using hourly source energy. So we -- we're keeping the 2019 compliance criteria basically exactly the way it is in 2019. And we're adding on this new EDR1. We changed the name of the 2019 ones to EDR2.

So it's an EDR2 efficiency and an EDR2 total. And we're calculating all that stuff, as I said, the same way. And now, the rule is that all three of those criteria have to be complied with, and again, no trade-offs between any of them. And a similar, exciting design of the summary screen shows that we now have three -- our three different criteria and three different compliance margin. And it says building complies when all source efficiency and total margins are greater than or equal to zero.

So you know, from Nehemiah's point of view, this is really complicated now, right? But in fact, you know, it's the same building with exactly the same inputs that we had in 20 -- you know, essentially, in 2016. The building isn't any more complicated when the building official goes out and looks at it. And so I think, you know, we're handling this complication behind the scenes in a nice and slick way.

So now, I'm -- what I'm going to do is present these example cases for residential results. And as I said earlier, it's -- the intention here is to illustrate the combined impact of the changes in the weather and the changes in TDV.

All of my examples here are calculated using one prototype for simplicity. It's the 2700-square foot two-story, four-bedroom prototype that we've used a lot for things. And you know, the results would be a little different if you used different prototypes. But that's not going to upset the conclusions here at all, I don't think.

And then there are two cases that we are using here because we have essentially these two different standard designs. One's for mixed-fuel, which has been the traditional California way to beat the code which is gas space and water heat, and cooking, and clothes drying, and then electric cooling. And that's -- we -- they return that in mixed-fuel. And then, there's the second case which is all-electric.

And in 2019, we developed the standard design for all-electric, so we now have these two different paths that are independent. And that makes it easier in 2019 for the all-electric cases to comply.

It makes it harder for all of us going forward to make the carbon work. So -- all right.

So I'm going to show you a whole bunch of these really exciting, very colorful bar charts here. So the way this is organized is that we -- across the bottom we have climate zone. So there's sixteen sets of bars here, one for each of the sixteen climate zones. And then, we have a statewide number which is based on the sixteen results for the sixteen climate zones weighted by housing starts. And then, there's actually an average which is just a straight average of the sixteen.

So if you want to look at the overall, you can look at those two bars. The blue bars in all these cases are calculated using the 2019 compliance criteria and the 2019 software and rules. And then, on -- and the orange bars are doing -- using new, proposed 2022 rules. And the one we're using for all of our cases except one variant is the mid-IEPR case.

It turns out I'll throw it a little while that it actually doesn't matter very much. But okay, so this is, like, one of the fundamental things here. How much energy was saved by the -- all the travail in the 2019 standards update. And you know, the -- this is judging that in terms of EDR with a compliance variable. And you know, there's a little bit of difference. It's not very much.

And you know, mostly, the new calculation is giving a smaller EDR credit to all that -- all those measures and all that stuff that was done. And I think this is generally what's going on here that -- and I think -- I don't know -- maybe Snuller mentioned this this morning, but we think some -- I think that this is mostly driven by the fact that we're not giving as much credit for solar because we now have more solar than we used to have. It's worth less. And so all this big solar credit that we got is now worth slightly less.

There's a whole bunch of other things going on here, too -- the weather changes, the -- you know, all of that. Anyway, so who knows? Anybody going to be freaked out by this change? I wouldn't think so.

So here's the other side of the same picture. This is -- if you look at the 2019 standards update, all the measures from 2016 to 2019, and we do this in TDV terms because you'd never do this for compliance. This isn't compliance. But if you're doing standards development where you want to do life-cycle costing, this is the life-cycle costing number.

And again, the -- they're different;

they're not radically different. And again, the 2022 numbers are slightly lower for this stuff and it's again driven, I think, by the PV. And the -- it's not as uniform as those EDRs. The EDRs put everything -- because it's a ratio, everything gets kind of put into the same absolute magnitudes.

So climate zone 15, which is the highest climate zone in the state, Palm Springs, you know, stands out here as having bigger TDV savings from the 2019 update than all the other zones. And so -- and -- well, we'll look at the individual cases here.

But again, I don't think this is very scary from anybody's point of view. So if you try and look at this without the PV -- just for Martha's sake -- if we look at the mixed-fuel house and the savings from the 2019 update, all the measures without PV, and look at it from EDR terms, then, you know, the picture's quite different because that PV credit is, you know -- it -- the -- it levels everything out real nicely.

And there is some significant differences now between the 2022 and 2019, particularly in cold climates. With 1 and 16, the 2022 numbers are significantly better, so same measures are worth more. And I think this is because there's more heating in the weather files now, and also because heating is -- gas is now valued at a higher number.

So that makes all the heating stuff more cost effective. So this is one of the changes that you're going to -- you can expect to see here, I think, and going forward, if we keep going on the path that we talked about this morning, that the heating gets amplified.

All right, so now we're going to start talking about single measures and looking at single measures. So this is if you start with a mixed-fuel house and you replace your instantaneous water heating with a high-efficiency, instantaneous, condensing, instantaneous water heater, going from a .82 to .92 EF -- UEF. This is the -- how much energy it would save in EDR terms.

And this is kind of an interesting pattern we get here. All these low number climate zones are getting bigger credits in 2022 than -- quite a bit bigger than they did in 2019. And then, when you get up here to the -- to, you know, the -- well, it's still true in a lot of them. 2022 is giving us more credit.

Again, I think this is because of the higher value of gas. There's some, maybe, temperature things going on or something, too. But it's -- the gas stuff goes all the way across there. And you know, this is a significant difference.

Go ahead, Martha.

MS. BROOK: This is Martha. So the title shows savings, but then the Y-axis says EDR2.

MR. WILCOX: Yeah, it's the -- well, it's -- the savings is in EDR2 total. That's the name of the metric in the new world.

MS. BROOK: But the -- so it's not the total amount for the building. It's the difference between two code vintages?

MR. WILCOX: Yeah.

MS. BROOK: Okay, thanks.

MR. WILCOX: So this is the difference between the standard design building which has a -- yeah, a .82, I believe, UEF heat pump -- I'm sorry, not heat pump -- instantaneous gas water heater. And we've replaced that with a .92 which is fifteen percent more efficient.

MR. NESBITT: George Nesbitt. The 2022 bars are taller than the 2019 bars.

MR. WILCOX: That's right.

MR. NESBITT: So is this total TDV or is this the margin of savings?

MR. WILCOX: This is the marginal EDR.

MR. NESBITT: Okay.

MR. WILCOX: So it's related to total TDV.

MR. NESBITT: It's the reduction of the EDR and that's --

MR. WILCOX: Yeah, right.

MR. NESBITT: Okay.

MR. WILCOX: So what you can think about is if you're looking for something to get you, you know, one point, one EDR point, you know, and you're in climate zone 7, you can do that trade-off and get it.

MR. NESBITT: Okay. So are both colors of bars the same .92 water heater?

MR. WILCOX: Yes.

MR. NESBITT: Okay. So --

MR. WILCOX: Same water heater. Same --

MR. NESBITT: So you wouldn't -- so you would need more credit. So this is a little counterintuitive, but -- so you're getting more credit for the same measure under the new metric.

MR. WILCOX: That's right.

MR. NESBITT: Okay.

MR. WILCOX: In some case --

MR. SHIRAKH: Okay. And the reason for that is if -- this is a natural gas saving measure. And because the appliance is more efficient in the 2022 TDVs have a higher natural gas cost in it. So anything that saves natural gas will get a point, like a bumped in.

MR. NESBITT: Yeah, I know. Okay, I got that. Thanks.

MR. WILCOX: So this is -- you know, part of the reason for poking down here into the weeds is because there's some stuff that, you know, you don't actually realize until you start looking at it. I -- you know, I'm thinking, I didn't -- wasn't thinking when I first saw this that this was right. So anyway.

Any other questions on that, John?

MR. MCCUE: John McCue. I'd understand this is if this was in TDV units, but given that it's an EDR which is divided by the TDV units for the 2006 IECC, why -- when you take something, you know, I'd expect that, oh, yeah, okay, so the IECC 2006 is a higher value, too. And also, the savings is a higher value. Why doesn't it sort of cancel out? Thank you.

MR. SHIRAKH: The 2006 IECC's using, you know, the inefficient appliances, right? That doesn't change.

MR. WILCOX: So now -- okay. So one way to look at --

MR. SHIRAKH: But the -- but this goes up because, you know, you're using a much more efficient, so the relative difference becomes bigger.

MR. WILCOX: Well, the other way to look at it is that, if you looked at this in terms of therms, they would be identical, right? They -- the two bars would be absolutely identical. It's the same physical device doing the simulation, the calculations the same. Everything would be the same. And -- but the -- in 2019, you know, whatever it is, three therms of gas is worth .6 in climate zone 1. And in 2022, three therms of gas is worth 1.1. And that's the function of the TDV calculation.

MR. SHIRAKH: The good news here is that the 2022 TDV actually lines nicely -- aligns nicely with the EDR1, the source energy. They're both pointing same direction toward decarbonization.

MR. WILCOX: I want to show you the electric version of this next. Maybe that would be helpful. I don't know. I think I'm going to. Hmm. Okay.

So if you take the all-electric house and we replace the heat pump water heater, the minimum efficiency EF2 heat pump water heater with a Sanden high-efficiency water heater, this is what that same plot looks like. And you know, depending on the climate zone, they're either about the same or quite different.

And I think this is -- there's some differences in TDV values in climate zones 1 and 3. And I think that's what's going on here. But the climate's also different. And so this high-efficiency water heater works differently in different climates.

And the best example of that is climate zone 15, where here it says -- everyone looks at this and says, that can't be true -- but the fact is that Sanden water heater, with its CO2 refrigerant -- this is the carbon dioxide refrigerant machine, so this is very clean -- apparently, it doesn't work very well when it's hot. So the performance drops off radically in the summertime in climate zone 15.

And we've known this for the last year or so when we've been working on these things. So this is nothing new in that regard.

MR. MCALLISTER: Bruce, are the vertical axes comparable? Because these are bigger numbers, right, than we saw for the condensing? So like, where we were trying to get one point here from a .82 to .92, where if we go to the heat pump, we're up at, like, a credit of, like, two or three in --

MR. WILCOX: Yeah.

MR. MCALLISTER: -- some cases, right?

MR. WILCOX: Well, so -- okay. There's the -- and that has to do with climate, I think. So the -- you know, in the mild climates here, climate zone 12 and --

MR. MCALLISTER: Um-hum.

MR. WILCOX: -- so forth, we're in that same range of one, right, for that. It's about the same kind of savings that we got for the high-efficiency gas machine.

MR. MCALLISTER: So Bruce, wouldn't that also have to do with the fact that the COP difference is a lot larger than the energy factor difference was --

MR. WILCOX: Yes.

MR. MCALLISTER: -- for the --

MR. WILCOX: Yeah, there's also -- it --

MR. MCALLISTER: Yeah.

MR. WILCOX: -- so it also has to do with that. But it also -- the minimum efficiency heat pump water heaters don't work very well when it's cold. The Sanden doesn't work very well in Palm Springs, but the other machines don't work very well when it's cold. So the machine that we're -- that's our standard design heat pump water heater is one of these things that if it gets to be below forty, it turns off and goes to electric resistance which is the standard, bottom-of-the-line model.

And so that happens a significant amount of time in the garage in climate zone 16 and climate zone 1. You run your heat pump water heater out there and you cool the garage down and then you're straight resistance.

But that Sanden, there's no back up. It runs all the way down to minus twenty or something. And so it works really well in cold climates.

MR. MCALLISTER: So I want to just make sure I'm understanding this. So we have -- in both cases, we have identical technology. All we're doing is looking at it through the two different -- through the -- to the old EDR -- the old TDV and the new EDR2.

MR. WILCOX: Yes.

MR. MCALLISTER: And we're getting different credits, basically.

MR. WILCOX: Yeah.

MR. MCALLISTER: And so for the electric technology, we're giving in the -- and going forward for 2022, we're giving the same electric technology less credit. And for the gas technology, we're giving the same gas technology more credit. Like, i.e., the same technology gets a lower relative EDR for gas and a --

MR. WILCOX: Okay. So --

MR. MCALLISTER: Yeah.

MR. WILCOX: -- let's pick one climate here. Let's pick climate zone 12 right here, 12. So --

MR. MCALLISTER: I'm trying to look at it through the eyes of somebody who wants to promote electrification, for example.

MR. WILCOX: Okay. So look at climate zone -- yeah, see that --

MR. MCALLISTER: And I'm not saying who that is or I'm not assigning --

MR. WILCOX: Yeah, I'm -- and also, Commissioner, I have to apologize. One of the problems of where we are and what I was able to present today is that this is using the 2022 research program which actually has a separate baseline for electric and gas.

MR. MCALLISTER: Um-hum.

MR. WILCOX: So I can't actually do -- there's no -- you know, I'm not saying I can do it all by hand. I can't actually compare a gas water heater

EDR with an electric water heater EDR.

MR. MCALLISTER: Well, then I'm just saying, like, look, if we -- like, for example, this -- we're getting more EDR credit with the 2022 metric than we were with the 2019 metric --

MR. WILCOX: Right. And so it --

MR. MCALLISTER: -- for the same gas technology.

MR. WILCOX: Yeah. At climate zone 12, we're going from a .4 -- am I looking at this right -- yeah, .4 in 2019 to --

MR. MCALLISTER: To a .7.

MR. WILCOX: -- a .7 in 2022 --

MR. MCALLISTER: Okay, conversely --

MR. WILCOX: -- EDR points. And --

MR. MCALLISTER: What --

MR. WILCOX: -- climate zone 12, it's going another --

MR. MCALLISTER: For the same --

MR. WILCOX: -- direction.

MR. MCALLISTER: For the same electric technology, we're getting less credit than we got in 2019 --

MR. WILCOX: So --

MR. TAM: Hi.

MR. MCALLISTER: -- in general.

MR. TAM: Danny. Some part of it might have to do with weather as well. Gas technology is not affected by the warmer weather as much --

MR. WILCOX: Yeah.

MR. TAM: -- versus the Sanden, in a warmer weather's going to perform a little bit worse.

MR. MCALLISTER: Well, yeah, but presumably, the twenty -- let's go back to the gas one. I mean, I understand it's probably because gas in the TDV world got more expensive between 2019 and 2022, so they avoided -- the cost was greater or something. But it seems counterintuitive that we're taking this same technology that's been around and we're giving it more credit in a later code cycle.

MR. SHIRAKH: But it's not --

MR. WILCOX: Well --

MR. SHIRAKH: Can you go to the -- I think it actually makes sense because the 2022 TDV has less value than 2019, you know.

You know, what -- Snu, what do you think?

MR. PRICE: So what I was going to say is what we're doing is we're basically putting -- if you go to the gas version, there's basically more reason to do more gas efficiency now in the 2022 code. You're getting more -- basically, we're valuing reducing the natural gas more --

MR. MCALLISTER: Right. Okay.

MR. PRICE: -- now. So there's --

MR. MCALLISTER: Okay.

MR. PRICE: So if you weren't going -- you're kind of on the fence about doing the condensing before, now it's like --

MR. MCALLISTER: Now (indiscernible).

MR. PRICE: -- oh, man, I really want to do it.

MR. WILCOX: I want that extra half point.

MR. MCALLISTER: Right.

MR. PRICE: I want that extra half point. So we're putting -- basically, putting more pressure on gas and -- than less.

MR. MCALLISTER: Okay. Yeah.

MR. WILCOX: Right, conversely --

MR. PRICE: I'll put another way. It's like you're increasing the cost of gas from three dollars to five. That means if you save a certain amount of gas you get more savings.

MR. WILCOX: Yeah.

MR. PRICE: And you're decreasing the value on the electric. So if you save electricity, you get less.

MR. MCALLISTER: You get less.

MR. PRICE: But the comparison between the two, gas is more expensive and therefore you're encouraging electrification. So these kind of graphs are not good at comparing electric to gas.

MR. WILCOX: Right, yeah.

MR. PRICE: You have to --

MR. MCALLISTER: Yeah, but that --

MR. PRICE: -- compare electric to gas.

MR. MCALLISTER: Yeah, and that wasn't my question.

MR. PRICE: That's how it should do it.

MR. MCALLISTER: I wasn't --

MR. PRICE: Yeah.

MR. MCALLISTER: I wasn't -- I was actually asking the fuel-specific questions, not the --

MR. PRICE: Yeah.

MR. MCALLISTER: -- comparison question, but you -- I think Snu answered my question.

MR. PRICE: Yeah, so --

UNIDENTIFIED SPEAKER: (Indiscernible).

MR. DELFORGE: As one of the people that have an interest in promoting electrification, I would also think that with revised retail adjustment, which wouldn't be -- which would go low in the middle of the day when you tend to have more heat pump operation, the penalty on heat pump would be lower.

MR. MCALLISTER: Yeah.

MR. WILCOX: Maybe, probably. I don't know. One of the things that -- one of the things that happen with the heat pump water heaters is they tend to run during the middle of the day quite a bit because of the big peak water use in the morning --

MR. MCALLISTER: Yeah.

MR. WILCOX: -- in the typical family. And then it spends all, you know, most of the day reheating that water. So there's a lot of use on peak in those.

MR. MCALLISTER: On solar peak, yeah. So but this is a -- so this same -- that same conversation, Pierre, that you bring up is our homework after today, is to get a handle on that retail adder option.

MR. WILCOX: Yeah. And we could, you know, Commissioner, if you really wanted to get into it, I could print hourly values of all this stuff and you could see what the patterns look like.

MR. MCALLISTER: I'm sure.

MALE SPEAKER: (Indiscernible) quite able (indiscernible).

MR. WILCOX: You know, I don't have to, but my schedule gets pretty full. So I certainly can understand that. Okay. So there's the two heat pump cases -- heat pump water heating cases. Okay.

Now, let's talk about heating. So this is a high-efficiency -- well, I should say high-efficiency heating and cooling. So this is in a mixed-fuel house and we're take -- leaving it mixed-fuel and we're changing to a condensing furnace, AFUE of 9 -- .96, and a high-efficiency air conditioner, SEER 18, EER 13. And the -- this is the -- again, that same comparison.

So for this comparison, in almost all -- let's see. Maybe in all the climate zones, except maybe 5. No, we're better -- you get a better bang out of the -- this efficiency upgrade in 2019 than in 2016.

It's also the case in climate zone 15 where there's no heating. The -- we don't get big bang. But so you know, modest change here.

Again, the -- in the cold climate zones, it's bigger because of the heating load, I think. So this focuses more on heating because of that change in the gas price. So this is the -- did I -- oh, okay.

So here's the other way of looking at that same -- this is just to throw a loop in your thinking here. Okay, this is EDR. And this is all done as ratios, right? So these are all on a scale of zero to one hundred. But if we're life-cycle costing, as I said earlier, which that's based on TDV, the TDV is the cost metric.

So this is the savings in TDV terms for these things. And it's quite different than the one for EDR. So that's why I wanted to present it, just to make sure, you know, that people can see that, even though the -- in EDR terms, you know, in climate zone 15, there was a toss-up.

And it wasn't the biggest one. And if you go to TDV terms, it's the biggest saver because that's where the biggest heating and cooling loads -- primarily cooling. And with our lower value of electricity, it's less than it was for 2019.

Just -- Mazi wanted me to present, you know, all of these for every case. And that's -- I'm joking. I think there's so many bars here you're never going to be able to remember this, but maybe we'll -- maybe you can download this and stare at it. Okay. So that's -- okay.

And then, one other thing to look at

here, so we have these two scenarios they -- for gas, the mid-IEPR level of gas value and the policy-IEPR level for gas value. And so this is the results that I just showed you for the TDV savings from the high-efficiency heating and cooling.

This is comparing those two different versions of the gas valuation. And there's a little difference. The policy one gives you slightly bigger credits in the -- especially in the cold climates where there's a lot of heating use. But you know, the pattern is basically identical and the differences are not -- on average are, you know, two or three percent.

So it's not a big deal, I think. And does that make any sense or not? Okay. All right.

So now we go to the all-electric house. And we go to high-efficiency heat pump instead of the standard line baseline heat pump. And you know, here we're -- you know, it's not very different between 2019 and 2022. In the cold -- two cold climates, they're basically flip-flopping on which is more.

So we don't have that in one of the big pattern that's driven by the gas price. This is all-electric and climate, I think. And the differences aren't so big.

If you go back up to -- this is the EDR.

This is the version for -- you know, it's quite similar to this chart, except we don't have those big outliers for the -- that high gas in the cold climates. Okay.

So it would, of course, be possible for us to say, suppose you had a -- suppose you had an electric standard design for that gas mixed-fuel house; what would that look like? And we could construct such a thing, but I don't have one at -- in the current software unfortunately. Okay. So moving on.

So I'm going to look at the envelope measures for the 2019 update. And this -- what we're doing here is we're taking the 2016 standard design house and we're adding these measures that were introduced in 2019.

So this one's adding the high-performance wall. It's a single change to 2016 package. And then we're analyzing that using the 2019 TDV -- or 2019 EDR and the 2022 EDR and comparing them. And so high-performance walls are not required in climate zone 6 and 7, so we don't have the results for that. And there -- you know, there are some differences, generally. And it's very mixed, on average. They're not very different, but again, we see the --

MR. SHIRAKH: What's up with climate zone 12?

MR. WILCOX: Well, this is all climate zones. What -- what's wrong with climate zone 12? I don't know, Mazi, maybe there's something wrong in the data. But I don't think so. But we can check that to see. I don't know.

MR. MCALLISTER: It's worth noting that the values on the axis are so small that it might look larger than it really is.

MR. WILCOX: Yeah, these are actually -- all my data has got -- it's to a tenth of an EDR. So that's why they're all lining up like that. So that's probably -- could be done better. Okay.

So that -- here's the second single measure one which is the high-performance attic. And again, there's some small changes. There's a whole bunch of climate zones where it's not required. And then -- you know, but on average, the results are pretty close to the same on average to -- from 2019 to 2022. And it varies a little in climate zones, depending on weather and so forth.

Windows and doors -- significant savings for windows and doors in that update. On average, the values are about the same. Again, we're getting the big benefit on the -- in the really cold climates from the high price of gas, and other than that, pretty much simple.

And here's QII which was the quality insulation installation, same basic pattern. So I mean, one way to look at this is that, you know, people are always think -- you know, worried that we're going to make these changes in TDV and do things for compliance, and everything will fall apart, and it won't work the way it did before, and you won't be able to -- you know, you won't be able to get the same kind of compliance package to work.

And I think this is maybe somewhat comforting here that it shouldn't be a new -- completely new world. And especially, as long as we keep the two separate baselines, all the buildings that comply, you know, right on the baseline before will still comply right on the baseline, and -- so things are not going crazy. All right, so here's the value of PV.

Nehemiah?

MR. STONE: Can you go back one slide? I want to ask you a question on that. So on this slide, 1 and 16 kind of stand out. And I'm wondering if that's just a matter of the weather or if it's because in those two climate zones a lot of the gas is propane and -- which is a higher cost. I mean, is that factored in?

MR. WILCOX: No.

MR. STONE: No? Okay.

MR. WILCOX: No, this is strictly gas analysis. I mean, you're -- if we were to do a weighted, you know, sample or something, yeah, that could be the case, for sure. But this is just --

MR. STONE: Natural gas.

MR. WILCOX: -- using the mixed-fuel.

MR. STONE: Okay. Thanks.

MR. WILCOX: Good idea, though. And here's PV. So you know, this is -- we've been looking at numbers one and stuff. This -- so these are -- this is numbers like twenty. So the -- you know, the PV, we give that a lot of credit in the final EDR in the 2019 standards.

And you know, it's slightly lower now, because I think the -- primarily, again, the value of electricity is a little lower and this is all electricity generated on-peak during the daytime, right? And so it's -- you know, there might be some differences in the weather files, but that's pretty minor. It's down in the one or two, three percent range.

And then here's the battery. And one

thing -- this is not the super aggressive battery. This is what we call the basic battery. And it doesn't have any smarts. It doesn't know when peak TDV is. And it doesn't save up and dump electricity onto the grid during the peak or anything like that. It doesn't even know from time of day.

And the reason we had to run this is because we just got this latest set of numbers recently. And the fancy control system for the advanced battery requires that it know about what the -- have certain levels and so forth. And that stuff didn't get done in time to run those cases.

So this is the battery that just runs out of the box the way you get it from Tesla where -- whenever it -- whenever there's a load, it discharges. And whenever there's PV it charges. So -- but it's -- you know, it's basically doing some of the same stuff. And we get a lot more credit in these -- the low number climate zones there. And I think that has to do with changes in TDV in those climate zones which my impression of looking -- just looking at TDV is it went up quite a bit in the mild Northern California climate zones compared to the others.

MR. PRICE: Bruce, remind us, the low numbers are just down the coast, right?

MR. WILCOX: Yeah.

MR. PRICE: So it's like all the mild climates all the way down through Santa Rosa?

MR. WILCOX: Yeah, well, so -- you know, to Santa Rosa, it's -- you know, it's Sonoma County, and then Oakland, and then, you know, right down the coast. And when you get to 7, it's San Diego. Okay.

So here's the -- that's all the measures that I'm going to present. I mean, I think, you know, we've looked at heating. We've looked at cooling. We looked at water heating. We looked at electric, and gas, and I think you got a reasonable picture here of the changes that are in the impact of the TDV and weather changes on the compliance process, and on -- to some extent on the standards development process. And so that's what the -- my intention was.

And then here's the same table that Mazi showed a few minutes ago, and this starts to try and talk about what happens with the hourly source energy criteria and what impact does that have. And then to be perfectly frank, it's hard to find an impact using the approach that we're doing here.

If you've got standard -- separate standard design for gas and electric, then that largely wipes out the impact of the source energy criteria because your standard design is using the, you know, basically in the same ballpark as much source energy as your proposed design does.

I see this as kind of a view into the future. I think Mazi said that, too, that once you get this and you decide you're going to do a single baseline, a single standard design in the future, then you can -- then this can actually significantly matter, but I think it's not going to matter very much at the moment.

MR. SHIRAKH: Even for based on the standards, this would prevent installation of a standard storage water heater. So it does have that impact. It makes it very difficult to slide back.

MR. WILCOX: Yeah. Well, that's what we did on the bottom line here, the bottom row. See it, okay. Suppose somebody wanted to maybe build a Passive House and put in a lower efficiency tank-type water heater, you know, the economics of that are kind of funny, but I mean, suppose you wanted to do that, and you would -- you could pass that under TDV, and you know, it's efficiency and EDR total could both pass.

What doesn't pass is the source because you're upping your natural gas consumption, and you aren't turning that off with sufficient natural gas savings to do it. And so, you know, this would keep that from happening, but you know, we had to stretch pretty hard to find this one, and I'm not sure how many there's real practical cases there's going to be. So until we get to the point of having a single standard design or single baseline, I think that's when that's going to kick in and we make a big difference.

Okay. That's my presentation. Questions? Nehemiah?

MR. STONE: Yeah. Nehemiah Stone, Stone Energy. So did you do all these same comparisons with an all-electric home, and if so, did you -- what did you see as kind of the comparison between 2019 and 2022.

MR. WILCOX: Well, I gave you a bunch of all-electric results here.

MR. STONE: I saw a couple. But I mean almost everything you showed was from mixed fuel.

MR. WILCOX: Oh, okay. Well, so one of the -- one of the reasons for that is that all these 2019 additions to the package, right, that's because in the 2016 standards there wasn't an all-electric standard design. So we didn't have any way to compare it. So I mean, this is just --

MR. STONE: Okay.

MR. WILCOX: I mean, we tried -- I tried to balance the cases out, but --

MR. STONE: Okay.

MR. WILCOX: You know, there's a -- we could have done the 2019 standards and taken out the high performance wallets, everything would have looked negative. I didn't want to, you know, be --

George?

MR. NESBITT: George Nesbitt. It might have been interesting to see you run the individual measures for the mixed fuel house but going for individual measures switching -- field switching. So going from a gas furnace to a heat pump and then just going from a gas water heater to a heat pump water heater.

The other thing, the numbers are so small, what's the magnitude of difference in energy in TDV between mixed fuel baseline, and an electric baseline, and not -- and I think partly why the -- well, some of the differences between the mixed fuel and the electric have to deal with the magnitude of total energy and then being, you know, converted into an EDR, and so that looks different, but --

MR. WILCOX: Yep. Well, I don't have

that number, George. I could figure it out, but this is the same thing that Snuller asked for, too, which was yesterday was -- he said, tell me what just putting a heat pump in will do, and I think you're right, that's an interesting thing to do, but the problem with the current CBECC software is -- and people who are going to work in this should know that this is the way it works right now is that the baseline is actually on an appliance-by-appliance basis. So if you put in a heat pump water heater, you get a heat pump heater in your standard design.

So you know, we can make a version where that doesn't happened --

MR. NESBITT: I know who you can talk to.

MR. WILCOX: He's not available to talk to.

MR. NESBITT: So the value of gas savings were higher in 2022 because the TDV values of gas are higher. So -- well that almost, I think maybe makes it easier to trade-off and then the question is if electrification and decarbonization -- if decarbonization is the goal, how does it really support that, and if electrification is a better way to get there, does it actually support that?

MR. WILCOX: As I said, George, I haven't tried to analyze this. We talked about what we should present here, and that's what we did. The current proposal is that there isn't such a trade-off, but you know, it could be looked at for sure and figured out. My sense is that although it's probably closer, I bet you still don't make it by putting in a heat pump water heater in a heat pump space heat condition. I think that still -- you're still left higher than the standard design gas, but I'm not sure if that's true in all climate zones.

MR. NESBITT: And the last -- so like the last chart on the new source energy --

MR. WILCOX: Yes.

MR. NESBITT: -- where you did the various measures, and so like the first three got you better on source energy, but they didn't help you on TDV, whereas the last one was the reverse. The complexity maybe is the people running numbers is if you haven't complied with both the source and the TDV, the thing is the impact of any given measure may help you one and hurt you in the other, and so the complexity of now -- of understanding -- and let me -- I think a lot of consultants don't fully understand the impacts that they put in at times.

MR. WILCOX: Yeah.

MR. NESBITT: That it may be harder to figure out to serve both of those masters.

MR. SHIRAKH: It's actually, the way this is shaking out, most measures that say TDV, they're also going to reduce GHG and vice versa. So I haven't been able to identify a measure that -- maybe there's some DR, but most traditional energy saving measures, it helps work with the TDV and GHG reductions. So you know, the packages that consults have developed, for instance, they're going to comply here, and there are not going to be big surprises.

MR. NESBITT: It may be that the magnitude of impact in the two is different, and it can be much harder to figure out how to do it and trying to balance cost. Okay. Well, what do I do that gets me where I need to be cost-reasonable? Although, you know --

MR. SHIRAKH: The EDR2 is just like it's always been. You have an EDR1, and it all depends on where we set the EDR1 threshold. Now, if in the future we go to like a single baseline and then we flip water heater from gas to heat pump water heater, then that would be the signal. I mean, you can put the same -- extension packages, but you have to switch your water heater, and it's not that complicated. Once you start working with it, it's not that much different than what's going on now.

MR. TIFFANY: Tedd Tiffany, Guttmann & Blaevoet. I want to encourage you guys to look at the single-fuel, high-performance heat pump baseline now for 2022 code cycle and not wait. Because this baseline issue and the change of the metrics needs to be done together. And I'm having this conversation on the Lead Technical Advisory Committee for National Standards. And I'm really looking forward to Roger explaining how we're doing this on nonresidential. So hopefully, we can transition into that.

MR. SHIRAKH: Any other questions in the room or --

MR. NESBITT: George Nesbitt, one last quick one. It would have been interesting to see some of this done with only the weather file changes, and only with the TDV changes. Then you can actually say, oh, this result changed because of the weather factor, or you know, the magnitude of them. As opposed to doing both at the same time, you see a change in -- you know.

MR. WILCOX: It would -- in fact, it was interesting, and we did look at that awhile back, but I think that doing boring down into the weeds mostly gets people confused because what counts is the overall impact in my opinion. So --

MR. ELEY: So Bruce, controlled EDR1 or EDR2 --

MR. WILCOX: In --

MR. ELEY: Which one?

MR. WILCOX: In which case?

MR. ELEY: More efficiency, which one resulted in a better building, EDR1 or EDR2?

MR. SHIRAKH: Traditionally, it's EDR2 that drives the efficiency. So EDR1 is a carbon budget. They established the budge --

MR. ELEY: If you're modeling a building and you've got two thresholds, one of them is going to be more stringent than the other. So my question is which one was more stringent; EDR1 or 2?

MS. BROOK: I think it just depends the measure --

MR. WILCOX: Yeah. And Martha said it depends, and I think that's right. But it also depends on, you know, which climate and which, you know, thing you're talking about in terms of are you talking about water heating, or are you talking about whatever?

And so what I'm -- we didn't even try to look at that, Charles. We didn't -- you know, what the most sufficient building would have been or whatever you're implying here because all we're doing is trying to figure out how much difference it makes in the answer when we change to the new metrics. And so I didn't ever compare measures on the basis of that. I told you it was going to be boring.

Okay. Thank you, guys.

MR. MCALLLISTER: Oh, we do have two questions online. I think they're from Dan Johnson. First, Dan asks can you show on slide 12 of your presentation, are you able to show a change to energy factor 3.5 heat pump water heater alongside this. And I think the answer there is no, is that we're not looking at what happens when you install electrical equipment into a mixed-use building on these slides, in particular, in part because when you go electric, you're using electric baseline at that point rather than the gas space line.

MR. WILCOX: That's correct, yeah. Thank you.

MR. MCALLLISTER: Okay. Second question from Dan was for fuel-switching cases going from legacy homes to new heat pumps what are the EDR and TDV differences, 2016, 2019, and 2019 to 2022. I think this is all relative to newly constructed buildings rather than looking at retrofits?

MR. WILCOX: That's correct.

MR. MCALLLISTER: Okay.

MR. SHIRAKH: Any other questions on --

MR. MCALLLISTER: I do not see any other questions at the moment.

MR. SHIRAKH: Okay. We're going to switch to NORESCO. But Fritz (phonetic) is actually here, the new advisor for Commissioner McAllister.

We introduced you while you were not here.

MR. MCALLLISTER: Yeah. I introduced you in abstention, but now everybody knows what you look like. So watch out.

MR. FOO: Thank you.

MR. SHIRAKH: Roger?

MR. HEDRICK: Okay. Thanks everyone.

I'm_Roger Hedrick from NORESCO. We provide the CBECC software, and so I've done some analysis with that looking at specifically focusing on the impact of adding this new source energy metric to compliance. And so I did that by running eight different buildings, three variations of the office, two different retail, a school, a warehouse, and a high-rise residential model. All sixteen climate zones using the new 2022 weather files.

The things I was asked to look at are the effects of using an all-electric building versus a gas building. What happens with certain efficiency measures. What happens when you want to trade-off envelope capability, envelope efficiency against something else, and then what can I say about grid harmonization.

So one of the things that I looked, and you'll recognize this graph from what Snu showed, I took the climate zone 12 and averaged the electric TDV and source energy metrics for each hour of the day for over the year. Top yellow line is the TDV, and the green line is the source energy, and as we've been talking about, they go low during most of the day, and I've superimposed there a little box that shows the primary level of activity for most nonres buildings, and it fits into that low value period pretty darn wall.

Now, this is a typical office kind of building, which is a lot of them, but if you look at retail or the hi-rise res, of course, doesn't fit that at all. But looking at this graph is really important when you then look at some of the results we're going to see later on, why are you seeing the kind of results you're seeing? So this is a good thing to keep in mind.

So one of the things I did so I took each of those models, and I identified some alternative HVAC systems that someone might use, some of which are mixed fuel and some of which are all electric. And so I'm going to show three graphs like this from different buildings, but the right-hand side is the all-electric buildings, on the left is the gas heat buildings options, and one of them is intended to replicate the baseline.

So in this case the large office, the baseline system is a gas variable air volume built-up system with chilled water and a gas boiler hot water reheat. And so then I put in these other systems. I've got the water source heat pump on the gas part of it, but really, the gas is the gas boiler that's adding heat to the condenser water loop when it's really cold out. Most of the heating is actually being done by the heat pump. So it's really mostly a heat pump heated building.

So if you look at the two, the water source heat pump and the water source heat pump with electric boiler, they're practically identical. That means the heating is being done by the heat pump.

There's very little energy going into the -- being provided by the boiler. But you look at the four-pipe fan-coil, which is a gas boiler hot water heat system, and you see that by adding the source energy metric, which is the green bars, you're penalizing that system more than you did under TDV.

The electric systems, on the other hand, you see that the source energy is positive for all those systems and the limiting criteria in here is the TDV for those electrics. So what's happening is we're adding an additional limiting criterion to the gas heat system, which is source energy, but the electric systems continue to use the same TDV criteria in that they used before.

Then we look at the small office building and you see the same pattern. In these, the gas heated systems, which are the four on the left. In this case -- so except for the large source heat pump, which we have the same issue that we talked about before, but the single zone VAV air-conditioner, the gas package VAV, and the four-pipe fan-coil, again, source energy is lower than TDV in all these, which means that source energy becomes the limiting criterion.

You go to the right-hand side starting with the single zone heat pump, and all those electric options, TDV, remains limiting, controlling criterion.

Now, you notice that on the last slide, we had some go up, some go down, and that's just an issue of the fact that the single zone air-conditioner that's used as the baseline system for this small office building is the worst performing system there is, and so everything else is better. That's not the case in the large office where the built-up VAV is a halfway -- is a decent system.

And then I looked at one addition here, the medium retail. So all the other buildings, nonresidential buildings, have the same kind of pattern, electric heat, TDV controls, gas heat, source energy controls, except for here in the medium retail where the single zone air-conditioner TDV controls. And so there's two things going on here, one is that that single zone air-conditioner, the reason that it's so bad is that you've got this large constant (indiscernible) fan that operates continuously. And then this one being retail, it starts to push into that evening peak, and so now, all of the sudden, you've got more energy being consumed in that high TDV range that you didn't have in the office buildings.

And so, in this case we're penalizing that high electricity consumption by the fans, and so you're seeing that penalty there. And so basically the heating benefit of the source energy -- or the heating effect is small enough that it doesn't get -- it's being overwhelmed by the electric impact.

And then finally, the high-rise residential building is distinctly different in characteristic from the nonres buildings, of course, it operates, you know, there's consumption late into the evening, and water heating is much more significant here. So before where we saw the water source heat pump system, whether it had gas boiler or electric boiler behaving virtually the same, here they show very differently, and the reason for that is that along with this change in gas heat, electric heat, you're also seeing gas water heating versus electric water heating.

And so -- and but it's difficult to compare this because for water heating, alone, we have a change baseline with that change. And so, you know, if I wanted to actually look at the total therms or TDV, I have no idea which one of these is higher or lower. It's just that in terms of compliance margin, the baseline is changing and we're seeing a penalty for that gas water heating and you get a benefit for when you do electric water heating.

But again, with our gas heated systems,

source energy is the limiting criterion, and with our electric heating ones, TDV is still our controlling criterion. And so that's the story here is that gas heat source energy, electric heat TDV is the limiting issue.

The other thing I want to point out very quickly is that the compliance margin changes on all of these are quite large in terms of percentage, right? My scale here is going up to fifty percent, twenty-five percent, forty percent, fifteen here on for the high-rise res, minus twenty, but now, the next thing I'm going to look at is what is the impact of certain efficiency measures.

And so I've only got this one side because the same slide for all the other buildings look very similar, but notice that the deltas here are quite a bit smaller. So my scale is only going from six to minus ten is the largest negative number I have here.

And so the first three on the left are a reduction in lighting power density. The next one is an increase in heating efficiency, and that was a fifteen percent increase, and then a fifteen increase in cooling efficiency. And you can see that all of those increased, both metrics, but the electric change gives you a larger TDV benefit, whereas the heating efficiency change in the gas heat case gives you a larger source energy benefit, pretty much as you would expect.

The other four on the right, those are all envelope, you know, reductions in performance. So I reduce the insulation. I increase the solar heat coefficient on my glazing. I increase the U-value of my glass, and then I increase the window-to-wall ratio to forty percent from I believe my original case was twenty percent.

And so again, you see -- as you would expect, you see reductions in performance with -- in all three of the -- so I'm going to leave out the solar heat coefficient. All three of the other ones, the insulation ones, you get a larger source energy penalty. So by adding source energy, we're making it more -- you know, we're give you a larger penalty for making your envelope worse.

The solar heat gain coefficient, what happens there is you by doing that, you're increasing the heat gain from solar, reducing your heating, but you're increasing your cooling, and so you see source energy go up and TDV go down because you're increasing electricity and reducing gas.

The right-hand side is the same cases

except for my electric heat baseline. Heating efficiency, you see no change because this is electric resistance reheat, and so it's already a hundred percent. So there's no change to be made. But other than that, they all pretty much track what we saw on the other case except that for my efficiency metrics, the difference between TDV and source is much smaller because it's all electricity.

Okay. Questions? Thoughts?

MS. BROOK: Martha Brook. I missed the part about why the envelope efficiency is not a good thing in either of the metrics.

MR. HEDRICK: Well, all I'm saying is that by adding source energy as an additional metric --

MS. BROOK: Yeah.

MR. HEDRICK: -- you are -- now, that becomes the limiting factor on these -- you know, you're getting a larger penalty for decreasing your envelope performance.

MS. BROOK: Oh, decreasing. Okay. Thank you.

MR. HEDRICK: Right. These are decreases.

Yeah. And so, you know, one of the things I thought of earlier and then of course I forgot about completely as I got up here is that I realize that I had an underlying assumption behind all this, and that is how does compliance work? And I realized I hadn't talked about that at all.

So my working assumption on all of these is that the basic process is the same now. We have a baseline design, single baseline that has a fixed, you know, for a given building type, number of stories of floor area, you get this kind of HVAC system. You have this much insulation, all that stuff, and you compare your proposed design to that. You get a TDV, and you get a source energy consumption for the baseline, TDV and source energy for the proposed. If the proposed -- if both of those two values are less than the corresponding baseline values, you comply. If one is higher, you don't comply. Both is higher, you still don't comply.

So that's my working assumption. And it's basically a single baseline that is not -- we -- on commercial, we try to make the baseline as independent of the proposed as we can.

And so that leads into one thing I want to point out on this is that window-to-wall ratio even though I'm showing a decrease here, that's because I didn't change the baseline.

In reality, the window-to-wall ratio in the proposed will carry through to the baseline, and so you won't actually see this change in compliance because the baseline would have gotten larger as well.

MALE SPEAKER: It goes to above forty.

MR. HEDRICK: Unless you go above forty, yeah. If I had taken this to eighty, then that wouldn't have been true, but so the window-to-wall ratio is one case here where the baseline does track.

And then I just have a couple more. I wanted to look at grid integration, PV, battery things. And so one of the problems with doing this is that it's hard to -- how do you establish equivalency between PV and something else? And so what I did here for was I took a cooling efficiency measure that save X amount of kWh and then I took a PV system which generated that identical number of kWh, and what would the impact be in terms of TDV and source energy?

And so cooling efficiency are the blue bars here, and PV are the brown bars, and you can see that for both metrics, you get a much larger benefit from that cooling efficiency increase than you do from PV that generate the same amount of kWh, and it's more than twice for the source energy.

However, this ignores the course of

generating those two things. So really the comparison we would want to make is as a design team or as an owner, okay, you can put in a chiller that has a higher efficiency and it will give you this much savings, or you can take that amount of money and buy PV with it.

I don't know how much that gets you in terms of kWh savings relative to cooling efficiency savings. And that would be the comparison I would like to have, but I don't have the data to do that.

MR. STONE: Nehemiah Stone. This doesn't -- this particular one doesn't make sense to me, and maybe you can explain something. So if assuming the PV is on the building and you're not looking for PV that is utility scaled PV --

MR. HEDRICK: Right.

MR. STONE: -- it seems to me like the source energy multiplier ought to be one. And so the energy that you use in the heat pump or, you know, whatever you're using for chilling --

MR. HEDRICK: It's the chiller.

MR. STONE: Chiller, okay, would if you have to buy it -- in other words if your chiller is not as efficient, that would cost you more in terms of source of energy and the PV. So what am I missing there?

MR. MCALLISTER: Do you want me to take a shot at that, Roger?

MR. HEDRICK: Sure. But it's right here.

MR. MCALLISTER: Oh, okay.

MR. HEDRICK: So that PV is generating right around a low point in this TDV line, whereas the chiller efficiency is going to extend into that peak period in the evening. And so the value of those savings, of those kWh -- right. So the value of the kWh produced at 6 p.m. is, what; twice as high --

MR. STONE: So you're basically saying that E3 had made a mistake.

MR. HEDRICK: No, no, not at all.

That's an intended result. I mean, we want things to save energy in that high speak period and cooling efficiency does that and PV doesn't.

MR. STONE : It depends which mistake you're talking about, right? So yeah. I mean, the source energy factors for electricity are hourly reflecting the generation mix that's on the margin. So it's just the solar PV at the building is saving less source energy than the air-conditioning because air-conditioning goes into the evening, and we have a thermal generation generating electricity for that.

MR. HEDRICK: Yeah. I mean, I was

pointing at the TDV line, but if you look at the source energy line, even though the absolute difference is small that -- during the day there, it's almost indistinguishable from zero, right? So the change at 6 p.m. is -- orders the magnitude multiplied. You know, it's -- you know, it's not even double. It's ten times higher so.

MR. STONE: But that's a good value. I mean, at the building -- if you're using the energy at the building, then it shouldn't be the good value. It should be the --

MR. HEDRICK: Well, I'm avoiding using energy from the grid.

MR. SHIRAKH: That's what TDV is; am I right?

MR. HEDRICK: Yeah.

MR. SHIRAKH: (Indiscernible).

MR. TIFFANY: Tedd Tiffany. Roger, thank you very much for this. I'm wondering if this is going to inform new baselines for us? Is that the intent of this trying to find a new electric baseline that is kind of metric-neutral, I guess, is my first question?

MR. HEDRICK: You know, I'm not convinced that the baseline is -- you know, the baseline sets how stringent the overall code is, right, and by adding source energy, we're adding a new criterion for gas heat systems and therefore making those systems more -- we're adding stringency for those by adding the new metric, right? And then the baseline, you know, is -- you know, so that's going to drive your system selection that make it more beneficial to use an electric heat system, or if you want to use an electric heat system, you're not going to be penalized relative to gas as much as you were in the past.

But then the other things that you have to do in terms of getting efficiency, you know, if we go -- you now, so -- let's see. Let me find a case. So here I've got single zone A/C on the medium retail, and I've got single zone A/C in the small office. And so really if I put that zero line on the small office graph, at the bottom of my single zone A/C columns, right? Now, all these other columns would be positive.

MR. TIFFANY: Um-hum.

MR. HEDRICK: You're not really changing the relative value of any of these systems, right? You're only changing what else do I have to do to comply, right? By -- oops. By going here where all these systems give me big credit, that means I don't have to do a bunch of other stuff to show compliance, right? If I put in a water source heat pump, boom, I comply. I'm done, right? And in fact, I've got a bunch of compliance margin to play with, and I can do -- I can put in cheaper glass. I can do a bunch of stuff that maybe we don't want people to do.

And so you know, there clearly is a discussion to be had about what's an appropriate baseline. Is it appropriate that our baseline for this office building is this bad? That's a discussion to be had, but it's really outside the scope of what I'm talking about here.

MR. TIFFANY: Yeah. It's fair. It's informative.

MR. HEDRICK: Yeah.

MR. TIFFANY: I'm sorry it's (Indiscernible).

MR. TAM: I'm just going to chime in because, you know, obviously what we're doing is we're setting up to do case studies --

MR. HEDRICK: Yeah.

MR. TAM: -- to codes and standards and enhancement studies with these factors. So it seems like what one could do is go through all of the different building type baselines and figure out what cost-effective electrification or what cost-effective measures there are and ratchet up the baseline, and then you would be -- you know, I think that's where you're going.

MR. HEDRICK: Yeah, yeah.

MR. TAM: And then that answers his question.

MR. HEDRICK: Yeah. I mean this really comes along the lines of aligning with ASHRAE 90.1 baseline systems and that really caused a problem and it's causing a problem at the national scale and we're looking at it. The Lead Technical Advisory Committee is as well. And it really comes down to that question of metric or measuring buildings and then the baseline which we are comparing to.

I've done a lot of analysis with the TDS data from (indiscernible), and you know, marginal emission rates and the TDV values, and I've taken a building with this natural gas baseline where it's forty percent out of compliance on TDV and then it's thirty percent better on emissions and thirty percent better on TDS. And it's really informative that that prevents compliance with that baseline for the gas system, and that's where NRDC and I, we're working on some of those baseline issues and whether or not that is a four-pipe fan-coil, you know, in high-rise residential buildings is a realistic baseline.

So the second element there is what I wanted to point out is almost every one of these comparisons is to electric resistance. And you know, heat pump, boiler, heat pump reheat loop --

MR. TIFFANY: So my VAV systems, I'm using electric resistance reheat, but for example, this retail building, this is a heat pump?

MR. HEDRICK: Yeah.

MR. TIFFANY: And the small office, that was a heat pump?

MR. HEDRICK: Yeah.

MR. TIFFANY: And when I did res, that's a heat pump as well?

MR. HEDRICK: Yeah. I just think it's going to be really informative when we have that capability to model heat pump and CVAC and, you know, a heat pump plus hot water storage applications as well is a very efficient and great responsive approach to that. So I think we need to consider that going forward.

But thank you for all your hard work on this. I really appreciate.

MR. SHIRAKH: Thank you. Any questions online?

MR. MCALLISTER: Yes. We've got --okay.

Are there more questions in the room?

MR. HEDRICK: I have one more slide, a couple more slides.

So I also tried to look at battery storage. This is even harder for me to come up with an equivalent. And so what I did is I took a battery system that gave me the same TDV savings as PV, right? Because it doesn't really save energy. It actually increases your energy consumption. And you know, so ideally, again, I would like to do my first cost comparison, right? If I put on a 1,000 dollars' worth of PV versus a 1,000 dollars' worth of battery, what do I get, but I don't have that.

And so this is for different -- this is a sixteen clime zones and this is a battery system that gives me the same PV savings as a PV system. This shows how much the ratio of source energies savings that I got for that comparison. And so basically, I'm getting much larger source energy savings because again, we're shifting into that evening period when the source energy is much more valuable than it is during the middle of the day.

And then -- so conclusion, TDV remains the limiting criterion for all electric designs, but adding source energy becomes the new limiting criterion for gas heating designs. Trading off envelope efficiency appears to give you a larger source energy penalty than it did TDV penalty, and both metrics give a similar signal when comparing PV to other efficiency measures, and source energy obviously greatly favors batteries.

Okay. That's all I have.

MR. MCALLISTER: Okay. Any other comments in the room before I go to the online comments.

MALE SPEAKER: Overall comments or this session.

MR. STRAIT: On this particular slide, and then we can -- I also have to open up the phone lines to the phones that dialers that don't have a login in case they have a desire to speak.

MR. TIFFANY: Sorry. Just one more, if we're not going to not allow trade-offs between the TV and TDS, that becomes an entirely limiting factor because if you can't comply with one, which you said in every case, that you can't comply with TDV for an all-electric building. That really prevents compliance at all the new metric with TDS. So --

MR. HEDRICK: Well, no. I'm not saying you can't comply with TDV. I'm just saying TDV is the metric that is going to limit that is the one you need to worry about complying with.

MR. TIFFANY: Right. But if that becomes a compliant factor for TDF and a noncompliant factor for electric buildings under TDV and we're not allowing trade-offs between that, that becomes an entirely limiting factor with having to comply with both of --

MR. SHIRAKH: So what he's saying is you can comply with TDV and that's an area of that building, which we've always been doing, it automatically pass the EDR1, the source energy.

MR. HEDRICK: Yeah. That's -- oddly, it's the --(indiscernible).

MR. SHIRAKH: (indiscernible).

MR. HEDRICK: -- gas space line, Mazi.

MR. SHIRAKH: Yeah. Being all electric, you need to worry about TDV, not source energy. In mixed, you need to worry about source energy more than TDV.

MR. HEDRICK: So if you look at this graph, if you just pretended those green bars weren't there, right? They are all negative in terms of TDV, right? And so with gasVAV being zero because that's the baseline, and so that would favor you using a gasVAV system. That gives you your best benefit, right?

But now, when we add source, that four-pipe fan-coil, which would have been reasonable before, now that becomes much more difficult to comply. The electric systems is the same as before, right? You had to do extra stuff to make them comply, but now they're easier relative to that gas alternative than they were before because we made the gas more difficult to comply.

MR. TIFFANY: Relative to gas --

MR. HEDRICK: Right.

MR. TIFFANY: -- if we're not going -- if we have to comply on TDV and TDS, none of those scenarios are going to show compliance for an electrified approach.

MR. HEDRICK: That's correct. With that system change alone, that's right. You'd have to do something else for all of these to get them to comply. Just like you did --you'd have to do now, today.

MR. TIFFANY: So that starts the argument of the fuel-neutral baseline for a nonres or --

MR. HEDRICK: Separate baseline.

MR. TIFFANY: -- a thoughtful approach to changing the baseline for these occupancies where it's a challenge. So that's where we need to go for the next set of standards.

MALE SPEAKER: I don't think we're looking for a fuel-neutral baseline. I think we're trying to meet both of these objectives with the best building, but a single baseline may be preferable in the future. It's, you know, not so differentiated by equipment type. I'll probably stop there because I don't know much about these buildings.

MR. HEDRICK: No. I'm having the same challenge with the ASHRAE baselines with the technical committees for ASHRAE, and it comes down to the metric or the baseline and we've had this discussion in residential and we've come up with a fuel-neutral baseline.

So ASHRAE had for the longest time a fuel-neutral baseline up until the 2013 90.1 standards. And so we need to go back to that or allow an average of these metrics to show compliance because you're not going to show compliance for an electrified, even an efficient-electrified building under TDV. And if that's going to be a limiting compliance factor -- and the EDR for residential says you have to comply with each EDR, right, for TDV and the source to show compliance with that building.

What you're showing here is that if

you're not meeting the TDV value and you just showed that you cannot show compliance for any of those electrified approaches under TDV, you have a noncompliant building.

MS. BROOK: I think this great comment. This is Martha.

MR. HEDRICK: I know we're running out of time.

MS. BROOK: I think that I'd like to talk more about it, because in my opinion, the main reason you do EDR2 with TDV is for electricity demand flexibility and storage. It's not for gas. Gas gets treated in EDR1.

MR. HEDRICK: Right.

MS. BROOK: And so if we're -- by mistake, throwing gas back into the picture in EDR2, that's what we need to talk about.

MR. HEDRICK: Yeah. I'd be happy to have that conversation with you.

MS. BROOK: Yeah.

MR. HEDRICK: I've had it for the last three years with the ASHRAE Technical Committee.

MS. BROOK: Yeah.

MR. HEDRICK: So I'll fill you in on the history.

MS. BROOK: To be continued.

MR. SHIRAKH: Any other comments in the room or online?

MR. STRAIT: There are some online. Let me start with the earliest. What was the last one? There it is.

Dan Johnson had a question. It's on slide 7. "It seems justified by cost-effectiveness to change the baseline for small office to one of the heat pump systems, that is VRF rather than gas fire single zoning C. Is there any baseline that should remain gas based on our 2022 metrics?"

MR. HEDRICK: That's a discussion to be had.

MR. MCALLISTER: Right.

MR. HEDRICK: I will say I don't think we would go for building-specific baselines, like split it for small office, not split it for others, have some be gas, or some be electric. Playing hopscotch building different building types would be drastically more complicated. So if that's where the question was going, I'm not sure we would do that even if we had separate independent two baselines or one fuel-neutral baseline.

Then follow-up slide 10, also from Dan

Johnson --

MR. STONE: Before you go on, can I comment on that?

MR. HEDRICK: Sure.

MS. STONE: Nehemiah Stone, Stone Energy. That is on high-rise residential, and I --

MR. HEDRICK: Yeah.

MR. STONE: -- thought the discussion that we've been having all along is that we will unify all multifamily low-rise through high-rise, in which case the baseline for this building will be different than for other high-rise buildings. So it will be similar -- more similar per square foot than to the low-rise multifamily.

MR. HEDRICK: Sorry. I mean specifically, the nonres building types. We've got sixteen, I think, different prototypes for those.

MR. STONE: The question is on this slide which is high-slide residential.

MR. HEDRICK: I forgot to mention that also this slide uses the old baseline. We've already made a change to the baseline for the high-rise res models. And so that change in baseline was not incorporated in this analysis. This still uses the old baseline. So all these will move up under the new --

using the new baseline, the new software, so.

MR. STRAIT: And I apologize. Because Dan had mentioned small office, I thought Dan's comment was relative to small office, even though slide 7 which he named, was about res rather than small office. So that's my fault.

Dan Johnson then had a follow-up, slide 10, "Source impact of battery manufacturing needs to be considered just like gas leakage and refrigerant global warming potential and the entry delivery stream" -- oh, and then follow up later, Dan Johnson didn't mean slide 6 rather than 7 with his earlier comment on small office which he just told us.

Thank you, Dan.

Other comments from Enna Doletseva (phonetic). "Have you tried to look at office with window-to-wall ration sixty or higher? This is most common office design, not window-wall ratio of twenty." Thank you.

MR. HEDRICK: We have looked at that. I can easily generate a model like that. I don't have any of those results here.

MR. STRAIT: Okay. Bill Dakin. On slide 7 -- and literally slide 7 this time. "What was assumed for water heating in the model high-rise residential on the electric building runs?"

MR. HEDRICK: Those are induvial unit heat pump water heaters.

MR. STRAIT: Okay. Neil Bulger, (phonetic) on slide 8, "wouldn't all of the large office electric heat buildings in the chart on the right be compared with a large office with gas?"

MR. HEDRICK: That's -- well, so what I'm showing here is if you start with an electric heat system and then you make these other changes, what's the impact? And so I'm comparing -- these are changes compared to the PTHP proposed design, not to the baseline. And so -- sorry, not to PTHP. GasVAV with electric resistance reheat. So I'm showing the change, you know -- I've already decided on my proposed on my proposed HVAC system, and now I want to get some extra compliance margin or I've got compliance margin to burn, what can I -- what do I get by making these other changes?

MR. STRAIT: And then a follow up from Neil Bulger. "Is the four-pipe fan-coil based on variable volume fan-coils or constant-volume-fan-coil?"

MR. HEDRICK: Constant volume.

MR. STRAIT: I believe that is all from the online comments.

MR. HEDRICK: Okay.

MR. STRAIT: Before we move on there were a number of participants that were only on their phones. They didn't have an ability to raise their hand or type into chat box. I'm going to unmute those lines. Only five of them.

Are there only call-in-only users that would like to make a comment at this time?

(No audible response)

MR. STRAIT: Hearing none, I'm going to remute those lines.

MR. SHIRAKH: Okay. Any general comments about the workshop?

MR. STONE: Yeah. I have three. One is that the -- let me get my glasses so I don't make a mistake here. I want to reemphasize what Peter said and what I said in the last two iterations of the standards that we -- we ought to be including the cost of gas infrastructure when we're doing the cost-effective analysis because electric infrastructure is a sunk cost. You're not going to run your lights and your washing machine on gas. So you have to have the electric infrastructure there. Gas is not required, and according to the utilities that we've looked at, the cost for multifamily is somewhere between 300 and

1,000 dollars per dwelling unit, and for single family, it's somewhere between 9 and 16,000 dollars per home. That's a major cost for having gas in your buildings, and that ought to be included in the cost-effective analysis.

Second is a new concept that I think we ought to be considering and that is the buildings with a carbon sink. We've talked about embodied carbon before in terms of what goes into materials to build buildings, primarily wood buildings and other organic materials like that can act as a carbon sink, and as we get closer and closer to a low operational carbon footprint, we need the -- it takes more and more years to make up for the carbon that was used in making the building, and if we look at the buildings differently as a place where we can sink that carbon, that will lead us to the right direction in the global -- in our global warming goals.

And on that, I'd like to recommend a book by Bruce King, an engineer, called The New Carbon Architecture where he goes into this in detail and shows the different materials you can use that -- and different buildings where it's already being done, where they're not only carbon-neutral in construction, they're actually carbon-positive rather than carbon-negative.

And lastly, it doesn't exactly pertain to what this is about, but I want to reiterate it, and every chance I get to the microphone, I will do so. Multifamily buildings are not single-family buildings, and a lot of the metrics we use in the analyses are based on research in single-family buildings. Lighting in single-family buildings, we don't know that it's the same schedule or the same power density as multifamily because that hasn't been researched.

HVAC schedules, DHW, the study that Jim Lutz (phonetic) did and Bruce Wilcox did on DHW schedules was all based on single family, and they admit that it probably does not represent the hot water use schedules for multifamilies. So I'd like to encourage some of the investment in research in those areas so that we can get multifamily building analysis done correctly. Thank you.

MR. SHIRAKH: Thank you, Nehemiah. Any other general comments?

MR. NESBITT: George Nesbitt. So you can currently by hundred percent renewable electricity or a hundred percent carbon-free. So I can convert my house. Just need equipment. The heck with the enclosure, and I'm done, right? I think not. I think it's important that we don't use energy we don't need. So as we've -- many have said, and we often said, trading off the efficiency of the enclosure is a bad idea because they last longer, they're harder, and they're more expensive to fix.

So our code should really reflect that, and that's where I think Passive House approach of setting the budget for heating and cooling meet that budget as well as meeting a source energy budget achieves both goals well because there is no trading off the efficiency of your equipment. Although, I suppose that's actually a part of meeting that budget, but that budget is small.

And so how we set budgets for buildings, we're setting budgets way too high. We're building buildings that are using way more energy than they need. So the other thing we have to think about, we have these long-term goals. We kind of know where we need to be. How does our code today reflect that? We need to think if we're going to have a separate budget for a gas building and an electric building, does that actually encourage anyone to electrify? Probably not.

So if -- how do we in the short term get people to install the highest efficient gas equipment if that's what they do, but we also need to plan for the future conversion. So just as you cycled back with water heaters, we decided, well, you need to have an electrical outlet so you can get a heat pump. Or you need to have a flue event for a high efficiency piece of equipment.

So if you're installing gas maybe, you're installing a gas dryer. Maybe you need to also wire it for electric dryer. Same with gas stove, you need to wire it also for a gas stove. You need to think about if you install the gas furnace how can it be converted to electric down the road. Because I mean, the life of equipment varies. Typically, it is shorter than the building, itself.

MR. TIFFANY: Tedd Tiffany, Guttmann & Blaevoet. Just wanted to thank you all for your very hard work and have been struggling with these issues with ASHRAE for a long time on the baseline issues and the metrics. The Technical Advisory Committee for Leads has been struggling with the metric change for quite a bit, and your job is not easy, nor is my job trying to figure out what that metric should be the best metric. And I just want to encourage you guys, that you guys have done some really hard analysis and not yet to the conclusions, and I'm here to help you guys have that conversation and set good metrics. And

I want you to be open to challenging both your metrics and your baselines as you go through this, and not allow ASHRAE and the alignment with ASHRAE to be your driving force, but to be a driving force in that decision-making process and help them evolve faster with what we're doing in California.

So challenge yourselves. I know you guys are really challenged as you are right now, and you're doing some fantastic work. So thank you, and keep challenging yourselves.

MR. SHIRAKH: Thank you. Any other comments in the room or online?

(No audible response)

MR. SHIRAKH: With that, we'll close the first workshop of the '22 standards, and please submit your comments on November 30th, if you have written comments.

MR. MCALLISTER: November 13th is the what Mazi meant, and also we will post documents on the web tomorrow.

(End of Recording)

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