DOCKETED	
Docket Number:	23-IEPR-06
Project Title:	Hydrogen
TN #:	252566
Document Title:	Transcript to 9-8-23 for IEPR Commissioner Workshop on the Potential Growth of Hydrogen
Description:	N/A
Filer:	Raquel Kravitz
Organization:	California Energy Commission
Submitter Role:	Commission Staff
Submission Date:	10/10/2023 4:13:28 PM
Docketed Date:	10/10/2023

STATE OF CALIFORNIA

CALIFORNIA ENERGY COMMISSION

In the matter of:

2023 Integrated Energy Policy Report (2023 IEPR)) Docket No. 23-IEPR-06
_____) re: Hydrogen

COMMISSIONER WORSHOP ON THE

POTENTIAL GROWTH OF HYDROGEN

REMOTE ACCESS VIA ZOOM

FRIDAY, SEPTEMBER 8, 2023

10:00 A.M.

Reported by:

Martha Nelson

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P R O C E E D I N G S

10:06 a.m.

FRIDAY, SEPTEMBER 8, 2023

MS. RAITT: Well, good morning. Welcome to today's Commissioner Workshop on the Potential Growth of Hydrogen. I'm Heather Raitt, the Director of the Integrated Energy Policy Report, or IEPR for short, here at the CEC. This workshop is being held as part of the Energy Commission's proceeding on the 2023 IEPR.

Today we're doing a hybrid meeting, so we're using Zoom while also meeting in person. So for those in the room, the videos of the presenters and Commissioners on the dais are being broadcast over Zoom. So everything displayed on Zoom is also shown on the screen in the room. And then we'll be using the microphones on the tables for the sound system.

This workshop is being recorded, and a recording will be linked to the Energy Commission's website shortly after the workshop, and then a written transcript will follow in about a month or so.

The schedule and slide decks have all been docketed and posted, and so they're available on the Energy Commission's IEPR webpage. And we also have hard copies available in the meeting room, if anybody would like to look at those, or at the front entrance. And then there's

also some signs with QR codes posted that have a link to the materials for the meeting today.

So at the end of the day, we invite the public to provide comments. So we'll be doing that at the end of the day, as I mentioned, and we look forward to hearing those. We can take comments from those in the room and also from those who are participating remotely, and we will limit those comments to one person per organization and three minutes per person. And while we look forward to hearing your comments, we will not be responding to any questions at that time.

And then, also, there's opportunity to provide written comments, which we also welcome, and those are due on September 22nd.

So with that, I will turn it over to Commissioner Patty Monahan for opening remarks. Thank you.

COMMISSIONER MONAHAN: Thanks, Heather.

I want to first just acknowledge the amazing work of our IEPR team. This is one of many IEPR meetings, and they've done an amazing job. This is, I think, probably the last one of substance for the drafting of the report that will be coming out in the next couple of months. And this builds on the work actually two years, no, last year from the IEPR that Vice Chair Gunda led, where we were exploring the role of hydrogen. And in this year's IEPR,

we are required, of course, by legislation to look at it more deeply.

And this is, you know, in the context of a lot of work that the Air Resources Board has done on the Scoping Plan in terms of evaluating how do we get to a clean energy economy that's affordable, safe, reliable, all these issues that we at the Energy Commission wrestle with on a daily basis.

And we are also -- this is also in the context of the state making a strong play to get a hydrogen hub and the importance of making sure that we get a hub here in California. I think it's clear that we are the leaders in the country in terms of supporting hydrogen, building out hydrogen stations, learning as we go about how do we make sure that we can make stations that work for consumers and that help us reach our goals when it comes to clean transportation and clean energy writ large.

So with that context, I think, you know, we are learning what it will take to make hydrogen clean, to make it affordable. And the possibility of the federal government providing, you know, for the first time we have a partner in the federal government writ large on clean energy, and this is the moment for hydrogen, honestly. We've never gotten such good policies to help hydrogen move from infancy into prime time. And I think that's the

opportunity that we're exploring. And here at the Energy Commission, I think we have this opportunity to have a conversation that -- and to really discuss these issues in a deep and analytical way.

So that's what we're looking forward to today. In the morning, we have sort of a setting the stage with various interests, including GO-Biz and including the Air Resources Board as well as environmental interests. And in the afternoon, we're going to hear a lot from the hydrogen -- from industries that are looking to hydrogen to help them meet their goals.

I want to welcome the other members of the dais, some in person, some virtually. My fellow Commissioners, Commissioner McAllister, Vice Chair Gunda, and I think on the line we have Commissioner Houck, I saw.

Do we have any other ones, Heather? Is Commissioner Reynolds on the line or --

MS. RAITT: I don't think Commissioner Reynolds is joined yet.

COMMISSIONER MONAHAN: Okay. All right.

Well, I want to pass the mic over to Vice Chair Gunda and the other members of the dais.

VICE CHAIR GUNDA: Thank you, Commissioner Monahan.

I also want to just thank the IEPR team, you

know, Heather and the entire IEPR team for the incredible work they do.

Also, just, you know, given that this is one of our last workshops, substantive workshops in IEPR, I think --

(Laughter)

VICE CHAIR GUNDA: No, for this year, sorry. We are going to call it different and it's just an inside joke. You know, for this IEPR, I just want to kind of elevate one of the core reasons we do IEPR.

I think the CEC has this opportunity to be a forum for ideation of thoughts, both, you know, in terms of the opportunities, in terms of solutions, vetting them in the public sphere, and being able to develop recommendations and approaches, you know, for the legislature and the administration. So that's an important role that the CEC plays.

And, you know, in keeping with that spirit, I think this is a really important workshop. You know, specifically, you know, over the last three years, we have really been looking at this multi-pronged transition; right? We have been focusing on the transition of electricity. We have seen these huge changes in how we think about the electric grid. But simultaneously, we are looking at the transition in the petroleum industry. As we

have high electrification, what does that do to petroleum? And, you know, how do we manage that transition?

And the other part of it is the clean molecules, right, the natural gas, the RNG, the hydrogen transition. How do we think about this wholistically from an energy systems point of view?

So I think this workshop today, you know, it would be an important, you know, discussion and data point in thinking through that broad strategy that we can lay out.

So I, you know, want to thank Commissioner Monahan for her leadership this year, especially the way she approached this IEPR in making it an all-California report, bringing in all agencies together on this, and taking the time to really have the agencies talk through every workshop and debrief on those items. So thank you, Commissioner Monahan, for your leadership, and Ben in your office, for your leadership, Ben.

And with that, I'll pass it back to you.

COMMISSIONER MCALLISTER: All right. Well, the problem with going last here on the Commission side is that, especially with such articulate colleagues, there's not much to add.

But I did want to just highlight the IEPR itself. I mean, really, California is unique in a whole bunch of

ways. But I think having this for -- this platform that is public, that feeds our processes, and feeds our various processes, you know, across all the different topics that we wrestle with at the Commission and across all the agencies, that sort of convening power of the IEPR is, I think, really quite unique and very -- and formidable. It makes our policy -- it gives our policy development gravitas.

And I think, again, I just want to thank Commissioner Monahan for all her leadership this year on all the different topics, interconnection, and just the range of interconnected and complex topics that this IEPR has wrestled with.

So, you know, I think hydrogen is really the new area. You know, we have a lot of known technologies and we have a lot of incremental improvement across the board in many technologies. Last week, you know, we were down, Commissioner Gallardo and Chair Hochschild and I were down in Imperial Valley talking about geothermal. And, you know, that's an important resource the PUC has called out and procurement going forward. But many technologies, you know, in a lot of ways are kind of off the shelf at this point with incremental efficiency improvements, but they're known.

And I think the ecosystem for hydrogen is a

little bit unique in that, of course, there is an existing ecosystem adjunct largely to oil and gas, but the uses we're talking about for hydrogen are new and innovative. And I think in that way, this conversation really is at the frontier. And we've called out, you know, in forecasting and planning, the need for clean, firm resources on the electric grid. You know, the transportation sector obviously is growing, is expanding into just really uncharted territory really quickly.

And so I think this conversation is super important, especially in the context that Commissioner Monahan articulated with the hydrogen hub. And, you know, totally agree that I think the -- you know, arguably California is, you know, the only sort of ecosystem that is truly a hub. And it's really built, you know, has so much involvement, stakeholder involvement, which I think is the hallmark of our processes generally.

So I think there's just so much sort of meat on the bones here to talk about, but also lots of sort of development frontier for innovation that is super exciting, so -- and a fair number of unknowns. I mean, I think as we count the electrons and the molecules, one thing I would just, you know, ask us all to keep in mind is let's try to be rigorous with tracking them back to the fundamentals of climate change, which, you know, it really matters,

actually, where the molecules come from and where the electrons that are related to those molecules come from. And those, you know, the nature doesn't care, you know, about the accounting. It's really just fundamental basic principles.

And so I just, you know, as we move through this and all the other conversations that are related, let's try to, you know, kind of hold ourselves to that standard where, you know, zero means zero. So I think I tend to approach this from an engineering perspective a little bit. But, you know, it requires discipline to sort of keep there, so -- but we, you know, we have a trajectory that we're all here to help plan. So I'm excited to get the conversation going.

Thanks very much.

And I think Commissioner Houck online, the mic is yours.

COMMISSIONER HOUCK: Thank you. And I also want to recognize Commissioner Monahan's leadership on the IEPR and the CEC and all of the IEPR staff for their work. Very much looking forward to hearing the discussion today.

I want to also recognize the work CARB and GO-Biz are doing. Hydrogen is going to be an important tool and component of us meeting our clean energy goals. And again, very much looking forward to hearing from all the

presenters today and seeing how we can move these efforts forward in a way that's going to help enhance and ensure that we get to our clean energy goals as set out in SB 100.

And thank you again for including us and looking forward to a robust discussion this morning.

COMMISSIONER MONAHAN: And I would be remiss not to say two things. One is that I have a partner. Everybody keeps congratulating me and thanking me, but really Vice Chair Gunda has been my thought partner all along the way, so just want to give a shout out to him.

This is, as he said, this is an all-California approach. So we're not coming at it from a this is the Energy Commission, we're trying to come at it from a this is California energy agencies working together. So it's been a deep collaboration with the Public Utilities Commission and with CAISO.

And also I want to call out Ben Wender, my advisor, who has really been working so hard on this year's IEPR it's been a labor of -- an intense labor, I don't want to say of love, maybe just of labor of learning maybe is a better way to articulate it. And the whole team, Quentin on the transportation side and David Erne who has been really just a leader on all fronts. Like this has been an all-hands-on-deck process.

So with that, I'm going to turn it over to

Heather to lead to help like -- maybe I'm just turning it over to David to set the stage?

MS. RAITT: Yeah, go ahead. David Erne is our Deputy Director for the Energy Assessments Division. He'll go ahead and help us get going on setting the stage.

Thanks, David.

Thank you, Commissioner.

MR. ERNE: Okay. Sorry about that. Good morning Commissioners, both here -- and Vice Chair, both here and on -- joining us virtually, as well as all of our participants here in the room and those who are online. Thank you for joining us today for this workshop. By the way, I'm David Erne, Deputy Director of the Energy Assessments Division.

And I want to say that this is really, as Commissioner Monahan pointed out, this is kind of a follow-on or a continued discussion on hydrogen. We had a pretty substantial volume in last year's IEPR on hydrogen and a similarly strong workshop to talk about the opportunities and challenges around hydrogen for the state. And we're going to continue that in the conversation today about those opportunities and the challenges that we need to overcome to make this a solution for us, for the state.

It's being driven by a Senate Bill 1075, which has two requirements, two broad requirements. One is for

the CEC, and that is to model the potential for hydrogen in the electric and transportation sectors. And it also has a pretty substantial requirement for the Air Resources Board, in consultation with CEC and CPUC, to conduct an analysis and help shape policy recommendations for the use of renewable hydrogen, and also strategies to support hydrogen infrastructure for the state.

And that, that analysis is ongoing. It was actually kicked off earlier this week in a workshop that CARB held to pull that together. And I want to point out to the points that were made on the dais about the cross agency coordination. So it involved Air Resources Board, CEC, CPUC, GO-Biz, all participating in that event to ensure that we are kind of bringing the best and the particular perspectives from each of the agencies together for these analyses.

Today, we're going to provide an overview, a very preliminary overview of the technical analysis that's been conducted for the electricity and transportation sectors. This is a first bite at the apple, if you will.

So the SB 1075 requires two analyses this year, in this year's IEPR, and then in 2025, and so we'll have a preliminary analysis today. We're going to continue to iterate on that, build on it, and have another analysis in 2025.

The 2025 analysis will be improved by the fact that we will have also gone through a substantial amount of analysis for SB 100. That report is due in early 2025. So we're going to continue this analysis, make it more robust to the SB 100 process, and then also conduct more analysis for the 2025 IEPR.

Before I walk through our agenda for today, I just want to put some things in perspective.

The state is transitioning from -- to meet its clean energy goals established in SB 100, it requires us to bring on a substantial amount of clean energy resources for the state to meet those goals by 2045 to reduce our greenhouse gas emissions and improve our air quality and public health.

At the same time, we're confronting climate change, which is making things a little more challenging, both from a perspective of the substantial variability of weather patterns, which is causing wildfires and more prolonged heat events, droughts, et cetera, that we have to address, so it's making it more difficult.

In addition, we have issues with the existing resources that we are procuring, clean energy resources, supply chain issues, interconnection, and permitting delays that are causing those resources to be a little bit more challenging to bring online. What this means is we need a

wider and greater diversity of clean energy resources to draw upon to help us meet that 2045 goal, to reduce our greenhouse gas emissions, to reduce our reliance on fossil fuels to help us get to that position.

And so we need to identify, though, where hydrogen will provide us the greatest value and kind of hone our investments, hone our efforts to kind of bring those to fruition, to bring down the cost of hydrogen, make those more valuable for electricity sector, industrial sector, transportation sector as examples.

So in covering that for today's workshop, we're going to be covering a number of those topics from a broad perspective.

Our first session will be a combination of panelists that will talk about setting the stage, giving us perspective on hydrogen from a national perspective to a very focused California perspective. That will be participants from Natural Resources Defense Council, Environmental Defense Fund, Air Resources Board, and GO-Biz.

We going to follow that with presentations from CEC staff who will provide an overview of both the electricity sector and the transportation sector preliminary analysis we've done for 1075. That will round out the morning.

In the afternoon, we have two panels and a speaker. The first panel will give us an overview of potential for hydrogen in the electricity sector, so we'll have panels talking specifically about that. And then another panel will focus on the transportation sector. And then we'll follow that up with a staff presentation on CEC's efforts around funding R&D to support the understanding of the value for hydrogen and ways to bring down the cost of hydrogen.

After that, we'll have -- we'll have Q&A after each session and opportunity for public comments at the end of the day.

So before I turn to the first series of speakers, I do want to say thanks to our Commissioner Monahan and Vice Chair Gunda for their leadership on this topic. They've really been helping the staff hone and shape the analysis, understand the broader perspective in the state, and helping us bring a more robust analysis to the IEPR this year, and also helping us strategize about ways we can further evaluate that for SB100, and also for 1075 and 2025. So thank you very much for all of your help and vision helping us with this process as we're working through it.

So with that, I'm going to introduce speakers one by one.

The first speaker I'm going to bring on is virtual, is Pete Budden. He leads NRDC's state and regional level hydrogen policy work, and I'll turn it to him for his presentation.

MR. BUDDEN: Hi, everyone. Thanks very much for having me. As David said, I'm Pete Budden with the NRDC. I'm very pleased to be with you all this morning.

Move to the first slide, please.

I'd like to start with this image -- oh, we can go back to the image -- which is just, it's a narrow path, but it's a path we have to cross. This represents the path of developing hydrogen. There's actually some big risks along the way that we have to be careful to avoid, but a lot of opportunity at the end. And it's also a very necessary resource for us to develop, so it's a path we've got to cross.

So next slide, please.

Quickly, to cover the outline of my talk, I'm going to cover hydrogen applications and how I think we should prioritize different applications of hydrogen, given it's the scarce resource. Then I'm going to give some national context on electrolytic production and the necessary guardrails around electrolysis. And finally, I'm going to give some examples from other states of what's going on with hydrogen.

So next slide, please.

So hydrogen applications.

If we go to the next slide.

Hydrogen can technically be used in almost anything where we use fossil fuels today. That includes heating buildings, electricity generation, heavy industry, and a variety of transportation uses. But it's important to note that just because you can use hydrogen for a certain use definitely doesn't mean that you should. And in almost every case where it's possible, electrification is going to be both more cost effective and a more efficient use of our resources.

Next slide.

A good example of this is heating buildings. It would take approximately five times as much deployment of renewable energy, that's wind and solar or anything else, to heat homes by green hydrogen than it would by heat pumps. And that's because of the inefficiencies of converting renewable energy to hydrogen and then burning it compared to directly using electricity.

Next slide.

Given hydrogen is a scarce resource, it's really important that we have a good hierarchy of where it should be used. And there is now a strong consensus around what counts as a good high-value use and what doesn't. You can

see the high-value uses in the top right here, placing fossil hydrogen in chemicals and refineries, using hydrogen in heavy industry like steelmaking, international shipping, long-haul aviation, these are all really good uses of hydrogen.

On the other hand, you've got things like residential heating, passenger vehicles, low and medium temperature heating. These are things we can do much more efficiently with direct electrification.

Next slide, please.

Specifically in California, I want to note there's a variety of opportunities to use hydrogen where it can be a real climate solution. Those include replacing existing gray fossil hydrogen.

Long-distance shipping and aviation in particular, I want to note that that's shipping but not necessarily all of the ports operations. And we really want to make sure that we don't use hydrogen as an excuse to delay electrification of any port operations.

High-temperature heat for industry, potentially a subset of long-distance heavy-duty trucks. But, again, I want to note that electrification is developing quickly in that area as well and will have a role to play.

And finally, long-duration energy storage to provide dispatchable, clean, firm power. But there is an

issue around air quality with this around NOx production.

Next slide.

We know that burning hydrogen to create electricity does produce NOx. And blending hydrogen into a gas turbine, as shown in this figure on the right here, increases the amount of NOx relative to just burning natural gas. That's obviously unacceptable for our communities that are overburdened by air pollution.

And so we need more research and data on both controlling combustion conditions and the after-treatment of exhaust gases, which are the two mechanisms we have to control NOx. We need to understand the potential to reduce NOx from burning hydrogen before we deploy it in our communities.

Next slide, please.

So now onto hydrogen production. I'm going to talk about electrolytic production, and the most important thing in this space right now is the national conversation around the IRA's production tax credit, also known as 45V. This graph shows you that if you can reduce the production emissions of your hydrogen from the status quo gray hydrogen of 10 kilograms on the far right of this graph down to below 4, then you get -- you're eligible for the tax credit. And the big prize in the top left of the graph is if you can reduce to below 0.45 kilograms of CO2 per

kilogram of hydrogen, you can earn $3.00 per kilogram of hydrogen, which is a huge incentive considering hydrogen is sold for about $1.00 a kilogram today.

Next slide.

The way to reach that really low carbon intensity is generally going to be through electrolysis. Electrolysis is the process of using electricity to break the bonds in water molecules to create hydrogen and oxygen, but this is extremely energy intensive. To create the 10 million metric tons of clean hydrogen the DOE is targeting for 2030, it's going to require 500 terawatt hours, which is more than the energy generation of the state of Texas. So that's a huge amount of clean energy. And as Commissioner McAllister pointed out, it's incredibly important that we track those electrons and make sure that we're doing this in a truly clean way.

Next slide.

It's really clear that if we don't do this, there's a big risk of increasing emissions from our electricity sector and blowing way past the 0.45 kilogram limit. If you were to power your electrolysis by the average grid in the U.S. today, you would be not only 40 times over the limit for achieving your $3.00 per kilogram tax credit, but you'd be twice as dirty as the incumbent gray hydrogen. Electrolysis is just very, very energy

intensive, so it's very important we make sure all the energy going into it is clean.

Next slide.

And the system that we need to achieve that, the system that we need, of guardrails that we need -- if we go to the next slide -- is known as -- there are guardrails in particular, they're known as the three pillars, and these are required to make sure that the power we have going into our electrolysis is squeaky clean and make sure that 45V tax credit doesn't act as a perverse incentive that increases emissions.

Next slide.

The first pillar is new clean supply, also referred to as additionality. This is making sure that we don't divert existing clean resources that are currently contributing to decarbonizing the grid towards hydrogen and do nothing to fill the gap that they leave. Because right now, in general, most of the time the marginal resource on our grid that can ramp up when there's a new load will be fossil fueled. And if we don't have a new clean supply requirement for our hydrogen production, then the load of the hydrogen production will generally be met by fossil fuels.

Next slide.

The second pillar is hourly matching. This means

that you have to match your new clean supply to your energy use on an hourly basis. It means you can't run your electrolyzer in the middle of the night and claim to use solar energy to do so, because in reality, the energy that's being used will be fossil fueled. And there's research from many groups, including some from MIT shown here, showing that the emissions consequences of annual matching are far worse than from hourly matching.

Next slide, please.

The third pillar is deliverability, and this is similar to hourly matching, but in a geographic sense, you have to match up geographically where you're producing and using electricity. Otherwise, it could be behind the transmission constraint, and then you wouldn't truly be delivering that energy to your electrolyzer. In this case, you would be turning on a fossil fuel resource closer to the electrolyzer to meet that load. And again, that would result in increased emissions.

Next slide, please.

There's been a lot of talk, especially from industry, that the three pillars will stifle growth, but we've seen the EU commit to these three pillars, and their pipeline of projects has only grown since then.

Next slide.

We also have really good modeling from a variety

of groups. This is from Evolved Energy Research, showing that the three pillars, which is the middle column in red, compared to the limited requirements, which is relaxed rules without the three pillars, they show similar deployment of electrolyzers, ample deployment to enable the cost reductions that are really the goal of this production tax credit. We want to bring down the cost of electrolyzers, and that means scaling up manufacturing, and we can do that with these climate guardrails.

Next slide.

There's also a bunch of other negative consequences to relaxed rules that don't include the three pillars. Consumer energy costs will increase. It will undermine the credibility of the industry. And it won't incentivize the correct most modern flexible electrolyzers that can ramp up and down with the availability of clean energy. It will instead result, likely, in a lot of Chinese-made inflexible alkaline electrolyzers that are a bit cheaper, but they don't have the ability to ramp up and down with the availability of energy.

Next slide.

Finally, I just want to touch on some developments in other states that I think are relevant here.

On the production front, these three pillars that

I've just mentioned have been put into law in Colorado around their end-use tax credit, and introduced in a bill in Pennsylvania that's currently being considered. And then on the production side -- I'm sorry, the end-use side that I started on, all of those states have made clear that there's a hierarchy of end uses, and public subsidies should really be directed only at these high-value end uses, so not light-duty passenger vehicles and not buildings.

With that, that's the end of my slides, I think, so thank you again for listening, and I'm happy to take questions. I'm not sure if we're doing them now or at the end of the panel.

MR. ERNE: We'll actually do questions at the end of the panel, so thank you for your presentation. I appreciate your overview from a national perspective.

Next, we'll go to Ilissa Ocko, who's a climate scientist at the Environmental Defense Fund, to provide her presentation.

Are you able to join us, Ilissa?

MS. OCKO: Yes, I'm here. Thanks for having me.

MR. ERNE: Wonderful. Thank you.

So hi, everyone, and thank you again to the organizers for inviting me. I'm Ilissa Ocko. I am a climate scientist at Environmental Defense Fund. And today

I want to talk about how to maximize the climate benefits of hydrogen systems and share some of the hydrogen science work that my team at EDF has been doing over the past several years.

For those of you who aren't familiar with Environmental Defense Fund, we are a global environmental nonprofit rooted in science, and we focus on averting the climate crisis using a combination of rigorous science, economics, law, and partnerships.

And a quick note before I dive in, I want this presentation to also be a resource, so you'll see that there's a lot of supporting information on the slide that I'm not going to read verbatim, but I wanted the deck to be shareable and standalone, so I wanted all that information in there.

Okay, next slide.

So the main message that I want to get across today is that hydrogen systems are not inherently climate neutral, and there are many climate risks that are associated with hydrogen. So in order to ensure the climate integrity of hydrogen systems, there are dedicated efforts that need to be taken.

So you can divide these climate risks into three categories, production, management, and use. Pete already discussed in detail challenges associated with production

and use, so I'm going to focus today on the challenges with hydrogen management.

But the key point I want to emphasize on production is that there is no hydrogen production method that is universally beneficial to the climate, so we need to be careful to do it right.

And the key point I want to emphasize on management is that hydrogen is a leak-prone gas that warms the climate, and so we really need to minimize emissions in order to maximize climate benefits.

And finally, the key point I want to emphasize with hydrogen use is that in many cases, as Pete said, there are better options available. So for example, we should not pursue hydrogen for applications that can be easily electrified.

Next slide, please.

So just briefly, a bit more about climate risks from hydrogen production. I want to reiterate Pete's point that using renewable electricity to make hydrogen can delay decarbonization goals if the renewable energy would otherwise have gone into the power grid. And this is why hourly matching and ensuring additional renewables is really critical.

In terms of biogas, using biogas to produce hydrogen can also increase greenhouse gas emissions through

a variety of different ways. So we have to make sure we only use waste biomass that has no other use or recyclability in order for it to be really beneficial to the climate.

And a major concern of using fossil gas with carbon capture is that carbon capture does not address the issue of methane emissions.

Next slide, please.

So for hydrogen management, the risk here is that when hydrogen is emitted into the atmosphere, it warms the climate. And hydrogen can easily escape because it is the tiniest molecule in existence. But we have no data on how much hydrogen currently is emitted into the atmosphere from infrastructure. And it turns out that the sensor technology capable of those measurements isn't even available. And we have a major reason for concern based on what we know about the natural gas system and leakage.

So in terms of warming impacts, hydrogen is classified as an indirect greenhouse gas because its breakdown in the atmosphere increases the amounts of other greenhouse gases. And hydrogen's chemistry and warming effects have actually been studied for decades. And a recent study even concluded that we now have high confidence in hydrogen's warming effects and our understanding is robust enough to be used in decision

making.

Next slide, please.

So the bottom line here is that the amount of hydrogen emissions is unknown. But there is scientific consensus that hydrogen emissions cause global warming.

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So for those that are interested in how hydrogen warms the climate, it's due to this one chemical reaction that occurs in both the lower and upper atmosphere.

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And this reaction leads to increases in the amounts of methane, ground level ozone, and high-altitude water vapor, which are all greenhouse gases that warm the climate.

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And the latest science suggests that the global warming potentials of hydrogen are 37 for a 20-year period and 12 for a 100-year period. And the reason that the 20-year value is higher than the 100-year value is because the three greenhouse gases that hydrogen affects are all short lived. So hydrogen's warming effects are highest in a couple of decades after its emission, which is very similar to methane, for example.

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So how serious of an issue this is depends

entirely on how much hydrogen is emitted.

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And we know that hydrogen can be emitted throughout the entire value chain, both intentionally through operational processes and also unintentionally through leakage.

Next slide.

And our research team recently published a paper that consolidated all of the reported ways in which hydrogen can be emitted at every stage of the value chain.

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And we synthesized all estimates in the published literature on how much hydrogen is emitted. And the key point here is that it could be really high, up to 10 or even 20 percent of the hydrogen may be lost to the atmosphere for some components of the value chain. But the reality is that we just don't have empirical measurements from real world facilities to confirm or deny any of these values.

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We also published a paper last year that looked at what the climate implications of hydrogen emissions are for different levels of emissions. And so we looked at a general case where a fraction of fossil fuel systems were replaced with either blue or green hydrogen alternatives.

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And what we found is that the climate benefits of hydrogen can be severely undermined with upper end estimates of hydrogen emissions, especially in the following decades.

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The good news though is that there are a number of actions we can take to address this issue, especially because the hydrogen industry is in its infancy. And so we have an opportunity to get ahead of this problem and minimize it in the future.

So we need to develop the sensor technologies that are capable of measuring hydrogen emissions site wide. And I'm happy to report that there is one instrument we know of that's in development by Aerodyne that can do this. And we then need to go out there and measure emissions. We need to determine how to effectively mitigate emissions. We need emissions programs eventually that are similar to what we do now for natural gas leakage. And we also need to include emissions risks and decisions, which we can do starting today.

Next slide.

So EDF in particular is working really hard to determine how much hydrogen may be emitted now and in the future. And we are in the early stages of developing a

measurement campaign with a number of academic institutions, and also industry, to start collecting this data.

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So Pete went into concerns with hydrogen use and best uses for hydrogen, so I just want to make this one point. Right now we often rely on tools like life cycle assessments or energy models to tell us how beneficial a specific technology or process is. But keep in mind that standard LCAs and energy models do not include the warming effects associated with hydrogen emissions, and they rarely look at near term warming effects.

So we need to start including these aspects in our decision making tools, because otherwise we are overestimating the climate benefits of hydrogen systems which could lead to us not making the best decisions for optimizing climate benefits of any decarbonization strategy that we pursue.

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So thank you all so much for listening. This is the same as the first slide and I'm happy to follow up with anyone individually on any of these key challenges and solutions. And I'm looking forward to the Q&A after all the panelists are done speaking.

And next slide is just a few of the references

that I mentioned in this presentation, which should be available where you can find the slide deck.

Thank you all so much.

MR. ERNE: Thank you, Ilissa. I appreciate your overview, as well as Pete's, on some of the challenges, particularly on the environmental side, and some opportunities for how we can be thinking about this moving forward.

So slightly pivot at this point and talk a little bit about how we can create strategies and create approaches that can help us think through the right and most appropriate ways to move forward.

So with that, I'll turn to Cary Bylin, who is from the California Air Resources Board. She's the Manager of Industrial Strategies Division and she'll provide an overview of work that CARB has done, both from the Scoping Plan, as well as 1075 preparations.

So I'll turn it over to you Cary.

MS. BYLIN: Thank you so much David, and hello everybody. I'm very glad to be here. Thank you for the invitation.

So I'm going to be talking mostly about SB 1075 and the work that CARB will be doing under SB 1075. But as has been mentioned, a lot of this work is guided, you know, in part by the Scoping Plan. So I just want to give a few

brief remarks about our Scoping Plan to set context for those who may not be familiar.

So the 2022 Scoping Plan update was finalized in last December. And the Scoping Plan is an actionable plan that lays out a cost-effective and technologically-feasible path to ensure that we meet the statewide greenhouse gas reduction targets in a way that is consistent with all existing directives.

We don't need to go to this slide yet, but it's fine.

So after each Scoping Plan is adopted, CARB and the other state agencies start the process of reviewing and updating related programs or developing new programs to align with any outcomes identified in the Scoping Plan. So that's just to say that, you know, in addition to the direction provided by the legislature in SB 1075, that we will also be looking to our Scoping Plan for the direction that it provided on our future goals of meeting carbon neutrality and other greenhouse gas reduction goals.

Okay, next slide.

All right, so as mentioned, the 2022 Scoping Plan update lays out a path to California achieving carbon neutrality by 2045. And with such an ambitious target, the plan emphasizes employing all tools available to reduce greenhouse gas emissions and remove carbon dioxide from the

atmosphere. This will require a deployment of a broad portfolio of existing and emerging fossil fuel alternatives to achieve deep decarbonization across multiple sectors of the economy.

And as has been mentioned, while electrification is poised to play a significant role in California strategy, the Scoping Plan also calls for accelerating the transition from combustion of fossil fuels to hydrogen, including as a fuel for ocean going rail, air and road transport, and as a non fossil energy resource in the industrial sector.

The 2022 Scoping Plan update envisions significant growth of low-carbon hydrogen. And we anticipate the need to rely on multiple hydrogen production methods to provide the needed supply.

We will seek to leverage federal funding and other incentives to achieve this growth in hydrogen production, distribution, and use. And doing so can yield significant beneficial impacts on greenhouse gas and local air pollutant emissions from hydrogen end use relative to fossil fuels.

In addition, reducing the use of fossil natural gas will reduce methane emissions, which is a short-lived climate pollutant with an outsized impact on near term climate change.

And to the extent possible, we also want to prioritize non-combustion options for hydrogen use to help the state meet its air quality goals.

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The current state and federal policy landscape provides a critical opportunity to expand hydrogen production and use in California.

At the federal level, the Biden administration is committing to and prioritizing a clean energy future and providing resources needed to deploy effective programs and strategies through efforts that include the Department of Energy's Regional Clean Hydrogen Hubs Program and the Inflation Reduction Act 45V Hydrogen Production Tax Credit. These investments will catalyze the development of carbon free energy and fuels, accelerate industrial decarbonization, improve energy security, create jobs and help communities benefit from clean energy investments.

The federal efforts are a strong complement to California's actions, which include Governor Newsom's recently announced hydrogen market development strategy, which will take an all-of-government approach to building up California's renewable hydrogen market, and ARCHES, a public-private partnership tasked with establishing a hydrogen ecosystem that drives down the cost of renewable hydrogen while increasing renewable energy penetration and

achieving our net-zero and carbon goals on an accelerated schedule.

These efforts are supported by regional and local initiatives, such as Angeles Link and Lancaster Hydrogen City. And CARB also has several complementary regulations, including the Low Carbon Fuel Standard, Advanced Clean Fleets, and Advanced Clean Trucks to increase zero emission vehicle and hydrogen deployment.

And as has been mentioned, and as the topic of my talk today, in consultation with our agency partners and via a public process, CARB will be doing additional analysis and making recommendations under SB 1075.

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So despite strong momentum and alignment of state and federal opportunities, there is still much work ahead to achieve the needed expansion of hydrogen production and use in California. This includes alignment of local actions to support state and federal air quality and climate goals and to leverage state and federal funding opportunities.

To meet the state's air quality and climate goals, we need more infrastructure to support hydrogen production and use and need to align local permitting actions with the scale of the current opportunity.

Additional funding and regulatory efforts are also

needed to support expansion of low carbon hydrogen supply and non combustion uses.

State and federal market signals should also spur private sector investment.

Lastly, we need further policy and technical evaluation to support increased hydrogen production and deployment, including analyses of water and air quality implications.

And in recognition of these important needs, last year, the legislature passed SB 1075.

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SB 1075 requires CARB, in consultation with California Energy Commission, California Public Utilities Commission, California Workforce and Development Board, and other partner agencies to produce a comprehensive report on hydrogen by June 2024.

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So SB 1075 directs CARB, in partnership with these other partner agencies, to conduct a broad range of technical, market, and policy analyses that will support hydrogen production and use across many sectors of the economy, including those that are most difficult to decarbonize. So these analyses will support -- will also support a broad range of other priorities, including air quality benefits and workforce development.

And if you'll just forgive me, I'm going to go ahead and list the elements that SB 1075 specifically mentions that we include in this report, and they are policy recommendations regarding the use of hydrogen, strategies to support hydrogen infrastructure, the potential for non-renewable hydrogen to achieve emissions reductions, using the ability to use curtailed electricity for hydrogen production, estimated greenhouse gas emissions, air quality benefits and costs associated with deploying renewable hydrogen, including when compared to alternatives, opportunities to integrate hydrogen into drinking water supply treatment needs, regulatory and permitting processes for hydrogen transmission and distribution, life cycle emissions of various forms of hydrogen production, and air pollution and other environmental impacts from hydrogen distribution and end uses.

Next slide. So just wrapping up here.

In terms of next steps, we are seeking public input as we begin this analysis. And as has been mentioned, CARB, CEC, CPUC, and GO-Biz participated in a kickoff workshop for SB 1075 work on Tuesday, last Tuesday, September 5th. And there is going to be a written comment period that is open on CARB's SB 1075 website, the link is on there, and we will be taking written comments on that

workshop from the public for two weeks until September 19th. And we, it's not quite up yet, but we will also be posting at that location a link to the recording of that workshop in case you want to go and take a look at that. So please visit our website or reach out to us at the email that's listed on the slide for more information.

That concludes my presentation. I thank you for the opportunity and I look forward to the rest of the discussion.

MR. ERNE: Thank you, Cary. Appreciate your overview, a pretty substantial lift required for the analysis for CARB in the 1075.

So last but not least, we're going to turn to Tyson Eckerle, who's a Senior Advisor for Clean Infrastructure Mobility at the Governor's Office of Business Development, Business and Economic Development, or GO-Biz. He'll be providing an overview of ARCHES.

MR. ECKERLE: All right. Well, thank you. I think it's hard not to be excited about hydrogen at this moment, and so I commend everybody. I think if you take a step back, one thing that we know for certain is it's going to take all of us working together to make this market work in a way that everybody's excited about. So I commend you, the Commissioners, for bringing all the agencies together to focus in on this.

If you go to the next slide, I'll just kind of -- today, I'm going to try to be brief, but there is a lot to share. And so I want to talk about both the ARCHES application and also the hydrogen market development strategy. And these are complementary activities that they're working together in tandem to both organize, you know, a lot working like in the IEPR context, for example, with the strategy and then implement, you know, kind of through the ARCHES context.

And so, oh, yeah, it's telling me to join the audio. Okay.

So if you go to the next slide here?

I thought it's worth kind of going through ARCHES mission. And so I am, at GO-Biz, I am also part of the ARCHES leadership team, if that makes sense, to help catalyze that for context. But it's a public-private partnership to create a sustainable statewide renewable clean hydrogen market and ecosystem in California and beyond. And I think it's important to focus in on that. So we're really driving towards that economic sustainability and with all the renewable environmental attributes associated with it. And we think we can get there.

So it's fully committed to using renewable resources to reduce hydrogen and decarbonizing our regional

economy. We have a ton of opportunity to do that. We're prioritizing, you know, environmental justice, equity, economic leadership, workforce development, and market viability.

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Our goals, you know, it's like it's really between now and 2030. We're trying to get to that economic sustainability in the 2030 timeframe and really kickstart, or I think we should probably start using catalyze instead of kickstart, it's an old term, the commercial viability of hydrogen. And we're focusing in early on the, you know, hard to decarbonize areas at the earliest opportunity. That's ports, it's power, and it's heavy-duty transportation. But that really enables expansion into heavy industry, into aviation, maritime, agriculture. We talked about ammonia (phonetic) earlier and others.

And so, you know, currently, you see this in the Scoping Plan, we have about 30 tons per day. We're trying to ramp up to 500 tons per day by 2030, so that's a big acceleration. And we want to make sure through it all that we have -- we're measuring the benefits. You know, the previous presentations was making sure that we're capturing all that. We have robust monitoring and strong accountability to make sure that the hydrogen we are delivering is delivering our carbon neutral renewable

economy.

And then finally, it's really important to highlight the workforce. So ARCHES is composed. The founding members were GO-Biz, the University of California Office of the President, and all the UCs organized behind it, the State Building and Construction Trades Council of California and a bunch of the unions associated with that, and Renewables 100.

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The way ARCHES has done, you know, in the context of the DOE application, has pulled together a bunch of stakeholders. So we have our foundational principles. I won't read them all, but, you know, we wanted to make sure it was statewide, it was centered on equity, environmental justice, you know, renewable, clean, green, hydrogen.

And then but it's really the core structure is pulling together industry. We have a higher education system, and National Labs have been great, the state, labor and communities to really drive this market forward. And the differentiators were, you know, we were pitching to the DOE, for example, we have infrastructure available. We have lessons learned here in California. We've done it. Our industry is ready to invest. We have offtake opportunities. We can serve as a market catalyst. California leads and the rest of the nation can, it opens

the door for the rest of the nation. And we're connected to the communities. And that delivery certainty is the ability to deliver projects.

If you go to the next slide?

I just want to like take a step back, kind of where we are in that process.

So the DOE put out the FOA back in September of 2022. That feels like ten years ago now, honestly. And then we had to put the full application in by April 7th. Since then, we've done written questions, we've done an interview, we've done more written questions. I think in all we've submitted about 2,000 pages to DOE. And the selections are expected in the fall of 2023. And, you know, for those keeping score at home, it is fall of 2023, so we're hoping that we hear soon, but that can be delayed, of course.

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So this is kind of -- I like to describe it, just because it shows kind of the scale. So what we've done is we've tiered the project, so to speak, so there's Tier 1 projects. There are 39 projects within the state of California that we believe gives us the best chance to meet those long-term goals and build up that market. But not only that, we have Tier 2 projects that are also viable and fundable, and there are 31 of those after a robust

selection process that can come in line. It's like our AAA team, so to speak, but, you know, lots of stack deck of players. And then in Tier 3, we have, you know, a bunch of OEMs and providers and stuff.

And so as we're working it through, it is a complex system, but that's part of the thing. With complexity, we can build resilience in this. And so that's kind of the overarching thing. I'll go a little bit into what that system looks like.

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And I thought it would be worth this kind of walking through the hydrogen flow. Some of you may have seen this before. We talked about it on Tuesday. But essentially, what are the feedstocks? Renewable electricity and biogenic feedstocks.

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We want to make sure, you know, that feedstock makes you produce hydrogen, so you need water. Most of the projects have recycled water or water contracts. You have electrolytic production directly connected to renewable resources, also connected to the grid. We have bio hydrogen production with some carbon capture.

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Then after the production, we have to distribute it. So we have, in the early market especially, it's

liquid hydrogen in fuel cell trucks transporting the hydrogen. But importantly, and you'll hear from SoCal Gas, for example, later, pipelines, you know, play a huge role in driving down the cost, but they do take time to build.

We have a minimal amount of storage. We really focused in on connecting supply and demand, but that storage can grow. And it's something I think we should think about in the IEPR context, like how important of a role is hydrogen and long duration storage? But for this context, now in 2030, that's where we focus on matching supply and demand.

And then that goes to the end use. And the end use is really important -- if you go to the next slide -- is really important. So we have, you know, power and transportation and ports. And you'll see these tons per day, I think, were kind of helpful to put in terms of the context. We're trying to get about 500 tons per day.

The power generation sector is a really important market catalyst because it can sign an offtake agreement today, you know, and it can -- and that helps drive down the cost, enabling investment in hydrogen into transportation, which takes a little bit longer to develop, as we know from our experience here.

And ports is also something that can move relatively quickly because hydrogen is a one-for-one

replacement of diesel. It's mobile fueling. And so from a pragmatic perspective, it works to get out there. And you can have great emissions reductions and benefits in the communities.

So that's more or less the ecosystem.

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The idea, you know, communities will benefit. And this is kind of our Andy Warhol graphic. I think we wanted to make t-shirts. We still haven't done that. But you can kind of see, like, in the top left, you have the ARCHES size, so it is statewide. Then we overlaid it, this is real data, with the disadvantaged communities, with low-income communities, and air pollution. And the projects are going in those communities.

On the tablet on the right, you know, we have some of the community benefits. I won't go into all of those. But that $380 million investment down at the bottom, we're making sure that those projects are investing into those communities that they're deploying in.

The big one -- the big two I think we want to call out is the close to $3 billion a year in annual health savings associated with just this amount of deployment, and over 200,000 jobs per year, family-supporting jobs.

Okay, if you go to the next slide? And I'm realizing I have to really hurry up.

So the hydrogen strategy, this is the press release. You can read it.

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So in that press release, we really talked about our North Star for the hydrogen market development strategy. It's really to leverage hydrogen to accelerate clean energy deployment and decarbonize our transportation and industrial sectors. So I think we can all agree on that that's what we need hydrogen to do.

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This is a work in progress, the hydrogen strategy, and I think intentionally sketched this because I'm my own graphics department. But if you really think about the why and the when, like we know the why and the when because we need to be carbon neutral by 2045. That is clear. It's in law. The what, you know, is often defined by the 2022 Scoping Plan, you know, that has gone through a bunch of analysis, this is what we need to do. The hydrogen strategy is really focusing on the how and the who. And the more we can answer that question, the more we can focus in on the doing.

And so within that, you have the SB 1075 report. What questions do those answer? We have the IEPR. What does that answer? Just making sure that we're all on the same page and rowing in the same direction to pull that

market forward. ARCHES has been developing white papers over the course of the year. Those will play a direct role into this.

And so it's, really, it's modeled after the ZEV market development strategy, which I think many of you are familiar with. And it's really just, it's all about getting people rowing in the same direction and making sure that we have clear objectives and we have defined stakeholder roles and we all understand each other.

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I think this might -- I might have made it. So we had the survey. This is a survey that we put out with a QR code. That's the first time I've done this, and made it myself, and so that's pretty cool. But you can click on the thing. There's a little survey. If you like have any general questions or concerns on the strategy, it's open-ended questions, but we will be rolling out more information. This will be done in direct partnership in collaboration with all of the agencies. We want to make sure we make everybody's job easier, not harder.

And so that's what I wanted to share today. I think there's one last slide. It's probably a feel good. Yep, it is. We need that partnership to succeed.

So thank you all for the opportunity. Thanks for organizing this.

MR. ERNE: Thank you, Tyson. Appreciate that overview.

And so I'm going to ask all of our presenters to join us by video and we'll move to the Q&A portion for the panel. So thanks all the panelists.

And I'll turn it over to Commissioner Monahan for questions from the dais.

COMMISSIONER MONAHAN: Well, first off, I want to thank all the presenters. That was really a great overview. And I think it really sets us up well for the afternoon sessions where we'll dive more deeply into, you know, the perspective of various interests in the hydrogen industrial world, not just industry, but transportation, of course, and electricity generation, all the different ways that hydrogen may play an important role in California going forward.

And I wanted to ask a question of Dr. Ocko. You said something I didn't fully grasp where you said that life cycle analysis doesn't include the warming effects of hydrogen. Can you elaborate on that?

MS. OCKO: Yeah, absolutely. Hydrogen emissions has not been on many -- on the radar of many different modeling assessments for hydrogen systems. So when I said hydrogen emissions, I mean physically the gas, hydrogen either intentionally emitted to the atmosphere or leaked.

I didn't mean emissions associated with hydrogen systems, for example, carbon dioxide and methane. Those emissions are typically included in life cycle assessment models and energy models.

But hydrogen emissions themselves and the warming effects just from hydrogen being an indirect greenhouse gas was largely off everyone's radar for several years until recently. And so the tools have not caught up yet and are not including those effects. And therefore, they are underestimating the climate impacts from hydrogen systems because they're not including that warming impact.

COMMISSIONER MONAHAN: Thank you. That's really helpful.

And then this may be at a disadvantage to all the panelists, but I'm curious about what you would recommend to us in terms of supporting research and data into hydrogen, if you have any specific recommendations for what the CEC can do. I know you're at a disadvantage because you actually haven't heard what we are currently researching. We're doing a fair amount of research in the space of hydrogen, including looking at blending and pipelines, and also NOx impacts from combustion. But just if you have any general recommendations for how you think we could be helpful as an agency and in the writing of this report for this year, we welcome those recommendations.

MR. BUDDEN: I mean, from my perspective, I think that the research you've already listed is going to be really helpful, especially on the NOx impacts that I mentioned in my presentation.

I think another really important area is the grid impacts that I focus on in such detail. I think for the Commission to really take a hard look at what the implications are for the California grid from different sets of policy guidelines is going to be critical. As I said, the national context is obviously very relevant here.

But, yeah, I think those are the biggest areas.

MS. BYLIN: And I would say I don't have specific recommendations. We are tracking the work that you all are doing just to make sure that we can stay aligned as we move forward with SB 1075.

And for us at CARB, it's been really valuable to have such a strong partnership with CEC. We have been doing, you know, very well-coordinated activities through SB 100, through the Scoping Plan process, and already starting off with the SB 1075 work, both the IEPR work that you're directed to do and the report work that we're directed to do.

So I think that has been going really well. And I would just say let's keep going there, well coordinated, as we embark on the 1075 report effort.

MS. OCKO: And no surprise here. But my recommendation is to all these projects that you're considering, we really need to incorporate the leakage issue and have it be on our radar for every decision that we make in terms of where we're scaling up infrastructure. Are we building pipelines? Can we co-locate production and use in the same place so we minimize, you know, the distance of the value chain? Making sure we're developing the right sensors that we're going out there and taking measurements of hydrogen emissions that aren't just concerns for a safety perspective, but are environmental concerns as well.

And then developing or planning in a lot of these projects for how we will go about doing LDAR and MRV programs, for example, when we start to have the sensor technology available to take measurements. So for those who don't know leak detection and repair, LDAR programs, we do it for natural gas. We need to plan for eventually doing that for hydrogen, and same with MRV in terms of monitoring reporting and verification.

So it's really important to start incorporating that into decisions now as we plan and develop these hydrogen systems going forward.

MR. ECKERLE: Maybe I would suggest, I think implementation focus, too. Like there's a lot we can learn

from actually getting projects into the ground. And I think, you know, the agencies are uniquely positioned to help pull that data and identify and get a shared collective understanding of what it takes to actually get these projects deployed.

COMMISSIONER MONAHAN: So I just want to say one quick thing and then I'll pass it over to other members of the dais.

But I just want to congratulate Tyson and GO-Biz for your leadership on ARCHES. It's been, I know, just very -- a lot of herding of cats and pretty amazing what you've been able to accomplish so far.

So with that, I'll turn it over to Vice Chair Gunda.

VICE CHAIR GUNDA: Thank you, Commissioner Monahan. I'm sorry I kind of had to step out for a few minutes there.

Just kind of bringing this up a tiny bit to all the panelists, I think one of the, you know, framing of the conversations was this, you know, three-track transition we are going through. And, you know, I think one of the critical issues here with both, like I know for example, Lithium Valley development, the offshore wind, or hydrogen. these are also opportunities for future workforce development, right, our future economic development.

And, you know, I think I'm thinking through the steps of how are we -- I mean, each one of you kind of have shared the perspective, you know, for example, specifically on leakage, specifically on the element of grid reliability and the need for more supply. How do we, you know, collectively think of a cohesive strategy? What are some best practices based on previous energy systems; right?

I think what I'm kind of recognizing is the need for clean molecules. You know, I think that's well established within the Scoping Plan that we would need some sort of molecules. And moving forward in developing those molecules, what are some, you know, best practices in thinking about how do we think at a systems level, you know, both from the energy transition, but the societal transition jobs? And I think, I know, Cary is going to do this by next summer, but any preliminary thoughts on how we align and develop a cohesive framing on the best practices moving forward?

MR. ECKERLE: So I think we have a great opportunity. I think the systems level thinking is key; right? And it's a hard thing to do, right, because the bigger the problem, you know, the bigger the system, the more complexity. But I think we have a big opportunity working through, like we've learned a lot through the ARCHES process and integrating, you know, even more amongst

all the state agency efforts. And we're hoping to help bridge that gap with the hydrogen strategy, kind of figuring out, you know, kind of who's doing what and how to do it. But I think that whole system thing is absolutely key.

I mean, on the workforce part, you know, the strong partnership with organized labor and the UCs and CSUs and community colleges all matter. But we also, you know, we go out there in the communities, we talk with legislators, and they, you know, they've seen these things. It's easy to say, it's hard to do

And so I think that's the thing we have to keep our eye on, making sure that we go and like, you know, even on the community and workforce development, our commitment is to get into the local communities and get jobs to the people who need it most; right? But that takes more effort. It's kind of like electrification takes more effort in areas where the grid is older, right, you know, but it's worth doing.

And so I think it's that whole system thing. And that's where I think we have this huge opportunity with all this investment. And it's not just emissions reduction, but it's that job creation that comes from that systems-level thinking.

So I'm not sure if I really answered your

question or not, but I think I'm just violently agreeing with you in terms of the way we have to think about it.

MS. OCKO: Yeah, I totally agree, as well, with the system-level thinking, and we need to be careful. We need to make sure that it's responsible deployment of hydrogen systems, whether that's -- and so we need to consider all the environmental impacts, the climate, air quality, land footprint, water footprint, and then also all the social impacts as well. How this affects different communities. Where are we getting our resources from?

And so we need to incorporate all these different parameters into our discussions and decisions about where to best deploy hydrogen, and also do the same thing for all the other alternatives, so that we're taking into consideration all these different aspects and putting it together in a very apples-to-apples way to figure out, you know, what is the best molecule or electron for the job, and how can we do that most effectively.

MR. BUDDEN: Yeah, I really agree with that perspective. Obviously, the systems-level thinking is critical here.

I would just add that I think for in terms, especially thinking about workforce development, we need to think about building a durable hydrogen ecosystem that is not going to be a flash in the pan. And that means not

following down any misleading paths that are going to end up with stranded assets that aren't useful down the road. It means really taking an approach that looks at all the available options, looks at whether the molecules we're going to be using are truly clean or not, and evaluates whether hydrogen should be deployed on that basis.

I think there's a real risk of taking some missteps at these early moments and both tarnishing the industry and wasting time and money, which is critical right now. We really need to bring down emissions urgently, and we can't afford to make these mistakes. So we do know what guardrails we need. The evidence is pretty clear that we need guardrails around hydrogen deployment, and there are targeted ways we can do it where it does make sense. And those are the avenues we should follow and try not to be distracted by anything else.

MS. BYLIN: And I would agree with what has been said already, and would add on, you know, with the Scoping Plan perspective of, you know, the 2045 carbon neutrality goal, very ambitious goal, relatively short timeframe for what we need to achieve to get there, and therefore, we really are looking at sort of all tools on the table, right, every tool, but implemented sensibly, as has been mentioned.

So a lot of that more, you know, deep analysis of

the hydrogen specific work will be done through 1075. We're at the very beginning of that. But we will be -- you know, I read that long list of things that the legislature has directed us to include in that report, so we'll be doing -- that's the purpose of this, is to be able to do that deeper analysis, air quality, environmental impacts. All of those things are in our directive, and CARB would be doing that anyway; right? The social impacts, the work workforce development is specifically mentioned in the bill.

So, you know, we want to also do this, you know, kind of an all-tools-on-the-table approach thoughtfully, you know, appropriately and rigorously analyzing the impacts. And then also, maybe I'll mention sort of the ability to -- you know, what can be deployed when, right, and the considerations then. Because obviously, electrification is a strong and very valuable tool in achieving carbon neutrality. But, you know, we have to grow the grid significantly with renewable and zero carbon resources and sort of, you know, we're also trying to eliminate fossil combustion as much as possible.

So achieving all, you know, kind of what is the best balance for achieving all of these goals?

VICE CHAIR GUNDA: Great. Thank you all.

I just want to just kind of make one note to

David and team as we think through not just this product, but the SB 100 and other pieces. I think one, you know, last time around in SB 100, and I believe Scoping Plan too, the hydrogen production was largely off the grid. You know, kind of like understanding the impacts of that would be helpful, the magnitude and the opportunities as an important data point.

And the other element is, I think, demonstrations are a good way, early demonstrations are a good way to gather a lot of this information as we continue to scale. So, you know, whether it's CARB or CEC or together, really kind of, you know, having a tabulation of all the projects we're funding and early lessons for transparency would be really helpful, both on the benefits and the challenges that we have to continue to, you know, fix, right? It's an important element.

And kind of finally, I think one element for us to continue to think through, especially this diverse panel, which is always really helpful when we have different thoughts here is, you know, one of the things as a grid planning side I've observed is we decided not to put in electrification demand until it actually really manifested for the purposes of planning in the grid planning, and we were always five, six, seven years too late. And you ended up now, now in this situation where

the demand is ramping up and we're caught off guard, right, a little bit.

So how do we plan some level of a pathway that's really important into the future planning to allow for that, you know, timeliness of deployment, you know, when it's ready for scaling?

So just want to put those thoughts for our, you know, consideration in IEPR and continue discussion. Thank you.

COMMISSIONER MONAHAN: So I just want to acknowledge that Commissioner Reynolds has joined. And I want to make sure that Commissioner -- that the Commissioners that are joining remotely have a chance to weigh in. So if you could just raise your hand or let me know if you want to ask a question so I don't leave you behind, because otherwise we'll dominate here in the room.

I know Commissioner McAllister has a question, so --

COMMISSIONER MCALLISTER: Well, great. Well, thanks for those great and complimentary presentations. I really appreciate the various perspectives and just, you know, I think it highlights the fact that we -- I think, you know, Tyson, you said we've all got to really work together and sort of roll up our sleeves and come to the table and share perspectives and hopefully, you know,

really sort of iterate around this, I think, requirement that we do a broad integrated analysis in the, you know, the context that Vice Chair Ginda was just describing.

Let's see, I guess, actually, maybe this is -- my question maybe it will be a good segue to our colleagues at the PUC on the dais, on the virtual dais. I'm curious about, sort of stepping back. I'm going to like avoid the urge to ask any technical questions. But stepping back, you know, we are talking about in this whole transition, not just with hydrogen, but across the board, we are talking about generational investments in public infrastructure. And so it brings up questions of, do we need any updates to our kind of regulatory model or regulatory approach?

And I'm curious, direct -- sort of relative to hydrogen, you know, we're going to see a transition in the gas system. And, you know, this is a gas, and we're trying to get out of fossil gas. The infrastructure is going to be similar, but not the same.

And so I'm curious how -- whether each of you has a perspective on what that infrastructure investment, what the involvement of the capital markets looks like? What kind of regular -- you know, should hydrogen, should the hydrogen ecosystem sit, for example, under the authority of the PUC or should it be more sort of out there in the

marketplace happening? Like what regulatory models do you think, are they different? Does our existing one work? Kind of, I'm curious as to whether any of you have given any thought.

You know, are we -- to mobilize the kind of capital that we need to get to 2045 and have, you know, whatever the wedge of hydrogen ends up looking like, what sort of, you know, public authority -- how should that guide this process?

MR. ECKERLE: That's a huge question. It's the right question. I don't know that we have great answers yet.

I'll give you where I think things might go. And this is, I think if we play this right, like ARCHES could become kind of an equivalent of CAISO for hydrogen, where you're starting to match supply and demand and all that type of stuff, you know, and making sure that we have clear, transparent, fair, open market rules. But I don't know if that -- you know, so that's kind of one view of the world where it could go. Like, is that where it's going to go? We don't know yet. We have to work together to get there.

But I think there is -- because we don't know exactly where, you know, all the regulation should live. And what I think we want to make sure is we're not creating

kind of this confusing patchwork of regulatory environment where it's like we need that long term certainty on principle.

And so that's one view of it. I don't want to throw it out there as a controversy, you know, but I think that's kind of one way to think of it. And I think the benefit of what the federal government has kicked up from the Bipartisan Infrastructure Law is a lot of organization across the country, not just ARCHES; right? But it's like that idea of bringing together the public and private stakeholders to get this right. I think there's a lot of value there. And the CAISO model seems to be working pretty well in a lot of ways. And so to me, there's kind of this natural synergies.

But that's a huge question. So that's not like a full answer. I'm just saying, you know --

COMMISSIONER MONAHAN: And I want to make sure Commissioner Reynolds has a chance to ask a question.

COMMISSIONER REYNOLDS: Thank you, Commissioner Monahan. And I'll be following on the heels of Commissioner McAllister here.

I think something that came through in all of your presentations, and thank you all for your presentations, they were really wonderful and informative, you know, the concept of electrification or hydrogen as a

different method of decarbonizing, depending on the application, is an important one, and one that has infrastructure implications either way, significant electrical infrastructure implications for electrifying different processes, significant infrastructure implications for hydrogen as the method to reach decarbonization applications.

I wonder if some of the panelists might be willing to share some thoughts about how we might weigh the opportunity costs of choosing one method or the other for the applications. And, you know, in conjunction with that, give some ideas for how we should think about some of the private choices that are going to be made in conjunction with the large-scale infrastructure choices. You know, an airline choosing a method to decarbonize its short-haul fleet is going to be weighing lots of different factors, and certainly infrastructure availability to support their application will be an important one and cost and I'm sure there are other factors, operational factors.

Do you have some ideas for how we might encourage conversations that help the infrastructure discussions and the private industry thinking aligned so that we're not ending up with stranded assets or so that the infrastructure is able to effectively meet the needs of different structures to decarbonize?

MR. BUDDEN: I think there's some lower hanging fruit to start off with. I hope this answers your question somewhat in that like we do use a lot of hydrogen already today in certain industries, particularly chemicals and refining. So starting off with cleaning up existing hydrogen use is definitely a place where we can deploy hydrogen and not build out a ton of infrastructure we don't think we're going to need.

I also think that there are some other just like really obvious things that we know we don't need hydrogen for that we can just avoid doing that we need to make sure we do avoid. Things like heating our homes, we don't want to blend gas into our distribution, blend hydrogen into our gas distribution networks. That would be really wasteful, and setting up infrastructure to do that would be a big waste.

Light-duty and medium-duty vehicles as well, just that would be a pretty wasteful way to spend our infrastructure money.

So, yeah, those are some easy things to get right. And I think for the rest, we just really need to see how the technology develops and make sure we're doing like really rigorous accounting of the -- all the impacts that have been discussed, including the greenhouse gases, the air pollution, all the community impacts that we've

touched on today.

MR. ECKERLE: And maybe suggest, and thanks for the question, taking even a step back. And I think if we get this right, like what hydrogen penetration should do is enable more renewable electrification, and vice versa; right? So it's kind of that mortar that can pull that system together and enable deeper renewable electrification into our markets.

And so that's kind of where we go, and so we can focus in on the heart of the carbonized sectors for sure, but we can also enable other sectors, you know? So like in the medium- and heavy-duty context, if you're getting those on the road, having passenger vehicles there is a net benefit to and, you know, we can debate the merits there.

But, you know, probably in houses, heat pumps make a whole lot more sense; right? You can start to tease it apart, but it's really that idea of being able to get more renewables out onto the grid and enable more renewable electrification across our economy writ large, and decarbonization into all the sectors.

MS. BYLIN: And just to, I know, I think we're a little tight on time, but just to also acknowledge the prior question about regulatory and permitting aspects, I mean, that was something -- that's something that's asked for in the 1075 report is regulatory and permitting

processes, analyzing sort of optimal regulatory and permitting processes and making recommendations for hydrogen transmission and distribution.

So I think the 1075 process, in partnership with, you know, our partner agencies through a public process we should -- it's not very satisfying because we don't have the answer now but just to know that that process is coming I think is really valuable and we'll be -- you know, have the opportunity to be thoughtful and really take this wholistic look at the intersection of all of these opportunities.

COMMISSIONER MONAHAN: And I see Commissioner Houck has her hand up and I know we're -- so let's finish off with her. We're a little bit over time but I want to make sure everybody on the dais has a chance to ask questions. So in the future, I'll start with the folks on the virtual dais.

COMMISSIONER HOUCK: I'll just make my comment really quick.

I just wanted to thank the panelists. The presentations were very helpful and informative.

And just to follow on regarding, you know, the SB 1075 and the jurisdictional issues that Commissioner McAllister raised, SB 1075, as was noted, clearly has a place to look at recommendations. And the PUC does

currently have some proceedings that are active before it that we are addressing hydrogen issue. So I would encourage you to look at that because I don't want to get into any ex parte violations. Commissioner Reynolds and I both have some of those assigned to our offices.

And just really look forward to working with everyone as we move forward with this effort. It's, again, important to our clean -- meeting our clean energy goals, so just wanted to add that in there.

And I know because of time, I will not ask a question here, but thank you, Commissioner Monahan, for giving me a couple minutes.

COMMISSIONER MONAHAN: Thanks, Commissioner Houck, and we'll make sure we'll start with you next.

So, all right, let's move on to the next panel. And, Jennifer, you're on.

MS. CAMPAGNA: Thank you. Good morning Commissioners and attendees. My name is Jennifer Campagna. I am the Supervisor of the Natural Gas Unit in the Energy Assessments Division at the CEC. I will be providing an overview of the initial approach and preliminary takeaways from the CEC's analysis of hydrogen potential for decarbonizing electricity generation. I'm looking for reaction and feedback today to help frame out future analysis.

Next slide, please.

This is just a quick overview of my presentation. I will provide the background of why we are doing this analysis, and then I'll give an overview of the analytical process that was undertaken. I will cover the preliminary challenges that were identified and the takeaways, and then I will be followed by Quentin Gee the Supervisor of the Transportation Energy Forecasting Unit, and he will present on the transportation analysis.

Next slide, please. Okay, just go oh, sorry. I just lost my place here. I'll just quickly through this.

This is just a background of why we did this analysis. You've heard already mentioned of Senate Bill 1075. This legislation requires the CEC to study and model potential growth of green or clean renewable hydrogen for the power generation and transportation sectors. As noted here, there are other analyses that look at hydrogen at a larger scope of uses, especially for hard to electrify applications. Our analysis builds onto SB 100 analysis, and this will help frame analysis and modeling for the next SB 100 report which will go out in January 2025.

Also, as Tyson covered in his presentation, another guiding policy is Governor Newsom's directive that came out on August 8th for GO-Biz to develop a strategy to create the hydrogen economy of the future.

So next slide, please.

Okay, this is just a nice graphic that sort of shows our analytical processes that we took on here. The preliminary idea is to look at substituting hydrogen for methane and generating electricity. We selected two different 2045 scenarios, an SB 100 scenario and CARB's 2022 Scoping Plan. We evaluated what it takes to create hydrogen to replace the 215 billion cubic feet of natural gas generation still in place in 2045 as identified in the Scoping Plan. Factors that we reviewed include production and electricity needs, the ability to generate and store hydrogen on site, delivery options, and costs.

So based off this early examination, we identified some challenges and preliminary takeaways that helped define the analysis and that we will report on in the 2025 IEPR. And this slide also includes an overview of the transportation analytical steps, which as I noted, Quinton will cover in more detail.

Okay, next slide, please.

Okay, so here I provide an overview of what it would take to generate clean renewable hydrogen from electrolyzers using renewable energy, mostly solar and wind. So you have the renewables that generate the electricity and it is sent to the electrolyzer where it is then converted to clean renewable hydrogen and then stored

in a hydrogen tank until needed to create electricity via fuel cells or combustion and then is sent to the grid.

Preliminary results show that 1 megawatt of renewable power produces enough hydrogen to replace only 0.142 megawatts of natural gas combined-cycle, so about a factor of seven. But I'll just note this estimate is based off current information and technologies; work to improve the efficiencies of this production process, you know, to get this to a better ratio, especially by 2045.

Okay, next slide, please.

Okay, so I showed you the energy -- let's see -- I showed you the energy needed for generating electricity from hydrogen. So I'm going to show you some characteristics of electrolyzers for this process.

So this table shows different models of Cummins PEM electrolyzers, HyLYZER series in a range of flow and sizes. A quick note that PEM stands for proton exchange membrane. It's a key feature of a PEM that allows for fast ramping, but it does cost more.

For purposes of our analysis, we reviewed the Cummins HyLYZER 4000. It's the largest found in the literature search. And if you see that red circle that shows it has a flow of 4,000 cubic meters per hour. The blue circle shows the footprint, so it's a pretty large tank.

So what if we want to replace the Scoping Plan's 215 billion cubic feet of gas burn? Well, when we looked at how many electrolyzers that would take, and the estimate is it would require about 537 HyLYZER 4000s, which is that largest model I was just talking about.

Okay, and I -- oh, and I will note that this does need more modeling in the future to match the sizing of renewables to electrolyzers and the gas burn hours.

So next slide, please.

Okay, so now that we talked about how hydrogen can be produced remotely on site, we can look here at a couple of delivery options. Each does have some challenges.

For trucks to liquefy hydrogen, it is an extra process and entails additional costs for cooling infrastructure. Gaseous form requires compression. This doesn't seem to be a feasible option at volumes required for a power plant because it would mean, you know, truck after truck delivering hydrogen. So pipelines, we looked at blending five percent. So, yeah, sorry, I'm losing my place here. And we just think that any new dedicated hydrogen pipelines would benefit from co-located facilities.

Okay, next slide, please.

So in talking about co-locating, we used GIS,

looking at co-locating electrolyzers and storage at existing gas-fired generators in California. And we found that a single electric generation power plant will require multiple electrolyzers. Only 33 to 40 in California have land space nearby to locate. Seven of these are maybe. I will note this does not include space for additional renewable generation or water requirements, and does not include storage tanks, and you do need almost as many storage tanks as electrolyzers.

Next slide, please.

Okay, so this is just a nice interesting visual that puts into perspective the size of hydrogen storage tanks. You can see this NASA photo shows a couple different storage tanks. On the left you have an older Apollo-era liquefied hydrogen tank, about 3,200 cubic meters. On the right is a new tank that holds about 4,700 cubic meters. Just for perspective on the size of these tanks, you can see there's big rig trucks parked in front of each of those. So it just shows how big these tanks are.

Next slide, please.

Okay, so this slide just talks about the cost of electrolyzers that were examined associated with replacing that 215 billion cubic feet of methane with hydrogen. Early analysis, as I noted, it takes about 537

electrolyzers to do this.

I will just note this is a preliminary effort to build out cost estimates. We made some assumptions for the total capital requirements. This included engineering, financing costs, and others for about 1,500 per kilowatt in 2023. And based on a literature search that predicts electrolyzer costs will decrease by about 80 percent between now and 2045.

So the average TCR for electrolyzers across this timeframe was determined to be $879 per kilowatt. It does not include some other cost factors related to renewable electricity delivery, et cetera. But again, this is very early analysis. We considered production tax credits and how those can help. And we do understand there are other federal funding opportunities and state and local initiatives that will continue to help drive down these costs.

Next slide, please.

Okay, this just tees up some issues that need further examination regarding the proximity of some of the California gas plants to disadvantaged communities. As you've already heard, hydrogen does have greater NOx emissions that would need controls. We could look at possibly prioritizing plants in disadvantaged communities for conversion. This will be an issue that we'll need

examined further in the next phase of analysis.

Next slide, please.

So this is my last slide and this just summarizes all the challenges I described. I won't go through these point by point in the interest of time. I do want to note, there is an error. That last bullet, it should not say $163 billion. I'm sorry, that should be $71.5 billion as was noted on slide ten. And so we will get that fixed when we docket.

But we will also be keeping track of advancements and improvements as we move along through this analysis, including the, as I noted, the incentives and other initiatives that are continuing to develop at a state and federal level.

Next slide, please.

And that wraps up for me. Thank you.

I will now turn over to Quentin Gee for his part of the presentation. Thank you.

MR. GEE: Great. Thank you, Jennifer. Good morning. Yeah, good morning Commissioners. My name is Quentin Gee. I'm the Acting Manager for the Advanced Electrification Analysis Branch, and also the Supervisor for the Transportation Energy Forecasting Unit.

So what we're going to do for the transportation component of the IEPR contribution in SB 1075 is kind of, I

think, limited in certain ways. And I think one of the reasons for that -- and what we're going to be doing is we're going to be sticking primarily to medium- and heavy-duty for the analysis. There are some light-duty fuel-cell electric vehicles out there. We have seen that their market penetration has been relatively small compared to other zero-emission vehicles representing less than 1 percent of new vehicle sales. That has grown a little bit. I mean, that has grown commensurately with other ZEVs. You know, ZEVs, zero-emission vehicles, ZEV sales have grown a lot and fuel-cell electric vehicles have maintained that sort of one percent point, but not really grown as a percentage of all the ZEV sales out there.

So when we got together and started talking about how we would do this modeling, we thought that the best area for us to really sort of show where we're going to need a lot of kilograms of hydrogen was in the medium-and heavy-duty market. There are certainties there.

We currently don't -- they're primarily in the pilot stage as far as fuel-cell electric trucks go, but we do see some potential promise there. And we thought, you know, one of the best ways that we could evaluate this is sort of taking our existing freight model and the truck choice model in particular on that and using it to modify the fuel prices and the truck, the fuel-cell electric truck

prices to sort of capture what the potential is in the hydrogen market out there and what would be the possibility for freight goods movement with hydrogen.

So that's kind of the main approach that we had. We didn't want to change too much in the whole freight model. The freight model is a very complicated mode and, sort of, you have to model out where all the goods are going to be moving in the state and all that stuff and we just sort of said, you know, we don't want to tinker with that.

But when it comes to adding new trucks, right, every year we have to add new trucks in our freight forecast, some retire, there's more goods that need to be moved, so when the trucks are added to the population to move those goods, we, you know, are sort of just saying, well, let's target that, and that's where our truck choice model comes into play. And the truck choice model is a little bit different than the light-duty choice model.

The light-duty choice model is very complicated. As we all know, consumers are very nuanced or complicated in their decision making. When, you know, you try to evaluate, you know, some people are like, oh, I like that color or I like this, you know, whatever, you know, lots of things go on with that. But that's a different story when it comes to medium and heavy-duty trucking and that sort of

thing, those sorts of things.

When it comes to freight movement, really, a fleet operator or even an individual truck driver, you know, an owner-operator is really more interested in like, what's it going to cost? I'm going to make an investment in this truck and it's going to cost. I'm going to make an initial investment in this truck and I'm going to have to spend money to maintain it, to fuel it and all that stuff, what's that going to cost me? If one truck costs twice as much to operate per mile than another truck, you're probably going to go for the lower cost truck.

And so that's where our truck choice model is really good at sort of evaluating that. And we thought, let's modify these scenarios so we can be as consistent as possible with our traditional forecasting framework, but then also, you know, try to get a sense of what could the possibilities be out there with hydrogen.

So why don't we take a look at the next slide and we can look a little bit at these preliminary results in the initial setup of these scenarios.

So really, the only places that we have -- we worked with some contractors a couple years ago to develop forecasts for fuel cell, well, for all truck prices, including fuel-cell electric trucks. And really, we were only seeing them at the time in the Class 6 market and in

the Class 8 market in terms of announcements and other sorts of things like that. Class 6 you could think of as maybe like one of the biggest U-Haul trucks that you can drive out there, what we call maybe a medium straight truck, or these large step vans, some of the really big UPS vans that you might see out there. And then we've got Class 8 trucks, which you can imagine sort of being like these sleeper cabs or other short haul of drayage type trucks.

So what you see there are the pounds or the gross vehicle weight rating, that's kind of like what the whole object, if you were to put it with all its goods and stuff, you know, on a scale, what's it supposed to be not weighing more than; right? And Class 8, you usually go from 33,000 maybe up to 80,000, maybe some cases 82,000 pounds. And so that's where we're really seeing the potential for trucks out there.

There may be some differences with the Air Resources Board on that, with where -- their medium-duty trucks they have forecasted or put into place some other trucks out there, and we want to keep a close eye on the market to see like if there are some other ones that could come forward.

Class 2B maybe is a potential out there if -- that's where you can imagine kind of like big huge -- or

not big huge, but large, really large pickup trucks, those might be an opportunity out there, but so far we haven't seen anything yet.

But with these two vehicle classes, we did have existing fuel-cell electric truck options available, we had prices, we had good data on that. And so what we thought to do with the scenario is basically just modify the prices of these trucks to see if we can get the prices to be a little bit lower, maybe there would be an opportunity for them to increase the percentage of those trucks added into the population.

Next slide.

Okay, so the next thing that we wanted to do, and we realized after conducting these preliminary, again, these are preliminary scenarios where we're still in the process of developing this, it's going to be aligned with the 2023 Integrated Energy Policy Report forecast, so this is -- what we did is we took last year's model, and we just kind of tinkered with some of the inputs there. But hydrogen fuel is one of the leading factors, the fuel prices is one of the leading factors that we found here in terms of adoption rates that we would likely see.

And so what we did was we ran three scenarios. One of them was what we call the baseline scenario where we took the new vehicle prices, so it's not the same as the

2022 IEPR, but we took the new vehicle prices, and then we also took the standard hydrogen fuel price forecast that we had from the National Renewable Energy Lab last year.

And we also drew two other scenarios in here. One of them was basically starting pretty close to the same amount, same price of the 2023 price. I think it was aligned with the 2021 price.

But we drew -- we kind of just linearly declined it to say like, well, let's say in 2035, the year that we're seeing a lot of our major zero-emission vehicle rules, you know, really kick in to their full force, let's just say in 2035, they just linearly declined down to $7.00 per kilogram of hydrogen or $5.00 per kilogram of hydrogen. This would be the retail price.

One thing we want to make sure we're clear on is there's a difference between the production price, you know, which might be coming out of the electrolyzer, then you've got to do all these other steps that some of the speakers spoke to before that, and then you've also got the cost of operation for a fueling site and those sorts of things like that. So we're talking about the retail price you fill up, you would pay $5.00 a kilogram or $7.00 a kilogram.

So we have this continually declining price linearly, just to kind of see what happens in the model

with this relatively simple modification. And, you know, from there we can get a sense of what are the possibilities out there. And what we found is that actually it's the fuel price that's driving some of the adoption in our work here.

Let's take a look at the next slide and we can look at another key input.

So the other key input, so fuel prices are one of the key drivers there, but another key input is the actual price of the trucks. Right now, hydrogen fuel-cell electric vehicle trucks, they are a little bit on the expensive side. But we think that there's quite a possibility, and we already actually had them declining anyway, but we introduced some new price declines in there to say, like, well, let's say that the learning rate on the fuel cell stacks can really get a lot better. In that case, that we could have these price reductions, what would happen?

And so what we did is we started with sort of what we have known and were able to document with some of our work with other folks is the starting price. We have these trucks - The Class 8 trucks are introduced in 2027, and they have a continual price decline out there, eventually meeting parity with diesel trucks in 2040 and actually undercutting electric trucks in around 2033, 2034.

Next slide.

So here's the results of the scenario. So we have these two major factors in the total cost of ownership calculation here that impacts the choice model. And we can see in the dark blue line at the very bottom there, you can sort of see that under the standard fuel price and the standard truck prices, not a whole lot of adoption going on there in total fuel-cell electric trucks. And then when the price declines to $7.00 per kilogram, you actually do see a larger uptake and quite a bit larger uptake if it can get down to $5.00 per kilogram.

That does differ in some ways from the CARB Scoping Plan scenario, and I think the leading reason for that is that we didn't have as many truck categories as we showed at the very beginning slide. We only had Class 6 and Class 8. And I believe, I don't have the exact numbers, but I believe in the CARB Scoping Plan they had many other vehicle classes of hydrogen fueled trucks. So we think that that was probably one of the leading drivers there.

Next slide.

Okay, similarly, we can see in the case of hydrogen demand sort of just growing in the same way that the trucks grow, pretty similar. You may have noticed in the previous slide, CARB had a lot more vehicles, and the

difference, the gap between our fuel demand and the vehicle demand is a little bit smaller when it comes to the fuel demand.

The reason I think for that is, again, having to do with the fact that we're seeing more adoption in the heavier trucks and didn't have as many of the lighter-duty trucks, or not lighter, but more medium-duty trucks. And so in that case, the heavier trucks, you know, they're less fuel efficient because they're moving a whole lot more stuff. So we think that this is the explanatory factor here, but still a solid amount of demand for hydrogen in these scenarios, these two scenarios.

Next slide.

So the last thing that we thought would be useful to draw attention to is we really didn't see a whole lot of changes across our scenarios in the Class 6 category. So making hydrogen a little bit cheaper, really, or a lot cheaper, that really doesn't help that much with adoption in those categories.

But if you take a look at what we call the IRP trucks, these are international registration plans, these are basically long haul trucks that go interstate, they go all the way out to Texas or all the way up to Washington or something like that, what we see in these cases is that, you know, the difference between the $7.00 per kilogram and

$5.00 per kilogram, you know, truck population levels, you can see quite a bit. It just really goes up quite high, especially for those trucks, because primarily, you know, they're driving so many miles. If you're driving a whole lot of miles and the price of the truck is not as big of a factor as the cost of the fuel because, you know, driving a lot of miles, the fuel is what's going to be a larger part of your bottom line.

So we noticed that with the IRP trucks and California-based, California home-based IRP trucks in both those scenarios, you can see that just a $2.00 per kilogram reduction in price could almost, I think, more than double the demand for the trucks. And so we thought that was a really important finding, a preliminary finding here. Again, we still need to run the model and its final setup with the 2023 IEPR. But we think that this is probably one of the strongest indicators here that the fuel prices is one of the key things, especially for long haul.

I should note one other thing is that we pointed out that really what we're kind of envisioning, the trucks in our fuel -- in our demand models, the trucks really have unlimited access to fuel. The price impacts how much they'll use it. But, you know, if a lot of these trucks are trucks that are going across interstates, we didn't evaluate the infrastructure availability for refueling, you

know, in these different states. So that's one important limitation. And I don't know if that's something that we can really address right now in our model.

Next slide.

The next steps, we want to refine the inputs, get feedback from the public. We want to explore some potential ways to maybe do this for fuel-cell electric buses. They're not quite as large in terms of fuel demand and total population. But there are a good number of them that may -- we may, you know, modify, improve this a little bit more, and also compare some of our results with some existing hydrogen, other existing hydrogen adoption scenarios.

So with that, I think Jennifer and I can take some questions. Actually, one last slide, sorry. Thank you.

I do want to give very, very much credit to Maggie Deng, who is our Lead Freight Truck Forecaster. She did a lot of this groundwork and I'm just kind of, I guess, sitting in her seat today. Yeah. She lives in L.A., so, yeah.

COMMISSIONER MONAHAN: That was great. Thanks, Jennifer and Quentin. Really excellent presentation. It's good food for thought, that's for sure.

And I want to make sure I commit to starting with

Commissioner Houck, if she has any questions, or Commissioner Reynolds, just to give the virtual dais space. Any --

COMMISSIONER HOUCK: Yes. I know that the focus was on looking at heavy-duty and vehicle transportation, but -- and I don't know if this is a question. I know CARB wasn't on this panel, so this may not be the appropriate panelists. But, you know, are we looking at how we're going to address fuels for airplanes? Because that's going to also be critical here. And I know I didn't see it in the earlier presentations or discussed here. So, again, we may not have the right folks for that, but I didn't want to lose sight of that either.

MR. GEE: Yeah. Thank you, Commissioner Houck. That is something that would be able to be addressed with us. We've been in some conversations with this. It may be something that we can integrate with our demand scenarios and something that we should be thinking about. There's a lot of uncertainties still in that area, but it's something that we -- I can work with the team to make sure that we definitely at least qualitatively discuss the possibility. We'll see about being able to quantify it. But that is something that we are working on.

COMMISSIONER HOUCK: Well, thank you, and thank you for the presentations.

COMMISSIONER MONAHAN: Commissioner Reynolds, do you have any comments or questions?

MR. WICHERT: No additional questions for me. Thank you, Commission Monahan.

COMMISSIONER MONAHAN: All right. And then I'm going to go to Commissioner McAllister because I cut him off in the interest of time, which I feel terrible about.

So, Commissioner McAllister, do you have any questions or comments?

COMMISSIONER MCALLISTER: I actually don't on this panel. I just want to say thanks to both of you, Jennifer and Quentin. A lot of great data there.

And, I mean, I will just remark that the differences in the various forecasts are, you know, quite notable. And I think, you know, it just reflects the -- you know, nobody has the same crystal -- you know, lots of different crystal balls here and lots of different methodologies and, you know, really important to track trends and incorporate those iteratively into our forecast and work with ARB and others.

So, but, yeah, thank you very much.

VICE CHAIR GUNDA: Thank you, Jennifer and Quentin, for the presentation.

I want to kind of pull it up a tiny bit. I think, you know, we've done -- you know, I understand this

is preliminary analysis and framing for CEC's part of the report. And I want to note Commissioner Houck's point on just the, you know, aviation sector and others, and potentially marine vessels and hydrogen, and how do you completely take that into account?

But let's kind of take a step up right here. Just, I think, from the first panel to going into this panel, we're trying to kind of -- and I think there's two things that are happening. There's a very clear understanding that we would need some level of clean molecules for the future transition; right? And I'm like framing this for the context of the work that CEC can do to support the conversation; right?

And then we are saying there's huge uncertainty here. The huge uncertainty comes from whether we have enough electricity to produce the green hydrogen and at what scale, what time, you know, and how does that drive the costs? And then we are talking about, you know, the usage of existing hydrogen in different sectors, right, like at the start, and then hopefully like, you know, bringing a pathway forward.

We also noted, especially from Tyson's presentation, kind of the opportunity for really coalescing a regional strategy, right, to really, you know, kickstart this opportunity. So I think from a policy standpoint,

it's really important to understand the bookends and the opportunities; right?

So when I think about specifically, you know, if I interpret the kind of statute as what is the total addressable market, I think the approach, Jennifer, that you've taken in the presentation that you provided was let me look at Scoping Plan and I'm going to -- and let's look at a scenario where we replace all of the natural gas need with a cleaner fuel like hydrogen; right? And then I'm going to create a bookend there on that side.

The other bookend is, you know, the Scoping Plan does not take into account high level of demand flexibility, does not take into account high level of the penetration. And what does that do to the potential need of natural gas fleet and how does that affect you, right, on the back end? And similarly for transportation, you have a high level bookend and a lower bookend.

And I think that the reason that's important to lay that out is this is a chicken-and-egg problem; right? At some point, the state and, you know, with broad public consensus has to decide whether we are going to invest enough money to create a market; right?

And if we are creating the market, how do you create the market in a way that there are clear step ups in scaling? Here you go, we created a regional market, a huge

test bed, ARCHES project, you know, like how Tyson kind of framed it, and that's the opportunity. And if that opportunity, you know, based on the demonstration of that, we've seen the benefits, we've seen the impacts, is that opportunity to then replicate the ARCHES model across California at different hubs, right, or not?

So I think it's important for us to like create that boundary and say, for this boundary to happen, these are the conditions that ultimately has to be in place to make that happen. If we are looking at, you know, business as usual, just looking at costs and with no incentives, we might not get there; right? Or the other bookends.

I just wanted to kind of make sure that we capture that nuance in the presentations we develop. I don't want us to kind of be in the situation going back, you know, and, you know, chastising myself. When I used to be in a staff here, you know, the Commissioners used to ask, hey, what is the EV forecast? And we would say our model is saying this. And they would say, no, that is not, you know, what the policies of the world are. And you're not taking into account all those policies. And it would have a different impact.

And we have seen over the -- you know, if you look at the earlier forecast, 2017, 2018, the EV forecasts were much lower. And suddenly, you know, and now we have like

this huge kind of inflection.

So I just want to capture that nuance and understand that a part of hydrogen journey is kind of state putting its finger on kind of saying this is an important element for XYZ regions, you know, like, you know, I think CARB will do that, and for us to allow for the space for the discussion to happen and create that independent forum for that, you know, broad information base.

So I just wanted to give that as an opportunity for us to consider as we develop a report. Thanks.

COMMISSIONER MONAHAN: Well, and I want to build on that a little and just say that I really appreciate this scenario-based approach, that where we say, well, if this happens, then that could happen. Because what we're trying to do is forecast what prices are going to do in the hydrogen, in the space of hydrogen. And we've seen volatile prices, in part due to volatile natural gas prices and in part due to changes that I think will happen to the Low Carbon Fuel Standard to increase credit prices. But the volatility has been in the opposite direction of where we want to go.

And to really reach these deep penetration of vehicles, we need to make sure that the price of clean hydrogen reaches, at least in the transportation space, you know, something commensurate with diesel. And that's

critical. We can't forecast that. We're doing all we can to bring down the price. I think ARCHES is doing all it can. And we have more opportunity now than we've ever had to be able to reach those goals.

But a scenario-based approach is really important. And I think one of the things as the lead energy planning agency we wrestle with is, so when do we start accounting for that in demand for electricity? And as the Vice Chair said, you know, we changed our -- dramatically changed our planning process to account for not just regulations that are passed, but regulations that we expect to happen just to meet state goals.

And so that's leading, I think, you know, to a situation where in the past we told, we as a state, the CPUC, really, told utilities to be more efficient, use less energy, plan for that. We have four-year general rate cases that did that. And now we're saying, no, we're changing our planning processes. As a state, we're looking more, you know, we're accounting for this electricity use that we're going to do. We're changing how utilities plan. Utilities are adjusting. They're changing their planning and investment and distribution level and transmission level, actually, on the bigger integration of renewables and energy storage side.

And all this is happening simultaneously. And

this is some of the appeal of hydrogen is that we want to have a diverse set of energy sources and we need to plan for all this renewable energy.

And, Jennifer, I was particularly like, I think the space considerations, if it's done here, that's important. We need to account for that. If it's done here, we need to account for the electricity generation. We're not right now and we need to.

So all this is, you know, in terms of, you know, we have these scenarios now, eventually we need to get to a place where we feel more confident, and then we incorporate that into our demand forecast. We're not there yet. We're at a scenario-based, I think. And we want to, we need to get there in order to plan appropriately for our energy needs.

VICE CHAIR GUNDA: Yeah, I think just elevating Commissioner Monahan's point right there.

So, you know, EAD, Energy Assessment Division, is right in the middle of, Quentin, you are in the middle of petroleum. And here you go on the petroleum side, we're talking about potential refineries, you know, closing in California. And what happens to all those tanks that are built out there, right, for that, you know? And maybe they're not usable, right, for hydrogen.

But, you know, kind of, I think that nuance of

that being able to have the discussion would be really helpful. And I think we inadvertently shape policy in this forum. And, you know, we need to be like really objective and methodical in the way we frame it so it gives space for people to really, you know, take those different points of view to, you know, shape the policy here.

The other kind of -- just as Commissioner Monahan was speaking, when we started thinking about the electricity planning and then baking in more and more electrification, the importance of that is to understand the impact; right? But I think we have some colleagues, stakeholders who call in, specifically reminding all of us, you know, the ratepayer impacts.

And so the important thing is to knowing the cost, where it's paid from, whether it's general fund, whether it's federal stimulus or whether it's something else, we just need to understand the cost so we can understand what can be borne by ratepayers meaningfully, what can come from a state funded or a federal funded. And for those things to have like meaningful discussions, we need to look at all edges so that we can have that clear opportunity at a table to think through all of this with the site on solving the issue.

So thank you. Thank you.

COMMISSIONER MCALLISTER: So I want to just also

mentioned, you know, we do have the -- we do a lot of R&D. And in the previous panel, there was a mention of, you know, leakage trades and things like that. We have funded some, you know, research on those issues.

And I think would just highlight that the quick turnaround. Like, as these technical issues come up and as we really are pushing the envelope on, you know, conceiving the market and incorporating that into our forecasting and really sort of talking nuts and bolts, what are we planning for really, these particular issues will come up that I think could require and really benefit from some state investment in targeted R&D or targeted studies and things like that, EPIC is, and I think we're very well positioned to keep doing that.

And so, you know, certainly, as those ideas come up, I think staff is paying attention and working with our colleagues at the PUC and really trying to find out what topics have the most value and that we can invest in as a state. And, you know, coordinating that with ARCHES, I think will be really important going forward.

COMMISSIONER MONAHAN: I mean, I think I -- and unless this has stimulated any thought on the side of the PUC, I think we're ready to take a break for lunch; is that right, Heather?

MS. RAITT: Yeah. Unless you want to say

anything more, we're ready to take a break. And we'll leave the line open and it'll be the same login if folks log off, just you can use the same credentials to get back on this afternoon. We'll start back at 1:30 with some more panels.

Thank you, everybody.

(Off the record at 12:16 p.m.)

(On the record at 1:30 p.m.)

MS. RAITT: All right, so welcome back, everybody. It's 1:30. I'm Heather Raitt. Welcome back to the workshop on the potential growth of hydrogen for the IEPR.

And just a couple of reminders. This workshop's being recorded. And so we'll post a recording, an audio recording, probably tomorrow, and then a written transcript in about a month or so. And so thank you, everybody, for being here in person and virtually.

One other thing I just wanted to say is that we have an opportunity for public comments at the end of the day. And so if you're attending remotely, you can press that raise hand, it looks like a high five, on Zoom. We'll be taking comments, like I said, at the end of the day after these presentations. Or if you're on the phone, you can press star 9, and that'll effectively raise your hand to let us know that you want to comment. And if you're in

the room, we can have folks come to the lectern to comment when the time comes.

But with that, we can go ahead and get started. And so our first panel this afternoon is -- Jason Orta is going to go ahead and get us started. Thank you.

MR. ORTA: Thank you. Good afternoon, Commissioners. This panel that's on, that's coming on right now, is the potential adoption of hydrogen in decarbonizing the electric sector. We have a very diverse panel of electric and gas utilities here on the dais, and also a representative from Mitsubishi representing the equipment side.

So we have, as follows, we have Carlos Koeneke of Mitsubishi, Melanie Davidson of San Diego Gas and Electric, Kevin Pease from PG&E, Yuri Freedman from the Southern California Gas Company, and Randy Howard from the Northern California Power Agency, NCPA.

So let's begin with Carlos.

MR. KOENEKE: Yes, good afternoon, and thank you. Thank you very much for the opportunity to participate in this workshop.

I put together a few slides that are mainly focused on three items, on three subjects. The first one is related to, you know, explaining or addressing safety concerns that I hear very frequently related to, for

example, material embrittlement, hydrogen leaks, et cetera.

The second one is to describe a little bit that our current main focus in development is the use of high-content hydrogen in dry low-NOx type of combustor, not, let's say, the vintage diffusion type that needs injection of either water or steam, which is obviously not a good thing.

And then the third part that I want to discuss is the way we are planning to approach the verification of not only how the turbines react to higher hydrogen, but also how do we produce the hydrogen upstream. And that, I will use -- for that, I will use that sketch that you see in the right side of the slide.

So let's move to the next, please. And let's skip this, because I don't think I have enough time. Next one, please.

So the graph on the left shows experience that we have through decades of operation with different hydrogen blends. So in the horizontal axis, you can see the years, and then in the vertical, the hydrogen content we have operated in many different locations. And without getting into too much details in the lower left corner, you see that we are listing their syngas, which is typically used as a product of IGCC projects, for example. Then steel mills is the red circle. COG, in that case, stands for

coke-oven gas, which has a relatively high hydrogen content. And the blue dots are for refineries, which typically are very high.

So you can see how there are a lot of plants that have operated. And if you look at the top, there are two blue lines, one says A plant and B plant, that have operated for a long time with margins as high as between 80 percent and 90 percent hydrogen.

So the reason I wanted to show this is despite the fact that these, you know, all these units, which are different, but they operated with diffusion-type combustors. But the fact of the matter is that if we have accumulated 4 million hours without any issue from the safety point of view, it means that if you design the plant from the very beginning, taking into consideration selecting the right material, using, you know, codes, whether it's NFPA or ASME, that are more strict for hydrogen than natural gas, for example, if we select proper sensors or devices that are around the equipment, everything works well.

So my intention was mainly to, you know, address some of those concerns.

Next slide, please. Next slide.

So this shows the two different combustors that we are using. On the left side is the large frame gas

turbine, and on the right is the meat and small size. So we are doing a big effort to, you know, develop a higher content here.

Next slide, please.

This is a very important demonstration that we did in Atlanta. This is a Georgia Power Power Station with an advanced class gas turbine that operates at 1,500 degrees C. And if you look at it, there are two very significant results from this demonstration.

If you look at the graph on the top, it shows the NOx emissions for different loads. And you can see the lines. The black line means the data we have measured with natural gas. And you can see the blue line that is basically the same or even slightly lower. So I have heard in previous presentations like a fact that the NOx has to go up, and that's not necessarily the case, and that is because we have the capability of doing tuning.

And the graph below shows that we also have benefit from CO emissions because we are putting less carbon when you're putting less natural gas into the fuel. So obviously, the amount of CO is lower, which is typically the restriction for low loads.

I'm getting signals that I've run out of time. I don't know if I can go to the last slide? I have more slide, just to show that this is what I wanted to talk

about.

In the center, you see a power station that we have developed in Japan. We have done validation through real power stations for about 23 years. This is the latest plant that we have. But if you see to the right-hand side, and you see a lot of infrastructure in blue color, including storage, piping to two different gas turbines, and in the center, you see a building that says electrolysis, that electrolysis generation facility is already in operation. We're filling up the storage.

And very soon, we will start doing combustion tests, not 24/7, not 24 hours, seven days a week, because the storage is not enough, but several hours in the large frame with, at this moment, 30 percent, and in the small that you see on the left-hand side, with much closer to 100. So that's the way we're going to validate not only the reaction of the gas turbines to a higher amount of hydrogen, but also upstream, how is the hydrogen generation.

So I'll stop here, because I run out of time.

MR. ORTA: Thank you. Thank you very much.

We will move on to our next speaker, Melanie Davidson from San Diego Gas and Electric.

MS. DAVIDSON: Thank you very much. And thank you for inviting SDG&E to participate in this important

conversation today.

So I'm really excited to talk about hydrogen for its ability to help enable electrification in the power sector. At SDG&E, we think about hydrogen not as a competitor to electrification, nor as an alternative, but really that key enabler that's going to allow us to continue to provide reliable, cost-effective energy to our customers. And I think that's ultimately the goal that we have here is carbon-free, reliable energy on our grid. And I think hydrogen is going to be a really important part of getting us there.

Next slide, please.

In the spring of 2022, SDG&E came out with its Path to Net Zero Study. And that study looked at the grid in 2045 taking a 1-in-10 year loss of load expectation perspective. And what the model showed is that not only are we going to require 4x the amount of generation capacity in the state that we currently have, but that a significant amount of that is going to obviously be renewables, but renewables and storage won't get us to all of the reliability we need. There is a role for hydrogen.

And then when we compare that to the CARB Scoping Plan, CARB Scoping Plan also for the 2045 scenario, it looks at and sees that there is a significant need for hydrogen generation to support reliability on our grid.

Next slide, please.

And what was really interesting about these two studies is that the numbers aren't too far off for 2045. So whether we're considering CARB's number of requiring 9 gigawatts of firm dispatchable hydrogen-based capacity in 2045 or 20 using the 1-in-10 year loss of load requirement, we're going to need a lot of hydrogen on the grid for reliability. And even further, CARB's model shows that in 2035, we will already acquire 4 gigawatts of hydrogen capacity.

Next slide, please.

So time is going really fast. And we have until 2045. So how is SDG&E thinking about hydrogen adoption for the power sector?

Here we are in the 2020s. We're really seeing this as the opportunity for pilots. And that's what we're doing. I'll talk about one of our more exciting pilots today. But right now, costs are high. The industry is immature. We're unclear what the policy directives are. And we have significant reputational hurdles and educational hurdles to overcome with this technology.

2030s, we're really seeing as the decade of adoption. So the industry is going to mature. Prices will come down. We'll see some pipelines enter into service.

And then 2040s, we're considering the decade of

mass deployment.

Next slide, please.

So when we think about this transition, 20 years sounds like a really long time. But when you're talking about significant heavy infrastructure investments, it's not. And when we look to see how long the IOUs took to procure 19 gigawatts of RPS eligible capacity, it took them 20 years.

And we're looking at the same scale of gigawatt addition of hydrogen generation capacity over the same time scale. And so we really think utilities must begin today. And what's so interesting is that when we compare the hydrogen transition to what we saw in battery and solar, as you can see, the transition started really slowly in the beginning. Technology was expensive. Over time, because of the utility investments that were made, price came down and scale was able to be achieved.

So we have good reason to believe that hydrogen will follow the same trajectory. But we need to begin those investments today. And SDG&E is doing just that.

Next slide, please.

So the Palomar Energy Center is SDG&E's largest power plant. It's a 588 megawatt natural gas combined-cycle plant located in our service territory. And in an effort to begin really understanding how to operate

hydrogen assets, SDG&E is in the process of placing into service a hydrogen system. So that system includes dedicated on-site solar canopies to help offset emissions to create the hydrogen. We're using electrolytic hydrogen, so we'll have a 1.25 megawatt electrolyzer. And the image you see here is that electrolyzer being delivered. It was delivered on-site last week. And we expect it to be operational by the end of the year.

We're also going to be using that hydrogen to fuel some vehicles that operators at the power plant use to visit our distributed microgrid sites and battery sites that are all managed out of that power plant. And we will be using it as a cooling gas. But the main goal is to blend the hydrogen with natural gas in the combustion turbine.

Next slide, please.

So here you can see the system design. So electricity and water goes into the electrolyzer. We get hydrogen out. And then we're demonstrating three use cases of hydrogen, as I said, gas blending, generator cooling, and hydrogen fueling.

What's really great about showcasing these multiple uses is the significant operational learnings SDG&E will achieve. SDG&E is an operating company. We learn by building and doing so that we can scale this in

the future. So with this prudent investment of this relatively small sized system compared to the scale of the Palomar Energy Center, we're gaining expertise in hydrogen engineering and system design, codes and standards, controls, learning about valves, piping, and materials that are proper for hydrogen integration, hazard mitigation, risk management, the performance of hydrogen equipment, cost implications, how to manage these assets and operate them safely, developing standard operating procedures, training staff, as well as represented employees, including labor unions.

So it's really important to us to have these small scale prudent investments in hydrogen so that as we approach the next 20 years when we believe we will be requiring significantly more hydrogen generation in the system, we're prepared to deploy it in a safe and effective way.

So thank you.

MR. ORTA: Thanks, Melanie.

We will move on to Kevin Pease from the Pacific Gas and Electric Company, PG&E.

MR. PEASE: Thank you very much. Thank you for the opportunity to be here. My name is Kevin Pease.

COMMISSIONER MONAHAN: I think your mic -- yeah.

MR. PEASE: Hello? Can you hear me? All right.

Thank you very much. Thank you for the opportunity to be here. My name is Kevin Pease, and I'm an engineer in PG&E's Greenhouse Gas Emissions Strategies Team. I'm going to be highlighting a couple of projects that we have involving hydrogen. One that we believe is key to getting the midstream component of hydrogen transportation completed, and another that showcases what's possible with hydrogen electric generation today.

Next slide, please.

First is our Hydrogen to Infinity project. This project is working, planning to be operationalized in 2026, and it will be a large-scale research demonstration, education, and market activation project for hydrogen blending and natural gas transmission systems.

Significant global efforts have been completed to understand issues and develop appropriate means to allow safe and reliable use of hydrogen in natural gas systems. Existing projects generally focus on natural gas blends in lower pressure natural gas networks, and there are issues that need to be addressed for higher pressure transmission systems. The goal of the project is to provide a facility which will address the significant issues and provide the information necessary to support safe permitting and implementation of blending into natural gas transmission systems.

Data from the project will be shared with all California utilities and will benefit national and international utilities as well. Industry and research associations will also benefit through reporting and public presentations on the project results. The project will facilitate market activation by providing multi-modality hydrogen fueling station to serve heavy-duty and light-duty hydrogen powered vehicles. And the project will serve as a testing ground for various technology developers, ranging from hydrogen production, power generation, gas separation, leak detection, and inline inspection tools.

To highlight one aspect, leak detection, PG&E is partnering with four teams being funded to develop parts, excuse me, parts per billion level hydrogen detection sensors. These teams are currently negotiating with the Department of Energy for funding, and PG&E will host these teams for field demonstrations of their sensors.

The Hydrogen to Infinity Project also includes electrolytic hydrogen production and electric generation by our project collaborator in Northern California Power Agency, which Randy will talk about here in a moment. The project will include testing facilities with a comprehensive RD&D program, training facilities with a workforce development program, supporting natural gas pipeline workers for a future working with hydrogen. And

it will also include an internal and external stakeholder education facility.

The project is in an area with a CalEnviroScreen rating of 81 percent and is along a major transportation corridor. This provides an opportunity for the project to benefit the local community by creating additional jobs, and the hydrogen fueling station will provide clean transportation fuel to improve air quality in the area.

Ultimately, Hydrogen to Infinity will support large-scale decarbonization of natural gas networks, demonstrate gas-fired electric generation, and do so in a cost-effective way by enabling us to leverage the significant existing infrastructure of the natural gas system.

Next slide, please.

The second project is located in the City of Calistoga. This is in partnership with Energy Vault. This project is going to be a hybrid battery and hydrogen fuel cell system to be capable of powering the town and their 2,000 electric customers for up to 48 hours using nearly 300 megawatt-hours of carbon-free energy during planned outages for public safety power shut-offs that occur to prevent wildfire risk during red flag weather conditions.

The long-duration energy storage system is first of its kind and integrates a short-duration battery system

for grid farming and black start capabilities, along with long-duration energies supplied by the hydrogen fuel cells. The project will also include liquid hydrogen storage system for green hydrogen storage.

The system will be managed and dispatched by Energy Vault's technology-neutral energy management system to optimize performance and safety while minimizing operational costs.

CPUC recently approved this project to proceed for construction scheduled to begin in Q4 of this year, with commercial operation expected by the end of Q2 2024. PG&E envisions this project to become a template for clean, renewable, community-scale microgrids.

Next slide, please. Thank you very much.

Any questions that you have for us at PG&E can be sent to hydrogen at pge.com. Thank you again, and I'll pass it to Yuri.

MR. ORTA: Go ahead. Go ahead, Yuri.

Thanks, Kevin.

You know I'll wait for a second for my slides. Good. Good afternoon, and thank you for the opportunity to be here today. I think this conversation is very important, and what I'm going to do in my short presentation is to touch upon some of the analytical work that we did to analyze the impact of and the importance of

clean fuels and hydrogen for reliability.

But before I do that, you know, I reflected a little bit on the panels this morning, and I just wanted to maybe take conversation one level up. I really appreciate Vice Chair Gunda's comments that clean fuels, clean molecules are very important to us as a state, as a country, on a global level.

But where I wanted to go is that in light of that importance, we need, while keeping in mind all the aspects that we should be focused on, such as safety, such as impact on air quality, and the indirect greenhouse gas impact, we should really think about scaling this up at the same pace that we are scaling the green electrons.

And the reason I'm saying that is that the analysis that was done by Bloomberg suggests that if you ask the fundamental question, how are we going to use energy in a carbon-free world, the answer is actually it's about 50-50 split between electrons and molecules. That, to me, was a very profound conclusion. That, by the way, stands on the shoulders of the fact that today 80 percent of our needs are supplied by molecules on a global scale.

So several things jump out of it immediately, but one of them is that they are equally important. And I think we would all agree we accomplished world-class success in electrons. We have a lot of work to do on

molecules. And in fact, reliability is one of the key points that connects them together, because we cannot advance too far one of them without taking proper care of the other, which is where reliability comes in.

We've done some work to look into this deeper -- a let's go to the next slide, please -- and we conducted a clean fuel study a couple of years ago. And recently, we updated this and expanded that with our reliability analysis.

The short of it is that if you analyze reliability in the context of the loss of load expectations, which is, I think, how we should be looking at that, that unsurprisingly brings to fore the role of molecules, and we need more of them than if you don't. That's the simplest way to think about that. So not only the combination of electrons and molecules is the most affordable, it is actually also the most resilient. And we have both studies on our website, happy to share them.

This is, by no means, the end of the work. But in my mind, this is what I see can play a major role and while we commend inclusion of reliability into the analysis. But to me, the question is, first of all, is not whether you include it or not, you have to.

Second of all, what are your assumptions on that? Because I heard just recently Chair Randolph speaking about

that maybe 1-in-10 is not adequate assumption. Because if we are looking to electrify homes and mobility, then we want to be sure that the resiliency that comes with that is going to keep people, obviously, safe and at the level of their expectations.

So these are, to me, very important points. And I just wanted to make them early on. I realize that time to talk about this now is very short.

Let's go to the next slide.

And the next slide is an important point. We summarized some of the policy recommendations. I will say that, and Commissioner McAllister touched upon this earlier on, what would it take to create a thriving, vibrant hydrogen ecosystem, which is all we're trying to do? And Tyson is working very hard on that, as well as many others.

There are four pillars of that, in our view. It's supply, demand, it's the connectivity, and then there's the market structure. And we, as people who provide this connectivity today on natural gas, we see how crucial it is to provide that connectivity between supply and demand. Because I think while there is production potential next to demand sources, I think the economics of production points to the fact that we will need to produce, ultimately, a lot of hydrogen far away from a load, where the land is more abundant, where the solar energy is more

higher quality. But that means we need to bring those molecules of scale. And we all know how hard it is to build these projects.

So that, to me, is where the Commission can play a major role into aspects in both, and also the market, and also in land use planning. Because the CEC has a rich and successful history in the Renewable Energy Transmission Initiative and other initiatives, which could be fully applied. We should be fully applied to this. So that, in my mind, is what's so important.

We, as you all know -- let's go to the next slide -- are developing a large pipeline project, Angeles Link, that aims to do exactly that, bring large amounts of renewables that can make a very large greenhouse gas impact, also very large air quality impact. Because, as I think the CEC analysis suggests, transportation, especially heavy-duty, has tremendous potential for displacement of diesel by hydrogen. And we really look forward to working with the Commission with other stakeholders on this.

And maybe I'll wrap up on the note where I started. Both electrons and molecules are important. I was thinking about a metaphor to describe that. And since now is the U.S. Open, I could think about, you can have a world class forehand; if you don't have a backhand, you're going to be in a very precarious position.

We in California have a world class forehand with our electrons. We should develop the world class backhand with molecules. And then we can be number one in the world.

Thank you.

MR. ORTA: And with that, I will serve the ball over to Randy Howard from NCPA.

MR. HOWARD: Thank you. Let me jump right in because I watched this time clock go and it goes really fast.

So next slide, please.

Thank you for the opportunity to share a little bit about NCPA, a little bit about the Lodi Energy Center and the hydrogen project that's going on down there.

So NCPA is a joint powers agency. We have 16 members. We also support a number of the CCAs, as well, with both procurement and scheduling services. We serve about 700,000 residents in Northern California.

Next slide.

So the Hydrogen Center, as proposed, it's currently our Lodi Energy Center. It's one of the newest. It's a fast-start unit, came online in 2012, so one of the newest for California, a very low emitting power plant today. And we're moving forward with that plant and trying to make sure that we can repurpose this investment that the

communities have made to be zero-emission output into the future.

And so it's centrally located in Lodi, so near the Bay Area, but also just on the northern end of the Central Valley. It sits along the I-5 corridor. And we also can support one of our members, the Port of Oakland, through this project as proposed.

Next slide, please.

So some of the basics that we're proposing to do there is we have a number of renewables in our portfolio already that support the needs of our members. Some of our members are already 100 percent emission-free in their portfolios. And that means they have excess quite often. It means we have excess at certain times of the day, certain times of the year into our supply.

We use recycled water currently. Our plant sits adjacent to reclaimed water facilities for the city of Lodi. So we use it for our cooling system. We have plenty of excess water to produce hydrogen there.

We already have a very large transmission interconnection for that facility. Our objective here is to utilize that same transmission interconnection to serve a load of electrolyzers when we're not using it to produce power out of the facility and sending it back so we don't feel we need a new transmission there. We're going to use

this primarily as a storage tool so we can store our excess renewable energy onsite as hydrogen and then use it in our turbines when our turbines are operational.

Next slide, please.

Multiple benefits. So in 2019, we had an opportunity to upgrade our turbine at that location. Siemens is our O&M provider there. And so we spent $50 million upgraded to a turbine. It's capable of a 45 percent hydrogen blend today. We believe we'll be capable of 100 percent by 2028.

We also plan on providing additional hydrogen and producing it at that location to support PG&E's activities, but also to support activities at the Port of Oakland and the airport of Oakland, as well as the transportation sector along the I-5 corridor and the 99 corridor that kind of are the boundaries of the city of Lodi.

So the initial phase is to have about 60 megawatts of energy storage on site. That shows our production capability and the proposed cost for this project.

Next slide, please.

Tried to show you here a depiction of that location. So it's a very rural area. It's an agricultural area. The City of Lodi owns about 1,000 acres around us that have been available for this project. And you can

kind of see the sewage treatment ponds that sit adjacent to our facility. You can see the I-5 corridor. And nearby as well, within about a mile, we have a rail corridor that's a direct link to the Port of Oakland. So right now that we're contemplating that we would send green hydrogen down to the Port of Oakland over rail, probably not by truck.

So next slide, please.

This gives you a little more pictorial, a little closer up. In the lower part is the existing power plants that we have on site there, the pondage that's available, and where we're proposing to put the electrolyzers. So these come in 60 megawatt blocks. And this is how we're proposing to lay them out at the location.

And again, you can see the proximity to the I-5 corridor across the freeway from us in that kind of triangle there is where we're proposing to have PG&E's project and support their needs over there, as well, and have a large heavy-duty truck refueling station located.

Next slide.

Another pictorial, just kind of a closeup of what we're proposing to build out there. And we can incrementally build this out as we have the funding and the need, as well as the renewable resources available.

So one thing I did want to mention is additionality that was mentioned earlier. We don't think

that is necessary. We don't think the federal government should implement any additionality. It wasn't contemplated in the legislation. And for a state like California that already curtails large quantities of renewable energy many days of the year, we don't think that is the right approach. We think we need to more efficiently use those renewables that we have available instead of curtailing them. That's what this project is really about. We don't think it needs to wait until you build new renewable facilities.

To the far right is where we're proposing to have refueling trucks. These would support the transportation sector and anybody else that was looking to receive green hydrogen.

Next slide.

This is, again, rendition of what we're thinking the trucks will look like as they go by the electrolyzer field. They'll come in empty and we'll fill them up and send them back out to support the other industries.

Next slide.

Again, showing just a refueling station rendition that we're proposing to build out there. Not our normal business, not something I would really venture to get into, outside of our communities have made it very clear, reducing the emissions and the emission footprints near the

communities is extremely important. And where so many of my communities that I serve sit along some of these major freeway corridors and impact the air quality of those communities, they're very supportive of us proceeding with this and supporting the transportation sector.

Next slide.

These are the Hydrogen Center participants. You can see PG&E, City of Lodi, Siemens being the technology partner, the Port of Oakland, and University System.

And next slide just kind of shows the participants that are the joint owners in the Lodi Energy Center today. And as you can see, the California Department of Water Resources, they're the single largest owner of the project. But we also, through this project, serve BART and many other utilities.

So thank you.

I think that should conclude my presentation and I look forward to questions.

MR. ORTA: Thank you, Randy. And thanks to all our presenters.

There's lots of discussion questions that we prepared for this and we would love to get answers to all of them but our time is limited. So I'm going to focus our discussion, since we have a good size panel and not a lot of time, I'd like to focus our discussion on two questions.

If we have time, we'll try another one.

So the two questions I'd like to focus on are: What do you see as the largest barrier to scaling hydrogen use in the electricity sector, and what recommendations do you have for overcoming these barriers?

So I'm hoping to hear all your perspectives but -- so please, who would like to take a stab at those two questions.

Randy?

MR. HOWARD: Yeah, I'll jump in first. Obviously for those of us implementing this early on, it's cost, cost and cost, you know, really looking for some of the levels of subsidies to be able to demonstrate the technologies.

I think you heard earlier some of this, while there's some unknowns, we need to proceed. We don't have time to wait around, we need to proceed. And some of this we're going to learn along the way. But with that comes some additional elements of risk.

I will make one point that was -- there was some comments earlier about, we're going to increase NOx. Well, I can tell you, NCPA installed this new turbine in 2019/2020. We were currently -- previously we were at about 25 PPM NOx. Once we installed the new technology, we went down to 9 PPM, so from 25 to 9. In our modeling, we're going to go up to 12 PPM with the hydrogen blend.

And yet then we put that through the catalyst and then we'll go down to 2 PPM with the catalyst. And this process with using hydrogen will reduce our ammonia usage by 50 percent. So that's what we're seeing.

So I just want to put that out there because a number of people have been very concerned about increases in NOx. But this new technology, because we're basically upgrading these turbines, we're coming in right out the gate with lower NOx than anything that's producing today. So wanted to make sure we brought that out.

MR. ORTA: Thank you, Randy.

Yuri?

MR. FREEDMAN: Thank you, Jason.

I'll go back to what I know I briefly covered in my remarks. In my mind, there are those four pillars that make a successful ecosystem for any commodity, it's supply, demand, connectivity, and the market structure.

I would say that the federal and state incentives on the supply side actually make it a reality. Between the federal tax incentives and the LCFS, there's plenty of people who want to produce hydrogen. On the demand side, it's been an issue because, as I think Randy and others know full well, you out in the transportation sector have maybe insufficient incentives to invest money today to convert to hydrogen. And DOE, at the federal level,

recognize that, and that's why they set aside recently $1 billion specifically for demand-side incentives, but more needs to be done there, the second pillar.

We are very intimately familiar with the third pillar. And, again, it's critical to get it right and to get it on time because transportation today, transportation of hydrogen is at least as much or more of cost of delivered hydrogen to the consumer. So when we think about production, which is super important, realize that we need to build pipelines to get commodity at scale at a cost that is going to be affordable. That is how molecules are going to get transmitted. So that to me is very fundamental.

And that combined with the permitting time, we have to get our heads around this, how we're going to make that happen. Because if we want it at scale, it starts cascading decisions about where you make it. That drives decision how we transport that.

And the fourth, not to belabor the point, market structure is very important because depth and liquidity is what ultimately brings benefits to consumers. It also is important to think about the infrastructure that underpins that. And the way we do it here, have been doing natural gas market, of course, for a while is open access infrastructure. It's something where producers and consumers can get access to infrastructure on non-

discriminatory transparent basis.

This, to me, are important pillars to get right. I know it's a lot, but that is the market that we need to work to create.

MR. ORTA: Great. Thank you.

Kevin?

MR. PEASE: Yes. Thank you.

So definitely echoing what's been said already, affordability is a key component. And I love that Yuri at SoCalGas is jumping in with 100 percent hydrogen pipeline. I think that that is amazing.

I think that in the shorter term, hydrogen blending into existing natural gas networks is going to really facilitate moving the hydrogen from production to end use. And we really see that the existing network is the most cost-effective way to do this. And yeah, I actually hadn't heard about the demand-side incentives, so that's super encouraging as well.

So I'm hearing what Tyson had shown earlier, a lot of projects planned and moving the hydrogen from source to use, I think is going to be key, and especially in keeping it affordable.

MR. ORTA: Thank you.

Carlos, is there anything you would like to add?

MR. KOENEKE: Yes, the first comment I have is

the second comment about NOx. As I show in the validation or demonstration that we did in Atlanta, it was exactly the same machine. So even for the same machine, the same combustors and everything, we were able to tune to keep the NOx within the -- like slightly lower. So even -- it's just a matter of being able to tune the unit with a mix of hydrogen.

And the second point I wanted to mention is related to that hydrogen part that we are going to start operating in Japan soon, that a lot of the results will be very helpful for the ACES project, because the gas turbine that is running at that facility is exactly the same type that are going to be in operation in ACES. So that's going to be very useful.

MR. ORTA: Okay, great. Thank you.

We still have some more time, so the next question I'd like to focus on is: What are the biggest opportunities to reduce the costs of hydrogen in electric sector applications? And this can include production, storage, transportation, and end-use conversion.

You know, and since we don't have a lot of time, let's focus on -- let's add a little bit to that and focus on what we can do in the near term. So if I'd like to go ahead?

MS. DAVIDSON: Yeah. Thanks, Jason.

I think that what we can do in the 2020s, like I said, this is the decade of pilots, and so working with manufacturers, working with equipment suppliers, putting the equipment to the test, giving those market signals that there are buyers out there that we do want to incorporate, or actually not want, we need to incorporate hydrogen to the power sector can help reduce the cost of the equipment.

So, for example, electrolyzers, DOE, roadmap puts out that the cost should come down by 60 percent by the end of the decade. That's not going to happen unless there's market signals that folks are going to be purchasing that equipment. So these early movers in the industry are going to make huge headway for everyone else to enjoy that grid reliability that hydrogen will provide in the decades to come.

And I also think that we need to solve this transportation problem, which pipelines are going to do. So in lieu of having electrolysis on site, which we heard earlier from the CEC presenter, requires significant amount of land, most power plants don't have that, the option is really to truck in liquid hydrogen which, you know, depending on whether or not those trucks are ICE trucks or ZEVs, could end up bringing more pollution to communities. And it's going to be expensive to do that.

So pipelines are going to be critical

infrastructure in order to make sure that those nine gigawatts, according to CARB or potentially more are able to be served.

MR. ORTA: Great. Thank you.

Any other input on cost reductions?

Randy?

MR. HOWARD: Yeah, I'll just add a few.

And again, I think it's being incorporated in our project, is how do we repurpose some of these existing facilities? And I think that's part of the IEPR is to really look at, you know, how do we take these existing power plants that are already interconnected with large transmission interconnections, that are located near load centers, so it's very, very important. They have a workforce, typically a labor union associated with that workforce.

And so the conversions, I think some of your least cost approaches to get up and running with both the production that could serve a broader group, such as the transportation sector, as well as meet some of the needs of the power plant. So I think quickly identifying some of those and those opportunities, I think will be some of the least cost to move us along a little faster.

MR. ORTA: Yuri?

MR. FREEDMAN: Yeah, maybe I'll just make one

point, where I think hydrogen is unique, I know there were references to it earlier, in that it actually has a very cross-sectoral end use. It, in theory, could serve all the uses that natural gas users serve today and transportation.

So that actually leads to the thinking that let's think about all the end-use sectors because this is the ability to spread cost of adoption of a new commodity over larger universe of end users, because every transition is hard and slow and difficult. We need to make it faster so we should think about the sector coupling.

And specifically what I'm getting at is transportation. Truck companies would like to build fuel cell vehicles, but before they build those vehicles, they want to be sure that there's enough demand. Enough demand hinges on, first and foremost, on price. They look at California, which is one of the major markets in the world, and they want to see that there are steps that we are taking to make this fuel affordable.

So that to me is a very short line to thinking what can we do as a state to make that happen? I think that the regulatory clarity and the land use clarity are major steps which we can take to give them more confidence, which will then start a virtuous circle, but we have to show the real credible steps in that direction.

MR. ORTA: Thank you.

MR. PEASE: Thank you. Yeah, speaking of a virtuous circle, I think that a feedback loop between renewable energy generation and hydrogen production is really going to reduce costs. As more solar and wind are deployed, hydrogen production will come down, and I think that that's really going to catalyze the industry.

MR. ORTA: Thanks, Kevin.

And anything from Carlos?

MR. KOENEKE: Yeah, the comment that I wanted to make is when we were working on the ACES electrolyzer selection, we compared three different types, the atmospheric alkaline, pressurized alkaline, and PEM. And of course, it's a complex comparison, but one of the things that drove us to use pressurized alkaline is the fact that the turbine needs the fuel at a high pressure, and therefore, if you do something like atmospheric, you will have to use compressors, and compressing hydrogen can be complex and expensive. So one way we think is a good alternative to reduce the cost of producing hydrogen at the site is to use a pressurized.

MR. ORTA: Great. Thank you very much.

I will pass it on to Commissioner Monahan to see if you have any questions for our panel.

COMMISSIONER MONAHAN: And I just want to say that my fellow CPUC Commissioners got called away to the

same meeting with the Governor's office, so I'm alone here on the actual dais, and I think I might be alone right now on the virtual dais. I know Commissioner Houck had a conflict, and I don't see Commissioner Douglas [sic].

So let me just say first, this is a really interesting panel. And it's really great to see the investments that utilities are making across the state to explore the role of hydrogen, really look into producing hydrogen with electrolyzers and evaluating the potential role in the electricity sector and the transportation sector. I think the two really are complementary, and we should be looking at this as a holistic strategy, especially in the early days as we're trying to figure out how do we produce low carbon hydrogen, how do we drive down costs by building scale.

And what gives me -- it's been interesting to see how for a long time the electricity sector, we never talked about it. I mean, this has been only in the last couple of years, really, that things have escalated, you know, that the expansion of hydrogen into the grid is being seriously considered.

And I want to just point to the fact that this is a global phenomenon, and what's really driving it in the EU has been war in Ukraine and a recognition that they have to get off Russian gas, and they need reliable supplies of

energy. And it's been -- I think, we talk a lot about IRA and how transformational that is, but I would just say that the war with Ukraine, between Ukraine and Russia, has really brought this to the forefront in terms of we need reliable power sources from just a global security standpoint.

And I also feel like from a how do we build scale globally, that gives me hope, because for a long time, California was kind of alone. I would argue we do way more than Japan, we've done way more than Germany, and -- but we can't do it alone and it has to be a global transition. So I think everybody globally, at least in the EU and the U.S., is exploring this nexus.

I do think it's good to hear that NOx emissions have been, at least from the facilities that are here represented, have not found a problem. I think it's worth considering to explore that, continuing to explore that. We are exploring that as an agency, and I know CARB cares deeply about this, but we need to make sure that we aren't increasing smog as we decarbonize our economy.

And so just getting additional studies on that, I think it's going to be really helpful, and understanding the processes. I don't know if there's specific processes that anyone here can talk about that help to minimize NOx emissions. I mean, from just a general standpoint, higher

temperature combustion should lead to more NOx. And so there are definitely process aspects to this, I think, that we want to learn from. So I would say maybe not in this IEPR workshop, but just anything you can submit to the docket so we can better understand that, I think will be really helpful.

I wanted to just talk or ask questions actually about the pilot projects that are going on and the hope in terms of, I know by the end of 2023, but this year, we're going to have one project at least online. What's your, like in terms of the next two years, what can we hope to glean from these pilot projects that would help inform where the state is going?

MS. DAVIDSON: Well, since SDG&E is the one that will be online, I'll respond to that.

So we're going to be getting a lot of data from the project and operational experience and learnings, which we hope we can then apply to future projects as required to maintain system reliability. And we're also training our staff, which is really, really important with a new gas, a new technology like this.

So I think those are going to be our main priorities in the next two years, understanding the equipment, understanding the operating procedures, understanding emissions impact and things like that, and

then taking our learnings and ideally scaling them at other generating facilities where appropriate.

So we're also very interested in integrating batteries into gas facilities, potentially bringing in hydrogen. So, you know, all options on the table to help decarbonize our natural gas assets and bring us to the reliability that we need. But certainly 2035 is looming large where 90 percent energy needs to be clean. And so it's not too far away.

This project started in 2021, so -- or 2020, I believe the ideation began, and will be in service at the end of 2023. And it's a relatively small-scale pilot. So if you think about scaling this to a large facility, the lead times obviously get longer, the investments are larger. So this is our first foray into this.

And we also hope to host whoever wants to come and learn so we can really be an educator of other folks. And that's a legacy that we're really proud of on the battery side. And we hope to continue that on the hydrogen side so that other utilities and LSEs can learn about integrating hydrogen into their operations.

MR. PEASE: So our project will not be operational in the next couple of years, but in the next year or two after that.

So in the meantime, we're going to be working

hard to understand our system, all the material aspects of it, and developing the research program that would take place at Hydrogen to Infinity so that we can close all the gaps in preparation for a system-wide hydrogen blending standard where we are in contact with Sandia National Laboratory and their Hydrogen Effects on a Materials Lab, and their subject matter experts in the area. So we plan to be developing the testing protocols and through the detailed engineering design of the Hydrogen to Infinity project, better understand exactly what needs to take place on the ground hydrogen blending.

COMMISSIONER MONAHAN: It seems like there might be an opportunity for you to lend your hydrogen detection tool to SDG&E too. I think that's something also we're very curious to better understand what's happening.

MR. PEASE: Yeah, so one aspect of the Hydrogen to Infinity is a testing ground for leak detection trials, and also dispersion, so understanding how a hydrogen leak would be dispersed. And so we offered our facilities to teams developing these sensors. So they're not our sensors, but definitely happy to put you in touch with anybody.

MS. DAVIDSON: Thank you. And Kevin and our team are also separately working on the hydrogen blending application on the gas system where leak mitigation and

detection is a very important component that the CPUC wants us to look into. So currently, the parts per billion leakage detection systems are still in development, but we're very keen in understanding how we can work with universities that are getting this DOE funding to deploy them.

And also just a comment on hydrogen leakage. Hydrogen is really expensive and it's basically a precious commodity right now. So our systems are being built brand new, functionally leak proof. And certainly, I don't think anyone would go about designing a hydrogen system with leakage rates greater than any 0.000 X percent because it really is quite expensive right now. And, also, it's just the right thing to do. And these things are being properly engineered and has opted on a risk mitigation is very important.

So I think that, you know, potentially large-scale deployment leak issues, yes, definitely need to be better understood. But for these pilot projects, they are generally newly built and have very high integrity. And so I don't think leakage in any way is going to be an issue.

COMMISSIONER MONAHAN: That's great to hear.

So, you know, we hear a lot about LADWP's ambitious plans in hydrogen. And it sounds like, at least from what I'm hearing from the small representation of

utilities, with the exception of SoCal gas, of course, it doesn't sound like you're committing at this point. You're in the exploratory stage, trying to figure out what's the role of hydrogen. Is that a fair characterization?

MS. DAVIDSON: I can comment on that. I think a difference between LADWP and at least the IOUs is our regulatory -- or our regulator.

COMMISSIONER MONAHAN: Um-hmm.

MS. DAVIDSON: So the City of Los Angeles has made it clear that their climate directive is, I believe, ten years ahead, I think it's 2035, and they've approved LADWP going ahead with this ambitious transition of Scattergood, whereas the IOUs, obviously we have a different regulator. And so regulatory directives matter here.

And so when it's the right time and when our regulator asks us to or authorizes us to make these transitions at the right time, we're certainly happy to do that. But it's challenging to get too far ahead of your regulator as an IOU.

COMMISSIONER MONAHAN: That makes a lot of sense. Thank you.

MR. HOWARD: Yeah, I would concur with the statement on the POU versus the IOU in this case. At NCPA, we've already spent the $50 million. The turbine is

installed. We're capable today of a 45 percent blend. So our next phase of our project really is to build out the electrolyzers, the production, as well as the storage and the blending skid for that.

So, you know, our steel is in the ground. We're operating today. Obviously, we're operating with natural gas until we get the other components. We are a Tier 1 project in the ARCHES process. So obviously, the funding will assist us in how fast we go and how big we go, but we're going regardless. And we have that commitment from the owners.

COMMISSIONER MONAHAN: Randy, what's your prognostication for how big you will go?

MR. HOWARD: Currently, we continue to work with our members that by 2028 we should be 100 percent hydrogen at that location.

COMMISSIONER MONAHAN: And would 100 percent of the hydrogen be produced proximate to the location?

MR. HOWARD: That's our objective.

COMMISSIONER MONAHAN: And did you --

MR. HOWARD: Our biggest concern right now remains storage. Storage is quite expensive. So the initial phase is about ten hours of storage of fuel on site, but also being able to support transportation, being able to support PG&E's project. Beyond that, we're looking

at other storage options, but that's probably our biggest challenge at the moment is trying to determine where else we could store produced hydrogen to ensure that we have a reliable supply to meet 100 percent.

COMMISSIONER MONAHAN: And have you done the spatial constraints on the electrolyzers and that? Have you sort of mapped out where you could put the electrolyzers to be able to --

MR. HOWARD: So I tried to show that in the rendition.

COMMISSIONER MONAHAN: So that's for the entire system? I thought that was just this one pilot piece of it.

MR. HOWARD: So we have a thousand acres available to us that's owned currently by the City of Lodi, one of the partners and owners in that project, and so they've made that available. And they said incrementally, obviously, we can continue to build out phases of storage. We can continue to build out phases of that project.

COMMISSIONER MONAHAN: Great.

Yuri, you're chomping at the bit.

MR. FREEDMAN: I'm the only non-electric utility here, so with that major caveat, I think, and I'm sure you know this, Commissioner, but the data points at the state level suggest that we need multiple gigawatts of hydrogen

power generation. The question is how to connect that with reality at the utility level where people have to make capital investment decisions?

But again, just in terms of order of magnitude, I recall the Air Resources Board, 9 gigawatts, I believe is the number that they came up with. I've seen, I actually haven't seen the full analysis, but I've seen the conclusions that the Environmental Defense Fund and Clear Air Task Force came up with. I believe the range there was 25 to 40 gigawatts of term dispatchable generation. And if you are aiming to not emit the hydrogens, probably the top, if not the only choice at scale.

So these are big numbers. And the question to me becomes, how does the state frame its policy to make sure that these numbers, these goals, that ultimately are driven by reliability and resiliency? How to translate that into the decisions of individual participants is the policy question.

MS. DAVIDSON: And I think layering on the time scale, as I talked about in my presentation, 20 years is really not that much time, given the scale of what we think is going to be required to maintain grid reliability. So now is definitely the time to be having these conversations.

COMMISSIONER MONAHAN: No, we really appreciate

it. I know we're butting up on time, but really appreciate these conversations. And I think, you know, as I said earlier, and I think the Vice Chair said as well, you know, we're really trying to map out. Right now we're in a scenario-based approach around what could happen. We don't know. Let's look at different scenarios.

Where the rubber hits the road is when we start integrating it into our demand forecast and we say, this is how much electricity we're going to need, clean electricity, in addition to just meeting what our base load. If, you know, we're producing the hydrogen here, what does that mean in terms of our electricity generation needs?

And so it's very -- and as we all know, these are -- then procurement follows, and these are big, that big implications once it gets incorporated in our demand forecast. I don't think we're there yet, but we're definitely in an exploratory state.

Thank you. This is great, a great panel.

MS. RAITT: All right, Commissioner, are we ready to move on to the next one?

COMMISSIONER MONAHAN: Yes.

MS. RAITT: Okay. Thank you so much, Jason, and thank you to Yuri and Kevin and Melanie and Randy for that panel, that was really helpful.

So next we'll move on to the next one on transportation. And Tomas Ortiz is a Supervisor for the Energy Commission's Hydrogen Refueling Infrastructure, and he'll go ahead and moderate that for us. Thank you.

Go ahead, Tomas, Tomas.

MR. ORTIZ: Hi, good afternoon. Sorry about that. I think we're good now.

So yeah, joining us today on this panel is going to be, in the room, we have Matt Miyasato, who's the Vice President of Strategic Growth and Government Affairs for First Element Fuel. Also in the room is going to be Salvador Llamas, who's the Chief Operating Officer for AC Transit. And then joining us online, we have Benjamin Happek, who's the Senior Manager for Eco-Friendly Commercial Vehicles for Hyundai, and Mike Galvin, the Director of Commercial and Waterfront Real Estate for the Port of LA.

So we're going to start with presenters in the room, and that is going to be Matt Miyasato leading us off.

MR. MIYASATO: Great. Thank you, Tomas, and thank you to the Commission staff, and of course, Commissioner Monahan for inviting First Element to participate. Really do appreciate the opportunity.

As Tomas mentioned, I'm Matt Miyasato, the VP for Strategic Growth and Government Affairs. And I do want to

start off with describing a little bit about who First Element is, if you'd go next slide, please?

So First Element, we are a purpose-built, small California company that was started just ten years ago. And the mission of our company is to provide -- our sole mission is to provide hydrogen refueling infrastructure to enable the transition to zero-emission transportation.

So our three founders started ten years ago with the investment from two major OEMs, automotive OEMs, some Japanese investors, but more importantly, with a fairly sizable grant from the California Energy Commission. And with that grant, we were able to establish the first 19 stations, or one of the first 19 stations within California, and you can see from this map, now we have about 40 hydrogen fueling stations throughout the state, about evenly divided, 20 in the greater L.A. region and 20 in the Bay Area.

And we consider ourselves to be the market leader in retail hydrogen fueling, not only in the state of California, but anywhere else in the world because of California's aggressive policies, we have more throughput than any retail throughput than anywhere else in the world.

And so I just want to highlight the fact that we are the poster child for the state's aggressive reduction of greenhouse gases and criteria pollutants, combined with

their aggressive policies and appropriate incentives to really enable a market. And so we are kind of the poster child for that strategy.

If you go to the next slide?

So we started off with the state-of-the-art fueling station. This is 2018. You can see in that little red arrow. That was a single dispenser gaseous hydrogen fueling station, 250 kilograms. But you can see this long line of vehicles, and this is no way to enable the market; right? So if you're the last guy in that line, you're probably not going to get fuel, or if you do, you're going to get not a full tank, and you'll probably take about 40 minutes to an hour.

And so if you go to the next slide, we have since gone to a liquid hydrogen delivery, four fueling positions, so simultaneous fueling of four vehicles, about five times the capacity onsite. And this really enables the customer to have a fueling experience, much like they do with current fossil fuels. So it's a very quick fuel, and they're able to fuel with other customers just at the next dispenser.

If you go to the next slide?

What this has done is, as you can see in the top right-hand corner, we can integrate our dispensers into our own design. You can see the true zero wings, as it were.

But it also could be integrated into existing gasoline station islands right next to the diesel and gasoline fueling islands. And you can see those are San Diego, Costa Mesa, and then Cupertino, as well as Fountain Valley.

Next slide.

So the liquid hydrogen has really enabled us to not only fuel more light-duty vehicles more conveniently, but also has laid the groundwork for heavy-duty fueling. This is a photo of one of the Hyundai fuel cell trucks. I know Dr. Happek is going to talk more about that. But to enable the fueling of these vehicles, we developed the fueling capability to do fast fills, 10-minute fills, 60 kilograms. And the intent is to really fuel these vehicles at stations in the same amount of time they would fuel with a diesel counterpart. So it enables fueling of about 100 to 200 trucks per day.

This is just an example of fueling these vehicles at one of our light-duty stations, which takes about 40 minutes. And just to enable the demonstration, if you go to the next slide, this is just showing two of the fuel cell trucks being fueled at our Livermore facility. And again, just to show that these aren't renderings, these are actual fueling of trucks.

You can go to the next slide.

and so you can see the two trucks filling there.

Next slide.

So I do want to talk briefly about some of the things that the California leadership has enabled, but also to provide some guidance, perhaps, for your continued leadership.

Three things, one is the realization that hydrogen retail fueling is new; right? It's less than ten years old. The supply chain is immature. A lot of the equipment they receive is not really retail-ready and not made for prime-time performance. And so it's a slow start.

We are actually the beneficiaries of a California Energy Commission grant to bring most of that manufacturing in-house, which we're doing now. And that will enable us to manufacture most of our equipment in California at one of our facilities, which will hopefully reduce the reliability issues that are seen from some of the equipment that we've received.

Secondly, the incentive structure for California is currently really dependent on two structures. One is the Clean Transportation Program, which Commissioner Monahan leads, but also the Low Carbon Fuel Standard, LCFS at ARB. Both of those programs are somewhat in limbo. On top of that, with the financial environment here in California, the banks collapsing, it’s really frozen kind of the incentives or the financial market and the ability

to do further financing. And so I really urge you to move forward with some of those programs.

And then finally, the pathway to zero-emissions transportation is really through two technologies, one is fuel cells and one is battery-electric. And we really think it's too soon to discount one versus the other, and both of those should be enabled to have an equitable chance at providing zero-emission miles.

Next slide.

And just to highlight that with an example, you know, there's 16 million vehicles are sold every year in California; right? ZEVs are only about 300,000. Fuel cells are less than 3,000. Likewise, drayage trucks, there's about 200,000 into and out of the ports every day. There's only less than 200 zero-emission vehicles, and only 30 of those, the Hyundai trucks that I mentioned, are being demonstrated this year.

If you go to the next slide?

If we go to 12 years from now, in 2035, all of that has to go to zero emissions. So, you know, even if it's only a third or less, it's still thousands or tens of thousands of light-duty vehicles and thousands of trucks that have to be zero-emission, likely fuel cells. And so we are really urging that the infrastructure needs to be available to fuel those zero-emission technologies.

And then finally, I'll just conclude with these thoughts and words of encouragement.

So if you go to the next slide.

Steve Ellis, you may know, he was a longtime Honda employee, he used to say, "It's not a sprint to get to, you know, zero-emission transportation." The next slide will say, "It's really a marathon." And then if you get one more slide, we just encourage you to pace yourself, keep your eyes on the prize. If you go one more slide, and that's even in the face of what sometimes feels like running through, you know, fiery brimstone, is to maintain your dedication and your vision towards zero-emission transportation because you have enabled the market.

With that, I'll just conclude, and thank you for the time.

MR. ORTIZ: All right. Thank you very much, Matt. Next up is going to be Salvador Llamas for AC Transit.

MR. LLAMAS: Good afternoon, Commissioner. Let me bring the mic a little closer here. Thank you very much for the opportunity to provide an overview of AC Transit's Zero Emission Bus Program. My name is Salvador Llamas. I'm the Chief Operating Officer.

Next slide, please.

I'm very excited to announce that AC Transit has

been awarded the Outstanding Public Transportation System by the American Public Transportation Association. And I say this because it just speaks volumes of the type of organization that we have and the employees that we have at AC Transit, from the bus operator seat to the boardroom dais chair. We are really excited to be innovators in the industry.

Next slide, please.

A little bit about AC Transit. We have seven publicly-elected board members. We serve an area of 364 square miles. We operate 128 lines; 18 of those lines are dedicated to go across the bay. We have 202,000 employees, seven facilities that support our operations. And currently we have 637 buses; 58 of those are zero-emission buses.

Next slide, please.

A little bit of our demographics. So just the important note here is that we serve essential workers, students, low-income, seniors, commuters, individuals with disabilities, and anyone wishing to reduce their carbon footprint. One of the things that we do during the school period is we have 30,000 students that board our buses every day, and we transport them to the schools to and from. And we're very proud to be an essential service for the state, and that was demonstrated during the pandemic.

Next slide, please.

So we have been running the marathon for a while. So AC Transit has been a leader in operating zero-emission technology since 2000 for over 20 -- more than 20 years. We started with hydrogen fuel cell technology. We ran a pilot for several years, learned a lot from that pilot, helped to design the future buses. And we're happy to say that we currently have operated more than five million zero-emission miles transporting the public, and which leads to eliminating over 12,800 metric tons of carbon dioxide. Now we're operating both technologies, battery and hydrogen, side by side.

Next slide.

So in order to educate our board and educate our staff, we developed a zero-emission transit bus technology analysis, also known as a 5X5 Study, because we have five battery buses, five fuel cell buses from the same bus manufacturer built on the same year, running side by side in the same facility operated by the same drivers and the same routes and operating environments, so a true apples-to-apples comparison.

We partnered with Stanford University's Precourt Institute of Energy to analyze the data to validate our methodology and the results of our data. And when we realized that this was such an exciting opportunity to

educate us, ourselves, we also added diesel buses and diesel hybrid buses, and then what we call the legacy fuel cell bus which is battery – or excuse me, a fuel cell-dominant, which creates the power for the motor versus the new one, which is a battery-dominant technology.

When we first launched the study, and we delivered our rollout plan to the Air Resources Board, we had predicted a 70 percent battery and 30 percent fuel cell bus mix. A year after we launched the study, we learned that there were some complications with each technology, but we changed that in our transition plan to the FTA to 70 percent hydrogen and 30 percent battery.

Next slide, please.

So this is a hydrogen, heavy-duty hydrogen fueling station. The other thing is we have two generations of stations that are at our facility. The lower right picture just shows basic components of a hydrogen station, the liquid storage tank, the vaporizer towers, and then we have buffer tubes. The old technology cannot fuel the throughput of the buses that we need, so we actually have transitioned to a cryogenic pumping.

On the upper left corner, you'll see the cryogenic pumps. Now we can fuel 65 buses back to back in a ten-hour window, which we need to service our vehicles with 32 kilograms in six minutes per bus.

Next slide, please.

We approach the zero-emission bus technology, as you mentioned, where the rubber meets the road. We have to serve our customers. We have to provide essential service. And we're operating both technologies side by side until we see the technology continuing to mature. They both still need some maturity not only in the bus performance, but also in the availability of the energy, the reliability of the energy, and the cost of the energy are both major impacts.

And so here you see that we have hydrogen at two facilities, and one we're operating hydrogen and battery. We are seeking grant opportunities and funding to build a third hydrogen fueling station at our Hayward facility, and we're adding charging infrastructure at our Oakland facility -- or Emeryville facility so we can have the same, both technologies at one property.

Next slide, please.

And in order to maintain the equipment, whether it's the vehicle or the infrastructure, we have to train the workforce of the future today, and this is also to preserve jobs and to advance the technology. So we're working and we're partnering with technology experts to utilize AR/VR technology to teach future generations how to transition from internal combustion engine or conventional

mechanic into a zero emission bus mechanic. We're building a Zero Emission Bus University. I'm happy to announce that we received an FTA grant to do that. We're going to modernize our facility, and we're going to develop what you see here are some virtual AR and remote assist teaching methods for every zero-emission bus technology that we operate.

Next slide, please.

There's a lot of information to cover. I can't cover it all today, but if you scan this QR code, our Zero Emission Bus Transition Plan and our four volumes of our study are on our website, plus other information that you can take advantage.

And that concludes my presentation. Thank you.

MR. ORTIZ: All right. Thank you very much, Salvador.

Next up, and he's already gone off, got to turn on his camera, and it's going to be Ben Happek for Hyundai. Thank you.

MR. HAPPEK: Yeah. Good afternoon, everybody. Thank you to the Energy Commission and also to Commissioner Patty Monahan for the opportunity to speak today. My name is Benjamin Happek. I'm in charge of electrified commercial vehicles at Hyundai, in particular, Hyundai Translead here in San Diego. And today, I'd like to

provide you with an overview of Hyundai for the U.S. market, in particular, for Class 8 fuel-cell electric trucks.

Next slide, please.

So this presentation is less about Hyundai, but more about the overall market potential and market realities. So I think it doesn't make a lot of sense to sugarcoat and to paint the brightest picture here. We should clearly point out what the current issues are and what we need to do in order to reach our common goal of bringing those trucks and solutions to the market.

So first of all, North America is a top-two global commercial vehicle market after China in terms of volume. But I want to clearly point out that in terms of revenue, the U.S. is the most important commercial vehicle market by far, because the average transaction price of a commercial vehicle in the U.S. is about two to three times the amount of the one in China. So for Class 8, we talk about 240,000 units per year that are being sold throughout the United States.

Class 3, typically pickup trucks, is number two after Class 8. But since many believe that, especially for the heavy-duty fuel cell and hydrogen makes a lot of sense, we focus on this, and Hyundai is also focusing on this product to bring it first to the United States.

And what is also clear is that we see now a very strong push, both national and subnational, that commercial vehicles, Class 8 commercial vehicles, are moving towards zero emission. And then there is this push and pull, that I'd like to explain on the next slide, between incentive and mandates, so the stick-and-carrot approach, that is very strongly followed upon here in California.

That is also why Hyundai and other OEMs start with truck deployments in California, because we have on the one hand, we have strong incentives, such as the HVIP Program from CARB. We have Energize. We have a lot of support from the Energy Commission, even for projects that we are doing right now. And on the other hand, we have strong mandates that force fleet operators and OEMs to bring these products to the market.

It all comes together with customers that have very strong ESG goals and programs that we see as first adopters in the market. And this is basically what is nurturing this ecosystem here in California.

Next slide, please.

So if you look at a bottom-up analysis of units, so what are we actually talking about? If we do a bottom-up analysis and look at California and the other ZEV states, you can see that in 2022, in California alone, the Class 8 market was about 17,000 units. And this includes

diesel, CNG, a small amount of battery-electric trucks. And so far, really no fuel-cell electric trucks, or when, then only in very marginal numbers.

Due to the mandates that are now in place, and in very particular, Advanced Clean Truck and Advanced Clean Fleet, we will see about 868 units in California that will be zero-emission from 2024. This goes up, all the way up in California, up to 6,000 units by 2031. Combined market with the other ZEV states and states that are most likely becoming ZEV states eventually, we talk about an overall market size by 2031 for zero-emission Class 8 heavy-duty trucks of 30,000.

So that is the addressable market. And it's important that we point that out, this kind of potential.

What is the split between hydrogen and battery-electric? Nobody knows at this point. Nobody. There are a lot of people who claim we have a crystal ball. But frankly speaking, we are not making any definitive claim here.

My personal belief is that if there is infrastructure in place, and we all know that battery-electric charging infrastructure is also a big challenge, also on the utility side, if enough hydrogen is available and enough hydrogen refueling stations is available, I am a strong believer that a majority of Class 8 heavy-duty

trucks ten years down the road might be fuel-cell electric versus battery-electric. But don't point that out ten years later that I might have been wrong.

Next slide, please.

So if you look here at the right-hand slide, this is a nationwide forecast. I talked about the ZEV states in California before. Market data shows us that by about 2037, zero-emission vehicles will be more than half of the market share of trucks being sold in the United States. And this will be, most likely, much earlier in California, given the incentives and also the mandates, of course. Even most conservative modeling is showing that by 2047, ZEV is overtaking diesel nationwide.

So due to, and this is what I told you earlier, early customer feedback is showing us that there seems to be a lack of feasibility in certain battery-electric solutions, which suggests that there might be even a higher demand in hydrogen to power fuel-cell electric trucks going down in the future. Currently, we have about, right now, 70 fuel-cell electric trucks in custom operation with almost 4 million -- more than 4 million miles driven.

Next slide, please.

So what are the benefits of fuel cell? And we don't need to go, due to time constraints necessarily here, into the absolute details, but we have higher payload,

longer driving range, shorter recharging times, and no impact on the electric grid. These are all the four major benefits of fuel-cell electric trucks.

Next slide, please.

But there are also challenges. And those challenges are trucks are too expensive for most of the customers right now. We talk about a 200 percent to 300 percent cost increase versus diesel. So we need subsidies in order to get the – reach TCO parity on truck cost. Clean hydrogen is very expensive. We talk about prices right now at the pump between $30.00, even $36.00 on the kilogram on light-duty side, which has been reported to me yesterday. That has to come down to $6.00, $7.00, maybe $8.00, but certainly not $30.00 in order to meet TCO for our customers.

We have only very limited midstream buildout of hydrogen pipelines, and absolutely minimal infrastructure. And it's startup companies, such as First Element, who are really pushing the boundaries here. And we have most of the stations in California, as you know, thanks to their efforts, and also thanks to the great support of the Energy Commission so far.

Next slide, please.

So what are we talking about in terms of infrastructure needs? We certainly need to scale up from

where we are right now on the light-duty side, where we have a throughput of maybe 500 kilogram per day per station. And we need to go to four tons per day with a throughput of two and a half tons to serve a significant amount of trucks per station.

For our NorCAL project that has been mentioned before by Matt, by Dr. Miyasato, we talk about 60 trucks that can be fueled at that particular site in Oakland.

Next slide, please.

So the overall thinking is that by introducing more and more commercial vehicles, we can create a business case for more stations that is then also catering passenger cars.

As in comparison, out of Switzerland, where we are already operating 50 trucks, we have a business case for one refueling station if we deploy 15 trucks. This is equivalent to 700 passenger cars. So here you can see what kind of a lever commercial vehicles are for this market.

Next slide, please.

So here I am highlighting what we do in Korea already. So Hyundai is showing that the technology is actually mature and works. We have 355 trucks and buses on the road in Korea right now, including 31,000 NEXO passenger cars. And we have 153 HRS operating in South Korea. The population of South Korea is roughly the same

as the one in California, about 40 to 50 million people.

Next slide, please.

This is another example of how we see the whole economy working in a circular way. We have a project running in Korea in Gyeongju where we collect biomass. We collect food waste that we put into a biogas methane reforming hydrogen production plant. And that hydrogen goes back into our garbage trucks in order to collect the food waste.

We believe that these kind of integrated approaches are very helpful to bring this technology in this market.

Next slide, and I apologize that I'm going so fast through the slides, but this is actually -- I'm running out of time here.

When it comes to customer and TCO, and I want to reemphasize this, it has to make sense for the fleets. It cannot be that we force trucks upon them that they can't afford in terms of truck cost and fuel cost. This is why Hyundai is approaching this whole ecosystem here in Switzerland with the pay-per-use model. Where the customer gets a truck, pays for the miles driven, and this includes the truck, fuel, maintenance, and service in one combined package, it takes away a lot of the anxiety, it takes away fear of residual value, and also reassures the customer

that the technology actually works.

Next slide.

This is another example of the Switzerland ecosystem. And since I'm running out of time, we just skip over it right now.

To the last slide, please. This is the current status of our -- no, one slide before.

This is the current status of what we do in Oakland with First Element as the refueling station partner. We have now ten trucks in revenue service as of July 7. And the remaining 20 vehicles just arrived today at the Port of San Francisco. And we have 30 trucks, which will be the largest deployment of fuel-cell electric trucks in North America, up and running from next month. And thank you, also, to the Energy Commission and CARB for making this happen.

So with that, I'd like to wrap up. Thank you very much for listening.

MR. ORTIZ: Thank you very much, Ben. That was a really great presentation.

Next up, we're going to go with Mike, who is gracious enough to join us from the road. So again, Mike Galvin is from Port of L.A.

MR. GALVIN: Go ahead, Mike. Thank you very much. And I appreciate the opportunity and invitation to

present here in front of the California Energy Commission.

So my name is Mike Galvin. I'm from the Port of Los Angeles. I work in real estate, but I've also been in charge of the port's energy assets for the last 15 years, and so that's where I find myself leading the port's hydrogen efforts.

If you can go into the first slide?

So just a little bit of background before we get into hydrogen. The port has very significant goals for decarbonization, both on our terminals and off our terminals. And those are all solidified through a Cleaner Action Plan that is actually a joint Port of L.A./Port of Long Beach document that's in its third iteration. And in the 2017 version of that, the ports both agreed to move forward to decarbonize both on-road terminal activity by 2030 and off-road trucking activity by 2035.

So that's really the driver here where we find ourselves trying to explore every single pathway that's available and the conundrum that I think we're all in and trying to figure out how much of this is going to go battery-electric and how much of it is going to go towards hydrogen fuel cell.

But early input from tests that we've done over the course of the last five-plus years show that hydrogen has a huge benefit opportunity that battery-electric

doesn't have, especially in the heavy-duty areas of our operations. And really, that goes to the long-haul trucks and to the heavy-duty equipment, which are really four pieces of equipment that we regularly operate on our terminals, which include yard trucks which haul around containers from the ship to stacks. They look very much like tractors, but they are off-road tractors. Then we have top loaders, which are basically large-scale picks that pick up containers from the ground and take them up to about five high. That is probably the heaviest duty piece of equipment that we have. We have rubber-tired gantry cranes, which take containers and manage stacks. And then we have the need for mobile fueling solutions.

And so with all of that, those are very heavy-duty pieces of equipment that really need to operate in various modes throughout the day. And operators need to be sure that the equipment that they're grabbing that day is going to be able to do various duty cycles and going to be able to last through an 18- to 20-hour day, because typically that's what diesel does today.

Hydrogen provides that opportunity in early equipment tests that we've done because it can last the entire duration of the day that we have operational at the ports, which includes about a four-hour dead time in the middle of the night when everything needs to be refueled.

And so the opportunity to be able to refuel in that time frame, very similar to diesel, is provided by hydrogen, where it's not really with battery-electric. On top of that, that electric equipment does not always evenly operate throughout the day, depending on what type of duty cycle it's placed on. So you have variable performance there. So hydrogen provides that.

The same with the on-road trucks. We have variable duty cycles with on-road trucks that are necessary for our trucking community. A truck may be going back and forth 10 miles a day to a local distribution center, or it may be going 300 miles. And the operators want to be able to grab any piece of equipment they need to grab at any given time to do any job and try to pick and choose between different technologies makes it very difficult for them. So having that opportunity to have a technology that actually duplicates diesel is very important to them as well.

Our longshore labor is very supportive of hydrogen as well because of the resiliency in that technology and the ability to really replicate the existing operation where they work the equipment very hard all day and it rests for about four hours in the night and all gets refueled in the location that it's at, typically, where a mobile refueler will go around and refuel, just like diesel

does today.

So because of this comparability with current operational capacities to diesel, hydrogen really makes a lot of sense, not to mention the weight of the hydrogen vehicles, especially the on-road trucks. We get a huge diminution in opportunity to haul because of the 16,000-pound necessity for the battery weight off-site of the cargo that we're trying to haul at the same time. So there are various issues there operationally that make hydrogen a really good opportunity for the heavy-duty sector.

Next slide.

We have various opportunities that we have been looking into over the course of the last three years for demonstration projects. Our Shore-to-Store Project was extremely valuable in really figuring out that hydrogen fuel cell was a real, real good option for on-road trucks. And that was ten on-road trucks that we tested. It ended about six or seven months ago but we tested over the course of 12 months.

It also included two built-out stations, smaller stations, but heavy-duty stations built in the community of Wilmington and Ontario to allow for trucks to go back and forth in between the ports and the Inland Empire. And those ten trucks went through their paces and acted very similarly to diesel trucks. When there were issues

technologically or there were issues with operations, the vehicles were down for a number of days maybe, but we're back on the road very quickly. Not the same experience we've had from various battery-electric on-road trucks and other equipment where it does go down on it, but when it is down, it's down for a significant amount of time.

Yard tractor demonstration at TraPac was very successful. The current Phoenix Marine Services demonstration of the top loader is actually the most important that we've had because that is the heaviest duty piece of equipment that we have. And they are working to add another fuel cell to that and add an additional tank to that, and being able to get it up to 22 hours of operational capacity is extremely important.

And then we have YTI working on five pieces of equipment coming out in the next couple of month, and a HyZET Design project looking at a hydrogen tug.

Next slide.

The issue that we really have right now, as others were speaking to, is the concern about consumer confidence. We don't have enough equipment out there right now to penetrate the market in a way that there is extreme confidence that the equipment will work. So we need to really work on getting more equipment out there.

Cost is a big factor there. We're looking at

working around that through retrofits, which is great because it actually takes out a piece of diesel equipment and retrofits it with a hydrogen fuel cell piece of equipment at a much lower cost. And so we're looking at cost comparability or even lower than diesel there. So we see that as a huge opportunity going forward. But we need more of that equipment out in the marketplace.

On top of that, the consumer confidence issue, which was spoken about regarding fuel. The fuel is variable, you know, between $14.00 a kilogram to $30.00 a kilogram, so there's a lot of concern with that needing to come down. And we really need to open up the marketplace, get to a larger scale of fuel delivery, and hoping that we can do that.

But we need government incentives to help us to do that. The ports do not have the money to be able to incentivize this ourselves. The ports ourselves are not equipment owners. We do not buy fuel either. And so we're really trying to facilitate this all for our tenants. So we're going to do that through a variety of funding sources from state and federal government.

Next slide.

So I think many are aware of the US DOE H2 Hubs Grant process. I'm not going to go in or belabor this much, but the ports are a foundational piece of the ARCHES

application.

Next slide.

We can go through this, too. I think everybody probably knows what ARCHES is, but the state application organization that is putting together the H2 Hub for the state of California, and like I said, the Port of L.A. and Long Beach have a very large project within that.

Next slide.

And that project includes, as a first deployment, basically a suite of vehicles that would go out to ten terminals, two yard tractors, one top handler, one rubber tire gantry crane, and one fueling solutions. The total overall grant application request is $300 million. $300 million would also be matched by the ports. Stage two would have a scaled up opportunity there for us to get to the point of commercialization so we can buy much more equipment and really get that demand up, which will then necessitate the sourcing of the hydrogen and hopefully bring the hydrogen market online with diesel comparison as far as an economic perspective.

And then on-road trucking deployments through our Clean Truck Program will serve as a large portion of our match as we are right now charging between $10.00 and $20.00, depending on if you're moving a 20- or 40-foot container through the port in a non-zero emissions vehicle.

So right now we have collected, I believe, this year about $90 million, but having difficulty actually distributing that money to offset the large differential between diesel equipment costs and hydrogen equipment costs.

So we're working on that to try to stack our funds with a variety of other sources. We went to our board last, yesterday actually, to be able to increase the overall dollar amount available to potential consumers that are buying new trucks and want to offset the cost delta (phonetic) with diesel.

Next slide.

And this is just an overall description of what our proposed grant looks like. We're really trying to de-risk this in the beginning with a much, much lower overall match from the ports, beginning with the first deployment, $100 million total, trying to buy, you know, in between 50 and 60 pieces of equipment, depending on where the pricing is, and then having that match reverse in the second deployment, where the ports are putting in much more money there. But overall, $600 million, we think this can really get things going.

But the overall cost of decarbonization on terminals and off terminals is a $20 billion calculation that we're trying to address. And so this is really a drop in the bucket of that, but at least it's a start that gets

us moving in the right direction.

Next slide.

So waiting for a response from the DOE right now and hoping that we get a positive one will really put us in a great place to move forward.

And I think that's the end of the presentation. Thank you.

MR. ORTIZ: Thank you very much. I really want to thank all of our panelists for their presentations today. I thought all of them were excellent, extremely informative.

And at this point, I want to invite you all to turn on your cameras if you haven't done so. And so we're going to spend a little bit of time. We have some discussion questions queued up.

So the one that I want to start with is actually probably the first one. I'm going to it modify a little bit though. I'm going to drop the "transit" off of that. And just generally, how have increased hydrogen prices impacted operations? And how do we get those down now more immediately and then over the next decade?

And then, you know, kind of a combination with another question. You know, this is kind of in response to the DOE's moonshot of $1.00 kilogram of hydrogen produced by 2030.

So I will -- I see Salvador chomping at the bit, so I will go ahead and let him start.

MR. LLAMAS: That is a very fantastic question that I'd like to answer, just by firsthand experience.

So in 2013, we were paying $5.93 per kilogram, and we only operated 12 buses. Fast forward to 2023, we're paying $9.81 per kilogram and we're operating 30 buses, so we're going backwards. And I think the promise that I've heard since then was in five years, the price goes down. In five years, the price goes down.

And the real issue that I see is that there has not been enough investment to produce hydrogen here in California at the volumes that we need to. And to really have the partnership that we're building with these discussions to get not only industry but to get government and policymakers involved to start to realize, how do we solve this challenge and this problem? Because what's going to happen at EC Transit is if we don't drop that price down to $5.00 per kilogram delivered, we cannot buy hydrogen bus anymore because we will not be able to operate it.

And what that translates to me is I have a $14 million a year budget for diesel fuel that fuels 640 buses. If I transition to 70 percent hydrogen, which is 458 buses, that turns into a $46 million a year budget. It's just not

feasible and not sustainable.

COMMISSIONER MONAHAN: Can I just ask Salvador to follow up? Sorry to interrupt.

I'm just curious because I know some production happens on site. So I thought perhaps that you would have more secure production, and is that the case?

MR. LLAMAS: Good question. Let me answer that.

So we take liquid delivery on site. And then we vaporize it and pressure it into tubes for our bus. So we need that liquid delivered hydrogen to be produced in California in the mass quantities that will scale down the price of the kilogram and make it green so we can take advantage of the LCFS credits.

I think that that's a big ask but it's not an impossible ask. And I'm actually very excited to be here to hear that there's some thought around that now. I think ARCHES is an excellent opportunity. We are partners in ARCHES and we're excited to see that come to reality because that's the type of investment that we need at the state and federal levels to make that a reality.

Because the demand is coming a lot faster than we know. And the challenge is when the demand is there, because the push has been there, we have a mandate to transition by 2040. We're on track to do it by 2035. But if the fuel cost and availability is not there, we won't be

able to do it.

And also, same thing with the electricity, reliability and availability is also a big challenge. So we're facing it from both ends.

COMMISSIONER MONAHAN: I hear you. And I just want to commend your leadership on this.

But you do produce a small amount on site, is that -- did I get that right?

MR. LLAMAS: We were producing about, yes, a small percent through an electrolyzer. We did a pilot through an electrolyzer to produce, but it's only enough for about three buses. We're just proofing the concept to understand how that technology works.

COMMISSIONER MONAHAN: And when the supply disruption happened a little bit just a couple of months ago or a month ago, maybe, were you impacted or do you have more secure contracts for that hydrogen?

MR. LLAMAS: Yes, great question. Thankfully, because we are operating a small fleet right now, it was actually we could absorb it with our spare ratio of buses that we operate. And also, we were able to work with our fuel supplier to alternate how we do our fuel delivery so we can keep some buses on the road. But if 70 percent of our fleet is hydrogen, that would not have worked.

And that's another reason why we're utilizing

both technologies. If there is a power outage, which happens in California, we can operate hydrogen buses to serve our customers. If there is, God forbid, an earthquake and the fuel truck can't arrive, we can charge our buses and serve our customers and be an emergency responder to the state like we have been.

COMMISSIONER MONAHAN: That's great, thanks. That really does highlight the importance of having dual fuel options.

MR. MIYASATO: Thank you. Good to see you, Commissioner McAllister and Gunda, who joined the dais. I want to address the elephant in the room, as it were.

I know there's a lot of discussion about increased consumer retail hydrogen prices. We have had to increase the prices. And I think I highlighted in one of my slides that one of the biggest challenges is the current California incentive for station providers is to go LCFS Program. And because that is now at historic lows, we were faced with a couple -- there are a couple of other confounding factors, including faulty equipment that we're forced to dedicate almost - so over three-fourths of our company is dedicated to operations and engineering, to engineer and manufacture better equipment, and then installing that equipment; right? So I'm just overhead. So I could be one of the first to be let go if that came

down to it.

But we were faced with the choice of keeping the stations and the network operational and keeping it to that maintainability or, you know, raising prices. And we felt like we needed to raise prices because, for the most part, it's really the LCFS Program. But, you know, we understand that ARB is going to address that next week, September 14th, in an informational hearing. They're going to go to their board with a regulatory decision in Q1. But we're kind of hanging on by our fingernails until, hopefully, it sends a market signal that the LCFS credits will go back up. But that is the reason that, unfortunately, drivers are paying the impact for high hydrogen prices at the moment.

MR. ORTIZ: Mike or Ben, I want to give you the opportunity. Did either of you want to tackle this question?

MR. GALVIN: For us, we don't have enough equipment out there to make a difference, except that the issue is that we've had delivery issues just for the very few pieces of equipment that we have. So when the rest of the industry out there hears, you know, we have 4,000 pieces of equipment total between the two ports and we have one or two pieces of operating hydrogen equipment and they can't get fuel, period, that becomes an issue.

So the supply issue definitely needs to be resolved. And we're hoping that there are some projects online very locally in Southern California that can provide pipeline delivered hydrogen at what we believe is going to be a reasonable price. And so we hope we can get to that place, but right now, it's a very big consumer confidence concern amongst our container terminal tenants that are trying to figure out how to get there.

MR. HAPPEK: Maybe just as a final comment here, so what we have seen in the past, and I think we had colleagues also from SoCalGas on the call earlier, in the past there have been efforts being made to bring CNG, maybe even LNG, to truck fleets. When they bought those trucks, and the CNG price went up, then what they would do is basically get rid of the CNG assets and go back to diesel and, basically, fluctuating. And that is what mustn't happen for commercial for hydrogen. So we must make -- we must be sure that we have a stable, over the year, stable hydrogen price.

And by the way, this hydrogen price hike is not just exclusive to California. We had the same problems in our operation in Switzerland, where we had the Ukraine invasion by Russia. We had France shutting down power plants. And all of a sudden, the middle market price for hydrogen increased tenfold overnight. And suddenly, the

hydrogen price went up like crazy.

So this is something I think the U.S., due to its size and resources, can mitigate, but what we definitely need is more hydrogen on the market. And hydrogen has to become a commodity and not a molecule that is controlled by very few players, as it is right now. And it has to become ubiquitous, basically, in order to achieve that.

MR. ORTIZ: All right, thank you.

And then this might be a question more specific to Ben, but are you aware -- you showed a slide showing, you know, demand of or anticipated demand for Class 8 trucks. Are you aware of any other states that are currently taking the steps to start, you know, the refueling corridors for hydrogen?

MR. HAPPEK: Well, what do you mean by corridors? So I'm seeing these questions also for the first time as the other panelists right now. So corridor would maybe mean interstate or within a state.

So we are talking, as Hyundai Motor Company, with several states, or let's say participants in hydrogen hubs, beyond ARCHES. So there are, as you are aware, efforts in Texas, there are efforts in the Pacific Northwest, Great Lakes. Most of the trucking in the U.S. actually happens on the East Coast. So the corridor from New York, basically, up to Chicago, this is where a lot of trucking

is happening in the United States, so this is certainly of interest for us.

Can I say that other states are as far ahead as California in terms of identifying hydrogen as transportation fuel of the future? No, not yet. So that will take more time. And I think hydrogen hubs will certainly play a major role in that.

Last comment would be, maybe you have seen that the state of Georgia issued an RFI recently, a couple of weeks ago. And this is also coming from conversations that we had with the Department of Transportation and our partners there. Hyundai is building out a relatively big zero-emission site called the Hyundai Motor Group Metaplant in Savannah. And our ambition is to basically deploy our fuel cell trucks in the state of Georgia, opening up also corridors to Alabama, because Alabama also is a location for us, Montgomery, with the legacy Hyundai Plant. We build 400,000 cars there per year. So that's what we try to connect. And thankfully, the state of Georgia and local players are supportive in that.

MR. MIYASATO: Tomas, let me just add, from First Element's perspective, we've been involved with a lot of the different hydrogen hubs, the regional areas that, you know, submitted proposals to the DOE. But I have to say, Tyson and his efforts with ARCHES is probably the most

comprehensive; right? So based on California's history and the incentive structure here, it's really difficult to start corridors without the incentive structure to enable a longstanding infrastructure married with vehicle incentives.

So having all those policies in place are really difficult to duplicate in other areas. It takes a long time. But I think the hubs are going to kickstart those other areas. But I have to say, California's way ahead in terms of really enabling that transition. They want to do science projects. California wants to do the transformation of the transportation sector.

MR. ORTIZ: Okay. Thank you.

And then I guess we can probably just skip to the last question. This has been, I think, a pretty important topic of conversation today. And then, you know, in discussions that we've had, you know, leading up to this workshop, I've heard the description of leakage as just dollars floating into the atmosphere.

So what are some strategies that are being implemented now to kind of, I guess, avoid the dollars floating up there? And, you know, what are some additional strategies that we may need?

MR. LLAMAS: Tomas, if I may, I can just speak on the perspective from the heavy-duty fueling station that we

have operated.

So we have two different designs. The original design that we built in 2010 takes the liquid hydrogen and compresses, vaporizes it, and compresses the gas using a compressor. The challenge there was that we had boil off, and that's the leakage, so that when the tank was over pressurized, it just went up to the atmosphere. And unfortunately, that was just something that we were told we had to live with.

Thankfully, when the state invested in our upgrade to the station, we worked with the manufacturer and we designed it so that we can recapture that boil off. So the new cryogenic pumping design runs the fuel through the high pressure vaporizers. And the tank itself, when it over pressurizes, it takes the gas and the hydrogen and it cycles it back into the station through the vaporizer and the high pressure tube, so we capture it all. It's a cycle that just doesn't end.

So we were able to solve that challenge. And I think that that's already been solved. It's just a matter of how do we scale that to the larger deployment?

MR. MIYASATO: Yeah, and this is Matt from First Element. I would agree. Like I think Melanie mentioned that, you know, hydrogen is a precious commodity, so -- and we pay for every kilogram that we receive and then

dispense. So we are being very careful in how we manage that commodity or that valuable asset.

And just an example, I think Salvador mentioned new processes and protocols are being developed because heretofore, by the industrial gas companies, they didn't view it as such. It was just kind of a, you know, cost of doing business. So when they would transfer the liquid hydrogen to our stations, there weren't a lot of protocols in place to reduce that boil off or that leakage.

Now we have developed monitoring and protocols to ensure that we get every last kilogram of hydrogen delivered to our station so it can be put in a vehicle. So because of this renewed interest and this new kind of sector that's being developed, I think there's going to be a lot less concern about, as Tomas mentioned, dollars going into the air or being evaporated into the air.

MR. ORTIZ: Go ahead, Ben. I see you unmuted.

MR. HAPPEK: No, I'm thinking about making the comment.

I'm aware of a facility, a legacy oil refinery that is venting every day 90 tons into the atmosphere. I mean, it has to be - it would have to be captured and cleaned somehow. But I'm just thinking about making available 90 tons of hydrogen per day to the mobility market. We could achieve that. That will solve already a

lot of problems that we have. Then we wouldn't need to talk about the last topic, I guess.

MR. ORTIZ: Okay. Well, I think we are at the point where we can now turn over to the dais.

So, Commissioners, if you have any questions for the panel, please go ahead.

COMMISSIONER MONAHAN: Well, I'm at an advantage because my fellow Commissioners were not here for most of the presentation. But I do want to give them a chance before, otherwise I'll dive in. Okay.

Well, this is really interesting. And, you know, I've been in this transportation space a long time, many, many decades, and each time, though, I learn something, and I learned a lot from this panel, so thank you all.

And I want to start, actually, with Benjamin around -- I mean, I got to say Hyundai and Korea, I'm fascinated. I'm really excited about the fact that the International Electric Vehicle Symposium is going to be in Korea next year because I've been so curious to see on the ground like the most light-duty fuel cells deployed in the world, and also a commitment to battery-electric vehicles and fuel-cell electric vehicles, you know, really doubling down. And so just want to appreciate the leadership of Hyundai and Korea in terms of advancing the market.

But, you know, I heard a lot about your plans on

the heavy-duty space. We're making a lot of investments in California in that space, as you've heard. One of the most interesting things, from my perspective, from our Energized Commercial Vehicles Program is so far about 30 percent of the money has gone for medium- and heavy-duty fuels -- hydrogen infrastructure. And so we do have a lot of, I think, companies that are really interested in the technology. And as you've heard, ports in particular, I think, see a need, long-haul trucks for sure. And so that's a space we're doubling down on.

But on the light-duty side, from Hyundai's perspective, what is your -- tell us more, or is that somebody else at Hyundai?

MR. HAPPEK: That is indeed somebody else. I'm the truck guy, but I'm still -- I can still tell you that we are committed to NEXO and our light-duty program for sure. And indeed, we are also developing a successor vehicle to NEXO, so that has been announced also a couple of months ago, so it doesn't stop with NEXO. We will continue to develop also light-duty products in the hydrogen space.

When it comes to deployment numbers and how many in which time frame, that is indeed something that I'm not 100 percent aware of. I will need to ask my colleagues at Hyundai Motor America who are in charge, but we are not

giving up on the light-duty side.

COMMISSIONER MONAHAN: And I know Vice Chair –

MR. HAPPEK: Even though there are big challenges, there are big challenges for sure, and we mentioned them today, but I believe come time, we can overcome them one by one.

COMMISSIONER MONAHAN: Thank you.

I know the Vice Chair has a question, so I'm going to turn it over to him.

VICE CHAIR GUNDA: Sorry I missed part of the presentations. I will listen to them over the weekend or early next week.

But just, you know, I think I want to pick up on Salvador's kind of comments on specifically the dual fuel requirements in your sector. I've heard that in the past from, you know, SoCal, and then the other energy entities. But could, you know, both the panels kind of comment on how do you see the kind of the transition, whether it's your sector services that you're planning for, you know, whether it's the services, you know, you're planning for in terms of energy, the resiliency component of future systems and, you know, thoughts on how we plan for it?

MR. LLAMAS: Good question, Commissioner Gunda. And so the way we approach this is we have some priorities for our Zero Emissions Transmission Plan and I'll just

share those. The last two are really the most critical ones. But one is we want to replace our equipment when they're past a useful life so they can become more efficient to operate and cleaner.

We also have developed a Clean Corridors Plan that identifies 13 major corridors that are impacted by climate. And we want to prioritize delivering the vehicles there. The corridors each have their route demand. So the demand on the vehicle is something that's guiding that decision and what type of vehicle we utilize. We're also going to purchase the zero-emission bus that can fulfill the service demand. So we're not going to alter our service. We're not going to alter our commitment to the community based on the technology that's on the market. We're going to buy whatever can fulfill that. And then in the end, whatever is sustainable and feasible to operate, so cost and reliability is a big factor.

So those are our guiding principles. So when we're faced with that decision, we look at the technology. And that's what really changed our approach from 70 percent battery, 30 percent hydrogen, to 70 percent hydrogen, 30 percent battery, primarily because a hydrogen bus, I can fuel it in six minutes and it can operate for 300 miles in our service environment. A battery bus can take anywhere from three to four hours to re-energize and it can operate

maybe 170 miles reliably before the warnings signal start going out.

But there's a fit for both. So any route that I have that's under 170 miles, we can run a battery bus. And it does cost a lot less on the energy. And the energy is more efficient, the electricity is, than the hydrogen. Hydrogen is more expensive. So there are trade-offs that we're hoping that are going to be resolved sooner or later.

And then, of course, as I mentioned earlier, the resiliency, during my presentation, if there is an emergency, we've been an emergency responder for the state. During the pandemic, we provided essential trips for the community and we kept operating. So we know it's about 65 percent of our service that's going to be required in a major emergency.

If there's a power outage, I can fuel hydrogen buses and respond to that, respond to the community. If there is an earthquake and the roadways are blocked and the liquid truck can't show up, then I can charge my buses and run some service. So I can continue to function regardless of what the impact may be.

MR. FREEDMAN: Maybe if I can add to that, thank you, Commissioner, for bringing this up -- excuse me, Vice Chair.

We have a few fuel-cell vehicles in our fleet.

We, too, are emergency responders and the resiliency is critical for us. To do a few is not a theory for us. It's something which we have to have because we have to be there because, obviously, the events could impact gas grid. And we need to be out there to be able to do it on time.

I will say that the reason that hydrogen takes minutes to fuel and the reason it can go longer than that, and that's kind of an important macro fact, it's not the technological fluke that could reverse itself, it's the fundamentals of physics. It's the energy density of hydrogen, which is head and shoulders more dense per unit of mass than any other way to store energy.

So there's a reason for those numbers that we are quoting, you know, of course, and that's why we think that there's an enormous importance of hydrogen mobility any time it relates to the emergency response. As there is an importance in anything related to resiliency, which was the topic of the power generation panel, this is, I think, one of the applications where hydrogen is remarkably important.

And we definitely are looking to make sure that we are going to provide this resiliency. We have some small-scale production on site just for our fleet because that will allow us complete resiliency. Equal resiliency can be accomplished in sectors which we didn't talk about today. Think about communities far out where you can

combine renewables and hydrogen can create microgrids and basically create high resilience to zero emissions.

So there are multiple applications, but a feature is really important.

MR. HAPPEK: (Inaudible), I'd like to add a small anecdote, if I may?

VICE CHAIR GUNDA: Yes, Ben, please go ahead. I also wanted to see if Mike had a comment, so thank you.

MR. HAPPEK: A small anecdote in terms of resiliency and power outages. I've been asked by a fleet customer if our truck could be used in terms of power outages to charge battery-electric trucks, which I had to reject out of -- well, in theory, it's possible. Yeah, the power takeoff could be done.

But I think this shows you also how far ahead already fleets are in their thinking process and what it actually means to charge a battery-electric truck and even a whole fleet of them. And do they have to stop revenue service if there's power outage? Do they go out of business, maybe even? So these are very important considerations.

MR. GALVIN: Yeah, if I could just add on the resiliency issue and the ability of hydrogen to act very similarly to how diesel does today, how gasoline does today around the ports is extremely important. Because if we can

replicate current operations without changing the entirety of our operations by dragging very heavy-duty electrical load everywhere to be able to load up vehicles when they need that energy, it makes the terminals operate as they do today. It allows our longshore labor to operate as they do today. It allows the fueling operations to act as they do today.

And there's always going to be a place for battery-electric within the medium- and light-duty areas of the port because there is a lot of equipment that is that. They can charge within a reasonable amount of time with some upgrades to electricity. So we're planning for that and bringing that electricity down. But in the case of outages, which we've had many because we're at the end of the line in San Pedro and in Long Beach, it's really important to have a resilient fuel source to be able to continue to move goods and services around.

And hydrogen provides that once we get to the scale that we need across the board. So that's why we see so much promise in it, especially in the heavy-duty section where we need that equipment to run for 20 hours straight at any variable duty that we need it to do.

VICE CHAIR GUNDA: Thank you.

COMMISSIONER MONAHAN: One more. I want to make maybe just a comment. I'm not sure, there might be a

question that follows, but to Matt and First Element, because First Element has really been a leader in California. It stepped up, took a risk, it's been hard. There's been a lot of learning. And I would say, you know, trying to bring -- well, bringing actually the components here to California to ease the supply chain constraints that we face, I think, is going to be a real hopefully gamechanger in terms of reliability.

And I do have a question. I'm wondering, Matt, from your perspective, what else is needed to improve reliability? And, you know, we're considering, you know, operation and maintenance grants. We're trying to figure out, just like with battery-electric vehicle charging where we've seen a lot of reliability challenges, we're seeing that in both technologies. So what would you suggest?

MR. MIYASATO: Well, let me just harken back to my last slides, is I think some of it is stay the course. You're doing the right things; right? It's been hard. You're getting a lot of criticism. And I may say something that's controversial. I think the light-duty market still deserves a chance and equitable funding to ensure that, you know, the biggest GHG emissions sector should get the opportunity to reduce emissions with fuel cell vehicles.

But in that vein, we have been the recipient of two California Energy Commission grants. One is to do in-

house manufacturing, which we're starting to do. So we have actually the best-in-class reliability of all the station providers. It's not 99 percent, it's not where it needs to be, but we're, you know, 5 to 10 points higher than the other station providers. And that's really because, as you've mentioned, Commissioner Monahan, and as I said at the beginning, we're purpose-built. There is no plan B. This is all we do.

The second grant is to develop our own cryo pump. And so as Salvador mentioned, right, liquid hydrogen offers the capability for faster fueling and higher throughput. And in order to get to faster fills at light-duty, and then the fills that are required for heavy-duty, we're going to need cryo pumping. And having that Energy Commission grant will enable to do things that we can't do with the original equipment manufacturing. We can't keep retrofitting or repairing their equipment. So we're building our own, thanks to the state's partnership.

So those things are all what you should continue to do. If there are other opportunities to help augment what is now lacking with the LCFS, I understand that Saria (phonetic) just came out for the LCFS regulation, so hopefully that will send the signal to the market and drive the prices back up.

But in lieu of that, is there something else that

can be done? One thing that we were kind of lamenting months ago before we received the Energy Commission grant was, is there a way to pre-qualify equipment, so when we get it, we know that it will work and work for hundreds and two hundreds of hours, as opposed to 50 hours; right? And maybe that's part of, you know, an R&D future grant where you can do some testing, you know, or some other thing.

I haven't fully thought that out, but you've got a lot of smart staff, the Commissioners are all pretty aware of what the issues are. So maybe there's something in that bucket that could be done and addressed.

COMMISSIONER MONAHAN: And, Commissioner Houck, I don't want to put you on the spot, but I want to make sure you have a chance to speak if you want to.

COMMISSIONER HOUCK: I am just listening for right now, since I just popped back in, but I really appreciate all of the information in the panels and did have a chance to go through some of the PowerPoints, so thank you.

VICE CHAIR GUNDA: Just one last question, maybe?

Ben, this is to you. I'm kind of just thinking this through; right? So I think today we've kind of broadly established and kind of statewide established, you know, we need these clean molecules. We need to figure out, you know, it's kind of a, you know, what's the least

risky steps we can do right now to not have standard assets, but really give an opportunity for this fuel source to flourish; right? So you need to kind of hit that balance of, especially with every emerging technology, you want to set the stage for opportunity with like investments not resulting in stranded assets.

So how does -- you know, how are you seeing, you know, the balance act? And I'll open it to everybody else. You know, like what are those least risky, we can do this right now and still kind of reasonably impact the growth of the market without having to constantly worry about, you know, how that would backfire?

MR. HAPPEK: Well, that's a very difficult question to answer, I would say, but I'll try my best to do so.

So while we are committed to our social responsibility and we want to do our part for the environment and so on and so forth, we have to always work back from our customers and we have to understand what they need and in what kind of way they can operate commercially viable. That's what I'd like to say.

So from my perspective, and I don't want to be redundant here, we said – we have many times during the panel, the stability of pricing and a longer planning horizon are super important.

When I was speaking in Sacramento for the first time, four years ago or three years ago, we discussed that the kilogram of hydrogen will cost sub-$10.00 in a couple of years, now here we are. And this is not to mean – this is not meaning to bash First Element Fuel because we know what the reasons are. The reasons are fluctuations in LCFS credit value.

So what can we do to stabilize this kind of situation? And what can we do to really, in a longer term, convince customers that the hydrogen price will be indeed in the range it needs to be for six, seven years of operation of a commercial vehicle, for example? That's super important to get to the TCO level that we need to be.

So while you have to focus, of course, also on the deployment of HRS, and the network has to be expanded, everybody's agreeing on that, I believe that we should also focus more on a hydrogen production incentive that is basically underwriting the cost for the molecules. I think that's the most important thing, actually.

MR. FREEDMAN: Yuri Freedman, SoCalGas.

I'm trying not to repeat myself and apologize if I will to some degree, but I would say that a successful commodity market that I think we are trying to envision and which will ultimately emerge if all the parts fall into place has to have, I think, four elements, if I'm looking

at other markets which have been successful. Very quickly, that's supply, demand, connectivity between the two. And last but maybe most important is the market structure and that Commissioner McAlester goes to the question that you brought up earlier today, I believe.

And maybe I'll start from market structure because to me, I think what we as a country have established for at least 100 years now, and I'm talking about Standard Oil precedent and then Natural Gas Act, is that efficient market that ultimately drives down costs and connects consumers and producers in an effective way. It has to be liquid and deep. And has to be connected with open access infrastructure, which is going to allow molecules to move just like natural gas moves today from ourselves to Texas to California.

Just like oil moves today, the same needs to happen ultimately with hydrogen if it is to be a large-scale commodity that will take a large element of the energy mix. It will have to happen. And for that, ultimately, it's a long-term vision, that's not going to happen in five years, but if you envision that state, you need to have physical infrastructure in place which needs to be permittable and buildable. And I think that the Commission has a tremendous role to play on both of these using your experience and precedence, using the Renewable

Energy Transmission Initiative and other things.

But I also think that open access infrastructure and the market design, non-discriminatory access is key. That is not the market we have today. Hydrogen market today is not that at all. There are reasons for that. There are few producers selling to very few consumers.

We're envisioning this entirely differently. We're envisioning multiple producers which will be incented by federal and state funding, ultimately driving down costs and selling to multiple consumers. That is how markets will work. And there are real steps that I think the Commission can take in that regard, not necessarily funding because I don't think it's a funding question, market ultimately has to be sustainable, but the market structure, I'll repeat myself, is critical to getting it right and that will get the private capital flowing.

COMMISSIONER MONAHAN: So we're bumping up on time, but Matt, did you want to get a final word in?

MR. MIYASATO: Sure, if you're going to give me that chance to get a final word in.

Let me just say in the long term, the vision of the state is to do all these things that Dr. Freedman just talked about, combining ARCHES production, matching it with distribution and end use, and that's all fine and well. I think that's the exact thing that the state should be

doing, setting these visionary goals.

In the near term, in the next five to ten years, I think we are proof that you need to develop a supply chain and to enable that market. And one of the ready-made supply chains now with a product and infrastructure is the light-duty market; right? So if you continue to enable that, it helps us with our medium-duty and heavy-duty because all those technologies are directly transferable. And had it not been for the light-duty station development that we did, we wouldn't be building the station in Oakland with the CEC and ARB funds to deploy those 30 Hyundai fuel-cell trucks.

So I think there's lots of things that the Energy Commission could do today that really will enable five to ten years and beyond.

COMMISSIONER MONAHAN: All right. Thank you so much.

I think we are now moving to our final presentation, with Peter Chen to talk about our R&D investments.

MR. CHEN: Good afternoon, Commissioners. I'm Peter Chen. I'm a Supervisor in our Research and Development Division.

So there was a lot of discussion today on knowledge and technology gaps. So I'm very excited to kind

of speak at the end of the workshop about CEC's own hydrogen R&D project portfolio, which I think is intended and well positioned to address these barriers, help bring down the cost of hydrogen, and also produce data to inform more beneficial and strategic deployment.

Next slide, please.

So starting with a high-level overview of our division, we strategically invest funds to advance new and emerging clean energy technologies, provide benefits to Californians, and accelerate achievement of our clean energy policy goals. In our division, we administer three active programs with hydrogen-related investments, including the Clean Hydrogen Program, Gas R&D Program, and EPIC Program. And each one has their own unique guiding principles and scope as it relates to hydrogen.

Next slide.

So in September of last year, the governor signed AB 209, which created the Clean Hydrogen Program with $100 million of general funds. The scope of the program includes financial incentives for strategic in-state projects to demonstrate and scale up clean hydrogen production, processing, delivery, storage, and end use. The overarching requirements of the program are set up to make sure we're positively impacting emissions, water use system technology readiness level, as well as costs, and

also benefiting local communities.

So far, we've released one solicitation on federal cost share earlier this year, and we are planning two other solicitations, one focused on large-scale centralized hydrogen production, and a second one on on-site distributed hydrogen production and use.

Next slide.

So with our federal cost share solicitation we released in May, we sought to provide cost share for eligible projects that applied for and hopefully will receive an award under DOE's Bipartisan Infrastructure Law funding opportunity on clean hydrogen electrolysis, manufacturing, and recycling. We released the Letters of Intent in July committing $3.1 million of cost share for three California-based projects. So if awarded by the DOE, the projects will be able to leverage over $20 million of federal funds.

All three of these projects are intended to improve efficiency, durability, and costs of some leading electrolytic technologies, including PEM, liquid alkaline, and solid oxide electrolysis cells.

Next slide.

So switching gears to a different program here. So the Gas R&D Program funds research to support greater gas system reliability, lower costs, and increased safety.

That benefits California citizens and supports the energy policy. It has a $24 million annual budget and it's funded by an investor-owned utility surcharge on gas consumption.

Through this program we initiated hydrogen research, primarily in response to our state's landmark decarbonization policies around the 2018-2019 timeframe, and from guidance from CPUC, which oversees the program. Hydrogen is a potential gas -- potential pathway for gas system decarbonization as a zero-carbon renewable alternative to fossil gas. Gas utilities can also play a role in delivering hydrogen through the existing gas network.

But, you know, we see that research is needed to better understand and mitigate potential impacts, especially on pipeline facilities, generators, and end uses. So with that we initiated a portfolio of projects to conduct this research through this lens of long-term decarbonization of the gas system.

Next slide.

So the next few slides will kind of be highlights of projects we currently have with the Gas Program as they relate to hydrogen. The first one here is on projects we have to advance waste biomass to hydrogen production pathways to lower the cost of low-carbon hydrogen production.

These projects are all advancing pretty innovative approaches. For example, electroactive technologies, they are testing a microbial and electrochemical process to efficiently convert organic food waste to hydrogen. And another example here is a project with UCLA to demonstrate direct conversion using concentrate solar to produce hydrogen from biogas, and also co-produce solid carbon as an additional value stream.

So the goal of all these projects is to demonstrate viability and also generate data that can inform future commercialization.

Next slide.

So as we heard from the last panel, heavy-duty transportation is an important potential end use for hydrogen in California. It's a significant source of criteria and emissions. And, you know, the certain duty cycles, for example, at the ports can be especially challenging to electrify directly.

We also see the gas system can play a future role in hydrogen conveyance for these end uses. So we have active projects to demonstrate hydrogen fuel-cell technology and some future work planned on innovative hydrogen delivery and refueling solutions for heavy-duty truck, rail, marine, and aviation applications that can enable higher fuel rates and also minimize leakage and

issues like energy losses.

Next slide.

And so one of the core research topics in our gas program, especially in recent years, has been on hydrogen blending impacts. We have an active project with UCLA and partners like Sandia National Lab, as well as the utilities, to quantify risk of targeted hydrogen blending in existing gas infrastructure. The project will conduct laboratory experiments to assess the behavior of relevant gas infrastructure materials and components under applicable conditions.

And then the project team intends to build models that can help predict component and system-level risk from the point of hydrogen injection to the end use. The models are also intended to be inclusive of high-pressure transmission system components, where it's likely that hydrogen will be injected for customers like power generators and large industrial facilities.

The project will also use these models to perform specific risk assessments of two targeted use cases. So one is an asphalt production plant with GraniteRock in Northern California, so that's representing an industrial customer. And the second use case is with UC Irvine and their gas-fired central plant, representing a power generation use case.

The project will culminate in conducting a technoeconomic analysis to assess scenarios for mitigating risk, including retrofitting existing gas pipelines, new purpose-built hydrogen pipelines, and also look at alternatives like hydrogen conversion to carrier fuels.

Next slide.

So while the previous project was scoped primarily to assess pipeline infrastructure impacts, this other project with TTI will be identifying and resolving research gaps concerning hydrogen end use in large commercial and industrial equipment. The project has already conducted some analysis to identify specific hard-to-electrify equipment that could be candidates for hydrogen substitution, so that includes industrial boilers, process heating, furnaces, commercial HVAC, and commercial cooking.

And the next steps for this project are to conduct laboratory experiments and evaluate the technical limitations of hydrogen fuel in current equipment, and also look at emissions impacts.

Next slide.

So another end use we're investigating in terms of hydrogen plant impacts is gas-fired power generation, where hydrogen can be used to displace fossil gas to reduce greenhouse gas emissions. However, challenges emerge,

especially as blends go beyond 30 percent by volume, all the way up to 100 percent, including equipment limitations, performance and efficiency impacts, and also emissions mitigation, especially with NOx.

So we recently proposed three projects for award to address these challenges, particularly targeting systems, smaller than 5 megawatts, so with a focus on distributed generation and combined heat and power. These projects plan to take innovative approaches, such as demonstrating the Argonne pyrocycle using in-cylinder combustion optimization and a split-cycle technology to optimize engines for high-hydrogen blends. So we hope to bring these projects to a business meeting for vote later this year.

Next slide.

So looking ahead on upcoming research for the gas program, we have two approved initiatives represented on this slide and one pending CPOC approval.

The first one here is our intention to fund a study to characterize optimal co-location opportunities for industries and clusters where they can share hydrogen infrastructure and reduce the cost for producers and also end users. This study will evaluate safety, risk, benefits, and technology advancements needed for this approach, as well as look at feasibility of repurposing

existing gas infrastructure.

The second study here, which is also approved, is to assess the economic feasibility of underground geologic hydrogen storage in California. This is absolutely a key barrier in introducing hydrogen at larger scales and into the gas transmission system.

And lastly, we have an initiative pending approval from CPOC to advance gas leakage monitoring and mitigation solutions, which will be inclusive of hydrogen and hydrogen blends. So through this effort, we hope to help acquire some real-world data on leakage, inform our understanding of leakage rates from production to end use, and also develop safeguards to minimize leaks.

Next slide.

And lastly, I'll speak a bit about our work in the EPIC program as it relates to hydrogen. So EPIC supports R&D of new emerging pre-commercial clean energy innovations. It invests around $130 million annually, and it's funded by an investor-owned utility surcharge on electricity consumption.

So EPIC is relatively new to funding hydrogen research as hydrogen is generally, in general terms, new to the electric sector as end use. Currently, our project portfolio was primarily established in response to SB 1369, which defined green and electrolytic hydrogen as a type of

energy storage to be targeted for increased use.

So EPIC's interest in hydrogen is really focused on its connection to the grid as both load and supply. We're very interested in understanding hydrogen's potential role as a type of zero-carbon firm dispatchable resource and long duration storage technology. And we're also very interested in assessing renewable integration opportunities, and also potential grid impacts, as well, of hydrogen production from electrolysis.

Next slide.

So in terms of EPIC's active portfolio projects, we're mainly testing these green electrolytic hydrogen storage systems for various use cases, including renewable integration, microgrids and resilience, peak shaving, mobile backup power, and EV charging support.

So one example here is a project we have with EPRI, which is developing mobile hydrogen fuel-cell backup generators to use as a zero emission alternative to diesel. This system will be designed to also support EV fast charging and peak shaving during normal grid operations to provide this additional value beyond just emergency backup.

Next slide.

So I think this is my last slide. And this is our most recent activity in EPIC as it relates to hydrogen. The EPIC Interim Investment Plan included an initiative to

assess hydrogen's potential role in electric sector applications. So going forward, we are currently preparing to kick off projects with RAND Corporation E3 to assess hydrogen's potential role in the space.

And we're targeting kind of several key results from these projects, one of which is to build on our learnings from our active EPIC projects and evaluate hydrogen for bulk grid use cases. We want to improve our understanding of cross sector impacts and benefits of potential hydrogen demand for electricity, for transportation, and industrial end uses. We want to assess the value proposition of storing hydrogen in geologic formations to meet time bearing demand across sectors, especially at very large scales. And we also want to analyze least cost configurations of hydrogen production, storage, transportation, and end use systems.

I think at the end of this project, another kind of key funding that we want to get is actual recommendations for future EPIC investments. So we have an EPIC 4 initiative to do research on green hydrogen, and we're hoping that this work will inform exactly what we will target with that funding. And we're also currently in our EPIC 5 investment planning process, still early stages, but we're hoping that this research will also inform what we propose in our EPIC 5 plan.

We're actively coordinating with CEC's SB 1075 team, and we definitely see an opportunity for this work, as well as the other projects I presented on, to inform our future hydrogen modeling work.

And with that, I'll conclude my presentation. Happy to answer any questions.

COMMISSIONER MONAHAN: Peter, that was great, and I just want to thank you for your leadership on all things hydrogen. You're really thoughtful, and I think it's just been a really interesting, comprehensive plan. And CEC, as you showed, is investing in all, I mean, from the sort of early stage companies evaluating how we can support to how do we evaluate the impacts of using hydrogen for various purposes, including most recently for our grid.

And also deployment; right? We're trying to look strategically about different ways that we can fund hydrogen production here in California to avoid some of the challenges that we just talked about in the last panel around access to hydrogen that's clean and that's locally produced, and that's more consistent than what we've had in the past.

So just appreciate your leadership and the team at ERDD that are working on all sides of this equation.

And I don't think either of my fellow Commissioners, I'm not sure, I'm going to look at

Commissioner Houck on the screen, see if she -- no, she's -

COMMISSIONER HOUCK: Yeah, I just wanted to say thanks. It's a lot of work, very impressive program, but I don't have any specific questions.

COMMISSIONER MONAHAN: All right.

VICE CHAIR GUNDA: Peter, I was going to ask you a very tough question, but I'm going to pass right now, so follow up. Thank you.

MS. RAITT: All right, well, thank you so much, Peter. It sounds like we're ready to move on. And so the next thing is public comment.

So thank you again to all our presenters today. I really appreciate everybody's time and expertise in being here.

And so with public comment, we'll start with folks in the room. We do ask that we limit comments to one person per organization and three minutes per speaker. And so I'll just ask, by show of hands, if anybody in the room would like to make comments? Okay, great. You would like to.

Do we have a microphone there? Shoot. Sorry about that. Yeah, so here's our microphone. If you can just come up and say your name and spell it for the record, please, and let us know your affiliation, if any.

MS. HAMILTON: Okay. Hello, I'm Jennifer Hamilton, H-A-M-I-L-T-O-N. I am the Deputy Director for the California Hydrogen Business Council. I'd like to thank you for your thoughtful remarks and presentations and the opportunity to comment on this draft 2023 IEPR report or IEPR.

The CHBC is the leading advocate for hydrogen in the fuel-cell industry that advances and supports policies to commercialize hydrogen in the energy and transportation sectors, which will help California achieve its climate, air quality, and decarbonization goals. The CHBC requests alignment of the IEPR Scoping Plan implementation of SB 1075 and the Hydrogen Market Development Strategy, along with federal policy to maximize the benefits of using hydrogen for decarbonization and air quality.

As Commissioner Gunda stated, future workforce development will be driven by the alignment of these policies and the ability to leverage the available federal funding to achieve California's ambitious climate objectives.

Federal government just launched an Interagency Hydrogen Task Force to take a whole-of-government approach to executing the National Clean Hydrogen Strategy, including development of a robust market supported by domestic supply chains and sustainable jobs. And

California can align with this approach.

The restrictions proposed by the NRDC would increase hydrogen costs by over 115 percent for no net benefit while preventing the short- and long-term decarbonization, air quality, economic and jobs benefits that can simultaneously be achieved by hydrogen. We must support the use of hydrogen to stabilize the grid when EV charging and intermittent renewables challenge grid operators who need hydrogen for maximum flexibility.

With respect to the policy and regulatory approach for hydrogen production, the incentives the CHBC would like to emphasize are, one, additionality should not be required for jurisdictions like California with a renewable portfolio standard. An additionality requirement will subject hydrogen projects to multi-year interconnection delays while achieving no grid emission benefit that would help meet the state's mandates for clean power resources.

Two, like those renewable portfolio standards, hydrogen should be allowed to use annual time matching. Numerous studies indicate the annual matching drives operational efficiency and more desirable grid outcomes.

Three, requiring the renewable power generation resource to match the location of the hydrogen production asset will add additional costs to many projects and

inhibit placing renewable energy generation and hydrogen production in the best locations.

Four, as with the RPS, biomass and biogenic resources should be eligible hydrogen sources within California and included within the IEPR.

And five, hydrogen must have parity with other clean energy resources. The three pillars concept have not been applied to other resources. These concepts risk the outcomes of offshore electrolytic hydrogen projects to other states and countries and jeopardize meeting decarbonization targets, job creation and energy security.

Additionally, I would like to point out that the CARB SB 1075 scenarios anticipate the use of fuel-cell electric vehicles to reach over 100,000 in the next ten years and then double by 2040. This is more consistent with industry forecasts than the CEC numbers. To reach these goals, we need to ensure that we create reasonable approaches through policy vehicles without delaying this market traction.

Thank you again for the opportunity to comment and we do look forward to supporting a data- and fact-based approach to the IEPR consistent with the SB 1075 report and the hydrogen market development strategy.

Thank you.

MS. RAITT: Thank you.

So, yeah, again, if you could just state your name and your affiliation, thanks.

MR. SKVARLA: Yeah, Mikhael Skvarla here on behalf of the California Hydrogen Coalition, so M-I-K-H-A-E-L S-K-V-A-R-L-A.

I want to thank the Commission staff for a good day of hearing workshop. I wanted to address a couple of comments kind of from the earlier panels specifically with regard to the technoeconomic analysis that's necessary to complete the work that you've been charged with under SB 1075 and what's necessary for the IEPR will result in the need to look at more than a single factor like efficiency. Our energy economy is far more complex than just that single metric.

And while we've done good at shrinking kind of energy consumption and the grid and individual uses such as households and very big proponent of heat pumps and all those things that you guys are doing than have done since the beginning of the Energy Commission, we need to understand that as we look to carbon neutrality by 2045 with an 85 percent direct emission target, we need to consider other factors such as productivity, effectiveness and efficacy of the products, capacity, scalability, economic efficiency and so forth. This brings into light time of day, capacity factor, and other things that are

necessary to fully decarbonize our economy 24/7 as is the goal of the state, as is the goal of our renewable portfolio standard.

And so to that end, you know, cost effectiveness is an important thing. We would disagree with the earlier panelists. We believe that hydrogen does bring an incredibly cost-effective thing even today. The NREL data provided to the last IEPR would show that per dollar invested on a dollar basis adjusted for energy delivered, hydrogen refueling stations are delivering three times more energy than the DC Fast Charging network that we paid for. That's just due to the fact that we're delivering more clean molecules at a faster pace at a more centralized location.

Additionally, as we get into kind of the three pillars in those things, we need to avoid the arguments of the strings (phonetic). California has a stringent carbon policy, as well as an RPS that contemplates all -- a lot of these issues already with regard to, you know, the additionality. Resource shuffling, a big part of our RPS. It kind of controls what we're talking about here and there will be need for new additional growth. But at the same time, the risk factor may not be the same in California and the WECC that it is in like ERCOT and the other balancing authorities that don't have the same carbon controls, the

same renewable portfolio standard.

And so to the end, that we look at kind of the integrated policy that bringing hydrogen into our renewable portfolio standard and into our full -- into the full fold of the decarbonized economy with all of these other factors, which is very complex and difficult modeling task, we look forward to working with you further to ensure that we get a great outcome from not only this report, but also for all Californians and ratepayers.

Thank you.

MS. RAITT: Thank you.

Go ahead, Scott.

MR. TOMASHEFSKY: Good afternoon. Scott Tomashefsky. I'm not going to spell last name for you, Heather, if you want, Northern California Power Agency. Just a couple of thoughts just to share. And hopefully I'm not double-dipping. I know Randy was on the panel earlier. So I won't talk about what Randy talked about.

COMMISSIONER MCALLISTER: Scott, if you don't spell your name, then your comment doesn't count, you realize?

MR. TOMASHEFSKY: It might take my entire three minutes, though, so I'm sorry, but thank you. Always a pleasure to be here and speak to you all.

I think as I've listened to this throughout the

day, and I know as much as we've been involved in the hydrogen issue, one of the challenges that you all have to deal with, and it's sort of a reflection of the 1075 work, is trying to balance the policy objectives, the timing of what we're trying to accomplish, and sort of the operational realities of how to do that, which is no easy task. And so having us all be part of the dialogue is extremely important.

So a couple of points just to kind of think through, just for consideration, is that really the focus is on the end game here. And so it's really about how hydrogen can feed to reducing carbon and getting to that end game. And the challenge we get into is what happens during a transition.

I think, Vice Chair Gunda, you have mentioned it a couple of times during the course of the day, is how you get there is the real challenge. And sometimes what will happen is you'll find yourself looking as if you're not going in a linear direction towards moving forward. And there might be steps back that are perhaps considered temporary setbacks, but they're not really setbacks, they're sort of steps along the way.

So when you talk about things like blending hydrogen, getting to a full use of hydrogen, the blending component is almost as important as getting to the end

game, because you can't quite get there because the technology is not there yet. So you sort of have this issue where you're not doing a one-to-one reduction in emissions today, but eventually you get there. And so what we don't want to do is we don't want to lose sight of those objectives. And so some things that we do may or may not look like we're moving ahead, but yet they're very important to deal with.

And so the question is how you optimize the policy challenges that you want to accomplish and make sure the capital investment is made in a way where industry does want to make those investments, but they also understand that there's a payoff at the end of all of this. And so their payoff, of course, is capital investment, you make profits or whatever that is. The state actually gains by doing that.

So sort of the basic point on all of this is we are at the early end of the market maturity curve. You can almost look at it like the solar industry 20 years ago, it really needed a lot of help. And so where we are right now with the hydrogen industry as it relates to some of this wider-scale deployment is that it's not only about R&D, but it's also about the financial incentives to deal with the fact that it's not cost competitive today, but that's the long-term objective.

And so getting hydrogen into the system and finding ways to maybe buy down some of those costs on the near term are just as important as spending money on R&D to do the work that actually gets you to a point where you have the technological answers you want to get at the end. So just wanted to share that.

And thank you again for this day. It's also very, you know, very informative and really appreciate it.

MS. RAITT: Great. Thanks.

So it doesn't look like anybody else in the room to make -- would like to make comments.

So we'll move on to the folks online. And we have six hands raised. And if the others want to raise their hand, I see more, yeah, just press the raise-hand function, and more hands are coming up. And then if you're on the phone and you wanted to raise your hand, press star nine.

So with that, I will open the line for Julia Levin.

Go ahead, Julia.

MS. LEVIN: Good afternoon. And thank you, Commissioners and staff, for a really exciting and informative workshop. I especially loved the two panels this afternoon, the transportation and electricity panels, which I think really underscored why we're going to need a

whole lot of renewable hydrogen in California to meet our decarbonization goals. And I think if there were a manufacturing and industrial panel, you would receive the same message.

I have two recommendations, actually three recommendations, though, that I think are really important.

The first is we really need the Energy Commission and the Air Board to adopt a definition of renewable hydrogen once and for all. There's a lot of uncertainty about what's in and what's out. We're spending a lot of time as an industry fighting over this in the legislature. And I think that the expert agencies should make that definition, should adopt that definition as part of the IEPR and the SB 1075 report.

And I definitely think it should include renewable organic waste resources. Tyson made that really clear, Tyson Eckerle in his presentation from GO-Biz this morning. The Air Board has made it really clear in workshops, it's held on SB 1075. But it's not clear to everyone that organic waste and biogas will be included.

And that brings me actually to my next recommendation. I was really concerned this morning with the CEC's modeling for SB 1075 because that modeling focused 100 percent on electrolytic hydrogen and didn't cover biogenic sources of hydrogen at all.

And I don't think that even complies with SB 1075, which specifically refers to short-lived climate pollutants. It refers to forest management, organic waste management, and a number of other terms, carbon-negative emissions that are potential with hydrogen, all of those are related to hydrogen from organic waste resources.

And I don't think that the legislature included all that language about the Lawrence Livermore National Lab report and bioenergy with carbon capture and sequestration that's converted to hydrogen and all the other references if the legislature didn't intend for the SB 1075 report to include biogenic sources.

That would also be consistent with the CEC and Department of Conservation's funding for projects that would convert forest waste to hydrogen and projects in development in the urban sector that will convert organic waste diverted from landfills into hydrogen to help meet the landfill diversion requirements of SB 1383.

So I think it's really critical that the agencies adopt a definition and that the modeling follow that definition, and it be consistent with SB 1075.

Last, on R&D, and here I just want to give a shout out to all of the CEC's R&D staff. They are amazing, and they've been amazing for a long time, and it makes a difference globally what you do on R&D. So I have four

specific areas in my last few seconds.

On NOx emissions, one of our members is the Placer County Air Pollution Control District. They are really excited about new ceramic air filters to reduce NOx emissions by 95 percent. We also need more R&D into steam methane reformation and water gas shift using organic waste resources and what the carbon capture and sequestration potential is for different conversion technologies.

Thank you all so much, and have a good weekend.

MS. RAITT: Thank you.

Next is Tim Ballard [sic], if you could also state your affiliation. Go ahead, Tim.

MR. SASSEEN: Hi, yes, this is Tim Sasseen, S-A-S-S-E-E-N with Ballard Power Systems.

Thank you very much for -- sorry about that - for the name mix up, but thank you very much for this meeting today, encouraging to see the advancement of hydrogen in the CEC's plans.

It was great to hear from Jennifer Hamilton from the California Hydrogen Business Council. Ballard fully endorses CHBC as being the voice of the hydrogen and fuel-cell industry in California. We'd like to see more participation of the CHBC be included in the CEC's discussions of hydrogen.

Very much appreciate EDF's comments on monitoring

hydrogen leakage. We agree with that. We think it's very important not only to avoid any detrimental impacts, but also to get real data and avoid assumptions that may lead to destructive policies. We find more and more that data is in our favor, so we appreciate that.

But I would like to draw attention to the National Resource Defense Council's three anchors to hydrogen, the additionality requirements, as it endangers their credibility in this discussion for decarbonization. We know that California has committed to grid decarbonization and to decarbonization in the transportation sector. And the transportation sector will take at least as much energy as the grid uses. We have less than half of our grid renewable. That means we need at least four times the renewable resources in the future to fully decarbonize.

So what additionality talks about are today's resources, less than 25 percent of what we need in the future at a time where integrating those resources is going to be its most difficult. We need to accept that we've committed to decarbonization across the grid, across transportation, and work in that direction. Everything else beyond safety needs to be towards resilience and reliability.

It is going to become more and more challenging

for grid and fleet operators to keep things going. As we have more and more volatile sources and charging loads, hydrogen is here to help. We're going to see that as fleets increase dramatically, zero-emission fleets in trucking, particularly drayage fleets, hydrogen is here to help. We can help backstop the interconnection cues that are building up on the grid.

And it's important that California realize this and not trail behind as the federal government moves towards moving beyond these three restrictions, which has been shown recently by Harvard and University of Cologne studies to increase grid emissions, in fact, while increasing the cost of green hydrogen by up to 27 percent.

So we applaud the CEC's movement forward in hydrogen in getting a more and more inclusive strategy. And we ask that hydrogen be considered as a equal player in the playing field as we've established it.

Thank you very much.

MS. RAITT: Great. Thank you.

Next is Steve Rosenblum, and just please state your affiliation.

MR. ROSENBLUM: Yeah, my name is Steven Rosenblum, R-O-S-E-N-B as in boy, -L as in Larry, -U as in Ursula, -M as in Martin. I'm with the Climate Action California, a non-governmental organization working to

avoid climate disaster.

And I was able to listen to most of today's presentations and I was a little bit disappointed. I think that the climate emergency requires that we not continue business as usual, but we pursue revolutionary solutions as quickly as possible.

I was particularly disappointed with the discussions today of the electrical system, which started with the presentation by Jennifer Campagna and panel number three. I think the paradigm is incorrect. I think what people are assuming is that we're going to continue with gas turbines and just change the fuel to hydrogen, which has been pointed out by several people today as being only ten percent as efficient as directly using electricity.

So the paradigm I would like to suggest rather would be to use batteries, either flow batteries or other sorts of batteries as the primary method of replacing these gas turbines for peaking power, and then using hydrogen fuel cells as a secondary method, you know, which are obviously somewhat less efficient. But I think that should be a very high-level effort that should be pursued at least at the R&D level.

With regard to hydrogen price, I think one way of getting the price down would be to tax fossil fuels and use the tax to subsidize hydrogen. That would automatically

increase the cost of fossil fuels and decrease the cost of hydrogen. So we don't have to worry about subsidizing it. We can actually kill two birds with one stone.

Then also, the question of using -- having light-duty fueling stations being a catalyst for transportation by heavy-duty and medium-duty trucks, I think is a red herring. It really doesn't help because the needs of the trucking industry do not require fueling stations every 50 miles or every 100 miles or many in cities. I think there are only 15,000 fuel-cell light-duty vehicles in the state and over a million EVs. There are 60,000 public chargers and only 40 hydrogen stations. So I think that the ship has sailed. There's no excuse for light-duty hydrogen vehicles being subsidized by the state.

And finally, we should not spend any money on mixing hydrogen into the methane supply for delivery to homes and businesses. That only can reduce it by ten percent, so it's not going to have much effect for the climate.

MS. RAITT: Thank you.

Next is Jaimie Levin.

Go ahead, Jaimie.

MR. LEVIN: I had to unmute. Jamie Levin with the Center for Transportation and the Environment. Not related to the previous speaker with the same last name.

Our organization is a nonprofit here in California. We're heavily engaged in deploying heavy-duty transit, buses, fuel-cell buses and trucks, very successfully, I might add. And I think it's very clear, you heard compelling testimony about the performance of these vehicles, these fuel-cell vehicles, reasons why you're seeing kind of a sea change in the commitment of -- towards fuel cells and a shift in many cases from battery-electric to fuel cells.

You heard in one of the testimonies all the rationale and reasons why there are benefits to that technology. No one questions that batteries are more efficient than fuel cells, but it's operational efficiency which has really made the compelling difference.

So the issue really comes down to hydrogen. And the question was asked about how to drive down the cost of hydrogen and what these challenges are. I want to make two points that I'd like to emphasize.

You heard about the three pillar concept. Look, we all have the aspiration of achieving 100 percent renewable. That's where we have to be. But I would like to emphasize, let's not make the perfect the enemy of the good. We need to go through a transition period.

And I always like to emphasize, fuel cells are agnostic as to where they get their hydrogen from, so we

can transition ultimately to those goals.

Secondly, there was discussion about leakage and the atmospheric impacts of leaked hydrogen to the upper atmosphere. And I would make the point, several did make this point, that hydrogen presently is a very valuable fuel source. And so station designs, which our organization has been involved in many of these heavy-duty station construction projects, they're driven by minimizing and eliminating leakage in order to minimize or eliminate the loss of fuel and the cost associated with that.

But also from a safety standpoint, your organization requires virtually every station that is funded with CEC money to be reviewed by the Hydrogen safety Panel. All of our projects require that as well.

So those two issues, that and the global warming issue, they need to be carefully evaluated. We need peer review analysis. We need forums and discussions.

And that comes to my final point that I want to emphasize. We have this marvelous opportunity with ARCHES. The state has prepared probably one of the strongest if not the strongest application with ARCHES to the federal government. We have an excellent chance of receiving $1.25 billion to leverage all the work that California has done. Now is not the time to be complacent, to stay the course as it is. Now is the time for the CEC, CARB, the state to

accelerate, but not by forgetting and not addressing these concerns about the environmental impacts. We need to do them together. But now is the time to put pedal to the metal to advance hydrogen applications.

Thank you very much.

MS. RAITT: Thank you.

Next is Peter Tull. Apologies if I mispronounced your name. Go ahead, Peter. You might need to unmute in your end. Okay, well, maybe we'll come back to Peter.

So, and again, apologies for mispronouncing, Serj Berelson, go ahead.

MR. BERELSON: Yeah, perfectly pronounced. Thank you. That was a treat. Can you all hear me?

MS. RAITT: We can, thanks.

MR. BERELSON: Great. So, good afternoon. I'm Serj Berelson from Mainspring Energy.

And first, I want to thank the Energy Commission Commissioners and staff as well as the CPUC Commissioners and speakers for putting on such a thorough and thoughtful workshop on the future of hydrogen in California.

Clearly, based on this fulsome discussion, hydrogen has a really important role to play in building a clean energy future across a number of sectors, notably power generation.

And in response to remarks from a few of today's

speakers, I wanted to highlight Mainspring's dispatchable linear generator technology as a valuable form of clean firm power that can utilize hydrogen to generate electricity without combustion. And I emphasize that last piece because we heard a few speakers and commenters today mentioned the importance of reducing NOx levels. And Mainspring's linear generator uses a low temperature uniform reaction that maintains peak temperatures below the levels at which NOx forms resulting in near zero NOx emissions.

Moreover, linear generators are fuel flexible without any hardware changes, meaning they're already being deployed to run on fuels available today and can seamlessly transition to hydrogen once it becomes available.

So, you know, Mainspring is very excited about the potential for hydrogen to help decarbonize our grid while maintaining reliability and fostering further deployment of variable renewable resources. And we look forward to continuing to collaborate across California's agencies to build towards the grid of tomorrow.

So thanks again and wishing everyone a great weekend.

MS. RAITT: Thank you.

Next is Christopher Murphy.

And Christopher, you may need to unmute on your

end. Thanks.

MR. PATEL: Hello, this is Pinakin Patel, P-I-N-A-K-I-N.

MR. MURPHY: He's speaking for Christopher Murphy.

MR. PATEL: -- P-A-T-E-L. Chris Murphy and I, we are colleagues. And I'm really delighted to be seeing so many CEC Commissioners. So hydrogen must be doing something right. It is such a high-level interest. So I'd like to thank you, everyone. And certainly, we are very happy with this initiative, a lot of new things we've learned.

We have a CEC project on producing hydrogen from waste, or waste resources, and that project has proven that it is very good for long-duration energy storage. And it has also helped us solve -- provide a cross-cutting opportunity, which I didn't see much today.

I'd like to point out that California is a leader, but California is also suffering of issues like forest fires. And California has funded, CEC has funded project to convert woody biomass, agriculture biomass to green chemicals, green fuels, and hydrogen.

But I would encourage CEC to look at transition strategies that is cross-cutting. So if you're providing solution for forestry wood, okay, which is, you know, PG&E

is a good example of that, that they cut the trees to keep the grid safe, but then they collect those trees in a wood yard. CEC has the opportunity to partner with PG&E and some of the companies that CEC's technology has funded to showcase that you can make hydrogen from wood waste, but also provide grid support and all.

And in this scenario, you're creating multipurpose solution and the cost of hydrogen will obviously come down when you look at the value of preventing forest fire or agriculture waste, which is also same way.

So the gasifiers that CEC has funded, and I really admire that, there are at least half a dozen gasifiers, and my team has evaluated them. And they provide opportunity to make green hydrogen at lower cost because it's produced from waste, okay?

And same way, the plastic waste, you can look at it and produce green hydrogen from it. But then some of the funding projects, they say plastic waste does not qualify. So there are some issues that needs to be addressed at the Commission level, that if you're providing solution that benefits cross-cutting in California, you don't come under one definition, which is just hydrogen alone and you must make it from water. Making hydrogen from water is one portfolio solution, but there are half a

dozen other hydrogen carriers.

MS. RAITT: Thank you. We should – we need to move on to the next commenter.

Next is Mark Nechodom. Sorry if I mispronounce your name. And also please state your affiliation, if any.

MR. NECHODOM: Well, thank you. And, yes, very correctly pronounced. Thank you.

I want to thank the Commissioners, staff, and all the panelists. This has been actually a very exciting day of workshopping things. We had some prepared comments, but I'll just start from the top and move quickly here. I'm Dr. Mark Nechodom. I'm actually the Senior Director for Science and Technology at the Western States Petroleum Association.

And rather than doing the pitch about what WSPA is, I think it's good to kind of frame what we do as part of what we are transitioning from, but needing to make sure that we maintain the one running horse as we're jumping to the next running horse, and that is that our members employ about 360,000 people in California alone. We serve California and the four Western States supplying 42 million gallons of gasoline and 10 million gallons of diesel every single day into the third largest fuel market in the world behind only the U.S. and China. And we do that for a fleet of about 35 million vehicles and at the same time investing

very heavily in low-carbon fuels and emission reduction technologies.

So I just wanted to kind of put that into context that we very much, we being the industry and my members, very much want to be deeply integrated into this conversation and not seem to be resisting or trying to preserve something that is not appropriate. We all know that we have to stop putting 32 gigatons of carbon into the atmosphere every year that the Earth system can't process. So we all agree with that. We are fully embedded in this.

I want to echo Dr. Yuri Freedman's point without butchering it, I hope, and that is the unprecedented nature of what we are trying to do, truly unprecedented. We are trying to simultaneously grow supply and storage, grow demand, grow transmission and distribution, stabilize policies, stabilize markets, increase access to those markets for providers and consumers, and keep it affordable across the economy.

And in each of these elements, it requires investment and ROI, reasonable ROI. It means a clear business case for whatever we're building and operating, and a stable policy environment like LCFS. I'm not saying it's stable yet, but we're very hopeful that LCFS will be stable.

And I also, just as a more productive way of

looking at this, I want to support Julia Levin's comment. You have to have a common definition of renewable hydrogen.

And as the last speaker said, there are many pathways to hydrogen that are not just electrolysis. Fisher Chope (phonetic), for example, which requires a lot more R&D for development of scaling, organics.

And then consider the gradual transition here. So use what we have for hydrogen sourcing as we drive greater demand and then transition to lower and lower carbon over time.

So that's what I think we're all aiming for. And I thank you for the opportunity to comment here.

MS. RAITT: Thank you.

Next is Jeremy. If you could give us your first and last name and any affiliation? You may need to unmute on your end.

MR. HAYWARD: Can you hear me?

MS. RAITT: Yes, thanks. Go ahead.

MR. HAYWARD: Okay. My name is Jeremy Hayward, H-A-Y-W-A-R-D. My affiliation is with Redding Rancheria. Our company is Redding Rancheria's H2EG. We have a project in Red Bluff, California, that we're going to be producing green hydrogen using woody biomass. And that’s something that I hadn't heard talked a whole lot about today, a few commenters spoke about it, but not a whole lot of

conversation around it. So it seemed like the majority of the conversation was around electrolysis and the processes for that. And I feel like pyrolysis has kind of been forgotten about or not really been as talked about. So I wanted to bring that up.

Our process is carbon negative. We are producing hydrogen using woody biomass, using pyrolysis system, and we're doing so by creating our own energy, so we're not hooking up to the grid. And I think that I heard some comments earlier that were kind of negative about how much energy it takes to produce hydrogen using the electrolysis process, but that's not true for all hydrogen production. So I just wanted to highlight that.

And that's all I have.

MS. RAITT: Okay. Thank you very much.

So I don't see any more hands up, but I'll just provide another opportunity, if anyone wants to comment to please raise your hand if you're on Zoom. And if you're on Zoom via the phone, just press star nine, and that will let us know that you'd like to make a comment.

And let's see, okay, they can -- for a second, there was a hand up, but it's gone. Give it another moment.

McKinley, would you like to make a comment? You can go ahead and unmute on your end if you wanted to

comment.

MR. ADDY: Yeah. Can you hear me now?

MS. RAITT: Yes. Go ahead.

MR. ADDY: Thank you. My name is Addy, M-C-K-I-N-L-E-Y, last name A-D-D-Y. And I'm a Vice President of AdTra (phonetic).

First, thanks to the Commissioners for this very informative IEPR workshop on hydrogen power and transportation, and congratulations to staff.

AdTra makes it possible for qualified consumers and businesses to own or deploy EVs or e-trucks at gasoline and diesel truck prices without relying on government incentives.

Myself, I was privileged to lead joint agency predecessor work on the State Oil and Fuel Plan and a full fuel cycle analysis that forms the basis for the Low Carbon Fuel Standard. Both of those proceedings looked at medium and heavy-duty vehicle hydrogen fuel cell scenarios. It would be of some value to see how our projections then compare to new projections.

CEC has been a leader in each H2 medium- and heavy-duty fuel cell vehicles from the first AC Transit fuel-cell bus and fueling stations to the BP LAX hydrogen fueling station, fuel-cell bus system stations at Chula Vista and SunLine Transit.

So AdTra is pleased to see a more focused effort on hydrogen for power generation and transportation. My comments focus on three areas.

First, on hydrogen fuel cycle analysis, AdTra encourages the follow-on work on H2LCA for two reasons. The possible indirect GHG emissions from hydrogen highlighted by EDF due to leaks could impact hydrogen use.

Indirect GHG emissions from electricity due to wildfires caused by grid ignition equipment need to be understood. And the reason for this is that the carbon intensity for transmitted electricity used for electrolysis or other electricity-dependent hydrogen production can be impacted and therefore expected hydrogen use and benefits might not be realized. Without understanding this issue, agencies risk overstating the possible benefits of contemplated electrification strategies and therefore limit the effectiveness of policy actions.

These two are important to properly characterize and capture the hoped-for benefits from both electrification and hydrogen use. We recommend the CEC explore how business model innovation can impact technology cost, uptake and penetration. This is particularly important in hydrogen for transportation.

Several speakers talked about cost as a major barrier. UC Berkeley has unique insights into this

question with two-factor analysis. This consideration is important because I think, as Jennifer observed, existing IRA incentives last for only ten years. Business model innovation is therefore essential to harness the desired role of hydrogen.

Finally, we encourage the consideration of land use impacts for renewables.

Thank you.

MS. RAITT: Thank you.

I'll just give a moment for if any other hands come up. And I'll just mention my appreciation for all the dedicated folks who are still in the room and over 100 people online this late Friday afternoon. All right, I'm not seeing any more hands up.

Raquel, could you just go to the next slide?

And since we do have such dedicated folks still on the line, I will just make a plug for our upcoming workshops. You can see there, October 25th, we're hoping to be presenting our initial findings and recommendations. And then November 15th and December 6th, stay tuned for our modeling results.

And with that, I'll just – oh, and then one last plug is, if you would like to make written comments, we always welcome written comments, and their due September 22nd.

And so with that, I'll turn it over to Commissioner Monahan.

COMMISSIONER MONAHAN: And I'll turn it over to Commissioner McAllister, who has time sensitivity.

COMMISSIONER MCALLISTER: Yeah. I just want to make some really brief wrap-up comments. And I really am bummed I missed the electric panel but I will go back and listen to it.

I guess I'm struck. I wanted to just sort of revisit this kind of regulatory model question. And I know this is on the docket now for -- or on the sort of task list for the work ahead. And the PUC is, as Commissioner Houck said, is doing some work in this regard. But this sort of chicken-egg problem, you know, that's come up multiple times today does -- I mean, the structure, the market structure that emerges and the sort of channels of off-takers that emerges does seem like it really would need to influence the regulatory model like it's applied; right?

So if we think about, you know, what's the equivalent of a core customer, are we really talking about true retail customers like individual, you know, the sort of light-duty, you know, they look more like core customers or retail customers? Perhaps fleets maybe look different. And certainly, large off-takers, industrial look different, or like sort of non-core customers or sort of, you know,

the large off-takers or direct access; right?

So like trying to sort of figure out what the equivalence between this world and the gas world that we have today and the electric world, sort of what is that? Is the investor-owned utility model the appropriate one or is it more a subscription service and kind of privately funded, you know, transmission, quote unquote?

So anyway, I hope we can kind of, you know, use fresh eyes and first principles as we develop thoughts and kind of unpack all these issues and kind of map what an eventual kind of market structure, you know, how retail focused and how sort of wholesale it looks, for example, how that would determine or would sort of tilt towards one regulatory model or another.

Anyway, sorry to talk sort of abstractly about this, but it seems to matter, right, sort of how, you know, what is this new infrastructure, how is it being developed, and how is it being regulated? Because, you know, at the end of the day, we're going to have, there's consumer protection, there's sort of, you know, making sure that markets function, and so it needs some regulatory treatment. But are our models that we're using today really the right ones and so how can we, you know, make sure that we're going in a direction that really makes the most sense for the long term?

And so a little bit of chicken and the egg. We don't know, you know, what the big wedges of demand are going to be yet, but that does seem really important for where we land. So anyway, very interesting set of questions and looking forward to seeing how it evolves going forward.

Thanks for a great day. I really want to congratulate the IEPR staff. Thanks to the whole team and all the presenters throughout the day.

VICE CHAIR GUNDA: Thank you, all. I just wanted to provide quick closing comments.

Heather, is it closing or do we go to the third session after this?

COMMISSIONER MONAHAN: Yeah, there's an evening session. It's not over yet.

VICE CHAIR GUNDA: For those of us who work in energy, I think this is the best part of our lives.

So I just wanted to say thank you to the staff, you know, the IEPR team specifically, and every -- all the panelists for a really productive discussion.

And I just wanted to kind of elevate the California spirit; right? I mean, I think we all, you know, we have a tremendous history of innovation, working together hard and solving big issues. And I think this is the next big one; right? I mean, how do we transition a

system from where we are to a clean, reliable, and safe system that's affordable and equitable to all Californians? And I think the task is big, and that's when we all thrive together.

So I'm just, you know, grateful for the participation, for the public who stuck with us. You know, 300 people stuck with us for a long time today. Just, you know, the incredible spirit we have in California to solve big problems. So thank you all. Looking forward to further conversations.

COMMISSIONER MONAHAN: I also want to thank everybody who has stuck it out and participated throughout the day, and Yuri, you've been ready to participate, and just all the folks that have commented and come with passion and vision. And I think it's clear that we all, as Vice Chair Gunda said, we're all working hard to develop a clean, affordable, reliable energy system. And I think all the presenters, even with the divergence of opinions, are all coming with that at heart.

And as I think a number of panelists said, we don't have all the answers. And we are learning, and we are, you know, investing in what we think are going to be the solutions of the future. And we need to. We need a diversity of fuels. We need a diversity of strategies.

I know, you know, Vice Chair Gunda is up nights,

late nights, weekends, really worried about keeping the lights on. And we've made some hard decisions about keeping once-through-cooling power plants that really should be shut down open for the sake of reliability. And those are hard decisions. We don't want to make those decisions, and we are making those decisions. And so, you know, investing in the future solutions that are really going to deliver truly clean, reliable, affordable energy for California, that's what we want.

And so this discussion today, you know, again, I keep quoting the Vice Chair. I don't know why, because he can really rub me wrong sometimes, is that this is a forum for ideation. And we, you know, we want diverse opinions. We need those diverse opinions. We can't shut down diverse opinions. We have to listen. We have to welcome and think about it and then come out with what we think as a state is the best solution moving forward.

So thanks, everybody. I hope everybody has a – no, you can't. Yeah, go ahead.

VICE CHAIR GUNDA: I asked her if I could have the last word, but, you know.

No, I just wanted to, for the record, just ask our team to look at the pyrolysis kind of pathway for hydrogen production. I think it's an important thing.

COMMISSIONER MONAHAN: Yeah, actually, that's a

good point. Actually, again, we have funded at the Energy Commission a number of projects in that space, as Peter was talking about. So we definitely don't want to close off that pathway, and it is a lower electricity draw.

So, well, but just thanks, everybody. I hope everybody has a lovely weekend. We are definitely ending the meeting now. There's not going to be an evening session.

(The workshop concluded at 4:54 p.m.)

CERTIFICATE OF REPORTER

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

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

IN WITNESS WHEREOF, I have hereunto set my hand this 10th day of October, 2023.

MARTHA L. NELSON, CERT**367

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October 10, 2023

MARTHA L. NELSON, CERT**367