DOCKETED	
Docket Number:	21-IEPR-05
Project Title:	Natural Gas Outlook and Assessments
TN #:	239968
Document Title:	Transcript - 7-28-21 for Commissioner Workshop on Hydrogen to Support California's Clean Energy Transition - Session 1
Description:	Session 1 - IEPR Commissioner Workshop on Hydrogen to Support California's Clean Energy Transition - International and National Applications
Filer:	Raquel Kravitz
Organization:	California Energy Commission
Submitter Role:	Commission Staff
Submission Date:	10/4/2021 3:08:41 PM
Docketed Date:	10/4/2021

BEFORE THE

CALIFORNIA ENERGY COMMISSION

In the matter of,	)	Docket No.21-IEPR-05
	)	
2021 Integrated Energy Policy	)	
Report (2021 IEPR)	)	Re: Hydrogen in
	)	California's Clean
_____	)	Energy Transition

IEPR COMMISSIONER WORKSHOP ON

HYDROGEN TO SUPPORT CALIFORNIA'S

CLEAN ENERGY TRANSITION

REMOTE ACCESS ONLY

FRIDAY, JULY 28, 2021

10:00 A.M.

Session 1: International and National Applications

Reported By:
Elise Hicks

APPEARANCES

Workshop Leadership

J. Andrew McAllister, 2021 IEPR Lead Commissioner

Karen Douglas, Commissioner

Patty Monahan, Commissioner

Matt Baker, Deputy Secretary for Energy, CNRA

Darcie Houck, Commissioner, California Public Utilities Commission

Staff Present

Heather Raitt, Program Manager, IEPR

Le-Quyen Nguyen, Advisor to Commissioner Gunda

Kourtney Vaccaro, Advisor to Commissioner Douglas

Denise Costa

Stephanie Bailey

Raquel Kravitz

Kristy Chew

Mike Petouhoff

Gabriel Taylor

Bryan Early

Ken Rider

Roberta Rothschild

Theju Prasad

Ellie Long

Jennifer Campagna

APPEARANCES (CONT.)

Staff (Cont.)

Raj Singh

Giana Villegas

David Gay

Public Advisor's Office

Noemi Gallardo

RoseMary Avalos

Dorothy Murimi

Panelists

Nick Damgaard Jensen, Center for Global Cooperation

Dr. Sunita Satyalpal, U.S. Department of Energy

Ulrich Benterbusch, German Federal Ministry for Economic Affairs and Energy (BMWi)

Paul Schultz, Los Angeles Department of Water and Power

Joel Ledesma, Northern California Power Agency

Arne Jacobson, Schatz Energy Research Center

Public Speakers

Yuri Freedman

Bruce Webster

William Zobel

David Blekhman

V John White

David Park

INDEX

P R O C E E D I N G S

JULY 28, 2021 10:00 A.M.

MS. RAITT: All right. Well, good morning everybody and welcome to today's 2021 IEPR Commissioner Workshop on Hydrogen to Support California's Clean Energy Transition.

I'm Heather Raitt, the Program Manager for the Integrated Energy Policy Report, which we refer to as the IEPR for short.

This workshop is being held remotely, consistent with Executive Order N-08-21, to continue to help California respond to, recover from, and mitigate the impacts of the COVID-19 pandemic. Public can participate in the workshop consistent with the direction in the executive order.

This workshop has a morning and an afternoon session, with separate logins for each. To follow along, the schedule and slide decks have been docketed and posted on the CEC's website.

All IEPR workshops are recorded and the recording will be linked to the CEC's website shortly following today. And a written transcript will be available in about a month.

Attendees have the opportunity to participate in a few different ways. For those joining through the

online Zoom platform, the Q&A feature is available for you to submit questions. You may also up vote a question submitted by someone else. Just click the thumbs up icon to up vote. Questions with the most up votes are moved to the top of the queue.

We'll reserve a few minutes near the end of the morning to take questions, but likely will not have time to address all the questions submitted.

Alternatively, attendees may make comments during the public comment period at the end of the morning and at the end of the afternoon sessions. Please note that we will not be responding to questions during that public comment period.

Written comments are also welcome and instructions for doing so are in the workshop notice. Written comments are due on August 11th.

And with that, I'll turn it over to Commissioner Andrew McAllister to start opening remarks. Thank you, Commissioner.

COMMISSIONER MCALLISTER: Thank you very much, Heather. And thanks, first, to all of our attendees. I see more than 150 people on and growing, so that is fantastic. I think that's reflective of the interest that we have in hydrogen at this particular moment.

I won't speak for too long here, but first I

want to acknowledge some colleagues who are on the virtual dais with me. I am Andrew McAllister, leading this year's Integrated Energy Policy Report. And lots of different themes that we're engaging with in that effort this year on reliability, looking at transition of the gas system which this conversation is largely part of that track. And then, also on decarbonization of buildings. And then, finally, our biennial forecasting effort which covers all the sectors of our energy economy.

So, that's obviously a core responsibility of the Energy Commission and really key for the overall planning across all the energy agencies in the state.

So, the IEPR really is a key platform for the critical discussions of the day. And we're really gratified to have various colleagues here on the dais and I will just thank them. Hopefully, I'm not leaving anyone out. Sometimes with the Zoom it's hard to kind of see it all at once.

But here at the Commission I want to thank Commissioner Douglas, particularly, for her leadership in this area on hydrogen. And I think she will be driving much of the conversation today.

Also, Commissioner Patty Monahan who is our lead on transportation and, obviously, hydrogen is relevant

there.

Commissioner Gunda would normally be here, but was called away to a meeting and his advisor, Le-Quyen Nguyen, will be taking some comments on his behalf.

From the Public Utilities Commission we have Commissioner Darcie Houck. So, thank you very much Darcie for being here -- Commissioner Houck for being with us. Really appreciate it. I think that's all from the PUC.

And then we also have, from Resources Agency, our really great colleague Matt Baker. So, Matt thanks for being with us as well. So, I really appreciate that.

I won't do a laundry list of all the things we're doing on hydrogen, but just suffice it to say there is a ton of activity across both the Energy Commission -- well, really, the Energy Commission, the PUC, and the ARB on hydrogen and looking at it through various lenses.

We are funding a lot of R&D from the Energy Commission, so we have a long list of projects there. And let's see, so I want to just acknowledge the fact that Laurie ten Hope and her team have been working on this issue and just have a lot of innovation both on,

sort of on the retail end of the spectrum all the way up to various aspects on the supply side, as well.

Obviously, we have a lot of activity on the offshore wind and there's a linkage of that with hydrogen and so, Commissioner Douglas is certainly leading that in a big, big way and will I'm sure comment on that aspect.

But generally speaking, you know, hydrogen has a little bit of a checkered history. I think we, you know, have to sort of look back. It's a very small -- it's the smallest molecule and it can be challenging to manage and so that has been an impediment in the past. And I think sort of the shift in the conversation is coming from the fact that we're getting some demonstrations and some examples of successful transition into using hydrogen as kind of across sectoral linkage. You know, energy storage, a transportation mechanism, you know, that's usable in various sectors. And so, from power sector over to transportation, even sort of at the retail end use potentially, and industrial thermal applications.

And so, we're investigating all of those aspects of the hydrogen economy and we're really trying to connect the dots and figure out where to optimize, how to optimize any investments in infrastructure related to

hydrogen.

There's a conversation across the whole Western U.S. Really, there's a global conversation. We're looking very hard at Europe and what they are doing there. They're a little bit ahead of us, honestly, in the hydrogen, sort of the big infrastructure hydrogen conversation. And so, we have some good collaborations going on with our European friends, largely Northern Europe.

And then, there's a huge project in the Middle East to generate large quantities of hydrogen to put on ships that ship around the world. So, it's a global conversation.

We also have here in California, and across the West, we have a lot of collaboration and I think a good conversation that started around the Western Green Hydrogen Initiative. So, various western states, you know, Montana, and Idaho, and Utah, and Colorado, and California really are trying to think about how to link up the various initiatives across the west. And in particular, Utah and California have an interesting project that's driven by LADWP, in the L.A. Region to, you know, convert the Intermountain Power Project specifically, but also have a broader conversation revolving around Los Angeles in the (indiscernible) L.A.

So, these are real initiatives with, you know, heavy-hitting partners and a lot of kind of inertia behind that. So, that's a lot of forward momentum. So, that's all very positive and I think this workshop will highlight much of that. And we have some really great speakers and I've really been looking forward to today.

You know, which dots we connect and how we connect them is an ongoing conversation and this workshop today will, hopefully, help us elucidate some of the directions that are most promising here in California.

So, really excited about today and I'll leave it at that and pass the microphone to my colleague, Commissioner Karen Douglas. Commissioner Douglas.

COMMISSIONER DOUGLAS: All right, thank you so much Commissioner McAllister, and thank you for your leadership on the IEPR this year, and also your deep engagement across the spectrum of issues on hydrogen.

This is a topic that has quite a lot of cross-cutting interest from different parts of the Energy Commission. This is, you know, an opportunity that can be brought to bear on our power generation side, as well as it can be related to offshore wind. It has a very strong transportation element, industrial element. And so, there's a lot of interest in this topic.

And so, I am engaging in this as our point for pulling together this workshop and topic to contribute to the IEPR, and just really appreciate the engagement of my colleagues here from the Energy Commission, the CPUC, and Natural Resources Agency. As well as the great speakers that we're going to have today.

So, as Commissioner McAllister noted, the Energy Commission is committed to bringing forward and really evaluating a suite of policies that can help the state achieve its greenhouse gas reduction goals and stay on a path to achieving SB 100 goals.

And as we look at different options and alternatives for the state to transition to a decarbonized electricity system by 2045, hydrogen has emerged as an important element that we need to assess and understand as we unpack and assess different pathways that get us to our goals.

Again, as Commissioner McAllister noted as well, as we look specifically at the outlook for natural gas look in the coming years, this is another place where it's really important that we consider and explore the possible role of hydrogen as one of a number of alternatives that could help replace and/or complement the use of fossil gas.

So, this exploration, which also includes

understanding how we can better gain efficiencies and economies in the use, the generation, storage and conversion of green hydrogen to provide long-duration storage is another important element of our transition. And making -- taking full advantage of the renewable power generation that California is very well situated to produce.

So, we're really fortunate today to have an array of distinguished panelists to discuss both national and international applications of hydrogen, as well as current and emerging technologies.

The morning session will include a panel of international and national representatives talking about initiatives that develop and deploy hydrogen technologies to support our clean energy future today.

The industry, we will also hear from industry and research institutions advancing and implementing hydrogen technologies.

In the afternoon session we'll hear from a panel of technology developers that will discuss current and emerging technologies in hydrogen generation, storage and transmission.

And finally, as we'll hear shortly from Mike Petouhoff of the Energy Commission's Research and Development Division, we're continuously -- we are

providing research funding in this area to continue to demonstrate approaches to generating green hydrogen, support development of new electrolyzer technologies, expand the uses of hydrogen, expand the opportunities to generate green hydrogen to support transportation and other sectors, and decarbonization in those sectors and more.

So, I'll close my opening remarks by thanking all of the staff who worked very hard to pull together this workshop. David Erne, Mike Petouhoff, Heather Raitt, Stephanie Bailey, Raquel Kravitz, my advisors. And I want to thank all of the workshop participants. I'm looking forward to the presentations, and the public comment, and I will be as engaged as I possibly can be today.

I do want to note that I have one or two conflicts that will cause me to step out and in one case return a little late, potentially, for the afternoon session. But that just happens sometimes that we get double booked. But I will be in as much as I possibly can. And at this point -- and when I am out, my Advisor, Kourtney Vaccaro, will be here on my behalf.

So, at this point I'd like to hand this over to Commissioner Monahan for her opening remarks.

COMMISSIONER MONAHAN: Thanks Commissioner

Douglas. Well, I'm really excited for this day. And I think, you know, it's been clear California has been a leader on hydrogen for transportation for decades. Decades. And, you know, Japan, South Korea, they're our partners in this.

But what I'm really excited about is this more expansive conversation that we're moving to. So, for a long time I think our focus was just light-duty vehicles. Now, we're looking at the opportunity in medium- and heavy-duty vehicles where we also get important reductions in criteria pollutants and beyond. So, rail, marine applications, air applications, these are all places where hydrogen can have an important role to play.

I was really interested in the recent report that came out from Bloomberg New Energy Finance, their new Energy Outlook 2021 Report. And when they looked at what we'll need to reach a fully decarbonized or, you know, reach our carbon targets for 2050, hydrogen played a really important role in most of their scenarios.

And interesting, the biggest application was power, the second industry, third aviation. So, I mean we're learning more and more about what role hydrogen can play and how especially for harder to decarbonize sectors hydrogen can plan an important role in helping

us reach our goals.

So, just really appreciate this conversation and appreciate the fact that Matt Baker and Commissioner Houck are joining us here on the dais today for this conversation.

I, like Commissioner Douglas, am going to have to leave, come in and out. I have a conference at 11:00 and a conference in the early afternoon, as well. But I'll be here as much as I can.

Just want to thank the leadership of, you know, my fellow Commissioners in pulling together this conversation on hydrogen and look forward to the day.

So, I'll pass this off to Commissioner Houck, if you would like to make any comments for today.

COMMISSIONER HOUCK: Thank you, Commissioner Monahan. I wanted to thank Commissioner McAllister for his leadership on the 2021 IEPR and all of the CEC Commissioners for their leadership in the area of examining how hydrogen can play an important role in our clean energy transition.

Recently, the CPUC had a briefing from Laurie ten Hope's group at our committee meetings and it was a great presentation. And I'm really excited about all of the work that the Energy Commission is doing in this area. I think it has a huge potential to move us

forward with our SB 100 goals.

I want to again thank the Energy Commission, the Commissioners and all of the staff for the work that they're doing. I'm looking forward to following the results of the work that Laurie's group is doing. And want to thank the participants here today. And I'm very excited about listening and learning more as we move through today and seeing how the advances that are being made in regards to hydrogen can be implemented in our clean energy policy going forward.

So thank you for having me here today and I'll conclude my remarks.

COMMISSIONER MCALLISTER: Great. I want to pass the microphone to Matthew Baker from Resources Agency. Mr. Baker.

DEPUTY SECRETARY BAKER: Yes, thank you, Commissioner. I want to thank all the Commissioners and staff for pulling this together. I think this is a super important issue that you're working on.

My name's Matt Baker. I'm from the California Natural Resources Agency. We oversee and support more than 26 departments, conservancies, commissions, including the Energy Commission.

I'll just quickly echo what everyone else has said. You know, basically, as we're making this

transition it seems apparent that we're -- in addition to clean electricity, we're going to need clean molecules. And hydrogen is probably the most likely candidate to fill that role.

And what we're looking at, what we're looking for at the agency is really, you know, what could be a no regrets pathway that can get us to the point where we need to be as we transition to carbon neutrality.

And we're really excited about this workshop and the continuing work that the Commission's doing to really kind of try to ascertain kind of a no regrets role for hydrogen and industry, or hydrogen and power, and fuel, and retail, and natural gas. You know, what are the things that we could be doing right now, such as what the Germans have been doing, you know, to create the infrastructure that these no regrets.

And I think one of the things at the agency that we're also very interested in is where can we achieve co-benefits as we're building this infrastructure. So, how can the production of hydrogen increase the air quality or reduce criteria pollution in disadvantaged communities.

What role can hydrogen production play in mitigating, you know, the hundreds of thousands of giant piles of wood that we're going to have to burn in the

forest if we don't find another use for that.

The same with agriculture. Is there a role for hydrogen production, you know, to mitigate methane emissions with regards to municipal solid waste.

And finally, are there opportunities to also help bring jobs and economic development to struggling communities throughout California.

So, you know, with that I'm really looking forward to this. You know, with a few exceptions, I'll be here for almost the entire program. And I want to really thank you for inviting me here today.

COMMISSIONER MCALLISTER: Thank you, Matt, really appreciate it.

And one final just observation. You know, there's a remarkably large existing hydrogen economy, right, already that's largely an adjunct to the oil and gas industry. And part of the big, sort of the generational issue here is how do we pivot that infrastructure to decarbonize, you know, completely. And then how much sort of how do we complement that with near term investments and infrastructure. And I think the economic development and the jobs piece of that is a really critical one as is the impact on disadvantaged communities that Mr. Baker pointed out.

So, you know, we're at point A and it's got

particular characteristics. And this is, in some ways, a traditional big infrastructure kind of question and that is really key to the economic piece of this. So, I just wanted to point that out.

So, back to you, Heather, to get us started.

MS. RAITT: Sure. Le-Quyen, did you want to make some comments?

COMMISSIONER MCALLISTER: Oh, I'm sorry. I'm sorry, I totally neglected to invite Le-Quyen Nguyen, from Commissioner Gunda's office, to give comments. Go ahead, Le-Quyen, sorry about that.

MS. NGUYEN: Oh, no worries. Thank you, Commissioner McAllister. So, Commissioner Gunda does send his regrets that he's not able to make today's workshop. And he just had a few brief comments that he asked I share on his behalf.

So, I think it's clear to all of us that we're facing the increasing impact of climate change and we need to move quickly to achieve our climate and energy goals. California has a goal of achieving carbon neutrality by 2045 and electrification has emerged as a key strategy.

Looking at sectors across the economy, there are a number of places where hydrogen could play a roll. The SB 100 report, published earlier this year, showed

that we'll need to accelerate our resource builds and also utilize a variety of resources. We also need to consider the diversity of the need and the importance of zero carbon firm dispatchable generation.

In the transportation space there has already been a lot of conversation around hydrogen and I think it's important to understand how hydrogen could be used in other sectors and try and create an integrated approach.

I look forward to watching the workshop recording later on and learning more about the work going on.

Thank you to Commissioner Douglas, Heather, David and teams for your leadership and efforts in putting this workshop together. And, of course, thank you Commissioner McAllister for your leadership on the overall IEPR effort.

Thank you.

COMMISSIONER MCALLISTER: Thank you, Le-Quyen. Now, I think that should wrap us up from the dais and back to you, Heather. Thank you.

Heather, you might be muted.

MS. RAITT: Oh, goodness. Thank you.

So, we'll start our panel this morning. It's moderated by Mike Petouhoff. And Mike is the Manager of

the CEC's Energy Systems Research Office, in the Energy Research and Development Division. There he manages a team focused on topics including energy storage, grid reliability, and the hydrogen roadmap.

Mike comes to the Energy Commission with a wealth of experience, including founding the Global Energy Team at Apple, Inc., where he led Apple's efforts to achieve 100 percent renewable energy for its operations in the U.S.

So, with that I'll hand it off to you, Mike. Go ahead.

MR. PETOUHOFF: Thank you, Heather. And good morning to everybody. I'm really excited to hear from our panelists today. We've got a really exciting set of speakers and this is a very fast-moving field, so the information will be really, really helpful to us.

I think it was mentioned earlier we have a panel that moves from international to national, and then kind of to a local California level. Time wise, we may go a little out of order because we have some speaker time constraints. And I might mention that because of the time constraints for our second and third speaker we may go to the dais for questions, and then come back at the end of the last speaker for questions as well.

I'll begin by providing a brief presentation

that talks a little bit about the project we have called the Role of Green Hydrogen in the Decarbonized California: A Roadmap and Strategic Plan, as a way of bridging over to our EPIC program and also providing introduction for the hydrogen topic.

The next slide, please. So, we're going to, today, have another milestone in what's been an ongoing process of staff collaboration in prior CEC research, and also information sharing with Denmark, Germany and Finland. We've also had lots of in-state collaboration and we'll hear from some of those folks as well today. And we had an EPIC workshop 1 July, and today we have the IEPR workshop the 28th of July.

As we build on that framework, what we're really doing with this roadmap is trying to bridge three areas. We're looking at how to generate hydrogen through electrolysis and other means. We're looking at some priority end uses of hydrogen. And then, in between how to bridge those in time and space with storage and distribution technologies.

And in that we're going to be looking at ecosystems. In many ways we're going to be building systems from scratch, even though there's a lot of hydrogen industry we can borrow from. And we're going to be looking at what those ecosystems look like and how

we can build them together.

The next slide, please. So first, starting on generation, we're going to be looking at various technologies for electrolysis, starting from the most mature to the more nascent. Alkaline and proton-exchange membranes are some of the more established. We'll also be looking at solid oxide and photon-based electrolysis.

Because offshore wind is important and electrolysis does consume water, we'll be looking at the special issues that may come into play as we look at saltwater electrolysis.

We're also currently having -- conducting research about non-water electrolytes. Generally, we're breaking H2O into H2NO2, but we can also use other electrolytes that may be more efficient and we're evaluating that as well. So, that's kind of the picture of generation.

The next slide, please. We're also looking at storage and distribution to connect those. As Commissioner McAllister mentioned, we do have a fairly mature industry from petroleum and other industries that are dealing with some aspects of hydrogen, and so we have some technology we can make use of there. Including gaseous storage and tanks, tube trucks,

pipelines, and geologic storage.

I should mention on pipelines, there's a lot of discussion on our transition of the natural gas system. We really divide that into pipelines that are purpose-built for hydrogen and the potential to put hydrogen in limited percentages into the pipelines built for natural gas. And we'll talk about the limitations there, about 7 percent by weight, and what implications that has for us.

Also important is converting hydrogen to other forms for efficient transition and use. This is important. As was mentioned previously, hydrogen's the lightest of the atoms, up in the upper left of the Periodic Table. And so, as it's move through transmission lines it actually has less energy-carrying capacity than let's say methane, but that can be increased by either converting to liquid forms or other forms of hydrogen that can be useful for other means.

For example, if we take hydrogen and combine it with the nitrogen in air we can get ammonia, which is especially useful in some applications, especially marine shipping, and potentially a future in the aviation. And green CH4, which is the essentially the same molecule we get from fossil-sourced natural gas, but it comes from a decarbonized source. That can

actually be produced from green hydrogen. And that would have the benefit of being able to be used more ubiquitously in the natural gas pipeline system.

We're also looking at different kinds of ecosystems. For example, how would hydrogen look with land-based PV? How would hydrogen look with offshore wind? How does it look in an ecosystem for transportation? So, in each of those cases we're trying to look at the overall ecosystem and see how that looks.

And in this process we're looking at priority end uses. The next slide, please. Which include firm dispatchable generation. The SB 100 report talked about the need for increasing amounts of either long-duration storage or firm dispatchable generation. As we move to greater amounts of intermittent wind and solar, we can't control when the wind blows and the sun shines, but we can firm and shape those resources with this type of resource.

Hydrogen is one of the candidates that can provide this option and we're going to be looking at that very carefully.

The general area of transportation is something we're going to also look at. Specifically, fuel cell vehicles, but also potentially for ocean transportation using ammonia and other forms of hydrogen such as that.

And then we're also looking at, on the end use side, an industrial application. In general we're moving towards new codes going to electric, but there are some hard-to-electrify applications that hydrogen may be one of the candidates to provide the heat source for those hard-to-electrify high heat industrial applications.

Those are just three examples of the priority end uses. And one of our goals is to figure out ecosystems that support those end uses and the hydrogen budget. How much hydrogen will we need for each of those because, ultimately, they'll be competing on the same supply curve for the same amount of hydrogen that we can produce. So, we want to get a picture of what that looks like.

The next slide, please. In the approach we're taking with hydrogen roadmap we're looking at, oh, how far down the road can our headlights see. We know some information, some information is very informative, and we're going to produce our roadmap with that information. But then we're also going to have follow-on research and demonstration projects and expect industry will evolve, and we'll update the roadmap every few years, probably in sync with the IEPR reports to reflect progress over time. Until we all get to the day

when California is 100 percent decarbonized, we'll update it and iterate over time. So, we're taking the model of how far can our headlights see down the road. Get a good picture of what the technology looks like and then update over time.

The next slide, please. As was mentioned previously, there is actually a pretty large industrial use of hydrogen now, mostly in the petroleum industry. Most hydrogen in use in the world today is gray hydrogen, which is not decarbonized, but made from fossil fuel feedstocks.

There's also blue hydrogen which is made from fossil fuel feedstocks, but then the carbon is sequestered.

Our focus is really on green hydrogen, which is either electrolytic hydrogen which is made from electrolysis of clean energy, wind, or solar, or other sources of renewable energy, or it can be made from reforming of decarbonized biogas or other feedstocks.

So, that's going to be our focus. We're really, in many ways, trying to borrow from what's been developed over time for other industrial uses to our green hydrogen use that we want to put together.

The next slide, please. One of the key drivers is hydrogen for grid reliability. The SB 100 report

showed that we have need up to 15 gigawatts of firm dispatchable storage and there's tradeoffs with long-duration storage, and other technologies that are developing in parallel.

The modeling also looked at the core option of complying with SB 100, but also a study option that was more aspirational of having no combustion. And we see there's a cost difference of $8 billion a year. And hydrogen is in the midst of this because we may have combustion and noncombustion options within hydrogen.

And also we know that hydrogen, as we look the next generation may have less land use impact than other forms of generation, so that's a key factor for consideration.

The next slide, please. One of the questions that comes up is if we have perfectly good electricity from wind and solar why would we store -- or, why would we turn it to hydrogen. And one of the answers is to be able to store it.

This chart shows, really if you look at the red, you see lithium ion which is a predominant form of energy storage for short-term storage. What we see is as it gets longer term it becomes more expensive.

But as we look at the green curve or the yellow curve if we're looking at ammonia, the costs really

level out and it becomes more competitive, cost competitive in the long term. One way I like to think about this is if you have a one-megawatt battery, at the end of an hour of megawatt discharge it's discharged by the one-megawatt turbine. It runs for an hour, at the end of an hour it just keeps running.

And in similar ways, if I wanted to go to 10 or 100 hours my battery has to get 10 or 100 times bigger, my turbine just continues to run.

So, there's a lot of different variables in play, but this why we're looking at hydrogen as a means of long-duration storage, especially as other means of long-duration storage evolve we're looking at how to compare those in a framework that looks -- that it gets to ratepayers.

The next slide, please. Some of the ecosystems we're looking at are land-based PV, hydrogen with offshore wind. And, of course, we'll see some examples from colleagues in Europe about hydrogen in the North Sea combined with wind.

The applications may look similar or may look different in different applications. In some cases we're going to see, for example we have a large solar farm and it's producing more energy than can be taken at the interconnect or that the grid needs at a particular

time. In that case, ecosystem might have the electrolysis right where the real energy is produced, and then we generate energy at the same site, or maybe a different site depending where the generation assets are when the grid needs it.

Offshore wind, likely we'll want to bring that energy ashore in an undersea cable. And the reason for that, we'll see in Arne's presentation later on, that the profiles for wind generation are quite complementary to solar. So, we want to use that electricity in its generated form to complement wind, or to complement solar, especially so for land-based solar which ramps up just as the sun is setting, and offshore wind which has a very steady capacity factor. So, we'll need to look at how each one can work as we look at the comprehensive ecosystem.

The next slide, please. One of the things we're looking at is that the cost of hydrogen is highly dependent upon the input price of clean energy. So, as the price of wind and solar has dropped, so too has the price of hydrogen.

In the baseline model here we say at $.07 input price for electricity we get about $5 per kilogram. It moves down quite substantially as the input price of electricity goes down.

Some people talk about free curtailed wind or PV and that certainly is the case initially. But as we purpose build systems, we need to really think about optimizing the utilization of the electrolysis and the PV, or wind system, and how they should be sized to be optimal as a system.

We'll see, hear more from Department of Energy, from Sunita, who will talk about their goals to get hydrogen down to $1 per kilogram. This will be one of the factors and we'll be interested to find out other factors that they want to use to reduce the price over time on their price reduction roadmap.

The next slide, please. We're going to be looking at various means of storing hydrogen and distributing hydrogen. That could be, as is currently used, tube trucks, compressed hydrogen in tanks, but also pipelines for gaseous hydrogen which could either be purpose built, or very judicious blending of hydrogen into our natural gas system.

We're also looking at geologic structures. Structures that are currently used for storing natural gas could be one option or other structures, such as salt domes, could be used for geologic storage.

In each case we need to look at the ecosystem, and what the needs are, and the storage capabilities of

these systems.

The next slide, please. Some of the main points we're looking at for end use are typically, when we're talking grid generation we'll be looking at turbines, which are generally more cost effective than fuel cells. But we need to be concerned about the criteria pollutants, specifically NOx that will be an issue for the combustion process of turbines.

For natural gas pipelines, as we mentioned for existing natural gas pipelines, especially in the U.S. where we have not used coal gas to the extent that it has been used in Europe, we're limited to about 7 percent by weight before metallurgical embrittlement becomes an issue.

Hydrogen may be transmitted in a 100 percent concentration with purpose built pipelines or we may also be able to convert hydrogen by sequestering with CO2 to a green -- a form of green CH4 which could be transmitted in a natural gas pipeline. So, that's something we're investigating.

There was some discussion before certainly about the future of the natural gas system and it's very relevant to that end of the picture.

We also know that hydrogen behaves differently in end use appliances. So, this is important from -- if

we're going to have a turbine, then the combustion may need to be changed out. Or, in homes or businesses hydrogen, if it's supplied for certain uses, high heat industrials, the burners may need to be changed, the flame characteristics are different. And that's something we have ongoing research to be able to understand that better as time goes forward.

The next slide, please. So, because of the importance of green CH4, that's a path we're going to be looking at. Where you have an electrolyzer combined with a methanation unit to take green H2 and turn it to green CH4. And it could be that green CH4 is either a byproduct of green H2, or competing fuel from decarbonized biogas.

This is an example of one plant in Germany where that's being done.

The next slide, please. So, one of the things we're looking at in the roadmap is also to consider alternatives to hydrogen for each end use. And so, for firm dispatchable generation we would certainly consider hydrogen, where we need to modify the turbines. We would also consider green CH4, either from hydrogen or from biogas where we could use the existing generation and pipeline. In both cases we would need to look at, carefully, local criteria pollutants and also comparing

to long-duration storage.

Transportation uses we'll look at as battery electric vehicles evolve along with fuel cell vehicles. And then, for stationary end uses we'll look at both green H2 and CH4.

The next slide, please. So, we have a lot of current research going on in ERDD. I won't go into each specifics, but we have research in generation storage, research in helping disadvantaged communities with PSPS events, and research in transportation both for locomotive and tugboat, harbor craft type of use.

The next slide, please. We also have planned research in many areas, generation, delivering storage, transportation, as well as buildings, industrial.

The next slide, please. And our colleagues in Fuels and Transportation Division have done nearly $200 million in investment and have additional funding coming from our legislature, where they'll be able to go much deeper into zero emission vehicles which will be both electric and fuel cell vehicles.

So, with that said let's move to our panelists. Let me say that our first presenter will be Nick Jensen from Demark, and he's the advisor for the Center for Global Cooperation. And he's prepared a prerecorded presentation from Demark.

MS. RAITT: Actually, you know what, Mike, this is Heather, since we're running a little behind schedule I wonder --

MR. PETOUHOFF: Do you see Sunita?

MS. RAITT: She is not on, yet. Let's see, so okay at this point maybe we should just talk about all the speakers we have and hope that she joins shortly.

MR. PETOUHOFF: Okay. All right. Well, let me introduce our speakers and then maybe -- and then we'll have Sunita join us. Does that make sense?

MS. RAITT: Sure.

MR. PETOUHOFF: Okay. So, after Nick Jensen we'll have Sunita Satyapal. Sunita directs the U.S. Department of Energy Hydrogen and Fuel Cell Technologies Office. She is in charge of about $150 million per year of research, and the staff there.

And she's going to be talking about Department of Energy's roadmap to get to a dollar per kilogram, within a decade, for hydrogen. And we'll be interested to see how her process works and if there's potential that we may be able to work with her.

We'll also hear from Germany. Ulrich Benterbusch will be talking with us about what's happening in Germany. Ulrich is currently the Deputy Director at the Federal Ministry for Economic Affairs,

and the group in Germany. He joined the Office of the German Chancellor. And from 2003 he headed the Department of Bilateral Economic Relations, Foreign Trade, and the World Trade Organization, and the G-8.

From 2009 to 2013 Mr. Benterbusch was the Director of the Office of Global Policy at the International Energy Agency.

And he's also going to be joined by Toni Glaser, who may be able to help with some questions.

We also have Paul Schultz, who's the Director of Power External Resources at the LADWP, Los Angeles Department of Water and Power. He's responsible for all of LADWP's external generation sources, also marketing and implementation of the energy imbalance market at the LADWP. Previously, he was the operating agent for the Intermountain Power Project and APEX Generating Station representing LADWP. And we'll hear about the Intermountain Project and the HyDeal Project from Paul.

Next, we'll have Joel Ledesma, who's the Assistant General Manager of Generation Services for the Northern California Power Agency. Previously, he was the Deputy Director of the State Water Project where he led 2,000 employees and had responsibility for over a $1 billion annual budget.

Then, finally, we'll have Arne Jacobson who's

director of the Schatz Energy Resource [sic] Center and Professor of Environmental Resources at Humboldt State University. He's also coordinator of Humboldt State University's Master's Program in Energy Technology and Policy.

MS. RAITT: Wonderful. Thank you. And we have -- I'm sorry, Dr. Satyapal is with us now so --

MR. PETOUHOFF: Oh, great. Welcome Dr. Satyapal. We're excited to hear the pathway to get to a $1 per kilogram. And if there's any ways that California might be able to participate in that, we'd be interested to hear that as well.

DR. SATYAPAL: Great, thank you. So, thank you for inviting me, Mike, and to all the organizers apologies for the change in agenda. But it's great to be here. First of all, thank you and congratulations to California and a lot of the stakeholders here who have been at the forefront of hydrogen and fuel cells.

So, if you go to the next slide, I thought I could give you just a high level overview of what's happening at DOE. In general, I think mostly we are of the early work with the Energy Policy Act and now, of course, the 2020 Energy Policy Act. We did release the DOE-wide Hydrogen Program Plan in November.

So, I just want to emphasize there's

coordination across DOE, also with other agencies. We have an interagency working group. You can see it's really a broad portfolio.

So, I just wanted to start right up front that hydrogen is one part of a very broad portfolio of activities and a lot of coordination.

And if you go to the next slide, I thought I'd again -- several of you may be aware of this but the H2@Scale initiative is what we launched a few years ago with our labs, and the industry, and multiple stakeholders. And here the concept, again, is looking at hydrogen as an enabler.

So, the versatility of hydrogen, many call hydrogen the Swiss Army Knife of energy. But again, the main point is you can produce this from a broad portfolio of diverse domestic resources. We're looking at renewables, nuclear as well. I know we have, for instance, four projects. Depending on where you are in the country, the availability of clean electrons you see. And then, obviously, fossil as well. We produce 10 million metric tons of hydrogen in the west, which is almost one-seventh of the global supply. And some are aware that other countries are looking very strategically at the opportunity to export hydrogen. So, more and more interest as countries are looking to

meet their climate goals, realizing that hydrogen will be part of the mix. Because they can only produce so many clean electrons in their regions, they're going to need to import that molecule, especially to decarbonize the hard-to-decarbonize sectors.

So again, the picture shows the conventional grid in red, that red circle, the conventional natural gas infrastructure. And we, in the U.S. have 3 million miles of pipeline. We have extensive LNG and CNG infrastructure.

And then the blue, again the main takeaway is once you've produced hydrogen you can store that hydrogen mostly from intermittent renewables, feed it back to the grid, use fuel cells for easily dispatchable resilient power.

And then, all those bubbles on the right, transportation hydrogen plus CO2 for syn fuels and sustainable aviation fuels. It can be used for oil upgrade, oil refining, and fertilizer production. Steel accounts for almost 8 percent of global emissions. So, we can inject it into the hydrogen or into the natural gas pipeline. So, basically, it opens up a lot of opportunities across sectors.

And we have looked at various scenarios,

potentially even five times more hydrogen. And to give you an idea, if we produced 10 million metric tons more of hydrogen in the U.S., that would basically double today's solar or wind deployment.

And then, many studies out there, industry studies looking at $140 billion in revenue, 700,000 jobs, a lot of analysis.

But the main three points I wanted to make here are the contribution of hydrogen and the administration's goal. So, obviously, completely carbon-free by 2050, net zero emissions, so across sectors. And then, the 100 percent clean grid by 2035. So, potentially opportunities for long-duration energy storage.

And then finally, last but not least, I do want to emphasize a really key initiative and that's the Environmental Justice EJ 40 Initiative, showing 40 percent of our benefits, the federal benefits in disadvantaged communities.

So, as we look to our future activities in clean energy how do we impact, you know, positively those most historically and currently disadvantaged communities. So, again that's really critical. I'm happy to continue the dialogue there.

So, the next slide shows basically where are we

today when it comes to hydrogen and fuel cells in the U.S. This is just one snapshot. You can see on the left the number of growing applications. These are commercial applications. And again, California's in the lead. They're down looking at the vehicles with the ZEV Mandate, the Low Carbon Fuel Standard.

But you see a number of examples, like over 40,000 forklifts, a niche market there. That's enabled over 100 stations just for hydrogen.

You can see in the map at the top most of the regions have hydrogen from natural gas. We have over 1,600 miles of pipeline. We have three caverns and that's including the world's largest geological cavern in Texas. There are a number of examples of projects that are emerging. Utah, different regions for instance looking at hydrogen end use.

And in the bottom, on the map, we show for the first time we've compiled the PEM electrolyzer installations and plans. And again this is pretty small, we're at about 170 megawatts of green hydrogen. And the largest in the world, by comparison, is about a 4-gigawatts plant in Saudi Arabia. And a huge planned, 40 gigawatts total in the next decade or so. And so, that gives you a snapshot.

And the next slide, basically wanted to cover

the tipping point. So, as we look at the U.S. and where can we increase scale, I think that's in the critical, this just shows scenario.

So, for instance in medium- to heavy-duty trucks, we can be competitive at $6 for the early market. You can see that wedge there $5. And this example is 20 percent of all the heavy-duty and medium-duty trucks that use fuel cells. We would enable another 5 million metric tons of hydrogen.

Similarly, if you go down, the third year you can see sustainable aviation fuels, ammonia fuel production, injecting into the natural gas pipeline or energy storage. And the main point, really is if we can get to $1 as the cost of hydrogen, clean hydrogen, that will unlock substantially more hydrogen and, obviously, hydrogen production.

So, the next slide basically summarizes when President Biden, at the Climate Summit, really emphasized the urgency, I think that's the main takeaway here is when he asked our Secretary how can we accelerate development of critical technologies, our Secretary launched the Hydrogen Energy Earthshot. This is the first in a series of earthshots to really accelerate progress in terms of meeting our climate goals.

And the next slide shows you what the earthshots typically appear. Clearly articulated an ambitious goal of "1 1 1", one dollar for one kilogram of clean hydrogen in one decade.

So, again, we're at about $1.50 now for natural gas to hydrogen. We're at about $5 at low volume. So, a capital cost of about an 80 percent reduction. But we think we can get there and we're going to be mobilizing. It's really an all-hands-on-deck approach.

And the next slide, I think we'll end shortly, shows you pathways of how we can get there. And again, all pathways are included.

And I think the last slide talks about the next steps. So, looking regionally how can we co-locate, look at production, end-use applications.

And then, if you save the date, August 31st, we've planned the Hydrogen Shot Summit. So, we'll provide more details on, again, what our plans are going forward.

So, with that I think I'll turn it back to you, Mike. And thanks again for the invitation.

MR. PETOUHOFF: Dr. Satyapal, thank you very much. And we understand your schedule's somewhat constrained, but we have a few minutes for questions from Commissioners if you're able to stay for that.

DR. SATYAPAL: Sure. Thank you.

MR. PETOUHOFF: I'll turn it over to the dais.

COMMISSIONER DOUGLAS: All right. Well, thank you so much for that great presentation and thank you for participating in our workshop today, this morning.

You know, we're really interested in pursuing partnerships here and certainly working closely with DOE, and understanding how the State of California can be part of an effort to realize the potential of hydrogen as we look at the state energy picture and the national energy picture.

And so, you know, I don't know if you have any suggestions for how to continue just collaborating on ideas, and moving forward and, you know, the level of partnership that we could achieve to move this forward. But I'd be really happy to engage in that conversation. And I know a lot of my colleagues here on the dais would, as well.

DR. SATYAPAL: Yes, thank you so much, Commissioner. And we've have such a great long standing collaboration, I see Patty here, too, in the past as well, when Janea was here. She sat on an advisory committee.

COMMISSIONER DOUGLAS: Yeah.

DR. SATYAPAL: With CARB, of course, we have

such a long history of partnerships. And so, I definitely look forward to, you know, reinvigorating that. I think partnerships will be key, so I'm happy to follow up there.

I think one other quick point I'll make is on the international scene, as well, we're coordinating with multiple countries getting back in the game again. Emission innovation. We are looking very strategically at basically the analytical framework. If countries are looking to import hydrogen, looking at how we can ensure, you know, a U.S. position there. And so, we've also been pulling in EPA and others.

And so, I think with CARB and the history of different policies, for instance LCFS, and looking at all of that, production tax credits how can we really accelerate progress. So, happy to follow up afterwards of, you know, what are the best policies and incentives.

COMMISSIONER DOUGLAS: Absolutely, we'd be delighted to follow up. And we have some relationships with international partners in energy as well, where we've had dialogue about hydrogen, about information exchange, and technical kind of knowledge exchange.

And the presentation you'll hear from Demark and Germany for example, both come out of some of these dialogues and collaborations that we've had.

And we certainly do see some nearer term and longer term areas where we very much welcome the collaboration and partnership. And I know, as you say, there's a long standing history of that.

So, thank you so much for making time to be part of this panel this morning.

DR. SATYAPAL: Thank you so much.

COMMISSIONER DOUGLAS: Let's just see if any of the other Commissioners have questions.

COMMISSIONER MCALLISTER: Go ahead, Commissioner Monahan.

COMMISSIONER MONAHAN: Oh, thanks. I appreciate that because I've only got a few minutes.

Sunita, that was a great presentation. It's really exciting to hear how DOE is investing in the strategies to reduce the price of clean hydrogen.

And I'm wondering if you can -- is there anything you could do to elaborate on how you're thinking about that? I mean right now in California the price of hydrogen at the pump is more like $16, $17 per kilogram and it's been kind of trending up, rather than trending down. And I think, you know, as we get cleaner and greener, at least in the near term there's going to be some expense and then, hopefully, that will fall with time.

But just curious about your strategy for that because that's something, as you know, that's critical in really being able to expand the market is to drive down the price of green hydrogen.

DR. SATYAPAL: Yeah, so thanks Patty. And again, the Hydrogen Shot is first focusing on the hydrogen production feed, which is the $1. Obviously, the delivery, the dispensing that's where all the cost comes in. So, even in our analysis it can be, you know, $8 to $11 just for that piece of that.

So, that's where I think getting to scale is such an important piece. It's not just the R&D, which we're continuing to fund. But that's where if we can get large scale production and end use even across applications, you know, steel plants for instance, and other industrial sectors, ammonia, that will help to drive down the cost of that infrastructure. So, again, it's that concept of marrying the supply with the demand. But we're continuing to R&D, definitely compression, the sensing, you know, looking at cryo pumps. How can we get the cost down for that infrastructure piece.

COMMISSIONER MONAHAN: And are you -- are you also looking at the distribution, how do we develop networks for distribution that are not just two trailers

going from point A to point B, but something cheaper and where we can transfer much larger amounts of hydrogen.

DR. SATYAPAL: Yeah, I think that's going to be really critical. So, if you look at some of the infrastructure bill language and its concept of a hydrogen hub, also the American Jobs Plan is so critical. We're hoping that passes. That talks about 15 hydrogen demonstrations.

And so, I think again look very strategically at where do we put in those pipelines or, you know, other infrastructure, which is again having the right location where we have sustained off takers will be important to determine, you know, where best to invest in that type of infrastructure. But I think all that will start -- there will be a deployment and financing session also at the summit, so happy to follow up later as well. This is just the beginning. So, I think getting the strategy right will be really important.

COMMISSIONER MONAHAN: That's great. Really exciting.

COMMISSIONER MCALLISTER: Great. Thank you, Commissioner Monahan. Actually, does anyone else on the dais have any comments or questions? I do, but I'll go last if that's okay.

Commissioner Houck or Matt? Okay, great.

Great. So, thank you so much, Dr. Satyapal. Thank you. I really appreciate all -- I feel like we're tag teaming different events all over the landscape here. So, it's great to see you again. Your leadership is just so tremendous in this area, so thank you.

I will point out that throughout this IEPR cycle we're doing everything we can to include, in every workshop where it makes sense, some representation from the federal government. And I think that's a really important point to make here that just the alignment that we now have with the Biden administration is a real game changer. There's just been a sea change in sort of esprit de corps, you know, the collaboration that we have with the federal government and just the alignment on all the different policies for buildings, and grid planning. And, of course, hydrogen here.

So, I think that's just an incredibly positive development that we need to take advantage of because of the urgency. You know, as we've heard, as we all know, the urgency is just higher than it's ever been in our lifetimes.

So, let's see, I guess just building on this spirit of partnership, you know, I think on policy certainly, you know, there's a lot of alignment. So, as Commissioner Douglas said we want to collaborate on

that, on any projects, you know, in California. Certainly, absolutely want to find avenues for partnership and cultivating partners across the globe.

And I think, I would just point out, you know, we do have a big economy. You know, I think we have some national -- we have partnerships with actually other nations, as well as some national entities. And I think it just makes all the sense in the world to speak with, you know, as much with one voice as possible and really leverage resources to help move our partners, to help lift them as well. And so, that's not just Germany and Demark, it's Japan, it's, you know, potentially China. It's, you know, Mexico even. I mean there's a lot of possibilities there.

And certainly on the research and development front, as I think Mike said, you know, there is the project of some significant resources coming from our state budget process to this arena and, you know, having and connecting all the dots, and trying to leverage all of those resources makes a lot of sense.

And I also would just maybe point specifically to the COP. You know, a lot of our collaborations have developed, you know, in the sort of period where it was just up to us and we didn't have a partner so much in the federal government. There was some opposition

there. And so, we developed a bunch of collaborations. And I think (indiscernible) is a really amazing opportunity to have alignment and really show that we're firing at all cylinders at the state and national level.

So, and then finally, I would just highlight, you know, we do have federal entities and lots of federal funding coming into California in the industrial sector and at the national labs that are excellent platforms for collaboration.

We have a couple of Industrial Assessment Centers, so hydrogen can absolutely be a -- play potentially a role there in the industrial side. And then, obviously, we have Berkeley Lab and, you know, SLAC, and other national -- other federal resources here as well that we work with, we fund a lot of work with, and would love to collaborate and look for avenues there as well.

So, thank you for being here. I don't have a question, but just wanted to sort of extend a robust hand partnership again, and thank you for all of your work and vision, really, over all these years. Thank you.

DR. SATYAPAL: Thank you so much, Commissioner. Maybe one last thing I'll mention that we'd like to do a better job of, and I think you've been out in front

here, too, is how to engage the, you know, the EJ aspect and the disadvantaged community. So, again, the message that not -- we're working for the disadvantaged communities, but with disadvantaged communities. And we have a Tribal Energy Office, we have, you know, the political appointee office, Office of Economic Impacts and Diversity.

So, in some states there has been some backlash for the hydrogen, and green hydrogen, and questioning our air pollutants and so forth. So, I think that's one area as well that we'd like to collaborate more and make sure we're increasing the purview here in terms of the dialoguing and the planning. So, happy to talk more.

And I apologize, I'm going to have to drop off for another meeting. So, thank you again for all the leadership.

COMMISSIONER MCALLISTER: Great. Thank you. By the way, we did have Tony Reames at a building decarbonization workshop.

DR. SATYAPAL: Okay.

COMMISSIONER MCALLISTER: And we're in touch with Shalanda Baker at DOE. And so, absolutely you're point is extremely well taken, so thank you.

DR. SATYAPAL: Thank you.

COMMISSIONER MCALLISTER: All right, take care.

All right, back to you Mike, thank you.

MR. PETOUHOFF: Thank you. Thank you for that presentation and for engaging questions.

I think at this point what we'll do is we have some speakers, live speakers from Germany. And considering time zones, we'll go next to Germany.

And I think what we'll do is we'll go through the other speakers in order. And since our speaker from Demark is recorded, we'll put that at the end of the program and then open up for questions.

So, we'll go to Ulrich Benterbusch, who's the Deputy Director General at the Federal Ministry for Economic Affairs and Energy, in the Federal Republic of Germany. And he may be joined by Toni Glaser as well, to answer some questions.

We'll have a presentation and because of time zones we will then again break for questions from the dais. Thank you.

MR. BENTERBUSCH: Yeah, thank you very much Mike. Thank you for inviting me. And it's really a pleasure to listen to all the discussions up until now. It really shows that we are really well aligned in California, in Washington, and in Berlin, and I would say even in Europe now. And I only want to allude that there has been a phase when this was not self-

understood, and it's really, really encouraging to listen to all your debate and in particular, also, from the contribution from our colleague from Washington.

So, with that I would like to start. And please, next slide, please. You will see that Germany had changed its plan. We want to be climate neutral not in 2050, but since June this year it's 2045. And we have, of course, increased our ambitions. So, the new target for 2030 is round about 543 million tons of CO2 equivalent. That means in this decade we have to reduce round about by 250 million tons, which is really a huge challenge for the different sectors.

But I would say it's manageable, we can achieve that. But it really means that the ambitions that we have, the policies that we pursue have to be quite different from what we have seen in the last decade. So, there is a game changer necessary and that is the message also which comes together with hydrogen.

The next slide, please. Now, I want to say one thing of course up front, hydrogen is an important source for decarbonization but it is, of course, not the one-size-fits-all solution for all our problems. But it is necessary.

And I'm grateful also for, you know, this observation from Commissioner Baker who said that, yes,

we need green electrons and we need green molecules. And, of course, not only green hydrogen, there are also other forms of gases that can be decarbonized and green. But the key is we need the green molecules, otherwise climate neutrality is not possible. And in our view, it's like a political, let's say, formula. If we want really decarbonization without de-industrialization, then the green hydrogen, decarbonized hydrogen is absolutely necessary.

For us, therefore, the market ramp up now of hydrogen is critical and the objective that we have developed in our national hydrogen strategy, they all center around the market ramp up for green hydrogen. We focus on green hydrogen in Germany. That's understood because it's really, in the longer run, the sustainable source of decarbonized hydrogen.

But in a transition phase we also think blue hydrogen will be necessary because we will need sooner and later large amounts of hydrogen, and we don't see how this can be produced as quickly as needed through green electricity.

But we see that as a transition phase and for us that we will not, let's say, support via state aid the production of blue hydrogen. That should be, you know, done by the market.

The next slide, please. Now, the situation is as follows. In our strategy we have set a target that we want to install on German soil, onshore or offshore, by 2030 5 gigawatts of capacity of electrolyzers. This will then lead to round about 14 terawatts of green hydrogen.

We have the demand project by 2030 90 to 110 terawatts, round about 55 of gray hydrogen is at the moment in the market. In terms of areas and uses, we see the industry and transport sector first. And, of course, we also need to focus on the infrastructure build up for that, but I will come back to that in a minute.

The next slide, please. Now, our strategy does contain a detailed action plan because the market ramp up will not come just by, you know, watching. It needs a lot of framework conditions that need to be put in place.

One is that you need sufficient funds in terms of state aid to complement the investment of industry. And with the recovery plan from the COVID crisis, our government has provided 9 billion Euros, which is quite a substantial amount, 2 billion Euros for projects with international partners and 7 billion for projects in Germany, basically.

We have decided that, well, in the first let's say years, we will try to focus in particular on projects that are comparatively close to profitability, so that the margin that we have to subsidize is not too high or hard sectors, of course, which is where we have no other alternative.

One of the key areas here is the replacement of gray hydrogen through green hydrogen in refineries. That goes back to European regulation, and in this context we do think that when it comes to a successful market ramp up this will be an important area of investment.

Another very important, let's say, lesson learned is that at the beginning in the phase of the market ramp up we need integrated projects. That means we're going to support only projects where, you know, there is an electrolyzer so there is production. We know how it is transported. Normally by a pipeline, but maybe also by truck or trailers. But we need to have an answer on the question of how is the hydrogen transported.

And in the end, we need also somebody who is going to use it, because we will not support just the production of green hydrogen without knowing on a project basis who is going to use it and how much it's

going to cost.

So, we need integrated projects along the whole value chain and we're going to do that in a European context. IPCEI is certainly an acronym not very well know I think in California, and you don't have to know it, but it stands for Important Projects of Common European Interests. That is the formula under which we can apply for the permission of the commission to grant certain state aid that we can then provide to the companies.

As European approach requires that, you know, it's not just a German investor, but there are still over 2 European partners, and there is collaboration with European partners. And this year we have now identified round about 60 big projects out of 230, which we will support in the upcoming two, three years. And the first round about 10 projects are now with the first wave of being, you know, presented to the commission and we hope that they will be approved by the end of the year.

One thing I want to stress here that is that we -- out of this European project, if things work out well, we will have by 2030 at least 1,700 kilometers of pure hydrogen network, transport network, transport grid installed which, of course, is very important.

The next slide, please. But in addition to necessary state aid, you also need tailor-made regulation. Because if companies should take a final investment decision, then the regulation around green hydrogen needs to be clear and encouraging.

So, one thing in the German context is that we have lifted the EEG surcharge from electricity used for the production of green hydrogen and also the grid cost is zero. The transparency on CO2 footprint is a need that we also need from a European regulatory viewpoint.

I also already alluded to the regulatory framework for the infrastructure. That law has now passed the Bundestag. We have election in September, so it was very critical that these changes were adopted. And it means in particular that our companies, infrastructure companies can use existing gas pipelines that, you know, today are used for natural gas transport, and converted into H2 pipelines. This is a relatively cheap way of transport of green energy sources and we do hope with that, at least for the starting and the market ramp up we have, at least on the German territory, a regulation that will work.

We have European regulation implemented concerning renewable energies in the transport sector. That will certainly help a lot of investment to be

fueled into this sector of hydrogen because it gives quotas and other incentives to produce synthetic fuels, synthetic kerosene, hydrogen for heavy trucks, but at the same time also other sources of green energy that you can use in the transport sector.

But to give you an idea, today we have round about 5, 6 percent renewable energy in the transport sector and by 2030 that number should be 32.

We are still working in Europe on the definition of green electricity. In this context it's a very, very crucial regulation because electrolyzers will also have to get electricity from the grid. And the big question is under which regulation you count it as green.

I will give you just one example. In the German context we have today round about 50 percent of green electricity, that's the average share of the year at this point in time, and the rest is of course gray. It comes from basically coal and lignite. And if we want additional green electricity for electrolyzers and green hydrogen, then the question is do you need 100 percent additionality or just the missing, the gap, you know the 50 percent that is gray. And, of course, we think that phase, you know, when you go into a ramp up market phase you need flexibility, so the additionality criteria can only be 50 percent.

But just to give you an idea that around this question that has also then to do with the question where is the electrolyzer located. Is it close to the electricity production, the windmills in the north, or is it more in the south. What is the question of, you know, how compatible are the electrolyzers run with the electricity system, with variable renewables. So, there are many questions in this upcoming regulation that the European Commission needs to decide on. And it's a very critical one for the ramp up of the green hydrogen market in Europe.

And, of course, when it comes to support we will also need CAPX, but we will also need OPEX. For example, in the industry we are not sure that we will get started without OPEX. There is an instrument like contract for difference. But this is utterly expensive and we need to be very careful with that.

The next slide, please. I will make this very short. Because one of the basic ideas that's now absolutely clear is that the German coal is not delivering enough renewable energies, you know, to produce enough green hydrogen. So, imports of green hydrogen or derivatives will be very, very important. So, we are looking out for cooperation in Europe but also, of course, also beyond the borders.

The next slide, please. In this context I want to mention one instrument that we are developing that is called H2 Global. It's a special program. We have, oh, let's say industry has -- a couple of companies have founded now the foundation, and that foundation has a job to offer via auctions the purchase of green hydrogen or derivatives, so they can offer and should offer 10-year contracts, and buy these new goods. And they should sell the H2 or derivative on the German market.

Of course, there will be a cost difference in the beginning and that we will -- you know, it will be financed by the state. But by this we do hope, you know, to encourage partners exactly in the Middle East, or in Eastern Europe to really produce the products we need and to build a value chain that can help is in round about 10 years really to decarbonize industry at large scale.

The next slide, please. Now, I would like to turn a little bit your attention to what is going to happen in wind energy. You see here our new targets. We'll have, by 2030, round about 67 to 71 gigawatts. Today we stand at 53. And we will add offshore round about 10 gigawatts in the next 10 years, that's the aim.

The next slide, please. You see that this is in comparison to your numbers. Not a lot, but in the

German context our coastline is rather small and if you take the 40 gigawatts by 2040 that we want to have offshore, then that's really all we can kind of use there. It's not much more that we can do because the North Sea and the Baltic Sea, they are really -- there is a lot of fuel transport, you know, and other things, so that is really the maximum that we can do.

Therefore, cooperation in Europe, next slide please, is critical. And that has to do, of course, with partners in the Baltic Sea, Demark or Scotland, because in general the North Sea has a very huge potential for offshore wind and we need to lift that in Europe.

You'll see here our system of ceiling prices for auction. That's determined for '21, '22, '23. We are very, let's say, we changed the model a couple of years ago to go to auction and that is very successful now. And in particular, the development of the sites is done by a public agency that has also a lot and, therefore, we do hope that we can develop this sector in the next years very efficiently.

The next slide is just, again, this capacity in the North and Baltic Sea. I think you are aware of that. It also shows how limited our coastline in Germany is.

But when it comes to hydrogen, and that is now the next slide, there are new developments and this is what I wanted to share with you at the end.

Mike, I think you were also hinting at that. Because when it comes to offshore wind you can, of course, put a cable under the sea and produce the hydrogen with the electrolyzer on shore. But there are also deliberations to put the electrolyzer in the tower of the windmill and then collect the hydrogen. We'll have a pilot project on that near a little island called Helgoland in Germany. And we are very kind of keen to see how that will power. The issue of, you know, you mentioned salt water electrolysis is also very interesting because that, of course, would help us hopefully save energy.

But this is really research and development, and we are not yet there. But I wanted to share these deliberations with you, so you see that we are also trying to enter new territory.

So, with that I would like to say thank you very much for listening to this presentation. And if there is time I'm, of course, happy to answer any questions you may have.

MR. PETOUHOFF: Yes, Ulrich, thank you for your presentation. And considering the late hour, we can

make a brief moment for questions from the dais, if you're willing to do that.

MR. BENTERBUSCH: Sure.

COMMISSIONER MCALLISTER: I just want to encourage anyone with questions. I want to thank you, Ulrich, for that great presentation. Really, I think we can learn a lot from you and that's why we have an MOU where all of us think about where that's going to go. And really thank you for really giving us that comprehensive rundown.

Matt, or Commissioner Houck, I'm thinking Commissioner Douglas might have had to drop.

DEPUTY SECRETARY BAKER: I don't really have a question, but I do want to just -- I think what Germany is doing, you know, really path breaking, and what the Europeans in general are doing, and I think we can learn a lot from that. You know, I think all of what you're doing very much fits into kind of a, you know, no regrets, certainly industrial-based approach. And it's super interesting and I hope we continue. I just found this very illuminating, thank you.

COMMISSIONER MCALLISTER: Yeah, I only have one quick question or one quick -- maybe a question, more of asking you for a reflection. But, you know, our systems of public/private partnerships in Europe generally, and

certainly Germany, differ from how we tend to do things in the U.S. You know, you have a very strong sort of tripartite, you know, government, labor, you know, consumer kind of industry, government/labor, you know, closeness I think that sometimes we have less of or our system isn't quite set up, you know, along those lines.

I wonder how does -- how do you see sort of -- how important do you see that partnership sort of, or how close is it between industry and government, and labor particularly in terms of pushing this enterprise forward?

MR. BENTERBUSCH: Uh-hum. Well, I think when it comes to industry in particular, the labor unions are very aware that without hydrogen certain production capacities we cannot sustain. There is chemicals, you know. This all needs a change in the feedstock. And, therefore, as we got labor, they are pretty supportive.

There are more issues when it comes to the heating sector, you know. Because I was really intrigued by your kind of aims of triple one, you know. One kilo, one dollar, in one decade. And if that happens, of course then that will help us also a lot if that is then transferrable to Europe to decarbonize the heating sector. Because how we decarbonize the heating sector with regard to the buildings built, which are

fully insulated, you know, where you cannot really work with a heat pump in winter because it would consume too much electricity. That has big, big questions. And we have a very, very, let's say sharp debate, you know. But on the one hand if you use then hydrogen for heating, it's maybe more inefficient, but because you need first electricity, right, at least when it comes to green hydrogen. But that is a very, very open debate I would say.

And the jobs that we as, let's say bureaucrats, in governments have to do is to keep the development open, you know. We should not take the decisions about technological solutions in the government. That should be developed by the market, yeah. Of course, here and there we need to develop, also, and help technologies to get into the market, like electrolyzers. But that has to do with, you know, the fact that we cannot by the way today come up with a CO2 price that makes these things compatible. Yeah, the downside of this would be too high. So, there is a need for, of course, here and there to help technologies.

But in the bigger picture when it comes to decarbonizing the heating sector, we have different options and that is our kind of approach.

And of course, I would also like to say thank

you for the partnership that we have with California and there is good cooperation going on. And I should also transmit best regards from Thorsten Herdan, who could not join today. And we are also very happy and I would like to express this here also in this context, that our government at national level has now agreed to set up a true energy partnership, a formalized energy partnership between Berlin and Washington. Which, of course, a year ago we were not dreaming of, you know. And that, I think, is very important and goes in the right direction. Because countries like Germany and the U.S., they need to closely collaborate in energy and also in hydrogen, you know, to make decarbonization something that really does not come too late when it comes to climate change.

COMMISSIONER DOUGLAS: So, thank you for the presentation and for being here late into your evening, I know. And I just had a quick follow-up question. Can you give us a sense of when you might have results on the offshore wind pilot projects or when we might be able to learn a little more about how those have gone? Because that's something of quite a bit of interest here right now.

MR. BENTERBUSCH: Yeah. I think it will at least take three to four years. If the commission, you

know, gives us an approval then in the next year, and the regulation comes out, right, from Brussels, then in the next year, in 2022, enterprises can take final investment decisions and then can start to work.

COMMISSIONER DOUGLAS: Uh-huh.

MR. BENTERBUSCH: But to get these windmills up and to get these new technologies working, it will certainly take two years or so. But that's round about the timeline, I would say.

COMMISSIONER DOUGLAS: Thank you. Thank you.

COMMISSIONER MCALLISTER: Anyway, thank you very much for being here. And I think we might be a little past time, so I think we should move on. So, I'll pass it back to Mike.

So, thank you so much for being here and have a great evening.

MR. BENTERBUSCH: Well, you're very welcome. And I wish you a good workshop.

COMMISSIONER DOUGLAS: Thank you very much.

MR. PETOUHOFF: Thank you, Ulrich.

At this point I think we'll move on to our California presenters. And we'll go through all three presenters and then have our recorded presentation from Demark, and then we'll open it up to Commissioner questions at the end of that.

So, I'll turn it over to Paul Schultz, Director of Power and External Energy Resources at LADWP.

MR. SCHULTZ: Thank you, Mike. Appreciate the invitation to present here. I'll try to be as quickly as possible, I know we have a full agenda.

I just want to talk, you know, L.A.'s hydrogen journey kind of started about four years ago. So, and it kind of started with the project actually in Utah.

So, the next slide. You know, a couple of years ago we made an announcement about a commitment to 30 percent green hydrogen at the Intermountain Power Project facility. That decision had been made a couple of years prior to that as we moved through developing of RFPs for the new facility.

Just to give you some background, on the existing facility it is -- it is not an L.A. facility. It's a collaboration between 35 participants owned by the Intermountain Power Agency. The facility's located right smack in the middle of Utah, just north of a small town called Delta, Utah.

It's two coal facilities. And the plan was to transition from coal to natural gas, but I think we saw -- as we saw greater and greater regulation on GHG and the advent of SB 100 there was a decision needed to be made that while we were contractually obligated for

natural gas at the facility, we needed a pathway to move away from that as a fuel source.

Why this is important to us? So, again in a few slides you'll see. But, you know, as a participant we've been served well, about 98 percent of that energy from the existing facility has been taken by Southern California participants through a 2400 megawatt HVDC line. Based on the physics of an HVDC line, we do need a dispatchable resource at that facility. Putting a lot of solar and wind at that facility won't operate that HVDC line.

So, in order to maintain the reliability of the power system and that transmission system, we had to settle on some type of a combined cycle unit.

So, the renewed project, IPP-renewed project is replacement of the coal facility with 840 megawatts of natural gas that's class -- part of that RFP requirement was we wanted to see a commitment on day one of 20 percent utilization of hydrogen. And then, a pathway by 2045 to get to 100 percent.

So, about a year and a half we signed a contract with Mitsubishi. I will tell you that the hydrogen was a small portion of the requirements, but we felt comfortable with the pathway Mitsubishi had laid out, their commitment to 30 percent on day one.

And so, we're working towards that. The commitment at that location has been solely on green hydrogen and I'll get to that in a few seconds. The renewed project also is the replacement of the 2400 megawatt converter stations. They have been live and been in use for almost 40 years here.

And then, we're looking for an in-service date of May '20 until 2025.

The next slide. So, why this location is important really is, you know, we're kind of -- Los Angeles to our west, and to our south bordered by the ocean. So, you know, we utilize a transmission system that allows us to reach into the southwest. This location is prime for wind resources. So, there's high voltage DC line that allows us to reach into Wyoming for wind resources. And we're currently under discussion with 200 megawatts of Wyoming wind to bring through that location.

So, you know, as we look at the facility, the facility happens to sit above a domal salt formation that would allow for what we initially saw as compressed air energy storage, and now we're transitioning to hydrogen production and storage at that location.

And because of that, because of the ability to reach into the southwest for solar, Wyoming wind, and

then geothermal resources in the area we consider this Utah's renewable hub, this specific location.

The next slide. So, this is the project at Intermountain and really kind of the first of its kind in the United States. We see this ever-increasing amount of renewables in that area utilized in the transmission system, the northern transmission system and the southern transmission system to bring renewable energy into that location. Using a commitment to green hydrogen through electrolysis process to create that hydrogen gas, store it as I said. The location is right above a domal salt formation that allows solution mining of multiple salt caverns. And it's not a new technology. It's been done in the Gulf Coast states for hydrogen storage.

And what this allows us to do is store up to 5,000 tons of hydrogen in each of these salt caverns, which would ultimately allow us to do seasonal storage of the renewable energy.

And I will tell you on day one that's what we're going to see. We're going to be seeing the influx of renewable energy, the process of creating hydrogen, and then using a lot of the hydrogen produced in the spring and fall months utilized during the winter and summer months when need is the greatest for the new combined

cycle units.

And, of course, the combustion technology that we've partnered with Mitsubishi on, the commitment to 30 percent by commercial operations date in May of 2025, and a pathway to get to 100 percent by 2045.

I'm hoping here that in the next three months we'll have the initial hydrogen production and storage contract signed and we can be discussing about exactly what the project will look like on the hydrogen production and storage.

The next slide. This is the hydrogen timeline at Intermountain. Like I said, the new units come on in 2025. There will be some switch yard upgrades completed in 2026, along with the converter stations. The pathway to 100 percent hydrogen, we're looking at the combined cycle units with minor modifications to the combustor system and some other portions happening in the 2032 time frame.

And the 2039-2040 time frame to get to the capability to utilize 100 percent hydrogen. So that by 2045 we are utilizing 100 percent hydrogen fuel source at that location.

Across the top you see the RPS targets for California. Our city has committed to greater RPS targets so that by 2035 we're at 100 percent GHG free.

We're still working through the details on how we're going to make sure that those units are capable of utilizing the hydrogen by 2030, 100 percent hydrogen by 2035.

The next slide. So, I said it was a hydrogen pathway for Los Angeles. It is not just Intermountain. A couple years ago our city council directed LADWP to work with NREL to achieve -- to document the pathway and the costs associated with achieving 100 percent renewable energy electric supply. And it wasn't just from a power delivery point of view. It has to deal with the impact to local jobs and the economic change, the benefits to the environment, and residential health. And then, environmental justice and how it was going to impact the communities.

The next slide. There were 9 scenarios studied by NREL. They were based on moderate, high and stress. You can see them in front of you. I won't get into the details. You can go to the nrel.gov/la100 to see the LA100 study and go through the details with that.

But what I really wanted to do was highlight something that came out of that. So, under all scenarios that were studied there was some commonality between them.

The next slide. So, across all scenarios there

was the requirement for electrical efficiency, customers with top solar renewable energy, in-basin storage, and distribution and transmission upgrades. What was also required was that we did need combustion turbines within the L.A. City Basin. The way our power system's configured, there's just not the capability to create a transmission system and bring all that energy in. You do have to have in-basin generation.

So, what all the studies called for was some type of new in-basin generation, which would be natural gas today, but would transition to either biofuel or hydrogen. It was -- in the studies, it's not specifically called out, but as we looked at what's happening at Intermountain we were able to use that technology and look for a pathway to 100 percent hydrogen.

The next slide. And the last thing I want to talk about is we've been working with the Green Hydrogen Coalition and their HyDeal North America goal of $1.50 per kilogram delivery system.

The next slide. So, we've committed as an off-taker to participate in the HyDeal L.A., committed to working with Green Hydrogen Coalition. You can have it -- there's a talk this afternoon about this, so I won't get into the details. But it is L.A.'s continued

commitment to this hydrogen pathway.

And the last thing I want to add is that out of the LA100 study, and the natural gas generation that we'd transition to hydrogen, we are releasing within the next couple of weeks here an RFI for hydrogen sourcing for the southern -- for our Southern California facility.

So, that is all. Thank you.

MR. PETOUHOFF: Well, Paul, thank you. It's exciting to see what's going on at LADWP and it's something we can all learn from. We'll hold off on Commissioner questions until the end.

But let me now move to Joe, from Northern California Power Agency.

MR. LEDESMA: Thank you, Mike. And I want to thank all the Commissioners for putting this workshop together, and the CEC staff. This is a really good conversation and I think it's timely that it's being had now.

So, I'm Joe Ledesma. I'm with the Northern California Power Agency. We're a joint action agency. We represent 16 public power utilities, with over 700 California citizens being served by electricity.

We have a little over 800 megawatts of renewable geothermal power plants, and hydroelectric plants, and a

fleet of natural gas plants.

The next slide. So, the discussion I'll be going over is we've been exploring at NCPA our Lodi Energy Center. About a year ago we had a failure on the turbine and it was an opportunity for our commission and our members to really be thoughtful in where they wanted to go with this power plant. And the decision was made to purchase a turbine from Siemens, which was capable of up to 45 percent hydrogen blending by volume. And that's also including the burners or the nozzles that we'll be installing next year.

So, really, this was a really forward looking decision that was really made, and it really allows this 300-megawatt combined cycle plant to be part of, you know, the research that's being done in California, the piloting, and eventually, hopefully, the transition to 100 percent renewable power.

You know, this is on -- Lodi LEC, or our Lodi Energy Center is really one of the most efficient combined cycle plants in the state. And so, it's got a lot of -- it provides a lot of service to our members and the state during a lot of these heat events. It's running almost around the clock sometimes.

The next slide. So, really, I think you guys, all the presenters and the Commission talked about

hydrogen. There's great opportunities for hydrogen and so we need to really look at that.

The next slide. So, what are we seeing on the ground as a generator, asset owner is we're seeing the commodity or price of gas go up. Right now it's currently over the $5 mark and it's trending, it's been trending around there for a while, so we're seeing gas prices go up. We're really seeing the gas turbines continue to play a significant role as part of the Cal-ISO energy balance. It's second to the renewables and it goes out past towards 2030 in the projections that we're seeing.

And roughly, 30 to 50 percent of the natural gas-fired plants make up the total supply to ensure grid reliability.

We're also seeing, you know, retirements that are coming. And we are -- we are really worried that after the Diablo Canyon Power Plant and other plant retirements come up that the system is really going to have to lean more on these natural gas plants.

The next slide. So, as an asset owner, one of the questions we're asking ourselves as we're looking at hydrogen is, you know, we're thinking about how fast will natural gas be phased out. We know that that's state policy and direction, so trying to figure out what

that timeline looks like. And will the natural gas infrastructure be repurposed for renewable gas, with blending of hydrogen. And, you know, is hydrogen going to be what replaces natural gas plants and what they provide to the grid as far as dispatchability, storage capability to really help everybody meet the carbon-free goals.

The next slide. So, what's creating that uncertainly based on those questions is, you know, always as an asset owner and as our members are always very diligent in trying to keep the rates down for the citizens of California, as they are a public utilities, is really understanding what the forward curves are going to look like. That's -- you know, there's a lot of uncertainty as to where the market will be from now to 2045 to really make investments that you won't strand going that far out.

You know, stranding investments in our natural gas plants, we made that conscious decision to go to a 45 percent blending by volume at LEC. You know, that was an expense that the agency made. And therefore, and continued to invest. You know, there's a concern on not stranding those investments.

And as other presenters have been talking about and is really will hydrogen production and storage, you

know, we talk about bleeding edge and leading edge emerging technologies but, you know, is it going to continue to move forward and become an emerging technology that becomes commercial enough at the scales that are really needed.

The next slide. So, as far as the affordability, and I was really happy to hear, to see the announcement by the United States DOE where they -- on the First Energy Earthshot, Hydrogen Shot Program, which really is targeting a $1 per kilogram by 2030. You know, that kind of lined out with Bloomberg's estimate about a year ago. We've been tracking where do we think hydrogen, and when will it be affordable.

And I think those, you know, the Bloomberg assessment and now the DOE target is really signaling that we could be at about a dollar per kilogram by 2030.

Us, NCPA, we took a crack at, you know, back-of-the-envelope projection on where do we think, using very conservative assumptions on the gas trends today, when do we think it will hit $11 per MMBtu, which is we're seeing that as equivalent to the $1 per kilogram. So, when do they cross the line where hydrogen can be -- will be at the same cost as natural gas.

The next slide. So, in our graph, and I apologize for how small that looks, but in the very

simple calculations that we did, and very conservative, it really landed around that 2030 time frame. So, it kind of showed us that -- it kind of demonstrated that the projections that are going on, and even if you look at the pressures that are going on, on the natural gas systems now, and just the natural economics around it, they're going to cross paths around 2030.

So, if you look at that as a timeline of when it could be affordable and, you know, we're in 2021, the conversation we're having today and then policy decisions that are being made now at the state level, and the national level, are really instrumental in allowing asset owners to be able to do all of the upfront work, and feasibility studies, and investment decisions so that in the next five years decisions can actually be made to build infrastructure.

The next slide. So, the Lodi, why did we really look at the Lodi Energy Center? I mean, we -- and I use this term shovel ready, that's used for really more construction, but the power plant is shovel ready meaning, you know, it's in a prime location to be used as part of piloting, or R&D to answer questions on hydrogen and really allow us to move forward.

The plant is right -- is in Lodi, California. It's adjacent to Highway 5. It's got all the needed

resources, it's right next to Lodi's water, wastewater treatment plant that already supplies recycled water to the power plant. So, we're next to water that's available for the electrolysis. You know, we are connected to the grid to take advantage of renewable energy. And the footprint is there to put an electrolyzer plant there, along with the power plant.

The next slide, please. And so, we did a feasibility study with Black & Veatch that was completed in February. And they did a design with a 155-megawatt electrolyzer plant and, you know, with some onsite water that we have available already. They looked at renewable, curtailed renewable, or low cost energy, green energy already available. And really, they came out with the -- and the objective of this study was really to see if we could size a hydrogen production plant and achieve cost parity with the current operations running natural gas.

The next slide. The conclusion was that it was technically feasible, all the resources were there. That it also really told us what the drivers were of making it feasible to reach cost parity. And of course, capital costs are a big component of that. And really, making sure that we could take advantage of some of the attributes of reducing our carbon emissions out of that

plant. And also, being able to -- you know, they used the term REC revenue sharing, but really it's saying that we need to figure out a way to get credit for green -- you know, producing green hydrogen and then burning carbon-free electricity out of that.

The next slide. So, as far as our approach, and I won't go through it in detail, but really the top lines are at the power plant. We really need to look at what do we need to do at the power plant. We've done that. We need to look at, you know, the storage component of hydrogen there and I think we've been putting in some applications with the DOE for funding there, so we could do some of that research and development.

But ultimately, it's going to depend on the industry and state policy and direction, really, to make sure there's enough storage and transportation to make it feasible at scale.

The last slide. And so, as an early adopter I think state policy to phase out natural gas has to include a transition plan for hydrogen to really allow the asset owners to invest money. Also, the coordination from the energy market and the gas rate structures is also important so that the natural gas electric generators that are on the system now don't get

burdened with, you know, unfairly all cost on them, that then gets translated back into the electric grid, or makes it not feasible to repurpose those power plants.

And then also, there should be incentives to repower and repurpose, you know, to really avoid additional costs to the ratepayers by paying to decommission these plants that have already been put in locations that are helpful to the grid for reliability purpose, and have a lot of investment built in. You know, there should be incentives to repurpose those, rather than adding additional cost.

And I went fairly quickly. I apologize, but I know time is important right now. So, pass it back to you, Mike.

MR. PETOUHOFF: Well, Joel, thank you. I think the Northern California Power Agency's really taking an opportunity to do something very innovative with repowering a power plant. So, that's really exciting to hear what you guys are doing. Thank you very much.

MR. LEDESMA: Yeah, and one last point, and it's in California.

MR. PETOUHOFF: And it's in California.

MR. LEDESMA: That's a really important point. Thank you.

MR. PETOUHOFF: Thank you.

Well, speaking of being in California, our next speaker is also from California, Arne Jacobson up from Humboldt State University. Really interested to hear what you have to say. And Arne, as we've talked before, especially interested to see your generation profiles comparing solar, and onshore wind, and offshore wind, and see how they complement each other. But interested in your whole thing, but especially that. So, take it away from there.

MR. JACOBSON: Great. Thank you very much, Mike. And thanks to all the Commissioners and everyone here today for the opportunity to present.

I'm Arne Jacobson. I'm Director of the Schatz Energy Research Center at Humboldt State University.

And the materials that I'll focus on today really look at offshore wind with an emphasis on potential for offshore wind development on California's North Coast.

I won't focus as much on hydrogen dimensions or hydrogen generation opportunities associated with that because our work hasn't emphasized that so far. Although, I will mention some work we're doing briefly in relation to that, just in the end.

The next slide. So, California has a significant offshore wind resource, which I think has

great potential to contribute substantially to California's clean energy and climate mitigation goals.

An NREL study published last year indicated estimated potential for installing wind farms with capacity up to just over 20 gigawatts across five areas. Offshore along the north and central coasts of California, with three of those areas and a substantial amount of that capacity being in far northwestern California.

The next slide. More immediately, the Bureau of Ocean Energy Management has begun the process of moving forward in relationship to two of those areas. One is the Humboldt call area, which is 20 to 30 miles offshore from Humboldt Bay. And has an estimated -- has an area that could be compatible with installing an estimated 1.6 gigawatts of capacity.

There's also an area that's being referred to as the Morro Bay "399" call area, which is the 399 refers to the area in square miles. And it has an estimated capacity for installation of up to 3 gigawatts.

The process is now moving forward in relationship to those two areas. And BOEM has indicated that they anticipate holding a lease auction for those two areas in 2022.

The next slide. Here, at the Schatz Energy

Research Center, we've been involved in research over the last several years focused on the feasibility of offshore wind on California's North Coast.

Here, I'm indicating project funders, as well as some of our key partners. And much of what I'll present over the coming slides draws from that prior work.

The next slide. So, the wind resource, the offshore wind resource in far Northern California, and also in Southern Oregon is perhaps the best in the continental United States. And the Humboldt call area is situated squarely in that area.

In the context of the studies that we conducted, we focused on three different sizes of potential wind development, just to get a sense of the role that scale plays. In that process we looked at a 48-megawatt, 144-megawatt, and 1.836-gigawatt scenarios, all within the Humboldt call area.

The next slide. In terms of the generation capacity, these numbers are based on the 144-megawatt case, but would be very similar for the other cases. We estimated a 52 percent net capacity factor for a wind farm in that area. That compares quite favorably to what's typical for land-based wind and solar PV, with land-based wind commonly having capacity factors on the order of 30 to 40 percent and solar PV on the order of

15 to 30 percent.

The next slide. The average diurnal profile of offshore wind is also quite favorable and indicates a potential to complement some of the other renewable energy sources.

This slide shows offshore wind in the blue line, which is consistent with that roughly 52 percent capacity factor, and it shows what the average profile is over the course of the day. Of course, on average much more steady than solar generation and also significantly better capacity factor than the average California land-based wind.

The next slide. However, before we get too excited, I think it's important to note that those values presented on the last slide were average values over the course of the year. There are of course -- there is, of course, considerable variability in the generation profile from day to day and week to week. So, there will be periods of low to almost no generation and might extend for days at a time. Periods of very variable generation, and periods of high generation where the wind farm is essentially operating at or near its maximum capacity for days on end.

In our simulation annually full power occurs 42 percent of the time and zero power occurs 16 percent of

the time. And that -- those numbers are quite favorable compared to what you would expect from land-based wind generation.

The next slide. Moving to specifics and thinking about offshore wind development on California's North Coast, and in the Humboldt call area, transmission -- existing transmission capacity is quite limited in far Northern California. And that, at least initially, could limit the scale of offshore wind development that may be possible.

The next slide. In terms of the current existing transmission infrastructure, the maximum import and export capacity is on the order of 70 to 75 megawatts. Our projected load for the region is on the order of 100 megawatts. So, fairly small load and limited transmission capacity. All of that affects the scale of development that could be possible, at least initially in the absence of some fairly significant investments in transmission capacity.

Our analysis didn't focus on the Central Coast, but I'll just note that the transmission capacity limitations are unlikely to be a significant factor in the same way on the Central Coast. And so, it may be possible to develop up to perhaps the 3 gigawatt scale working with existing transmission capacity. Again,

that's not the result of our studies, but that's my understanding.

The next slide. So, we're currently, in relationship to the Humboldt call area, with funding from BOEM, we're conducting a study to look at transmission and interconnection alternatives for small commercial, on the order of 50- to 500-megawatt offshore wind farm development in the Humboldt call area. Working together with some partners, including Quanta Technology and NREL, the preliminary results of that work indicate that you could install something on the order of 140 to 170 megawatts, or a project of that scale without transmission upgrades if interconnection were to occur on an energy-only basis.

And there would be some curtailment in that context, perhaps on the order of -- occurring on the order of 4 to 6 percent of the time with that varying with the size of the project.

The results are sensitive to assumptions about the projected regional load and local generation from other sources. And we are doing this for a 2030 study year.

And in addition to looking at transmission-related issues, we'll conduct some preliminary analysis related to the possibility of coupling either battery

storage or hydrogen generation with offshore wind at that small commercial scale. We haven't completed that analysis, yet, and we're expecting to have results toward the end of that year.

One thing I will note is that the far Northern California is fairly isolated from a grid perspective and it's also fairly isolated in other ways. And so, hydrogen transportation, if there were significant hydrogen generation, transportation of hydrogen out of the region would also be something that would have to be thought about.

And that's a brief summary of the work that I wanted to present.

The next slide. My contact area information is here, and also I'll just indicate the website there at the bottom or near the bottom of the page indicates a link where studies that we've produced in this area are available.

And with that, I will pass things back over to Mike.

MR. PETOUHOFF: Arne, thank you so much. It's really exciting what you're doing at the Humboldt State University. I think the offshore wind may be a little bit of time for it to come to fruition, but we're excited to see that happen and see some other things

happening in the interim that will lead up to that. So, thank you very much.

And Arne, we're hoping that you, as well as Joel and Paul can stay. We have one more recorded presentation and then we'll be having some -- then we'll be able to have Commissioner questions and some public questions. So, even though we're running a little bit late, we're hoping you can stay with us for that Q&A.

MR. JACOBSON: I can do that.

MR. PETOUHOFF: All right, great, great.

With that, we'll now go to our presenter from Denmark, who has been waiting patiently in an electronic storage recorded format. Nick Jensen, who's the Advisor for the Center for Global Cooperation.

And I think our IEPR staff will queue up his presentation and then we'll go to general questions after that.

MR. JENSEN: Good morning everyone and thanks for having me. My name is Nick Jensen and I'm an Advisor in the Center for Global Cooperation at Danish Energy Agency.

I apologize for not being able to be able to join you all live but, unfortunately, I have some other commitments. However, I've tried to prepare a brief, about a 10-minute presentation that is going to focus on

Denmark's target of climate neutrality by 2050, and the role of Power-to-X and the Energy Island.

If you have any questions after the presentation, my contact information will be at the last slide and you are more than welcome to reach out.

So, last year, 2020, Denmark passed the Climate Act with broad political support. It consists of two ambitious targets. The first one reducing emissions by 70 percent compared to 1990 by 2030. And the second one of being climate neutral by 2050. Both of them passed by law and thereby are legally binding.

Also, as part of this climate action strategy of the Climate Act, Denmark has a name or wants to be the front-runner and create opportunities for Danish companies in the renewables sector.

If you look at this graph, it shows the expected emissions by sector in 2030. These are the areas where we need to reduce emissions in order to achieve our 2050 target. And as you can see, especially transport and agriculture are the two largest emitters in 2030, with a combined total of 57 percent of the emissions.

They're also two sectors that are difficult to reduce, at least by -- sorry, at least by direct electrification and that's why indirect is going to play a significant role on the longer term.

But if we look, start by looking -- if we start by looking at how we're approaching it in Denmark, this commercialization shows you have the direct electrification and the indirect electrification. If you look short term, from a direct electrification we have already done a lot. There are market-ready technologies that are ready to contribute, such as heat pumps and electric vehicles.

But looking longer term, on the direct electrification we need to be able to scale up and mature new technologies and existing technologies, and we also need to be able to build out the infrastructure to support this.

Looking longer term, the indirect electrification is going to be more important. So, the longer term we look, the more important it's going to be, but at the same time it's much more immature right now and so technology development is an important part of it.

This is where the Power-to-X in green hydrogen is, and it's where there are solutions that we don't know of yet that is going to help us get to the 2050 target.

So, as we look at Power-to-X, Power-to-X is the conversion of electricity to gases and fuels via

electrolyzers of water. So, you have the water electrolyzers and you get -- and you can get different outputs. So, using it directly you have hydrogen, which can be used for refineries. It can be used for heavy transport using fuel cells. And you can actually export it.

If you add air or nitrogen gas, you get the synthesis for ammonia. Ammonia can be used for the fuel for transports for shipping, one of the big emitters that I mentioned earlier, in 2030. And likewise, it can be used for green fertilizers, which was also one of the significant emitters by 2030.

What is also an interesting option looking at is if you do the synthesis with carbon and make hydrocarbon, either as gas or liquid. With CO2, you can actually combine the Power-to-X process and the CCS or CCUS technologies. You can have some carbon capture and actually use it in the synthesis or together with Power-to-X, creating hydrocarbons that can be used for methanol jet fuel chemical products, et cetera.

So, really, Power-to-X supports the indirect electrification of hard-to-abate sectors heavily relying on fossil fuels. Carriers such as coal, natural gas and oil. And it really supports the heavy emitter sectors that I mentioned earlier, so agriculture and transport

that are sectors that traditionally have relied a lot on the fossil fuel carriers.

However, I mean with Power-to-X it's also important -- you know, Power-to-X is only really relevant if the first process, the first start of the process is renewables. And that's where the Energy Islands come into play.

So, the Energy Islands was decided in June last year, again with broad political support. I believe that 9 out of the 11 of the parties in parliament support it.

The islands will consist -- it consists of two islands. You'll have an artificial North Sea island in this area. It will, first phase, be a 3-gigawatt project that can be expanded to 10 gigawatts. And then, the second island will be in the Baltic Sea, utilizing the existing Island of Bornholm as a physical hub, which can facilitate 2 gigawatts.

So, the islands combined will have greatest of 12 gigawatts in service power plants, gathering and collecting green electricity from the surrounding offshore wind farm. And the connection is to connect the energy hub to Denmark and to the neighboring countries and contribute to large scale of the green transition in Denmark and the wider Europe, as well.

And this especially applies to the North Sea island. The Power-to-X part of the island where you can actually, again, not only to Denmark but also to the wider Europe.

For the Baltic Sea Island of Bornholm, it will be located -- the turbines will be located 20 kilometers, which is 12 miles south, southwest, which is down here, of Bornholm. And for the North Sea, the artificial island will be located at least 80 kilometers, about 50 miles off the coast of Denmark. And also, once fully built out with the 10 gigawatts and it will be the largest construction in the history of Denmark, with the total cost around $210 billion Danish Kroner, which is equivalent to approximately $34 billion U.S. dollars.

So, power industry is going to be really important in this equation, both in terms of the energy islands, but also in terms of the Power-to-X and developing these new solutions.

For the energy islands, the government is going to have a majority ownership, as it is considered critical infrastructure. However, private industry is going to be crucial for the development of these islands, both in terms of cost effectiveness, innovation, and flexible. Private industry can have a

stake of up to 49.9 percent of the islands.

For the Power-to-X, I wanted to just highlight just examples of where we're already seeing private industry getting involved. CIP, Copenhagen Infrastructures Partners are currently planning Europe's largest Power-to-X facility in the City of Esbjerg on the West Coast of Denmark. It will be able to deliver green fertilizer and fuel starting in 2026. Green fuel -- sorry, green fertilizer to support the agriculture industry and, of course, the green fuel to support the shipping and transportation industry. Again, going back to the slide I showed earlier, two of the heavy hitters in terms of emissions, in 2030.

And in addition, any excess heat can provide heating to about a third of the local households of Esbjerg and the surrounding area. And Esbjerg is, I think, I believe it's the 7th largest city in Denmark.

Another project is the Orsted, or another, Orsted, which is working on two projects. One is the H2RES project, where they will take two offshore wind turbines just outside of Copenhagen and convert the electricity to green hydrogen that can be used in buses and trucks.

In the Copenhagen area on the Island of Zealand, which is where Copenhagen is located and the third

project is a three-phase project that ultimately, by 2030, can have a capacity of 1.3 gigawatts.

Lastly, just briefly, I do want to mention some Danish involvement in projects going on in Australia, where the concept is similar, but at a much greater scale. So, they're looking to develop, I think for one of the projects it's 26 gigawatts of renewables, so onshore wind and solar. And then have the Power-to-X facility to convert this electricity into hydrogen that can be transported to markets in Asia.

And the reason for mentioning these are they're examples, I think they're good examples of how already now, despite being such an immature technology, we're seeing private industry investing and being part of developing it, and driving the development of these new, innovative solutions.

And so, not only our Power-to-X, you know, we're really seeing the sector coupling, but you're also seeing the involvement of private/public partnerships. And I think, you know, that's the way to go. At least that's what we're planning on in Denmark.

So, with that being said I just want to thank you for your time. Obviously, it's not possible to cover everything in 12 minutes, but I hope I've given some kind of introduction to what's being considered and

being developed in Denmark.

Again, if you have any questions, feel free to reach out and you can either do that by email or phone. And if I'm not able to answer your questions, I'll make sure that it's passed on to some of our experts on either the energy islands or the Power-to-X.

So, thank you for listening and enjoy the rest of your program. Thank you.

MR. PETOUHOFF: Okay, that concludes our panel. I'll turn it over to Stephanie and Heather for what's next in terms of our questions.

MS. RAITT: I had it turned on mute here. So, thank you for that.

So, Commissioner McAllister, we are very short on time, but if you have a couple burning questions for the remaining panelists, feel free.

COMMISSIONER MCALLISTER: I do not want to ask about combustion, if that's what you're asking. No burning questions of that nature. Sorry.

Commissioner Douglas, do you have any questions you wanted to ask?

COMMISSIONER DOUGLAS: I had a couple quick questions, if I could. And thank you because I also have a hard stop at 12:30.

So, first maybe for Paul, first of all thank you

for participating and congratulations on, you know, LADWP's hard work to look at pathways to achieve the city's leadership climate goals.

So, you know, one question I had was just the process. What's involved in going from the 30 percent hydrogen to 100 percent with the Mitsubishi turbines that you're looking at? Is it a big upgrade? Is it a -- you know, how significant is that transition? I was just kind of curious about that.

MR. SCHULTZ: Okay, so there's a couple of things. One is the technology today for combustion turbines, for combined cycles is set at 30 percent. So, looking at a greater percentage would be difficult today.

Mitsubishi has shared with us their direction. And we think by 2024, 2025 the technology, which really is just the combustor technology that we're really focused on will make sure or be ready for testing at some greater percentage, you know, 70 to 100 percent.

It's not clear that the technology is going to leap up straight to 100 percent. It might be iterations.

COMMISSIONER DOUGLAS: Uh-hum.

MR. SCHULTZ: The other technology is, you know, there's a lot of talk about air pollutants other than

GHG. This being a new build, we're taking that into account, oversizing some of the components, the HRSGs -- so that we can place some additional catalytic converters, ammonia processing, to keep NOx emissions as low as possible.

Again, technology not completely developed and we don't know based on the technology of the combustor side how that would roll into the rest of the emissions projects. So, we're waiting for that.

And then, the other part that is difficult is the build out of salt caverns is not a one-year project. It's a three-, four-year project. So, you know, as we start to look one, maybe two by 2025, 2032 we may be able to build four or five additional ones. But you can't go as quickly as you'd like to just because of the amount of construction that needs to be done.

COMMISSIONER DOUGLAS: Uh-huh, that makes sense. Well, it's got obviously huge potential in the sense that there is just so much in the way of diverse renewable energy resources in that region that could produce, could be stored, and could be delivered when needed. So, you know, I'm really interested in learning about your progress on this project and on these efforts, and so thank you.

If I could, Commissioner McAllister, let me ask

maybe one or two more questions before I disappear, which is just a question for Joel as well.

COMMISSIONER MCALLISTER: Go ahead.

COMMISSIONER DOUGLAS: So, you know, Joel, I definitely appreciate the points you made about how the efforts to invest in the work at Lodi, for example, has to take place within a policy context that gives you some certainty about the pathway, and the policy framework.

And as we said at the beginning of this workshop, you know, this is very much in the context of the natural gas transition and what are some pathways that achieve important goals, or can supplement, or can substitute for fossil gas.

And so, I was just wondering if you could speak a bit to what more you would be looking for in this area or what your thoughts are in terms of that kind of policy direction.

MR. LEDESMA: Well, I think on the -- you know, I'll step back and maybe talk a little bit about the research and development funding that your CEC has implemented. That's a really good, I think component of it because we really need to research, and do a lot more testing and research in these areas, as Paul was mentioning.

Siemens is very committed, also, to going to 100 percent, but there's a lot of work to get there. So, it's a long transition. And ours, you know, they're committing this turbine to 45 percent.

But I think at the policy level it's really about making sure hydrogen is included in, for example, the Joint Agency SB 100 Resource Analysis. That hydrogen, it's more specific to include hydrogen.

COMMISSIONER DOUGLAS: Uh-hum.

MR. LEDESMA: And also that there are discussions on how are we going to create incentives for asset owners, like ourselves, to not abandon these assets and really focus on the transition. Because it is a long haul to transition to invest now, incrementally and so they can get to the 100 percent.

And some of those things that we learned on the feasibility study that they say the gas, you know, the REC program that even ARB has, you know, some way that there are credits given to generators as incentives. You know, because the way the market is set up right now, you only get it at the megawatt production level which would be the solar, not at the hydrogen production.

So, then how do you carry that forward so that the RECS can be either shared, or double counting so

that there's more? So, it's these type of incentives and gas -- and hydrogen, I mean, being part of it.

You know, on the natural gas system, too, you know, the CPUC has just started the gas rate case. And even that, you know, it's really having the transition plan of the natural gas system be inclusive of hydrogen, not keep them silo discussions and keep them separated.

I think all these things will lead to policy decisions that will give asset owners confidence. Because there's never a guarantee, right, but to give confidence that the market is moving in a direction that will be inclusive of hydrogen and, therefore, they should start investing now.

I don't know if that answered -- I hope that answered some of your questions, Commissioner but --

COMMISSIONER DOUGLAS: Oh, it was a very helpful answer.

I'm going to jump off, I'm afraid, but I think Commissioner McAllister and maybe others have some additional questions.

Thank you all, and thank you as well, Arne.

COMMISSIONER MCALLISTER: Thank you, Commissioner Douglas, very helpful.

So, I think my questions had to do more with the market confidence and investor kind of perspective and I

think you kind of answered those just now, Joel. So, thank you for that.

So, we're a little bit over time, we're actually at 12:30. I want to really just thank all of our speakers. I mean this was a really great, everyone complemented each other well. I think Nick and Ulrich from the European perspective.

And I'll say I was in Copenhagen for the Clean Energy Ministerial a few years back and got a firsthand view of how committed Denmark is to this. And just wind turbines right there in Copenhagen, and all different kinds of power plants with bioenergy all right there.

And district heating is something that I think Ulrich suggested we can talk about, but that's something that I think is an interesting sort of difference with California and Europe.

But then the U.S. Department of Energy, obviously, with Sunita. And then, our two speakers about actual projects that are with us today and have really compelling value propositions for learning going forward, you know, with the NCPA. And then, all assisted by the research and policy work that Arne and his team are doing. So, everyone great job, thank you for that. And for staff for putting that panel together.

I did want to just perhaps create, jimmy open a little bit of time for Zoom Q&A. We're at, we're a little bit over time, but I think it's the right thing to do to pass it over to Heather for at last a couple of questions from the Zoom Q&A.

MS. RAITT: Okay. Great, Commissioner. So, Jennifer Campagna is here to moderate a couple of questions from the Zoom Q&A. So, go ahead, Jennifer.

MS. CAMPAGNA: Okay great. Thank you, Heather.

So, the first question I have here is from John Hamilton. And I believe this is geared towards Joel of NCPA. The question is: Are there freshwater supply considerations for siting hydrogen electrolyzers in the Central Valley, particularly given the current drought we're in?

MR. LEDESMA: Yeah, so our feasibility study or the project, the conceptual project we're looking at does not intend or have any backs on any freshwater or drinking water. We're merely using available recycled nonpotable water.

MS. CAMPAGNA: Okay, thank you.

So, okay, one other question we have is from Karin Sung. And this is geared towards LADWP.

Regarding the LADWP IPP Renewable Project, what is the reason there is a plan to blend 30 percent if

that only decreases CO2 emissions by about 10 percent?

Second question, why not just jump to 100 percent? Further, why is combustion the primary technology for electric gen if fuel cells are significantly more efficient?

MR. SCHULTZ: So, I think with Commissioner Douglas's question kind of answered the first few questions. You know, 30 percent is where the technology is today. Our constituents, ratepayers have requested us to move aggressively towards 100 percent, but it's kind of waiting for the technology. It's also waiting for the technology around electrolysis to mature so that it starts bringing down those costs.

You know, as to why we're just doing 30 percent and not waiting until 100 percent, you know, these are learning experiences. We need to take these steps. We need to put these projects in place to, you know, create maturity in the market so that we're committed to not only at Intermountain, but at the other locations that DWP needs this generation.

And then the question about why not use fuel cells, I thought I tried to respond to that one earlier in the presentation. It's always kind of difficult. But high voltage DC line requires, based on the physics, a rotating mass. So, we look at studies looking at

putting batteries there, synchronous condensers, but without a dispatchable rotating mass that high voltage DC line in Utah will not operate properly and will cause liability issues in that area. So, we do need a dispatchable resource to run that HVDC line appropriately.

MS. CAMPAGNA: Okay, thank you.

I don't know if we have time for any others or are we moving to public comment? Can you advise, Heather?

MS. RAITT: Commissioner, if it's okay with you, I suggest we move to public comment.

COMMISSIONER MCALLISTER: Yeah, I think we should move to public comment. That was a very stimulating panel, so thank you all very, very much. Really appreciate the need for multiple pathways, you know, that is alluding to, you know, and then not necessarily pick the final technologies and cultivate all the solutions so that we can get that percentage up on the combustion side, and be able to market the electrolyzers alongside and see what happens.

So, thank you. Go ahead with public comment, Heather and Jennifer, please.

MS. RAITT: Okay, great. So, we have Dorothy Murimi from the Public Advisor's Office to help with

public comment. And since it is already after the 12:30 time when we expected to come off, I'm suggesting that we move to a 1.5-minute per speaker for public comment, unfortunately.

COMMISSIONER MCALLISTER: Perfect.

MS. RAITT: Go ahead, Dorothy. Thanks.

MS. MURIMI: Thank you, Heather.

So, just with the instructions. One person per organization may comments and comments are limited to one and a half minutes per speaker. If you are using the Zoom platform, raise your hand. And if you're on the phone, press *9. That will raise your hand and *6 will unmute on your end and we'll unmute you on our end.

Let's see, I'll start with folks on Zoom. I see Yuri Freedman. Yuri, you're able to speak, go ahead and unmute. And apologies if I said your name wrong. Again, that's Yuri Freedman.

MR. FREEDMAN: No, that's perfectly fine. Can you hear me now?

MS. MURIMI: Yes, we can hear you.

MR. FREEDMAN: Excellent, thank you. So, first I'd like to thank all the panelists for their exciting and informative presentations.

And just to recap, as we observed in these presentations, clean hydrogen by now enters the

mainstream of decarbonization and enjoys to momentum. More than 30 countries developed national hydrogen roadmaps. And in Europe we see that the work is underway in Germany and Denmark, as we saw today, but also in France, Italy, and the Netherlands, and many other countries.

I think another arm of that of course is that the European hydrogen backbone is being developed and the milestone has been reached earlier this year. We observed that in Asia, Japan just took hydrogen to (indiscernible) -- and China defined hydrogen as one of the six industries of the future in their five-year plan. And Australia. So, it truly is a global momentum in hydrogen.

But what I wanted to mention is that many countries on this list are exploring hydrogen opportunities in production, but also transportation, distribution, and storage. And many of them are looking at using existing infrastructure. I think it's been address by Herr Benterbusch, but also from Paul at LADWP, and by Joel from NCPA. It is a really important topic because delivery of hydrogen is every bit as important as production.

We at SoCalGas are actively involved in collaborations globally, working with the companies in

France, in Canada, in Australia and others, as well as being involved in HyDeal collaboration efforts. And we believe that the potential for hydrogen blending and overall use of the gas grid is really also a key priority and we see --

MS. MURIMI: Yuri, apologies, your --

MR. FREEDMAN: -- pilots as critical to accomplishing our standards. Thank you for the opportunity.

MS. MURIMI: Thank you, Yuri.

Wini Chen, and apologies if I've misstated your name. Go ahead and unmute on your end and you can give your comments. That's Wini Chen. We'll come back to you, Wini.

Let's go on to Bruce Webster. That's Bruce Webster. You may give your comment now. Unmute on your end.

MR. WEBSTER: Yes, this is Bruce Webster. I'm with Pac Scientific. We're in Marin County and we have an SBIR with the United States Navy to a couple of hydrogen electrolyzers and use their waste heat. Power thermal distillation instead of the traditional reverse osmosis. This gives a better price point production.

And in a sense we also then become part of the balance of the plant of the electrolyzer. That is we

cool their heat and return also the water to be -- so if I'm saving water, whether it's Bay water, or agricultural water, or sea water we give back the water for the electrolyzer without any pretreatment.

And we would like to mention this that basically when you look at not just energy, but water, especially with the California drought, this is something that we'd be interested in finding partners and collaborate with this community. Thank you.

MS. MIRIMI: Thank you, Bruce.

We'll move on to William Zobel. William Zobel.

MR. ZOBEL: Good afternoon. Can everyone hear me okay?

MS. MIRIMI: Yes, we can hear you. Thank you, William.

MR. ZOBEL: Okay, thank you. I'll be brief. There's an awful lot of cover and I really appreciated listening in this morning to the panel led by Commissioner McAllister. He always does a great job.

I'll be very brief in our remarks today. I represent the California Energy Business Council as their Executive Director. We represent over 120 companies involved in the commercialization of hydrogen and fuel cell technology.

I was very glad to see today that there is some

emphasis on the cross-sectoral benefits of hydrogen. I think that's very important and I'm glad to see that that's part of what's being evaluated here.

Taking that to the next step, integrating hydrogen into the various regulatory programs to achieve the state's goals is going to be important.

The current focus has been on a color wheel, or colors of hydrogen to define where it fits and where it does not. As an organization, we are promoting a carbon intensity standard as opposed to the color wheels to define where hydrogen fits and where it doesn't in various platforms.

Hydrogen can be produced from a variety of different renewable feedstocks and it can be produced in a variety of different ways, many of which don't fit well or expertly within the color wheel and need further definition.

So, we are supporting an objective measure of including hydrogen into regulatory programs that is based on the carbon intensity standard, similar to what's being used by the Air Resources Board today for the Low Carbon Fuel Standard.

So, we'll have more conversations with the Commission, both the Energy Commission and the Public Utilities Commissioner, and the Air Resources Board

about that. We will defer that for another time. And appreciate the opportunity to make those comments here and participating in the remainder of today's workshop. Thank you.

MS. MIRIMI: Thank you, William.

We'll try Wini Chen again. Wini Chen, you can unmute on your end and give your comments.

Hearing nothing, let's move on to David Blekhman. And apologies if I've misstated your name.

Please state your name and give your comments.

MR. BLEKHMAN: Hello, my name is David Blekhman. I'm a faculty at Cal State LA and a Technical Director for the Hydrogen Discharge and Fueling Facility.

I also had an opportunity to work in Sweden and Scandinavia in 2019 and 2020, and actively participate in European or observing European projects that are being developed.

I am really encouraged by the comments Commissioner McAllister made this morning about building economy, hydrogen economy in California. I would like to encourage to continue looking at European examples where hydrogen is integrated from production, delivery, and distribution. Applications of hydrogen include industrial applications, and also mentioned residential applications.

So, if you look at example of Utah to L.A., and burning hydrogen in the turbine can we add to that pipeline transportation applications, fuel and trucks or, you know, providing hydrogen to the communities along that pathway.

So, overall I would like to encourage what we've heard from our German speaker about integrated economy. To create a study and create a plan that's more integrative of all of the technologies that hydrogen can support, and then it will create a lot of opportunities for our economy and workforce development. Thank you.

MS. MIRIMI: Thank you, David.

We'll move on to V John White. V John White, you're line is unmuted. You can give your comment.

MR. WHITE: Thank you. Thank you very much for the opportunity. I appreciate, as always, the thoroughness with which the Commission prepares and -- can you hear me?

MS. MIRIMI: Yes, we can hear you.

MR. WHITE: Okay, sorry. So, thank you for this opportunity. A couple things come to mind. First of all in Southern California, in particular LADWP, I think one idea should be some consideration to producing electrolytic hydrogen for LADWP's power plants, but also making it available to the refineries to displace fossil

hydrogen. It's a very large industrial use of natural gas in Southern California. And so, I think that's an opportunity to green the refineries with green hydrogen.

Second, I think we need to be aware that there are a lot of claims being made about green hydrogen, and particularly about how green the hydrogen is. And we don't have a reporting or a tracking mechanism that I'm aware of, and so claims are simply being made that the hydrogen is green, 100 percent renewables.

And we need to know because there's a lot of difference particularly between steam reformation hydrogen from natural gas versus electrolytic hydrogen from renewable.

So, those are two issues that I think need some consideration as we move forward. And I will have other comments later in the day, but I appreciate this opportunity.

MS. MIRIMI: Thank you, John.

Moving on to David Park. David Park, you may unmute on your end and give your comments.

MR. PARK: Hi. Good afternoon. Thank you for the opportunity. This is David Park with the California Fuel Cell Partnership.

Well, first of all I want to, and we want to commend the CEC Commissioners and staff for undertaking

such a comprehensive overview of emerging hydrogen economy. The California Energy Commission is a founding agency of the California Fuel Cell Partnership, which is a 21-year-old organization.

Given the magnitude of greenhouse reduction goals, we recognize the need to achieve reductions across all available sectors and technologies. And this is the time to accelerate all hydrogen pathways.

Given the head start on the light-duty hydrogen fuel cell vehicle deployment and retail infrastructure, we greatly urge CEC to continue to invest in those markets as an example for the world.

And we also -- furthermore, we suggest that collaboration with USDOE on a gap analysis of the California hydrogen economy, with a focus on the California retail marketplace, which is the first in the world through DOE's Earthshot Initiative, will identify opportunities for future hydrogen investment systemwide, and provide potential to accelerate expansion of the marketplace to the rest of the U.S. and serve as a model for the world. Thank you.

MS. MIRIMI: Thank you, David.

We will try Wini Chen again. But before that, let me reiterate for any individual who is calling in on the phone you can dial *9 to raise your hand. And then,

unmute on your end by pressing *6. And I'll call on the last three digits of your phone number and unmute, so you can give your comments.

So, now we'll try Wini Chen again. Wini Chen, that's W-I-N-I, Chen, C-H-E-N. You may unmute on your end and give your comments.

Seeing no indication of commenting, I will close -- and no other hands, I will close public comment at this time. So, I'll hand the virtual mic back to you, Commissioner McAllister.

MS. RAITT: Commissioner, I think you're muted.

COMMISSIONER MCALLISTER: Sorry, the dreaded double mute.

So, we're over time, so I'll be very brief in closing remarks. I don't think we have, actually, any other Commissioners on. Le-Quyen, did you want to make any closing remarks on Commissioner Gunda's behalf? And perhaps he will be with us this afternoon.

Okay, hearing none. So, we heard a lot today, a lot of stuff and essentially scratched the surface on some really important topics around industry structure and, certainly, the need for investment and targeted investment in this sector. And the importance of not only the supply and the delivery, but really the importance of identifying off-takers, you know, to have

a robust market and having some long-term view of that so that the marketplace can have some confidence that this transition is actually taking place in the hydrogen sector.

And that's really important, I think, to be able to put the numbers to this and incorporate it into the SB 100 scenarios, and really have the various industry sectors shake hands and work together on this to help make it all work.

So, I want to just thank all the speakers from this morning.

There is an opportunity for written comments and I would absolutely encourage everyone who would like to do that, to do that. Just, you know, we can only speak so much in a given amount of time and written comments really do help buffer the record so that we can help incorporate this topic in its full glory into the IEPR document, itself, and then do our planning in our division and our other divisions to really shape this policy area going forward.

So, I think the slide there that Heather's just put up on how you can e-file your comments.

and with that, I will just encourage everyone -- we're going to talk about technologies, current and emerging technologies to enable the expansion of this

sector. We talked a little bit about that in the context of the DWP, and the Lodi projects. But we'll get deeper into that this afternoon. So, encourage everyone to rejoin us at 2:00.

So, with that, I will pass it back to Heather to close us out for the morning.

MS. RAITT: We've covered everything, Commissioner. Thank you. We'll be back at 2:00.

COMMISSIONER MCALLISTER: All right. Lots of practice. Okay thanks a lot everyone, see you at 2:00.

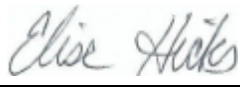
(Thereupon, the Workshop was adjourned at 12:52 a.m.)

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 1st day of October, 2021.



ELISE HICKS, IAPRT
CERT**2176

TRANSCRIBER'S CERTIFICATE

I do hereby certify that the testimony in the foregoing hearing was taken at the time and place therein stated; that the testimony of said witnesses were transcribed by me, a certified transcriber.

And 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 1st day of October, 2021.

Barbara Little
Certified Transcriber
AAERT No. CET**D-520