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STATE OF CALIFORNIA
CALIFORNIA ENERGY COMMISSION

In the matter of,)
)
2022 Integrated Energy Policy) Docket No. 21-IEPR-05
Report Update)
(2022 IEPR Update)) RE: Role of Hydrogen

IEPR COMMISSIONER WORKSHOP ON
ROLE OF HYDROGEN IN CALIFORNIA'S CLEAN ENERGY FUTURE
SESSION 2

IN PERSON AND REMOTE VIA ZOOM VIRTUAL MEETING

Warren-Alquist State Energy Building
Rosenfeld Hearing Room (Hearing Room A)
1516 9th Street,
Sacramento, CA 95814
(Wheelchair Accessible)

TUESDAY, JUNE 21, 2022

1:30 P.M.

Reported By:
Peter Petty

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IEPR Update

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Sara Gersen, Earthjustice

Brenor Brophy, Plug Power

Dave Edwards, Air Liquide

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INDEX

	Page
Welcome Back Heather Raitt, CEC	4
Remarks from the Dais Siva Gunda, Vice Chair and Lead Commissioner for 2022 IEPR Update	5
1. Panel: Current Use of Hydrogen & Near-term Opportunities to Expand Use for MDV/HDV/Off-Road/Marine Applications Moderator: Jane Berner, CEC	6
A. Amgad Elgowainy, Argonne National Laboratory	10
B. Peter Chen, CEC	18
C. PJ Callahan, Center for Transportation and the Environment	28
D. Michael Galvin, Port of Los Angeles	41
Discussion between commissioners and presenters	51
Questions from attendees to panelists Tomas Ortiz to moderate	72
2. Panel: Emerging Projects & Opportunities for Hydrogen in Economy-Wide Decarbonization Moderator: Rizaldo Aldas, CEC	74
A. Sara Gersen, Earthjustice	75
B. Brenor Brophy, Plug Power	80
C. Dave Edwards, Air Liquide	89
D. Robert T. Do, SGH2 Energy	99
E. Nicholas Connell, Green Hydrogen Coalition	110
Discussion between commissioners and presenters	118
Questions from attendees to panelists Peter Chen to moderate	136
Public Comments	141
Closing Remarks and Adjourn	149

P R O C E E D I N G S

1
2 June 21, 2022

1:32 P.M.

3 MS. RAITT: Welcome back to the afternoon part
4 of this 2022 IEPR Update Workshop on the role of
5 hydrogen in California's clean energy future. Again,
6 I'm Heather Raitt, the lead for the IEPR. Just
7 reminder, all of our IEPR workshops are recorded. And
8 so, we will be linking our recording to the CEC's
9 website shortly after the workshop, and we will have a
10 written transcript that will be posted about a month
11 later.

12 If you need or want to find the meeting
13 schedule and the presentations, they're are all online,
14 on the Energy Commission's web page for the IEPR, and,
15 just, we have a few ways for folks to participate today.
16 We'll have some limited time to take questions from
17 attendees using the Q&A feature on Zoom. You can ask
18 questions just hitting that Q&A function. Or if you're
19 in the room, you can write them down and give them to
20 me.

21 And if you'd like to make a comment, you use
22 the raise hand feature, and we'll take comments at the
23 end of the afternoon. But again, the comments are just
24 for making comments. We won't be responding to
25 questions during the public comment period. And if you

1 do have a question, please use the Q&A function.

2 So, with that, I'll just turn it back over to
3 Vice Chair Gunda. Thank you.

4 VICE CHAIR GUNDA: Thank you, Heather for
5 kicking off the afternoon session. I want to just begin
6 by thanking all the panelists in the morning. We had
7 some excellent discussion on, generally, the updates
8 from the state agencies on the different initiatives
9 from CEC, PUC, CARB, as well GO-BIZ, kind of talking
10 about the hydrogen hub and the opportunity there.

11 So, it was a really good discussion. We then
12 discussed about the forecasts of hydrogen opportunities
13 in an economy wide decarbonization. And to Matt Lewis
14 from LADWP and Yuri from SoCalGas, was an excellent
15 conversation. Subsequently, we had some comments, kind
16 of encouraging us to broaden the discussion beyond the
17 electrolytic hydrogen. That — that kind of, that took a
18 lot of discussion today to, you know, also including the
19 biogas side of it and other opportunities. But also
20 really challenging to think about, you know, what are
21 all the opportunities for hydrogen? Which is perfect,
22 because we're going to dig into that this afternoon.
23 Thinking about the near-term opportunities for hydrogen
24 and different applications, including MDHD —

25 (OFF MIC)

1 (Pause)

2 Can you hear me now?

3 So, I was on a roll there. So, I'm not sure I
4 can repeat. So, what I'm gonna say, is thanks to
5 everybody in the morning. And welcome, everybody, for
6 the afternoon. And we're going to look into — jumping
7 into some media topics then I will hand it back for, for
8 jumping.

9 MS. RAITT: Perfect, thank you. So our —
10 we'll move into — our panel is on — so, third panel,
11 first one of the afternoon, on the current use of
12 hydrogen and near-term opportunities to expand the use
13 for medium-duty, heavy-duty, and off-road, as well as
14 marine applications.

15 And so, our moderator, back from this morning,
16 is Jane Berner from the Energy Commission. Thanks, Jane,
17 go ahead.

18 MS. BERNER: Thank you, Heather. Well, you
19 just explained our panel and I'm — the esteemed
20 panelists are listed on this slide here. But, before I
21 get to introducing them and having them do their
22 presentations, I'm going to take just a couple of
23 minutes to go over the current use of hydrogen for
24 light-duty fuel-cell electric vehicles before we get
25 into the, the full panel.

1 So, next slide, please. And actually, you can
2 keep going.

3 I want to recognize the current light-duty
4 fuel cell electric vehicle market, because it is largely
5 where hydrogen is used today in California in the
6 transportation sector. As I mentioned this morning, the
7 Clean Transportation Program funds public hydrogen
8 refueling stations to, to support the deployment of
9 SCEVs.

10 I wanted to take a minute here to show our
11 station maps. The image on the left showing the entire
12 state, and the ones to the right, zooming into the Bay
13 Area and South Coast, where most of our stations are
14 located. The ones shown with green icons are the open
15 stations, and the ones in red are the ones that are
16 planned for which we have locations.

17 So, and, as in all of our programs, we
18 consider how these investments will benefit
19 disadvantaged communities, which is why we've included
20 those in yellow in the zoomed-in map.

21 Next slide please.

22 These stations support the over 12,000 fuel-
23 cell electric vehicles that have been sold or leased in
24 California to date. That includes 826 in quarter one of
25 this year. This slide gives me the opportunity to

1 highlight the Zero-Emission Vehicle and Infrastructure
2 Statistics website that was created by, and is
3 maintained by, our talented friends in the CEC Energy
4 Assessments Division. This website includes several
5 pages, including the ones shown here, on new ZEV sales.
6 And when I made this slide, I hovered over the FCEV
7 cumulative sales, which brought up the line chart
8 showing in the center of the screen there where — how
9 cumulative sales have grown by year. So, this website I
10 just wanted to point out has a lot of different ways to
11 look at data for all ZEV types and, as well as
12 infrastructure.

13 Next slide please.

14 (Pause)

15 And finally, I wanted to mention that there
16 are two annual reports prepared about the deployment of
17 hydrogen refueling stations in California. These
18 reports are required under Assembly Bill 8, and we often
19 refer to them as the AB 8 reports. The one shown on the
20 left is the summer AB 8 annual evaluation that the
21 California Air Resources Board prepares. And the one on
22 the right is the Joint Agency Staff Report that the CEC
23 and CARB prepared together. That's due at the end of
24 each calendar year.

25 Since we do a lot of analysis already related

1 to light duty FCEVs and the stations that support them,
2 we're not really focusing on them in this particular
3 panel. But again, I just wanted to acknowledge what a
4 large part of the current hydrogen transportation market
5 they are in California before we delve into this
6 discussion about additional current and near term uses
7 in the medium-duty, heavy-duty, off-road, and marine
8 spaces.

9 So, now that I've made this short
10 presentation, I'm pleased to be able to introduce and
11 turn the flow — floor over to our esteemed panelists.
12 I'll introduce them one at a time as we go through their
13 presentations. And so, I'm going to start with Dr.
14 Amgad Elgowainy. Dr. Elgowainy is a Senior Scientist
15 and a Group Leader at Argonne National Laboratory, who
16 leads techno-economic and environmental lifecycle
17 analysis of hydrogen fuel-cell vehicles and battery
18 electric vehicles.

19 He has contributed to the development of the
20 environmental lifecycle analysis models that many of you
21 know as GREET. And, he has led the development of a
22 hydrogen infrastructure techno-economics suite of
23 models. Dr. Elgowainy, please come on camera, and, like
24 to welcome you to make your presentation.

25 DR. ELGOWAINY: Thank you Jane, so much. Can

1 you hear me?

2 MS. BERNER: Yes.

3 DR. ELGOWAINY: Okay. Excellent. Thank you.

4 So, thank you for the introduction. Today I will give
5 you a sense of analysis in general about hydrogen
6 infrastructure vehicle applications, where we see the
7 opportunities, where are the key challenges, for the
8 fueling in particular?

9 Next slide, please.

10 So, I want to start with this slide. This
11 slide actually shows, I mean, where are the
12 opportunities for hydrogen vehicles? If you start by
13 looking at the green line, this is really — the vertical
14 axis here is the cost. The horizontal axis is the
15 storage amount for batteries. The slope of that green
16 curve is the battery cost. And it, I mean, it could be
17 any number, right? Today or future there will be some
18 slope. There's \$1 per kilowatt hour of usable battery
19 storage.

20 And then if you look at the very bottom, you
21 will see the dotted line, this is the hydrogen storage.
22 And all other things yield lower than the battery
23 storage. So, the batteries is at 171-50, hydrogen tank
24 is about \$15 to \$17 per kilowatt hour. If I adjust for
25 fuel economy, you know, batteries are more efficient,

1 then I would increase the slope of the hydrogen storage
2 as they adjust to the economy. And then, I lifted that
3 below curve up, because there is, as you see on the far
4 left, there is the fuel cell as an overhead, there is a
5 battery hydrogen powertrains i— are hybrid.

6 So, you'll see over there, there is a
7 crossover point in the middle of the chart. On the
8 right of that crossover point, the hydrogen powertrain
9 is lower cost than the battery powertrain, and on the
10 left of that crossover point, you will see the green
11 line is below the blue line, just means the batteries
12 could be more attractive.

13 So, this kind of chart is a space for
14 powertrains that, whenever they need more storage means
15 higher VMT means higher energy intensity of the
16 powertrain, then hydrogen can be attractive. Of course,
17 I put there in the yellow box is a feeling cost, the
18 charging cost could key factors as well.

19 Next slide please.

20 (Pause)

21 So here, I would like to highlight something
22 related to fuel costs. Fuel costs is related to two
23 things. I mean, one of which, if you look on a per
24 service provided, whether per mile, or per passenger
25 mile, or per ton mile — it relates really to how much

1 energy is consumed to produce a service you want it.
2 And that strongly depends on the powertrain efficiency.
3 Here is show three cars. This is just illustrative. I
4 mean, diesel engines, for example, for the medium/heavy-
5 duty vehicles, become very efficient when the engine is
6 operating near full load.

7 However, hydrogen fuel cells, they will peak
8 near part-load, as you see there, 60-65 percent, about,
9 drop near full load. So, you could see if your duty
10 cycle, and this is very important. If your duty cycle,
11 such as that you are mainly in part-load, the fuel-cell
12 efficiency could be significant compared to the diesel
13 internal combustion engine. And here, I am focusing
14 only on medium/heavy-duty vehicles that are diesel
15 operated. And if you are near full load most of the
16 time, like longer haul trucks, then the efficiency
17 benefit will erode. Why this is important?

18 Next slide please.

19 So here you see two examples. You see the
20 classes, look at the table below there. Classes, like
21 trucks. Diesel is roughly 6 miles per gallon of diesel
22 equivalent. Hydrogen could be 15, 16. So, this is two
23 and a half the fuel economy ratio to diesel. At \$2 a
24 gallon, hydrogen can be five, and competitive. If
25 diesel at \$4 a gallon hydrogen could be 10 and be

1 competitive. Like today, it is \$6, and we could be even
2 \$15 and be competitive.

3 But look on the right, Class 8. Fuel economy
4 ratio is closer to one. This means that if diesel at
5 two, then hydrogen need to be at two. I don't have much
6 room there to be competitive. So that fuel economy
7 ratio that is decided by the duty cycle and the how more
8 efficient or less efficient, will play into
9 competitiveness of hygiene costs and whether you could
10 really sell, sell hygiene at a premium and be
11 competitive or not.

12 Next slide please.

13 (Pause)

14 So here I saw, like, an example of
15 infrastructure. Can we skip next slide please? This is
16 the gaseous delivery pathway. If you look next slide,
17 it will be the liquid delivery pathway. And I want to
18 give another key message there. So, fuel economy ratio
19 duty cycle is important to fuel costs.

20 And, next slide please.

21 (Pause)

22 And then you have the liquid pathway. You
23 liquefy and remove liquid hydrogen. Liquid is more
24 attractive. I will show you why.

25 So, next slide please.

1 (Pause)

2 So, we use, really, our techno-economic models
3 to understand the supply chain. Actually, the resource
4 liquid is also gaseous. What is the impact of onboard
5 storage and things like that on the economics, and also
6 on the carbon intensity? So, we use for that our model,
7 HDSAM, that is also publicly available. And the link is
8 there at the bottom of the screen.

9 Next slide please.

10 So, some outputs of the models, we get really
11 some insights. You know, in California, hydrogen sells
12 at \$15-\$16 a kilogram. I mean, if you look at the first
13 pie chart on the left, you see production is a small
14 portion. Packaging delivery is another big portion and
15 then fueling is even the bigger portion. And you see
16 fueling is mainly compression, storage, pre-cooling
17 refrigeration dispensing. So, it is very capital
18 intensive.

19 One thing I want to point here, this is
20 another key message. That tank reserve, highlighted in
21 yellow, demands a lot. Is very favorable, really, for
22 taking on board energy storage. But it demands a lot on
23 the fueling components, and therefore you see the two or
24 less, maybe \$1 per kilogram production suddenly inflates
25 to 15 or 16. Why? Because that onboard storage has a

1 significant impact. So, whether it at 350-bar or 700-
2 bar. Type three or type four. I mean, even futuristic
3 tanks — all of these could really play a significant
4 role on the cost of hydrogen.

5 Next slide please.

6 So here we show, actually the value of liquid
7 delivery. If you di— deliver liquid, you deliver it
8 cheaper today. And then, you could you— really use the
9 liquid to fill current onboard storage, 350 bar, 700
10 bar. But you could also do futuristic onboard storage
11 like cryo-compressor or low-pressure liquid hydrogen
12 tanks. And these will have significant impact on your
13 fueling costs.

14 Next slide please.

15 So here are I show four groups. The first
16 group there on the left is gaseous supply with different
17 — different fueling grades. This is a 350-bar
18 compressed hydrogen tank. This is only the station
19 contribution. Up to \$5 per kilogram for the past
20 feeling. If you do 700-bar it will be even higher about
21 30, 40% higher.

22 Now, the second group there is the liquid
23 supply. Same thing. Same onboard storage tank. You
24 see, you could cut the fueling contribution by almost
25 half. So, liquid actually. is very attractive. You

1 could get the cost of the molecule lower, you could
2 really design your station at a lower cost. And then on
3 the far right, you see actually even if we avoid all
4 these high-pressure carbon fiber tanks, you go into a
5 cryogenic liquid tank. Your fueling costs could be
6 significantly lower, and it could be effectively less
7 than \$1 per kilogram. This is only contribution of the
8 station.

9 Next slide please.

10 However, delivering liquid is really cheaper.
11 I mean the station costs could be cheaper, but
12 liquefaction really is very energy intensive. State-of-
13 the-art today is ten kilowatt hours per kilogram. It
14 could be up to 12 or 15 kilowatt hours per kilogram
15 depending on electricity. You see two liquefier in
16 California. They're the North Air Product discovered by
17 Linde.

18 This actually would, depending on the
19 electricity carbon intensity, liquefaction could add two
20 or three kilograms of CO2 per kilogram of hydrogen. So
21 yes, it is attractive economically, but we need low
22 carbon, low cost of carbon, low carbon electricity for
23 liquefaction.

24 Next slide please.

25 (Pause)

1 Here, I want to come back to that— you just
2 have to (INDISCERNIBLE) hydrogen fuels (INDISCERNIBLE)
3 details to be more attractive at the near-term. Against
4 the fuel economy this a big deal. This is a big deal
5 for fueling processes that it gives me room to sell
6 hydrogen at premium over diesel. This is attractive
7 from greenhouse gas perspective. You see on the left.
8 Busses, car, trucks, fuel economies near 2.4-2.5, even
9 with, with SMR hydrogen, the blue bar, significant
10 reduction compared to this.

11 Transit buses, you get 40 percent reduction
12 fuel economy wise you need 1.7. Drayage trucks, 1.6.
13 You get 36 percent reduction. With longer haul, you
14 will get marginal reduction with this SMR. And if you
15 do liquid, it could be even worse than diesel. Unless
16 you go all very green, as you see on the far right. And
17 then the yellow bar there is California, like 50/50 or
18 60 percent SMR, 40 percent renewable. You could see,
19 really, what does it mean for the different location.

20 Again, I would like to emphasize the
21 importance of the vocation and the duty cycle on the
22 fuel economy ratio, which will play both in carbon
23 intensity and the competitiveness with respect to costs.

24 Next slide please.

25 And this will be my last slide. That carbon

1 intensity, especially in California, translate into costs
2 depending on the dollar per CO2 avoided, the credit
3 given there. It will translate, really, into economic
4 value. So, liquefaction is not without economic value.
5 It will translate in the California market into some
6 data. So, it is important to get the benefit of liquid,
7 but also to reduce the carbon intensity of liquefaction.

8 Thank you very much.

9 MS. BERNER: Thank you, Amgad. Next up is
10 Peter Chen. Peter Chen is a mechanical engineer with
11 the CEC's Energy Research and Development Division in
12 the Transportation Unit. He manages grant solicitations
13 and a portfolio of projects focused on hydrogen as a
14 pathway for decarbonizing heavy-duty, on-road, and off-
15 road vehicles. And he's just a great co-worker. Peter,
16 I'll turn it over to you.

17 MR. CHEN: Thanks, Jane. Likewise, you're
18 great to work with. So, earlier this morning, my
19 colleague, Rizaldo Aldas, presented a high-level
20 overview of CEC's investments in green hydrogen research
21 and development. I'll be going into a little bit more
22 detail on our portfolio of R&D projects focused on
23 hydrogen for transportation end uses.

24 Next slide please.

25 So, to begin, I would like to give a brief

1 overview of the Gas R&D Program which has funded a lot
2 of our recent hydrogen research work. The program's
3 goal is to find R&D not adequately addressed by
4 competitive or regulated entities, while also supporting
5 key state energy policies including the transition to
6 cleaner energy, greater reliability, lower costs. And
7 increased safety.

8 The program prioritizes benefits towards
9 under-resourced communities as well, including job
10 creation, improved air quality, and economic
11 development. The program has a \$24 million annual
12 budget and it's funded through an investor-owned utility
13 gas consumption surcharge. So, it's very analogous to
14 our much lighter EPIC program, which serves the
15 electricity side.

16 Next slide please.

17 So, the \$24 million budget is allocated
18 towards several research topics, including energy
19 efficiency for buildings and industrial sector,
20 renewables and advanced generation, transmission and
21 distribution, environmental research, and
22 transportation. Since around 2018, and the
23 establishment of our economy wide, decarbonization
24 goals, the program has included more hydrogen-related
25 initiatives, as we see a role for hydrogen as a

1 renewable molecule that can help decarbonize these hard
2 to reach and uses, where electrification can be a lot
3 more challenging.

4 So, for this presentation, I'll be focusing in
5 on our transportation portfolio, again, with the lens of
6 targeting hard to reach end uses and subsectors where we
7 think hydrogen makes sense.

8 Next slide.

9 So, over the past four annual Gas R&D Program
10 budget plans, we've invested a total of \$19.1 million
11 towards hydrogen-related transportation initiatives.
12 Starting with our fiscal year 19/20 budget plan, we
13 targeted hydrogen fuel-cell demonstrations and rail in
14 marine applications at ports through the H2RAM
15 solicitation. H2RAM released summer 2022 as a joint
16 solicitation, combining our gas R&D program funding with
17 the Clean Transportation Program funds.

18 We funded the vehicle design demonstrations
19 and our Clean Transportation Program funded
20 infrastructure. A year later, we released a
21 solicitation targeting hydrogen truck and bus technology
22 integration and demonstration projects, and now we have
23 two active projects kicked off.

24 Looking forward at our most — our two most
25 recent budget plans. We are shifting focus a little bit

1 from vehicle demonstrations to address barriers for
2 refueling larger pieces of on-road and off-road vehicles
3 and equipment. We actually proposed the same initiative
4 in back-to-back years with the goal of developing a
5 single larger solicitation that combines these two years
6 of funding. And with that, we help to attract more
7 applicants, get more ambitious projects, and also be
8 able to target more of these emerging sectors like rail,
9 marine and aviation, that we're hearing a lot of
10 interest about for — for hydrogen. So in the following
11 slides, I'll go into a little bit more detail on each of
12 these initiatives and I'll also highlight some projects
13 we've funded.

14 Next slide.

15 To start off, I like to highlight the HyZET
16 project, or the Hydrogen Zero Emission Tugboat project.
17 It was funded out of the H2RAM solicitation. Just some
18 quick background on — on tugboats, or towing vessels.
19 They are a type of commercial harbor craft that operate
20 around ports, inland waterways, and shipping channels.
21 And, among other tasks, they are used to assist
22 oceangoing vessels, or, like, container ships when
23 they're docking and undocking at a port.

24 There are around 229 tugboats operating in
25 California waters, and they largely rely on a pair of

1 very powerful diesel engines making them very
2 challenging to electrify, and also relatively high
3 emitters. The gas R&D program funded a project to
4 conduct a design and feasibility study of a hydrogen
5 fuel-cell powered harbor tug for future deployment at
6 the Port of Los Angeles.

7 The team con— consists of a consortium of
8 hydrogen and maritime industry experts, as you can see
9 on the slide. And the design will be based on an
10 existing tugboat operated by Crowley at the Port of LA
11 today. The objective is to address key technical and
12 safety challenges and ultimately prepare an actual
13 design that can lead to a future deployment. The
14 project will also evaluate critical questions about how
15 to handle liquid hydrogen fuel systems onboard a marine
16 vessel, and also investigate potential bunkering or
17 refueling solutions at the port.

18 When looking at missions, marine vessels
19 account for some 60 percent of diesel PM and 62 percent
20 of NOx emissions at the Port of LA. So, converting
21 these vessels to zero emission will be, you know,
22 absolutely critical for improving air quality around
23 portside communities, obviously along with the benefit
24 of decarbonization. While most of these emissions are
25 attributed to the larger ocean-going vessels, the

1 project will help establish a design and regulatory
2 pathway for decarbonizing the maritime sector, broadly,
3 with fuel-cells and with liquid hydrogen.

4 In terms of status, the project will complete
5 a majority of its technical tasks this year. And
6 they're looking for follow-on funding to actually build
7 the vessel. They recently completed a preliminary
8 design, as you can see on the slide here. And some of
9 their next steps include doing a — a detailed cost
10 benefit analysis, and also developing the refueling
11 infrastructure plans in partnership with the port.

12 Next slide.

13 So, moving on to the Sierra Northern Hydrogen
14 Locomotive Project, also funded out of H2RAM. Just a
15 quick background on switcher locomotives. Switcher
16 locomotives are older, and usually lower power, freight
17 locomotives that operate in and around ports and rail
18 yards. They assist in putting together trains before
19 those trains ultimately move across the country. Unlike
20 on-road vehicles, many switcher locomotives are still
21 powered by diesel engines with very minimal emissions
22 after-treatment. So, they do have a big air quality
23 impact to the local communities.

24 We have an active project to build and
25 demonstrate a hydrogen fuel-cell switcher locomotive at

1 the port of West Sacramento. Sierra Northern Railway, a
2 Class 3 short line railroad that operates around the
3 port, is retrofitting one of their existing switchers
4 with fuel-cells, compressed hydrogen storage, and
5 batteries.

6 In partnership with the Clean Transportation
7 Program, a sister project was funded to develop a
8 multimodal hydrogen refueling station, which will
9 support both the fuel-cell locomotive and on-road
10 vehicles at the same site. This unique station design
11 will benefit from economies of scale, higher—higher
12 utilization, and also, the surrounding community will
13 hopefully benefit from infrastructure that supports ZEV
14 adoption across these multiple transportation end uses.

15 When looking statewide, locomotives contribute
16 to 12 percent of NOx and 8 percent of PM 2.5 emissions.
17 So, this project helps establish a pathway to address
18 these emissions with hydrogen and the fuel cells. And
19 we — we definitely see, you know, wider adoption,
20 especially beyond switchers and into the line haul
21 freight locomotives as being critical for improving air
22 quality for communities located around rail activity.

23 The project team is currently refining the
24 detailed design of the locomotives and the various
25 modules, and they're preparing for detailed design

1 reviews with the Federal Railroad Administration or FRA.
2 And that'll be critical for ensuring their design meets
3 rail safety standards. And hopefully, we can get the
4 locomotive ready for a demonstration mid next year.

5 Next slide.

6 So, we recently kicked off two projects to
7 demonstrate hydrogen fuel cells for heavy duty trucks,
8 specifically with challenging duty cycles. One of the
9 projects is with Cummins Electrified Power. They'll be
10 devel— demonstrating hydrogen fuel cell trucks for an
11 industrial gas with delivery operation with air
12 products, which involves pulling heavy payloads of
13 cryogenic gases, and also using a power takeoff system
14 to offload the gases for their customers.

15 The other project is with GTI Energy, Symbio,
16 Michelin and Facurecia. That project will involve
17 extended regional haul, or long-haul operations, between
18 the Inland Empire and northern San Joaquin Valley. This
19 type of operation is — is quite challenging due to
20 develo— long routes, and also the limited refilling
21 opportunities.

22 Project objectives include improving fuel cell
23 vehicle efficiency, lowering costs, assessing
24 feasibility of emerging solutions, like liquid hydrogen
25 onboard storage for trucks, which the previous presenter

1 alluded to as a emerging technology. And these
2 objectives will be met through design out to
3 optimizations of the controls, battery storage systems,
4 and also the use of some next-generation fuel cell
5 modules.

6 Both projects are targeting around 500 miles
7 of range for — between refueling as well. And the
8 projects also include workforce development — aspects,
9 where the technology providers plan to engage with local
10 community college students through EV-technician
11 training programs, and also engage with existing service
12 and repair facilities with the hydrogen fuel cell truck
13 technology.

14 Next slide.

15 So, this is my last slide. Our latest
16 transportation initiatives out of the gas R&D program
17 are focusing on more innovative hydrogen refueling
18 solutions to help decarbonize heavy transport, which
19 were defined very broadly at this point, as medium and
20 heavy-duty on-road vehicles, including trucks and buses,
21 mobile off-road equipment such as ag, construction,
22 mining, cargo handling equipment, and this emerging off-
23 road sector, which includes rail, marine and aviation.

24 So, when looking at the hydrogen refueling
25 network today, it's largely designed and dedicated for

1 light-duty vehicles. And, you kind of saw that in
2 Jane's opening remarks. We see that there is a need for
3 further R&D, in terms of standards, equipment, and
4 refuel efforts to enable hydrogen refueling for these
5 larger and more emerging heavy transport applications.

6 Some research targets that we have in mind
7 include enabling higher flow rates, lowering hydrogen
8 delivery and fueling costs, improving reliability, and
9 also redoi— reducing energy losses throughout the
10 conditioning and distribution of hydrogen fuel.

11 This initiative is being developed into future
12 funding opportunity, targeting a release later this
13 year. And, we are actively coordinating with our agency
14 partners including the CEC's own Clean Transportation
15 Program yet again. And also, the California Air
16 Resources Board, you know, with the hope of maximizing
17 the benefits of these funds across multiple programs.

18 And with that, I — I'll conclude my
19 presentation.

20 MS. BERNER: Great, thank you, Peter. Next
21 up, we're gonna switch gears and talk about a different
22 project, the NorCAL Zero project with PJ Callahan. He
23 is a Lead Engineering Associate for the Center for
24 Transportation and the environments, or CTE. PJ leads
25 projects across the industry, including battery electric

1 and fuel cell transit vehicles, Class 8 drayage trucks,
2 and the nation's first full size automated transit bus.
3 He co-authored reports to the California Air Resources
4 Board, and several transit agencies, on fuel cell
5 electric transit bus performance. Take it away, PJ.

6 MR. CALLAHAN: Thanks, James, for the
7 introduction and for having me here today. And thank
8 you to Amgad and Peter for the great presentations that
9 I hope to be able to build on here. As Jane mentioned,
10 I'm here to share with you some highlights of our NorCAL
11 Zero Emission Drayage and Regional Operations with Fuel
12 Cell Electric Trucks, or the NorCAL Zero project, funded
13 primarily through the Clean Transportation Program, the
14 Energy Commission and CARB's Clean Transportation
15 Incentives.

16 Next slide, please.

17 So, CTE, if you haven't heard of us, are a
18 501c3 nonprofit. Our mission is to improve the health
19 of our communities and the planet with the focus on zero
20 emission transportation technologies. You know, just
21 using our skills and engineering and planning, to focus
22 on both battery electric and hydrogen fuel cell electric
23 technologies. Most of our hydrogen work focuses within
24 our prototype development group, and with a strong focus
25 in California where there are dedicated state and local

1 funding programs that we've already covered here today
2 for advancing the hydrogen economy.

3 We have four — four service areas overall.
4 Smart deployments focus on deploying larger amounts, in
5 particular to these transit agencies that have these
6 types of vehicles and technologies and complete the
7 transitions helping agencies look past their initial
8 deployments into the full zero emission transitions, and
9 then some education outreach activities covering all of
10 these.

11 We have a national private presence. We're
12 headquartered in Atlanta, but I'm based out of our
13 Berkeley office, and we have satellite offices in LA and
14 Minneapolis, St. Paul area.

15 Next slide, please.

16 So here are just a few examples of some of the
17 fuel cell electric vehicle projects we've managed over
18 the past several years. The Energy Commission and Air
19 Resources Board have been really critical in funding the
20 development of these vehicles in their associated
21 building infrastructure. We've been working with UPS to
22 build and deploy two different purpose-built vehicles
23 through viability for parcel delivery. One in West
24 Sacramento, the other in Ontario.

25 And one of the most impactful projects we've

1 completed that has really set the stage for medium and
2 heavy-duty hydrogen vehicles, is the fuel cell electric
3 bus commercialization consortium, where we worked with
4 AC Transit and Orange County Transit Authority to deploy
5 20 New Flyer fuel cell electric buses.

6 This project really helped to lay the
7 groundwork for future bus deployments, with
8 commercializing New Flyer's technology at — at scale and
9 around the country, and — and has helped pave the way
10 for our NorCAL Zero project, which will be the largest
11 deployment of its kind in North America when the trucks
12 hit the ground next summer.

13 We're also excited, they recently awarded the
14 V2B Oakland Project, to demonstrate the viability of
15 using these buses as a bus-exportable portable power
16 system in emergency response situations to provide
17 backup power to community facilities.

18 Next slide please.

19 I think we've — we've covered this
20 additionally in some previous presentation, but just to
21 highlight these again, one of the few key advantages to
22 using hydrogen as a transportation fuel that we've
23 demonstrated in several of these projects, is the fast
24 refueling time offered compared to charging an
25 equivalent battery electric vehicle with refueling times

1 more comparable to their conventional diesel
2 equivalents. Hydrogen allows fleet operators to really
3 maintain their current schedules and reduce the amount
4 of changes to their logistics and schedules in their
5 transition to zero emission vehicles.

6 So largely, hydrogens can also reduce the
7 amount of additional electrical infrastructure which is
8 required on site when supplying — with centrally
9 produced and distributed hydrogen, either in gaseous or
10 liquid form. The energy density of hydrogen allows for
11 longer ranges than we see with battery-electric
12 vehicles, affording for wider adoption across a range of
13 duty cycles. And the payload on board is more
14 comparable to what fleet operators are used to carrying
15 with diesel trucks. So again, reducing the amount of
16 changes to their logistics and schedules, and number of
17 vehicles they need to operate to maintain their — their
18 current operations.

19 Next slide please.

20 So, building on these projects that we've
21 managed and the lessons learned in the space, we're
22 working with several industry leaders and funding
23 agencies to deploy 30 Hyundai fuel cell electric trucks
24 operating in and around the Port of Oakland, slated to
25 begin operating in June of 2023. We started the project

1 last year and expect to continue it through the first
2 three years of truck operations, including in the spring
3 of 2025.

4 The project is funded with close to \$53
5 million in total funding with grants from the Energy
6 Commission to the Clean Transportation Program, and the
7 California Air Resources Board with cost share grants
8 provided from the Bay Area Air Quality Management
9 District, and the Alameda County Transportation
10 Commission.

11 The trucks will primarily operate in and
12 around the Port of Oakland, reducing the amount of
13 diesel particulate matter emitted in a community that's
14 historically been really overlooked on issues of air
15 quality, located adjacent to the major transportation
16 corridors that service the area in and out of the Port
17 of Oakland. And lastly, we're building a fueling
18 station at the East Bay Municipal Utilities District
19 facility, right nearby to the port.

20 Next slide please.

21 So, it takes a lot of teamwork and
22 coordination with leaders in the hydrogen industry to
23 execute a project as large and groundbreaking as NorCAL
24 Zero. CTE, we're serving primarily as the grant
25 recipient and project manager with cost share mentioned

1 provided by BAAQMD and ACTC. Macquarie is an
2 international investment firm that's getting involved in
3 zero emission space. They'll purchase and own the
4 trucks from Hyundai and lease them to a leading
5 international logistics provider and Globex America.
6 First Element Fuel has a really established track record
7 of successfully deploying fueling infrastructure through
8 many CEC's programs in California, and they will build
9 and operate the station at East Bay MUD with fuel supply
10 from Air Liquide.

11 And once deployed, the trucks will be serviced
12 at a local service provider in San Leandro, NorCal
13 Kenworth. They'll be providing the maintenance for —
14 for the trucks and will need to conduct facility
15 upgrades to maintain the vehicles safely and — and
16 comply with NFPA codes.

17 Additional project partners include the TSRC
18 at — and UC Berkeley, working with the West Oakland
19 Environmental Indicators Project to collect data for
20 reporting and conducting community engagement activities
21 to gain support in and around the West Oakland
22 Community, and demonstrate the benefits that the project
23 can bring to air quality in the region.

24 Next slide, please.

25 And this is just an overview of the station

1 location at East Bay MUD, located right near their
2 digesters. There will be enough fueling to accommodate
3 up to 60 trucks with extra storage to supply the nearby
4 markets including a light duty retail fueling station
5 onsite.

6 Next slide please.

7 We believe this project is — is really one of
8 our most impactful to date, as I mentioned. Building on
9 the Fuel Cell Bus Consortium and a lot of our other
10 demonstration work that we've done. The NorCAL Zero
11 project will demonstrate commercial viability to fleet
12 operators introducing a new fuel cell truck OEM and
13 Hyundai to the US market, and a new fuel supplier, First
14 Element Fuels, first heavy-duty refueling station to
15 expand the hydrogen refueling network with 10 to 20
16 minute kilo— 60 kilogram fills. Like I mentioned, up to
17 60 trucks with a sort of innovative fueling protocols
18 pushing the industry forward to — to even, to bring the
19 fill time down even further.

20 An additional benefit is to provide local
21 workforce benefits through the NorCal Kenworth facility
22 in San Leandro. Bringing along workforce training
23 aspects to the project as well. And as I mentioned,
24 reducing those harmful emissions in and around the port.
25 The — the fuel supply will be guaranteed 54 percent

1 renewable fuel content supplied through Air Liquide's
2 recent— recently announced and initiated North Las Vegas
3 facility with a zero CI score, for the first three years
4 of the project.

5 And here you see just a brief timeline. We're
6 expecting the trucks to be fully deployed by June of
7 2023, and we will report on their first year of
8 performance evaluation the following year in 2024, and
9 then the trucks will fulfill their six years of service
10 through 2029.

11 Next slide please.

12 And here's just a snapshot of some of the
13 progress that we've made so far, just in the — kind of
14 the first year already of having the project kicked off.
15 So, we've divided the project into several sub-teams
16 focused on the truck build, with Hyundai, the
17 infrastructure build, with First Element Air and Air
18 Liquide and East Bay MUD, and the maintenance facility
19 upgrades, involving NorCal Kenworth and Fiedler Group
20 providing the facilities assessment, and the community
21 outreach strategy sub team.

22 So, just where we're at so far, we have
23 obtained the CARB Executive Order to operate on public
24 roadways in California recently in April. We completed
25 the vehicle production plan, which outlines how the

1 trucks will be built, the timeline for build, and
2 testing, and deployment and shipping to the United
3 States. And we are — Hyundai is currently prote—
4 conducting prototype testing in California, both
5 Northern and Southern California, to inform final
6 specifications for the trucks.

7 First Element Fuel, on the infrastructure
8 side, has completed a preliminary Hydrogen Safety Plan
9 that will be finalized and submitted to the Hydrogen
10 Safety Panel for review. We are working through the
11 demolition of the existing site. I was there just about
12 a month ago and saw the existing building on site
13 already coming down. And so, working through that. And
14 then the station, actual permitting is also active and
15 ongoing for the future build out.

16 And lastly, as I mentioned here, the — the
17 facilities assessment is complete to assess what's
18 necessary at the NorCal Kenworth facility to safely
19 maintain hydrogen vehicles to meet compliance in order
20 to, you know, actively vent hydrogen from the building
21 in the event of — of a hydrogen vent from the vehicles.

22 And we're working through the upgrade
23 permitting currently with — with Fiedler group and the
24 building architects. And we're also drafting the
25 community outreach plan, again with UC Berkeley's TSRC

1 and the West Oakland Environmental Indicators Project.
2 This will include community meetings, outreach to
3 drivers and web materials to educate the community on
4 the project and the benefits that it will bring.

5 Next slide please.

6 So, looking beyond the NorCAL Zero project, we
7 still have a long ways to go to achieve a commercial
8 hydrogen economy at scale. The early-stage development
9 projects that we've been doing are really critical to
10 carving out new technologies and introducing new OEMs
11 into a competitive marketplace to advance
12 commercialization, but there's still a lack of options
13 available. We need to drive investment in trucks and
14 port and off-road vehicle demonstrations, like the ones
15 that Peter was just mentioning, to continue to increase
16 the amount of commercially available options for fleet
17 operators.

18 In tandem, there's a lack of available
19 refueling infrastructure, specifically for individual
20 owner operators who may not have the capital to finance
21 their own stations and rely on publicly available
22 refueling infrastructure. Specifically in the heavy-
23 duty market, there's just a lack of infrastructure to
24 support their deployments currently. So, looking
25 forward to — to driving investment in, in this area as

1 well. Obviously, there's currently a high TCO. We
2 really need to scale the vehicle and fuel production and
3 distribution, which California is really leading the
4 nation on by investing in projects like NorCAL ZERO.

5 And lastly, the technology readiness is still,
6 you know, still has a way to go to progress. Even
7 though we're demonstrating a range here of up to 500
8 miles, there are several duty cycles, not just for
9 short-haul drayage, but long-haul regional trips. And
10 many independent truckers really operate a variety of
11 routes to continue to stay in business, and they really
12 require a one size fits all solution, where they don't
13 have to be assigning vehicles to specific routes and can
14 just kind of dispatch across their different variety—
15 varieties of routes. Additionally, we'd like to see
16 some additional weight reductions on both the vehicle to
17 increase payloads, and achieve total parity with the
18 diesel payloads, for these types of vehicles.

19 Next slide, please.

20 And this was mentioned in an earlier workshop
21 panel, but it's really hard to talk about hydrogen,
22 especially in transportation right now without talking
23 about the Hydrogen Hub Initiative announced by the DOE
24 just recently. So, I think this is covered in an
25 earlier panel, but the DOE just released Notice of

1 Intent to fund four more regional clean hydrogen hubs to
2 incentivize the deployment of renewable hydrogen
3 production and refueling infrastructure, and with some
4 guaranteed offtake. And we — we really see California
5 being able to leverage strength in the transportation
6 end uses and goods movement, specifically it could focus
7 on deploying transit buses, rail coaches, and drayage
8 and regional hub trucks such as this project.

9 We believe California is really best
10 positioned of all of the states or regions in getting
11 this funding, or meeting the economic self-sufficiency
12 in a commercialized hydrogen market with the work that
13 we've already done to date, far beyond any other states.
14 We're — we're very advanced in getting these projects.
15 We have a lot of early document transit agencies, like I
16 mentioned, AC Transit, OCTA in Orange County, and
17 Sunline Transit Agencies, and the list goes on, of all
18 these transit agencies. Meeting the ICT rollout plans
19 and adopting this type of technology and looking to
20 scale projects like NorCAL Zero to achieve a — this
21 self-sustaining, commercialized market, commercialized
22 hydrogen economy.

23 And very importantly, I don't think we've
24 talked about this, without discussing the need to reduce
25 criteria pollutants, specifically from conventional

1 fuels, especially in our disadvantaged communities.
2 Scaling the benefits of the NorCAL Zero project to the
3 entire West Oakland community, and bringing the port
4 zero-emission, and deploying zero-emission technology in
5 our Central Valley and the areas of Southern California
6 located directly adjacent to highways causing high
7 amounts of diesel particulate matter. These areas have
8 historically been — been really underserved and
9 overlooked on the issues of air quality, and we have the
10 chance, specifically here in California with this Hub
11 Initiative, to advance these and really put these
12 communities at the forefront.

13 Lastly, California has a really strong
14 position for applying to this initiative, and we look
15 forward to working with the governor's Go-BIZ office on
16 successful application to the state.

17 And that concludes my remarks. Thank you.

18 MS. BERNER: Great. Thank you, PJ. We have
19 one panelist left, and he's gonna bring us home.
20 Michael Galvin, he is the Director of Waterfront and
21 Commercial Real Estate at the Port of Los Angeles, the
22 nation's leading container port. Michael also oversees
23 the port's energy business and related terminals, which
24 support regional refinery operations, LAX aviation, fuel
25 logistics, the San Pedro Bay Bunker fuel market, and

1 advancement into renewable fuels required to create the
2 zero-emission port of the future. Mike, thank you for
3 joining us.

4 MR. GALVIN: Thank you, Jane. Appreciate the
5 time. So, we can jump into the first slide. So,
6 getting into, you know, the enabling policy that the
7 Port has put forward over the course of the last two
8 decades through our Clean Air Action Plan that is a
9 collaborative effort between the Ports of LA and Long
10 Beach, two biggest ports in the country, local community
11 organizations, environmental justice community, as well
12 as local and statewide agencies, really intended to
13 reduce emissions coming from the port.

14 Over the course of time, as technology
15 advances — and we're rapidly at that last stage now
16 going from as low as we can get, using the diesel power
17 plants that we have, to many of our moving vehicles and
18 moving toward zero emissions. So, the focus in the next
19 12 and a half years is really to get to — all terminal
20 equipment zero emissions by 2030. That's right around
21 the corner, and all on-road trucks to zero emissions by
22 2035, with the overall goal of reducing greenhouse gas
23 emissions to 40 percent and — and 80 percent
24 respectively below 1990 levels by 2030 and 2050. So, we
25 got a big task in front of us and we see hydrogen as a

1 major player in getting us there in some of these hard
2 to electrify areas of equipment and auto and trucks.

3 Next slide.

4 So, we've made a lot of progress that, like I
5 mentioned, we're hitting our goals, the 2023 goals, and
6 DPM, NOx, Sox, greenhouse gases, is this next goal that
7 we're really going after and — and getting to zero
8 emissions will — will help us get there, and hydrogen
9 will play a role there.

10 Next slide.

11 And all of this continues to happen while the
12 work continues to grow our volume, maintains its
13 resiliency, and our ability to move forward in the
14 overall marketplace, and then continue to provide goods
15 — the goods movement services that the nation depends
16 on.

17 These are all areas that require
18 decarbonization over time, but the areas that we're most
19 focused on right now, as I mentioned, are the heavy duty
20 trucks, and the cargo handling equipment. So, we have
21 over 18,000 heavy duty trucks that are registered in the
22 Ports of LA and Long Beach. They're doing work in and
23 out of the port and almost 2,000 pieces of cargo
24 handling equipment. On top of that we have locomotives
25 and harbor craft that also make up some of the

1 opportunities to further reduce our emissions here in
2 the port. But, the real big focus in the next decade is
3 — is those heavy duty trucks and the cargo handling
4 equipment that can build up a large part of the overall
5 hydrogen demand here in Southern California.

6 Next slide.

7 (Pause)

8 So, on the areas that we've been looking at,
9 obviously, on-road trucks are — are a big potential, and
10 really trying to find both on on-road trucks and in the
11 cargo handling equipment, the right transition
12 equivalency there, for the truckers that move goods in
13 and out of the ports every day, and to longshore labor
14 that moves goods around the port, and onto ships, and
15 off onto trucks and trains every day.

16 So, really important that in this transition
17 for us to help — to create a just environment and just
18 economic outcome for our local communities who've been
19 burdened with the goods movement business here. We — we
20 want to make sure that, that we have the ability to
21 transition, to remain resilient in doing that.

22 And to do that, we really need to have
23 equipment that acts the same way the equipment does
24 today that is fueled by diesel. And so, we've seen that

1 hydrogen can — can be that equipment. We're just
2 starting to test it on a — on a much larger scale. But,
3 we're not seeing the same sort of duty cycle and
4 performance issues that we have seen on battery electric
5 in various areas of, of cargo handling equipment.

6 So, we see a huge opportunity there and the
7 ranges of on-road trucks really provide the opportunity
8 to address what PJ mentioned, is that trucking companies
9 don't want to need to be selective in what truck they
10 put into a certain line of business on a — on a specific
11 day. They want trucks to be able to be put into any
12 line of business they need to be, whether that's going
13 20 miles back and forth from the port to a rail yard, or
14 400 miles somewhere outside the state. So that is
15 extremely important in getting fueling infrastructure to
16 allow for those — those trips to happen, are important
17 as well.

18 Next slide.

19 NREL did a study for the port to get to that
20 issue on the on-road trucks, really looking throughout
21 the region and up and down, and outside the state to see
22 what trips the trucks took in various areas, and the
23 thicker the lines mean more trucks were taking those
24 trips. So, you can see in the densified LA County area
25 and the Inland Empire, you have a real densified

1 utilization of trucks but you do have quite a bit of
2 traffic that's going in and outside the area outside the
3 state, you know, going past 200, 300, 400 miles. And
4 so, you need to have a type of duty cycle that's going
5 to allow those kind of trips to happen. And hydrogen
6 provides that — that opportunity without having to be
7 selective on a daily basis.

8 Next slide.

9 So, the port has participated in the ZANZEFF
10 grant. We received about \$41 million in, in grant money
11 with the opportunity to advance both on road trucks and
12 fueling stations to provide for the network that was
13 required to allow these trucks to get tested between
14 here and the Inland Empire.

15 Next slide.

16 So, through that project grant, we have ten
17 hydrogen fuel cell, Class 8 that are operating in and
18 around the region, two heavy duty hydrogen fueling
19 stations, one of which is operational, one of which is
20 very close to being operational, in Wilmington and
21 Ontario, so the two endpoints between here and the
22 Inland Empire. There's also another station being built
23 out on Port of Long Beach property right now.

24 And this is all done with a partnership
25 between Toyota, Shell, Kenworth, UPS, South Coast AQMD,

1 NREL, California Climate Investments, really an
2 intention to bring all the pieces on a small — on a
3 small scale basis together, to allow us to test these
4 trucks on a daily basis and see how they perform and
5 we've had really good results so far.

6 Next slide.

7 This is a picture of the trucks going up Pikes
8 Peak. And so, unlike other types of power plants that
9 we're demonstrating in the zero emissions area, these
10 did not have any issues with altitude change, and were
11 able to perform, go up and down several times without
12 showing any type of performance failure. And so that
13 was really important to show that they could operate in
14 different altitudes.

15 Next slide.

16 So, the locations of the fueling stations,
17 like I said, Wilmington, right next to the port, Long
18 Beach, right next to the port, that's being developed
19 right now, and then Ontario, out in the Inland Empire.

20 Next slide.

21 You can see some pictures of Ontario, there.
22 Up and operational, ready to go. Adding additional
23 tracks there's — there's LNG tracks here. There's also
24 diesel tracks here, and then you have a couple of
25 hydrogen tracks associated with this facility. So,

1 showing how you can either put this into an existing
2 truck stop or — next slide — utilize a stand-alone, as
3 we do in the Wilmington, which has two lanes and the
4 ability to provide the same capacity fueling.

5 Next slide.

6 So, right now where we are with the testing.
7 30,000 miles in service. We're having really good
8 feedback coming back from drivers and operators.
9 Typical issues that you would see in testing any new
10 technology that are able to be resolved on a routine
11 basis without the trucks going down for a prolonged
12 period of time.

13 There's gonna be a test run to Hueneme, back
14 and forth for August. Like I said, Ontario is fully
15 operational at this time. Wilmington will be online
16 this summer. And, we've had reliability issues at — at
17 the stations that are typical for putting up something
18 new, but they're operating at about 50 percent capacity
19 right now.

20 Next slide.

21 Getting out of the cargo handling equipment.
22 These are areas that are really, really difficult to
23 electrify because the type of power consumption that you
24 have in different cargo handling equipment, and really,
25 the cycles. These vehicles run often, you know, 24

1 hours or 20 hours a day, and that— there's limited time
2 for refueling in between shifts. So, you really need to
3 find a technology that is going to allow that to refuel
4 similarly to how diesel does today, and hydrogen gets
5 you pretty close to that. Fueling time is — is maybe
6 double of diesel, so maybe instead of 10 minutes, you're
7 looking at 20 minutes to refuel. But, the ability, the
8 range that it has after that is, is significantly
9 similar to diesel. And so, from an operational
10 perspective, from an ILWU perspective, it works the same
11 way, it'll be easier to transition for this cargo
12 handling equipment.

13 On the yard tractor demonstration, we're doing
14 a — one a— two a tray pack right now. Phoenix Marine
15 has tested some yard tractors and they'll be testing a
16 top handler that the belief is if that top handler works
17 the way they expect it to, that it's pretty much going
18 to be applicable to all other potential cargo handling
19 equipment areas.

20 YTI is also demonstrating a yard tractor and a
21 top handler, and there'll be an RTG development
22 deployment later on this year. And then the HyZET
23 project that was already discussed previously in
24 relationship to tugs and — and getting into the marine
25 side, which obviously the marine side of the business

1 and the marine shipping side of the business is really
2 the largest demand part out there.

3 And we're working very, very closely with our
4 partners in the Port of Shanghai right now to create
5 this green shipping corridor with a zero emissions shift
6 in that quarter by 2030. That'll be the next step after
7 we get the land-based issues addressed.

8 Next slide.

9 (Pause)

10 So, looking forward, it's important to
11 continue these demonstration projects and to continue to
12 work with partners that we have. Toyota has been a
13 really big partner of ours, being able to really advance
14 technology and allow for different types of ideas,
15 retrofit ideas, or retrofit operational equipment that
16 can — that — where people can buy equipment now not
17 worried about that they're going to need to get to zero
18 emissions in 2030, because they'll be able to change at
19 the power plant.

20 So that's really been important, and we'll
21 continue to demonstrate that type of technology in the
22 next year or two. Hopefully as we drill up towards the
23 final application for the Hydrogen Hub that was
24 discussed previously, and we think we can put a — a very
25 good application together, focusing on the ports in

1 Southern California, Northern California, and all the
2 industries around both, to show that there's a
3 significant amount of demand here that can match with
4 supply within the state, or close to the state of
5 California, to provide that long-lasting sustainable
6 hydrogen economy.

7 So, we need to do the overall cost down, that
8 was discussed previously. The hy— H2Hub is extremely —
9 will be truly helpful in pushing this economy in the
10 right direction, and then letting the private sector and
11 other partners take over and — and build it to scale.
12 But, the most important thing is that we create this
13 open ended market that can be built to a significant
14 scale in between 100 thousand and 300 thousand metric
15 tons, you know, in the next 10 to 15 years to really
16 meet the market demand that we have, and the goals that
17 we have to create a zero-emissions port here in Southern
18 California.

19 And, I believe that is last slide. So, thank
20 you very much for allowing us to present today.

21 MS. BERNER: Thank you, Mike. So now, I think
22 we're gonna get into a discussion period. I'm gonna
23 turn it over to Vice Chair Gunda to start us off with
24 questions from the dais, but I also want to invite um,
25 Amgad, PJ, Peter, and Mike to go back on camera so that

1 we're already for taking questions. Thanks.

2 VICE CHAIR GUNDA: Thank you, Jane. That was
3 —that was a wonderful set of presentations, you know, to
4 Amgad, PJ, and Michael, for your respective
5 organizations. Thank you for everything that you're
6 doing in — in advancing the conversation around the fuel
7 cell and hydrogen applications, and in the different
8 MDHD, off-road, and marine applications.

9 So, a couple of questions that I want to start
10 off with. But before that, just, Michael — I did have a
11 chance to ride in one of the Kenworth-Toyota trucks this
12 — two days ago, along with Chair Randolph. Really
13 appreciated the ride. It was very quiet. And, the
14 interesting thing that I learned about it was, it was
15 just too Mirai stacks put together.

16 So, one of the conversations I had was the
17 importance of the technology translation from light-duty
18 vehicles to heavy-duty, versus the other way around, and
19 how important it is to think about all scales at the
20 same time. But, just wanted to call that out. I really
21 appreciated that.

22 So, to all four of you, before I go to the
23 question at the CEC team, congratulations on, on the
24 different projects that were greenlit and the
25 collaboration between the transportation division and

1 the RDD and just creating a slew of both R&D and DND
2 project. So, congratulations on the work. Really
3 thrilled to hear about all that.

4 So, all — all four of you could weigh in on
5 this, just a 30,000 foot level question, you know. You
6 know, looking at the deployment of the technology over
7 the last decade, you know, hydrogen fuel cells. I mean,
8 what are, what are the lessons learned? And now, are
9 you all looking back and saying, you know, we've — we've
10 done as well as we thought we did? We thought we would
11 want to do? You know, what went well? What didn't go
12 well? And any, any learnings as we move forward.

13 (Pause)

14 Maybe I'll put my Michael on, on kind of —

15 MR. GALVIN: Sure. I'll jump in. You know,
16 it's, been relatively new for us to, to get involved in,
17 in the testing of, of the equipment. I think the bigger
18 thing that I've learned from talking about issues with
19 others as we deployed in the passenger vehicle area, was
20 having resiliency in the supply chain of, of equipment
21 that you don't really think about. And so, so that
22 could be dispensing equipment, it could be technological
23 equipment related to the fueling.

24 These are issues that became a big is— became
25 a big concern. All of a sudden when you, you built out

1 stations, and then you found out that all of the
2 dispensing equipment was built by the same manufacturer.
3 And so, when there was a technological problem with one
4 piece, the supply chain stopped at that point and you
5 didn't have resiliency there.

6 And so, I think as much as, you know, I try to
7 simplify it, as much as we can learn from the oil and
8 gas business today, it's taken us a long time — 150
9 years to deploy that business and make it extremely
10 resilient, redundant connective. That's what we have to
11 really strive towards in the hydrogen economy as well.
12 And every single piece of the supply chain, from
13 storage, distribution, into the region to distribution
14 throughout the region, to the dispensing, it has to be
15 redundant.

16 It has to be well connected. You gotta bring
17 as many partners as possible to meet — meet the need,
18 because there's going to be pieces of it that fail.
19 That fail in distribution, that fail in the end user,
20 and you want to be able to make sure that that failure
21 doesn't create a failure for the entire system, but it's
22 just a small failure and you have other pieces built up.
23 So, you have the resiliency and the redundancy to be
24 successful long term. So that's something that I've
25 learned in the last several months as we've been working

1 through, through these issues.

2 (Pause)

3 VICE CHAIR GUNDA: Thank you. Anybody else
4 want to weigh in?

5 MR. CHEN: Yes.

6 VICE CHAIR GUNDA: Great, Peter.

7 MR. CHEN: So, this is — this is Peter. And
8 I, I think there are definitely a lot of lessons
9 learned. You know, from the CEC perspective, we've
10 invested in, in light-duty stations. You know, we're,
11 we're a leader in that, and we have 58 open retail
12 stations. Jane, kind of presented on that earlier.

13 And, and definitely, I think, as we move into
14 more heavy-duty station deployments, we — we have
15 understanding of, you know, what the kind of pain points
16 are with the current light-duty stations. There, there
17 aren't — there have been reliability issues, there's
18 been supply chain issues.

19 So, when we think about scaling up, we
20 definitely need to keep those in mind. And, you know,
21 for one example, interesting lesson learned, I think, is
22 kind the, the transition to more liquid hydrogen
23 delivery pathways for larger capacity light-duty
24 stations. I think that translates directly to how you
25 might want to plan around heavy-duty stations that might

1 need a lot more hydrogen on site than, than a typical
2 likely one. So yeah, definitely I think there's a lot
3 of things we can take from the light-duty station
4 deployments.

5 MR. CALLAHAN: This is PJ with CT. I'd also
6 like to chime in here with a couple additional points.
7 I would definitely second what, what Mike was saying
8 about the resilience in the supply chain. And, just
9 kind of add to the conversation that hydrogen as the
10 potential to be, you know, even more resilient than, you
11 know, typical battery deployments based on the ability
12 to still truck in hydrogen from other, other areas when
13 there is a grid-down scenario. It's much harder to
14 charge a battery electric vehicle when there's no power,
15 but you can still continue to fuel by bringing in
16 hydrogen from other areas. So, still an additional
17 benefit there.

18 Just specific to, to Hyundai, and, and some
19 lessons that we've learned there. You know, they've,
20 they've been operating these vehicles, a very similar
21 vehicle, different — slightly different box-truck
22 configuration, in the Swiss market. And they've
23 obtained over 2.3 million miles with, with hardly any
24 issues and, and really high uptime. So, they're
25 operating very similar to their diesel trucks. And so,

1 we're learning that with, with those deployments and
2 they've got a payload they're able to pull — hoping, you
3 know, to, to basically mimic this deployment and expand
4 on it in the American market.

5 So, these, these trucks really are technology
6 ready. I mentioned technology readiness for the broad
7 commercialization of, of the technology across the
8 sectors, but these trucks themselves are really proving
9 to be really technology ready. And, you know, Hyundai
10 is, is working through being vertically integrated
11 within their, their design. So, that helps to improve
12 the overall design and performance and the benefits in,
13 in terms of being able to modify the vehicles.

14 We really see that, that just one more point —
15 that there's not necessarily a one size fits all
16 solution in a lot of these markets. What works for
17 parcel delivery may or may not work for other, other
18 applications. That's why we built two different types
19 of vehicles with UPS. And so, it's a — it's important
20 to have a lot of communication with the OEMs that are,
21 that are building the vehicles, building these
22 demonstration programs, to really, you know, work
23 through these issues and advance the technology.

24 (Pause)

25 VICE CHAIR GUNDA: Thank you. Amgad, did you

1 want to weigh in?

2 DR. ELGOWAINY: Yeah. From an analysis point
3 of view, we have seen two major things. One is the cost
4 of the station, in the recent solicitation, has been
5 dramatically lower than the previous one. The scale is
6 bigger. So, we know there are big economies of scale.
7 We know costs came down with its rapport or with fueling
8 demand.

9 The other thing is like, I mentioned earlier,
10 the, the liquid supply will be key, or a larger demand,
11 fueling demand a ton a day or bigger. Liquid will play
12 a key role there. And we have seen, like, almost half
13 of the new stations now source liquid compared to a much
14 higher percentage, compared to the previous ones. So,
15 liquid will be key for low fueling costs. Especially
16 with higher fueling daily demands.

17 VICE CHAIR GUNDA: Thank you. I have a couple
18 of more questions, but I want to first go to
19 Commissioner Monahan.

20 COMMISSIONER MONAHAN: Well, I have a really
21 quick, simple question for Amgad, which is — you had
22 said that the liquefaction process is more greenhouse
23 gas intensive. I didn't see on the — on the slide
24 exactly what that translates to. Can you give us some
25 specificity on what that means in terms of greenhouse

1 gas emissions?

2 DR. ELGOWAINY: Yes. Yes, so — so
3 liquefaction today is state of the art. You wouldn't
4 get better today. State of the art is 10-kilowatt hour
5 to liquefy a kilogram of hydrogen. So, we know our
6 kilowatt hour, if you look at the US average grade
7 today, it is about 440 grams per kilowatt hour times
8 ten. This translates into 4.4 kilograms of CO2 per
9 kilogram of hydrogen. If I use just the US average
10 grade.

11 We know California is cleaner. Actually,
12 California grade is less than half of the US carbon
13 intensity so rather than 4.4 kilogram of CO2 penalty for
14 liquefaction, it might be two, closer to two. Of
15 course, this is where the state of the art, like ten-
16 kilowatt hour per kilogram.

17 Some plants will liquefy at a higher, like,
18 energy intensity. Maybe 12, maybe 15 kilowatt hours per
19 kilogram. And then, you will see that energy intensity
20 tie in, tie in the carbon intensity of the grades that
21 really supplies the liquefier will bring, really, the
22 carbon intensity of the liquid, I mean delivery,
23 significantly higher than a gaseous pathway, for
24 example.

25 So. there is some trade off there. This is

1 why I say, you want low-cost electrons, but also you
2 want low carbon electrons because if you increase the
3 carbon intensity just simply by liquefying, it may hurt,
4 really, the GHG credit you may get under the LCFS for
5 example.

6 COMMISSIONER MONAHAN: Right. But over the
7 long run as we decarbonize the grid, that — that will go
8 away or shrink?

9 DR. ELGOWAINY: Exactly.

10 COMMISSIONER MONAHAN: Thank you. And Mike
11 and PJ, it was really great to hear about the projects.
12 Mike, I had a question for you about how long the trucks
13 have been operating — the ten trucks — how long have
14 they been on the road? How long, how long has it been
15 since they've acc— you know, for accumulating the 30,000
16 miles?

17 MR. GALVIN: You know, I believe it's about a
18 year that they've, that they've been out there
19 operating. I think that is about the timeframe.

20 COMMISSIONER MONAHAN: Okay. And are the
21 ZANZEFF and the NorCal projects, are — are you talking
22 to each other? Like, what's the relationship between
23 the two projects?

24 MR. GALVIN: I think there's similar funding
25 that, that was allocated in, in different ways

1 generally. So, our people on the environmental
2 management team here are, are definitely in coordination
3 with others that are doing similar projects around the
4 state. So, I'm, I'm imagining — I'm not directly in
5 contact, but I think that those teams are in contact.

6 COMMISSIONER MONAHAN: And PJ, I know that
7 the, the NorCal trucks are not yet deployed. But,
8 what's your — what is your vision for how they intersect
9 with the ZANZEFF project?

10 MR. CALLAHAN: That's, that's a good question.
11 Like Mike said, I'm not necessarily involved in a lot of
12 communications that go on between, between ourselves and
13 the ports. But you know, I just see the ability — I saw
14 recently the Volvo Lights Project, which you may be
15 familiar with, down in Southern California, came out
16 with a guidebook. And, and lessons learned from their
17 key projects, and taking some of those lessons and
18 applying them to our projects, and communicating and,
19 you know, having these types of workshops where you can
20 hear about their success and, and their challenges that
21 we can then go and apply to our project since we are a
22 little bit, you know, behind. Or are just, you know,
23 our project is just coming on board a little bit later.
24 It's, it's useful to see these other projects, you know,
25 take a little bit of a trailblazing approach and, and we

1 can learn from a lot of those, a lot of those hiccups in
2 their projects.

3 COMMISSIONER MONAHAN: Yeah, I mean, my
4 understanding is that these are the only two major fuel
5 cell Class 8 deployments in, in California. And so,
6 they're, they're really — they really are unique.
7 Everything else has been on the transit bus side, which
8 CTE has been deeply involved in. But this Class 8, big
9 trucks — beyond transit, these are the only two projects
10 I'm aware of. Of the scale.

11 MR. CALLAHAN: Yeah. Yeah, and we do draw a
12 lot on that kind of experience. A lot of the, the
13 lessons learned in that fuel cell bus consortium that
14 we, that we did with AC Transit and OCTA. Just the
15 communication that required with the OEMs. I think it
16 was mentioned earlier, but the gaseous delivery is one
17 thing that we're learning as you look to scale these
18 projects. Pre-cooling at the AC Transit Station was
19 really necessary to achieve the fast fill times, and
20 that was a lesson learned directly in the transit
21 agency, that we're now applying with for some fuel and,
22 and other industries, and as we expand into Class 8.

23 COMMISSIONER MONAHAN: Well, I'm really
24 looking forward to the deployment in NorCal, because I
25 did get to ride in the Hyundai ones here, and I thought

1 they were out, and then I was very disappointed to learn
2 that they were actually just prototypes and they weren't
3 yet on the road. So, looking forward to seeing them.

4 And I'll pass it over. Fritz?

5 (Pause)

6 MR. FOO: Hey everyone, thanks — thanks for
7 the good presentations. Just had one question. Do you
8 offer, especially for those with projects — have
9 renewable hydrogen procurement criteria, or any kind of
10 target, and if so, how do you all account for that? And
11 if you don't, you know, maybe is there any thought as to
12 what that might be?

13 I think I was looking at the slides and I want
14 to say that there was one renewable hydrogen target,
15 maybe around 30, 40 percent. But, I would love any
16 clarification on that?

17 MR. GALVIN: So, I can speak for — in Los
18 Angeles, by direction from our city council, and, and
19 our own policies, that we want to hit a full green
20 hydrogen which based on 100 percent renewables. How we
21 get there as a question, because that's not going to be
22 available at scale in the timeframe that we're going to
23 be starting to deploy the new cargo handling equipment
24 and, and on road trucks.

25 And so, we're going to have to understand the

1 market's going to provide what the market's going to
2 provide in the meantime to allow us to build the demand
3 by deploying these, these vehicles. But the goal is, is
4 in — what we're doing through the Hydrogen Hub
5 application in Southern California, is focused on
6 renewable hydrogen 100 percent. And, and that aligns
7 with what we see our power grid system getting to in Los
8 Angeles by 2035, which is 100 percent renewable by that
9 timeframe.

10 So, so, we're focused on building out a hub
11 that is going to provide the same type of resilient
12 renewables, but through hydrogen in that same zone. And
13 — are there some issues there? And you know, it would
14 be helpful if, if state legislation lined up with that
15 as well, and regulated the hydrogen business and market
16 the same way that the grid is regulated, and then you
17 would have some consistency there to, to drive some of
18 these other issues regarding naysayers that, that talk
19 about — the grid is going to be renewable by this
20 timeframe, hydrogen, we don't know.

21 And so, those are some issues that, that we,
22 we manage on a local level, to try to unders— explain to
23 people what our goals are and what our objectives are,
24 as far as proliferation of the fuel as 100 percent
25 renewable. But there would be some assistance there on

1 the state level if we get to that point. And I'm sure
2 we will, as time goes by, you know, we're at a very
3 nascent state now, but I think we can get there. And
4 then, we'll have two energy systems that, that are
5 basically held up to similar standards.

6 (Pause)

7 VICE CHAIR GUNDA: Great. Just a couple of
8 questions, high level here. So, the first one is, and
9 especially Michael, you had kind of talked about, you
10 know, the, the opportunity for, you know, community
11 benefits in terms of, you know, aid quality and such. I
12 think PJ, you also mentioned. Has there been active
13 engagement with the community in, in kind of, showcasing
14 giving tours, explaining this opportunity? If you can
15 share that, that would be great.

16 MR. GALVIN: It's a step that we're getting
17 ready to, to get into next. So, through our interaction
18 plan, we have quarterly meetings with 200 to 300
19 stakeholders, depending on who participates on a given
20 quarter. And there are community members embedded
21 within that as well. And so, as we're getting our Hub
22 application team together here in Southern California,
23 that is a step that's right in front of us, is to start
24 talking about hydrogen, the huge environmental effects
25 that it's going to have on local communities with the

1 ability to take all the emissions out of the air that
2 currently exist from those land-based operations.

3 And then layer that on with the economic
4 benefits that we want to be able to pump back into these
5 communities. So, we're just going to start that
6 process. A - education on hydrogen and why it's
7 important and why it's going to get us there faster, and
8 in a way that make the ports continue to be resilient
9 as, as they are today. And two, what are the other
10 benefits that are going to come from that? And we
11 really think that that's why it's so important that we,
12 we keep this money as much as possible from the DOE in
13 California to benefit Californians, so that they're the
14 ones that are receiving the benefits, because they're
15 the ones that endured the burden all those — all this
16 time.

17 So, I think that that will be the messaging
18 that we put forward in our application. But getting
19 these groups, it's a conversation that's just starting
20 to happen in regard to how we're going to do that. But
21 that's going to happen the next 30 days for sure in
22 regard to the Hub application.

23 MR. CALLAHAN: Thanks, tanks for that, Mike.
24 It's definitely something that's on our radar, and I'm
25 really glad you asked the question. Just last week we

1 hosted — we were participants in an event at the East
2 Bay Bridge yard underneath port in the East Bay Develop—
3 Economic Development Association. A block party event
4 bringing together members all over the community in
5 different, different, working through different
6 nonprofits and air quality issues, and showcase the
7 trucks. And there was a lot of interest generated from
8 a lot of different community members, just kind of
9 demonstrating how important this technology is going to
10 be for these, these community members.

11 We also hosted, just today, down at the
12 maintenance facility, in San Leandro, a sort of show
13 event with the, the service provider NorCal KW, to
14 further engagement on the servicing side. And we're
15 working with West Oakland Environmental Indicators
16 Project, as I mentioned, to start drafting the community
17 outreach plan to see what exactly this is going to look
18 like.

19 So, I think this is another opportunity for us
20 to, kind of, take some lessons learned from the ZANZEFF
21 projects in terms of how they approached community
22 outreach as we look to develop our own plans. But it's
23 certainly a really important issue, and I don't think
24 one that can be talked about enough when we're talking
25 about a zero emission technology and, and reducing the,

1 the diesel particulate in these communities located next
2 to highways that have just been historically so
3 overlooked.

4 VICE CHAIR GUNDA: Thank you. Just a, you
5 know, one last thought and I will pass it back to
6 Heather for the next section here. So first of all, and
7 again, congratulations to each one of you and, you know,
8 thanks for all the great work that you're all doing in,
9 in advancing the clean future for California.

10 So, one of the things I mentioned, you know,
11 in my opening, kind of, comments was — one of the hopes
12 we have for this workshop is to have some tangible
13 recommendations on how we continue to advance the
14 hydrogen conversation. So, I don't know how prepared
15 each one of you are to, to speak to that but, you know,
16 if there is one or, you know, maybe two things that we
17 could solve and what would your recommendations be?

18 (Pause)

19 MR. GALVIN: My, my main one is what I
20 mentioned already, and aligning regulation of the
21 hydrogen markets and electric grid, I think would help
22 to clarify a lot, a lot of the issues related to concern
23 from, from different organizations about the
24 proliferation of hydrogen. So that there has been a
25 debate going back and forth that, well, we know when the

1 grid is going to be green. We don't know when the
2 hydrogen is going to be green. And so, we can make that
3 our policy, we can make that our plan here. But if it's
4 not backed by the state and rules, then we're not as —
5 on as solid ground as we can be. And so, I think that
6 is very critical in, in moving forward in the next
7 couple of years.

8 (Pause)

9 VICE CHAIR GUNDA: PJ, do you have anything to
10 add?

11 MR. CALLAHAN: Yeah, definitely. Our, our key
12 takeaway would just be that we really need to continue
13 to ramp up and scale our deployments like I mentioned.
14 This is one project, you know, it will be the largest to
15 date of 30 trucks. But that's, that's really not going
16 to do it. We need to continue to advance and, and
17 really deploy at, at large scale, and that's why this H@
18 Hub program is — the timing is, is perfectly aligning
19 with projects like this. And, it's really going to help
20 be, be — it's going to be critical to proving the
21 technology and, and driving down the cost of deploying
22 not just 30 trucks at the Port of Oakland, but 100,
23 1,000 trucks at the Port of Oakland, ports of LA, Long
24 Beach, 1,000 buses all across the state. And, and
25 reaching that scale on, on the vehicle and off-take side

1 which will drive the production and, and the business
2 case for that as well.

3 MR. GALVIN: And, if I can just add to that,
4 more grant money is always helpful, because that can
5 continue to allow us to drive the marketplace that PJ
6 was talking about. The faster we can get the equipment
7 and the trucks deployed, and into commercial
8 availability, and get the cost down, the better we'll be
9 all around. Right now, the Delta is, is very large, and
10 so taking a lot of potential money, when you look at the
11 Delta between diesel and hydrogen, then you— the Delta
12 between electric and — battery electric and hydrogen.
13 So, more money will allow for us to deploy more, test
14 more, and get a— adapted to the marketplace quicker, and
15 to commercial reliab— availability as soon as possible.

16 VICE CHAIR GUNDA: Wonderful. Amgad, did you
17 want to add anything, or?

18 DR. ELGOWAINY: Yeah. If I may add, so back
19 to to my presentation. I think you want to focus on the
20 vocations or classes where you get the best bang for the
21 buck, your environmental benefits. And these are where
22 your duty cycle will allow you a higher efficiency
23 compared to the diesel incumbent.

24 This will help you economically it will help
25 you with carbon reduction. And the why it is that way

1 is because most of these, like, locations where you're
2 high — you have high fuel economy ratio, are mostly
3 urban. It will help also with the air pollution issue,
4 and the impact on communities.

5 The second thing is also, plan to think about
6 how to expand the liquid hydrogen supply network. And
7 this will be also key to enabling a low-cost hydrogen
8 fueling.

9 VICE CHAIR GUNDA: Wonderful, Peter, do you
10 want to close this off?

11 MR. CHEN: Yeah. A little — I'm preaching to
12 a choir here. But yeah, I definitely see a role of, you
13 know, continuing doing this government supported pre-
14 competitive R&D and demonstration projects. I think
15 we've, we've heard it here already. But, it can be
16 really important to de-risk issues and kind of the
17 mysteries of using hydrogen as a transportation fuel,
18 you know, before letting private industry take over and
19 really develop a self-sustaining market.

20 You know, we have existing programs in place.
21 You know, we have EPIC, Gas R&D, Clean Transportation
22 Program, and a lot of mechanisms to, you know, support
23 both established companies and also startups,
24 entrepreneurs, with innovative ideas on how to how, how
25 to use hydrogen efficiently as we, you know, look to

1 decarbonize the police, very challenging end uses.

2 You know, I think another key thing to think,
3 that I'm always thinking about is, how do we refuel, you
4 know, larg— larger pieces of equipment. You know, we're
5 talking about a lot of land uses now. You know, heavy
6 duty trucks, cargo handling equipment, et cetera. They
7 store an order of magnitude more hydrogen onboard than,
8 than a light duty car. And if our, you know,
9 infrastructure — our — I think our infrastructure needs
10 to be developed with that scale in mind. And there,
11 there's definitely room for more research into that
12 space, as we scale up.

13 (Pause)

14 VICE CHAIR GUNDA: Thank you. Thank you all
15 so much for taking those questions. I said to Heather,
16 do you want to

17 MS. RAITT: Sure, thank you. So, yeah, and I
18 checked with Jane, I think we're ready to move on to —
19 we got a couple of questions from attendees and Tomas
20 Ortiz is here to moderate those. So go ahead, Tomas.

21 (Pause)

22 MR. ORTIZ: Thanks, everyone. So, we have,
23 currently we have two questions. So, I'll start with
24 the first one. The first one is from Robert Perry, of
25 Synergistic Solutions.

1 (Pause)

2 One second, sorry.

3 (Pause)

4 So, the first question is: "Are there
5 currently plans to co-locate large MDHP — HD EV charging
6 and refueling stations with utility scale generation
7 storage and electrolysis capacity along major transit
8 corridors, such as I-5, 101 and 99. It would seem that
9 productive planning in this area would incentivize
10 private investment in long-haul, MDHD FCEVs. These
11 facilities don't have to start large, but should be
12 designed with enough room to expand according to need."

13 MS. BERNER: And this is Jane. I was actually
14 thinking this is probably a question, I'll say, for the
15 CEC in terms of plans for funding. And, I just was
16 gonna add that we did recently have a workshop related
17 to several concepts. Both EV charging, and hydrogen
18 refueling stations for MDHD uses, including some for
19 long-haul trucks. I'll — if — I'll try to find that
20 link and put it in the chat to that workshop. That
21 might be of interest to you. And thanks for the idea of
22 also including utility scale generation storage and
23 electrolysis. I think the, you know, where the hydrogen
24 supply, and if there can be grid benefits is something
25 that, yeah, we will be looking at more closely when we

1 develop these solicitations. So, thank you

2 MR. ORTIZ: Okay, and then thank you for that.

3 We have one more. This one is John Banner. Question
4 for Peter Chan: "We're developing a greenfield MDHD
5 green H2 refueling/fast recharging truck stop on I-10 in
6 in Riverside County. Our R&D funds available through
7 your advanced H2, H2 refueling infrastructure solutions
8 for heavy transport, develop and demonstrate innovative
9 H2 refueling solic— solutions, funding lane to assist
10 with preliminary design, F-E-E-D, et cetera?

11 MR. CHAN: Thanks for that question, John. So
12 unfortunately, I can't speak to the details on, you
13 know, what's eligible for the solicitation since it's
14 still being developed and we haven't released it yet.
15 But you know, I, I think generally speaking, you know,
16 this type of projects, building out, you know, a green
17 hydrogen shared refueling, recharging truck stop, I
18 think that's a really important type of project. And
19 definitely, I think the workshop that Jane highlighted,
20 or mentioned, I think it does include a concept that,
21 that's similar to, to what you're talking about here.
22 And Jane, maybe you can add more details or correct me
23 if I'm wrong.

24 (Pause)

25 MS. BERNER: I was just — I'll think Esther

1 for adding in the link to the workshop where the
2 information is. I was just supposed to do it and to
3 beat me to it. And so, Esther is one of our staff that
4 did a lot of work on that workshoo—workshop.

5 (Pause)

6 MS. RAITT: Alright, so I think that's all the
7 questions. So, thank you so much Tomas and to Jane for
8 moderating, and to the panelists, Amgad, and Peter and
9 PJ and Michael, greatly appreciate your time and
10 expertise.

11 So, we will move on to the next panel on
12 emerging projects and opportunities for hydrogen in
13 economy-wide decarbonization. And, we're joined again
14 by Rizaldo Aldas from the Energy Commission.

15 MR. ALDAS: Thank you, Heather, and good
16 afternoon, everyone. We are in panel four, welcome.
17 This is the last but certainly not the least panel of
18 the day. We have five panelists or speakers to discuss
19 emerging projects and opportunities for hydrogen in
20 economy-wide decarbonization. Our panelists will talk
21 about different projects, perspectives and of course on
22 renewable hydrogen, particularly hydrogen production.

23 And we have to get insights from them on what
24 worked, what didn't work. What else are needed? Is
25 regulatory, policy, incentives, technology, is all of

1 the above? Increased renewable hydrogen production and
2 the contribution towards a decarbonized economy. And
3 then, of course, this morning, we heard about concepts
4 of green hydrogen. So, that's a question related to the
5 economy. And that — the question for me there would be
6 what — which could or would help us to get a carbon
7 neutral? Is it the color scheme? Focus on the process?
8 Or carbon intensity? And so, I think we will also hear
9 some insights or feedback on those kinds of questions.

10 And without further ado, I will ask Sara
11 Gersen, Senior Attorney with Earthjustice to kick us off
12 in the presentation and discussion.

13 MS. GERSEN: Well, thanks so much, and good
14 afternoon. My remarks today address why it is essential
15 for California policymakers to focus on promoting zero
16 emission technologies for producing hydrogen. But for a
17 much broader look at hydrogen policy questions, you can
18 download the report I co-authored with Sasan Saadat,
19 it's available at the website at the bottom of the
20 slide. It's called "Reclaiming Hydrogen for a Renewable
21 Future: Distinguishing Oil and Gas Industry Spin From
22 Zero Emission Solutions.

23 Next slide.

24 Now, to understand why a transition to zero
25 emission hydrogen matters, it helps to understand how

1 hydrogen is produced today. Each year, globally,
2 industry produces many millions of megatons of hydrogen
3 from fossil fuels through processes that are so
4 building, that hydrogen production alone contributes
5 more climate pollution than the entire nation of
6 Germany.

7 Here in California, the predominant method of
8 producing hydrogen is to crack it off of fossil gas
9 through a process called steam methane reformation.
10 Steam methane reformation doesn't just emit climate
11 pollution, but also significant amounts of coal forming
12 pollution, like NOx, particulate matter and carbon
13 monoxide. And, because California's hydrogen production
14 facilities primarily they exist to supply oil refineries
15 with the hydrogen that they use. The hydrogen
16 production facilities are polluting the same fence line
17 communities that bear the brunt of refinery pollution.

18 Next slide.

19 Fortunately, there is a zero emission,
20 hydrogen production techn— technology that is well
21 understood and ready to scale. That is renewable
22 electrolytic hydrogen, also known as green hydrogen,
23 which is produced using 100 percent renewable
24 electricity to split hydrogen from water molecules.
25 Exclusively relying on renewable electrolytic hydrogen

1 would both protect public health and avoid the
2 gamesmanship and inaccurate carbon accounting that can
3 plague productive pathways that rely on biofuels.

4 If go to the next slide I have an example to
5 illustrate this.

6 So, this slide summarizes key data from two
7 actual hydrogen production pathways that CARB has
8 certified to produce LCFS products. On the left, you
9 have a real production pathway that uses steam methane
10 reformation of fossil gas at a facility in Wilmington
11 California, which is a disadvantaged community
12 overburdened with refinery pollution.

13 The producer pairs the fossil gas in takes
14 from the gas pipeline with the environmental attributes
15 of cattle manure gas in Indiana, and CARB certified this
16 pathway to claim that is hydrogen as a carbon intensity
17 of negative 287 grams of carbon dioxide equivalent per
18 megajoule. Now, compare that the production pathway on
19 the right, which uses zero emission electrolysis powered
20 by solar resources. CARB certified this pathway to
21 claim that this pathway a carbon intensity of zero
22 carbon — zero grams of carbon dioxide equivalent per
23 megajoule.

24 This comparison is very troubling, because the
25 pathway on the left, which relies on a polluting

1 technology that is already standard and lowest cost,
2 represents a far more lucrative LCFS credit generation
3 opportunity than the zero-emission technology that's
4 still nascent in the market.

5 You may have the rare entity that chooses the
6 zero-emission technology because it has a public
7 interest mission. Here, the example on the right is a
8 production pathway that was submitted by Alameda County
9 Transit. But any profit maximizing company will have a
10 strong incentive to maximize LCFS revenue by simply
11 following business as usual, producing hydrogen from
12 fossil fuels, and relying on a crediting scheme to claim
13 that their hydrogen is carbon negative. And this does
14 nothing to catalyze the market for zero-emission
15 hydrogen.

16 Next slide.

17 So here, this slide presents a few ideas for
18 catalyzing the market for zero-emission or green
19 hydrogen. The first priority should be displacing the
20 hydrogen that's already in use to supply chemical
21 feedstocks to businesses like refineries, with the zero-
22 emission hydrogen. And addressing that public health
23 and carbon pollution imperative that I discussed earlier
24 in my talk. I understand that mandating this transition
25 maybe outside of the CEC's jurisdiction. But, you can

1 certainly note in the IEPR report, that it will be much
2 easier for new applications that run on hydrogen to
3 access zero emission of hydrogen if facilities like
4 refineries stimulate demand.

5 Second, whatever the CEC and other public
6 entities are using taxpayer funds to support the
7 hydrogen project, they should never spend those scarce
8 taxpayer resources on polluting hydrogen production
9 processes. And finally, CARB should implement SB 1505.
10 Back in 2006, the legislature order CARB to conduct a
11 rulemaking to require a third of the hydrogen dispensed
12 from publicly funded fueling stations to be produced
13 from renewable electric resources.

14 It's been more than 15 years and CARB has
15 failed to implement this mandate. But, to fill this
16 gap, and CEC can and should include grant conditions
17 whenever it funds fueling stations and other projects,
18 that require the grant recipient to dispense or use
19 renewable electrolytic hydrogen.

20 Next slide.

21 In closing, I want to urge all of you to never
22 let questions about scaling up as to zero-emission
23 hydrogen overshadow the real questions that should be
24 driving policy debates. Which are first, how do we
25 confront California's air pollution crisis? And second,

1 how we decarbonize the economy?

2 Because hydrogen is not going to be the best
3 tool for most sectors, and California needs to focus
4 relentlessly on deploying the zero-emission solutions
5 that are ready to scale today, without waiting for the
6 market for zero-emission type project to mature.

7 Thank you.

8 MR. ALDAS: Thank you Sara, appreciate your —
9 sharing your ideas for catalyzing markets transitioning
10 to zero-emission hydrogen, and, uh, different other
11 ideas. With that, we'll call on Brenor Brophy, he is
12 Vice President of Project Development of Plug Power, to
13 invite his presentation. Thank you.

14 MR. BROPHY: Thanks very much. And thank you
15 to the Energy Commission for inviting us to present
16 today. We appreciate the opportunity to tell you about
17 our California Green Hydrogen Project.

18 Next slide please.

19 So, plug power has been in the hydrogen
20 business for more than 25 years. We pioneered the first
21 viable economic market for fuel cells in the logistics
22 sector powering forklift trucks, and that's enabled us
23 to sell more fuel cells to sell — to accumulate more
24 operation hours than literally anybody else in the
25 world.

1 We purchase more merchant liquid hydrogen and
2 deliver more hydrogen than any other single entity in
3 the world, over about 40 tons today, and we operate well
4 in excess of 165 refueling stations behind the fence
5 across the entire United States. Plug Power has the
6 entire supply chain for hydrogen. We make the fuel
7 cells for the applications, everything from forklift
8 trucks to Class 8 trucks, we make electrolyzers to
9 produce hydrogen. My responsibility is building
10 hydrogen production plants. We make the equipment for
11 the liquefaction of hydrogen and use that equipment in
12 our own plants. We make the transportation and storage
13 for liquid hydrogen, and we operate a logistics network
14 across the entire country delivering liquid hydrogen to
15 our customers.

16 Next slide please. So, Plug's footprint is
17 pretty large. This is a — it's even an outdated map at
18 this point. But we have customer locations across the
19 entire United States. Our, you know, top tier customers
20 or our folks like Amazon, Walmart, Home Depot, Lowe's,
21 GM, Kroger. We, we estimated during the pandemic about
22 30 percent of all groceries consumed in the US were
23 transported on a Plug forklift at some point during
24 their transport to market. So, Plug is deeply embedded
25 in material handling logistics space, and deeply

1 embedded in the supply of hydrogen.

2 Next page.

3 So about two years ago, we decided that we
4 could make our own green hydrogen far cheaper than we
5 could buy gray hydrogen, which is what we're forced to
6 buy today. When anyone says green hydrogen costs \$2 a
7 kilo, you cannot go buy gray hydrogen for that. It
8 costs a lot more than that, and believe me, it's
9 considerably cheaper for us to make our own green
10 hydrogen than it is to buy from the industrial gas
11 companies.

12 So, we announced a network of 500 tons per day
13 of liquid green hydrogen production by 2025. We have
14 announced plants in New York, Georgia, in Texas and of
15 course California. I'm happy to say we have already got
16 an operating plant in Charleston, Tennessee, 10 tons per
17 day. And Plug is the only company, other than one of
18 the industrial gas companies, to build and operate and
19 own their own hydrogen liquefaction facility.

20 The New York and Georgia facilities are under
21 construction as we speak. The first production in
22 Georgia is expected to start within the next four weeks.
23 That's a two ton per day facility, just a small
24 facility. But Georgia New York will be online by this
25 time next year. New York is 45 tons per day and Georgia

1 is initially 15 tons per day, and those plants will go
2 to 75 and 45 tons per day respectively in a phase two.
3 The Texas plant and plant in Louisiana, we will break
4 ground on this year and start construction. And our
5 California project, I'm going to get to — it holds a
6 couple of slides of its own. So, I'll, I'll hold for
7 that.

8 The idea here is a national high resilience
9 network of liquid hydrogen supply. We know better than
10 anyone how the existing supply chain for hydrogen looks.
11 We deal with it every single day and we understand that
12 high resiliency in the supply is, is critical. The
13 other important point here is 500 tons per day is two
14 and a half times the current size of the liquid hydrogen
15 — the entire liquid hydrogen market in North America
16 today.

17 We're obviously building ahead of demand, but
18 we're doing that to plant a really large flag on the top
19 of a really big mountain to indicate to first adopters
20 that you can go with hydrogen for your transit buses,
21 for your truck fleet, and the fuel supply will be there
22 and that's absolutely intentional. Give a clear signal
23 that you don't need to worry about the supply of
24 hydrogen going forward.

25 Next slide please.

1 So, just really briefly, what is green
2 hydrogen? Why do we call a hydrogen farm? Our
3 California project is sunshine and recycled water. So,
4 we're just taking water and sunshine like any farmer,
5 we're processing it, we're getting — we're liquefying
6 it, and then it's going towards the logistics space,
7 which is our core market, and the heavy-duty freight
8 space. So, it is sunshine, water, for clean fuel.

9 Next slide please.

10 This is the location of our project in
11 California. So, it is in West Fresno County. It's just
12 eight miles south of the city of Mendota, the cantaloupe
13 capital of the world. This part of the Central Valley
14 is one of the most economically disadvantaged areas in
15 our state. It is one of the areas that is mo—
16 disproportionately affected by diesel pollution.

17 It's — gets none of the economic benefits of
18 that pollution, it just gets to sit next to Interstate
19 five and, and Highway 99 and enjoy the pollution without
20 any of the jobs that come with that. So, I think it is
21 particularly apt that it's this community that's going
22 to participate in the economic advantages of starting to
23 produce a replacement fuel for, for diesel. The
24 facility itself is over 2,000 acres, and — of, of a
25 solar farm, new-build solar. And, the hydrogen facility

1 is just a small, a small postage stamp within that
2 larger solar farm.

3 Next slide please.

4 So, the rendering there is actually of our
5 Georgia plant. I don't have a nice rendering of the
6 California plant yet. But, clearly wouldn't have green
7 grass and trees like that. The plant we're building is
8 30,000 kilograms, or 30 metric tons of liquid hydrogen.
9 That's 120 megawatts of PEM electrolyzers. That puts it
10 in the top tier of electrolyzer — PEM electrolysis
11 plants in the, in the world. That's the same size as
12 our phase one in New York.

13 And I'm delighted to say this will be
14 California's first new build hydrogen liquefaction plant
15 in 36 years. I had to go back in history, and I think
16 Air Product's plant in Sacramento came on board in 1986.
17 So this is finally another new liquefaction plant. And
18 that'll take California's liquefaction capacity from
19 about 40 tons a day to over 70 tons a day. So, we're
20 delighted. We are strong believers to, to — in liquid
21 hydrogen as, as an excellent method of storage and
22 delivery of, of hydrogen.

23 This is 2,000 acres of what's called priority
24 least conflict, excuse the typo, least conflict plan.
25 So, this is land that is withdrawn from irrigated

1 agriculture. It was in fact, damaged by over irrigation
2 over the previous decades, and its land that was studied
3 for all conflicting uses and prioritized for renewable
4 energy development. So, it is one of the best places
5 within the state where we can build on extremely
6 degraded land and put it to a use that will generate
7 jobs, and economic development, and clean fuel for the
8 state.

9 It is a 300-megawatt AC solar farm that is a
10 new build solar farm as part of the project. The
11 hydrogen production plant itself is about 30 acres in
12 one corner of that. It will have storage for half a
13 million gallons of liquid hydrogen, that's about 134
14 metric tons, or, you know, call that four, or five days
15 of production. And that goes to the high resiliency
16 aspect. All of our plants have significant on-site
17 storage of fuel, so if a plant goes down, it can cover
18 its customers in the short term, and then neighboring
19 plants can cover it in a longer-term shutdown scenario.

20 This plant is 100 percent green. So, on an
21 annualized energy basis. So, that means every megawatt
22 hour that we use for synthesizing the hydrogen, for
23 liquefying the hydrogen, and we talked about that
24 earlier — liquefaction takes about 10 kilowatt hours per
25 kilogram, and also transport, because we will deliver

1 this hydrogen on fuel cell Class 8 trucks to, to — that
2 we can't think of something dumber than a replacement
3 for diesel being hauled by a diesel truck. So, we won't
4 do that. We'll be an early and enthusiastic adopter of
5 fuel cell trucks.

6 So, all of the energy that we need for, to all
7 the way to, to delivery will be solar energy, solar
8 based. We're currently in the environmental impact
9 review, California CEQA process. That is anticipated to
10 complete in August of 2023. After that, we've got
11 construction permits, and we would hope to start
12 construction in late '23 with a, a opening in early '24.
13 So, a little over a year of construction. So, we are
14 far advanced in, in this process. Apparently, also
15 involved with the large load studies and electrical
16 interconnect studies with PG&E.

17 Water is always a concern in the West. We say
18 whiskey's for drinking, water's for fighting over. So,
19 a good rule of thumb is for US gallons of water per
20 kilogram of hydrogen. And I would just like to
21 reiterate what several other speakers have said, that
22 existing fuels — diesel, gasoline, and even natural gas,
23 use between four and seven or eight gallons of water for
24 the equivalent energy content that hydrogen produces.

25 So, at four gallons a kilogram, we're actually

1 at least no worse and probably better than the
2 equivalent fossil fuel that we replace. Water is still
3 a concern though, and this project is funding a new 1.2
4 million gallons per day, so about ten times what we
5 need, tertiary water treatment plan for the city of
6 Mendota. So, the city does not have a recycled water
7 plant currently. In fact, it has a significant issue
8 with disposing of its waste effluent. So, this solves
9 the problem for the city.

10 We will build it for the city, pay for it, and
11 then we will deed it to the city, so the city owns the
12 plant. The project pays full commercial rates for the
13 water, because we want to make sure the city has an
14 income stream to enable them to operate and maintain the
15 plant, and then whatever they want to do with the other
16 90 percent of the water, be it irrigating their school
17 playing grounds, street trees parkland, they have that
18 water to do as they wish.

19 We do not use water for cooling. It's dry
20 cooling only, which is a significant savings on water,
21 and there's zero offsite waste discharge. So, we have
22 thought, not just about how do we make really clean fuel
23 with 100 percent clean energy, but how do we absolutely
24 minimize our environmental footprint of the plant. And
25 we think that this is a model for the energy transition,

1 right? This is, this is the oil field of the 21st
2 century. It emits no pollutants, and it only uses green
3 energy, it runs on sunshine. With that I'll conclude my
4 presentation.

5 Thank you.

6 MR. ALDAS: Thank you, Bill, and thank you for
7 sharing the extent of Plug Power's activities
8 nationwide. The network of 500 tons per day of liquid
9 hydrogen, more importantly for me, I'm really excited to
10 hear about your plans and update for the hydrogen, green
11 hydrogen plant in Fresno County. Those attributes are —
12 really looking forward to see that built and operated.
13 And with that, let me call on Dave Edwards, Director and
14 Advocate for Hydrogen Energy with Air Liquide, to
15 provide his presentation. Dave, take it away please.

16 MR. EDWARDS: Thank you very much. I look
17 forward to, to engaging with the CEC and with the public
18 on these interesting topics. It's always, it's always
19 kind of nice to go last. We get to show the examples of
20 how the real world is responding to all the
21 opportunities that are out there. I think Brenor did a
22 good job of showing the electrolytic side of things.
23 I'm going to show you some other examples of things
24 we're doing at Air Liquide. And I think together, they
25 represent what the industry as a whole is transitioning

1 toward in, in this new market.

2 If you can go to the next slide.

3 I think everybody is probably familiar with
4 Air Liquide, we're a large industrial gas company that's
5 been around for about 100 years. Hydrogen, just one of
6 many of our products, and traditionally as an industrial
7 project. And now, as we think about it in these new
8 energy applications.

9 Let's go to the next slide.

10 For us, hydrogen isn't anything new. We've
11 been in this market for more than 50 years. We think
12 about that in terms of the variety of production
13 methods, the variety of supply chain, and the variety of
14 uses for the hydrogen. And all three of those are
15 changing as we think about this new energy market that
16 we're entering into. Production is shifting toward
17 renewable and low carbon, supply chain is shifting
18 toward fuel markets more so than gas supply markets, for
19 example. And, the customer is very much shifting toward
20 the energy applications more so than a traditional
21 refinery and ammonia off takers, for example.

22 Let's go to the next slide.

23 What I really want to do is, is talk about two
24 projects that Air Liquide has not. And not because
25 they're specifically for California, but because they're

1 representative of the kind of production facilities and
2 that kind of challenges that we're faced with in the
3 market as we think about these new markets. So, the
4 first one is our new plant that's in North Las Vegas,
5 Nevada. It came online earlier this year. Our grand
6 opening was about a month ago and we're now in full
7 production, supplying California and other — other
8 regions of the West with low carbon, liquid hydrogen.

9 This was an investment of about \$250 million.
10 It's about 30 tons per day of production. And you'll
11 hear the 30 tons per day tied to liquefiers commonly,
12 because that's the typical industry large size
13 liquefier. There are plans by ourselves and others to
14 make that larger production facilities, or to have
15 multiple liquefiers at single sites to go beyond 30.
16 But 30 is going to be a typical scale for the largest
17 liquefiers that you see in the US or anywhere else in
18 the world for that matter.

19 An important characteristic of this project is
20 how quickly it could come online. We began construction
21 in 2020. We began planning just a few years before
22 that, and operation and delivery, obviously now in 2022.
23 So, a very short timeline from initialization through to
24 production.

25 The second project I'd like to talk about is

1 not servicing California, but it's servicing the East
2 Coast of the United States and Canada. And it's located
3 in Becancour, Quebec. It's about a \$40 million
4 investment for us. A 20-megawatt PEM electrolyzer,
5 which produces about eight tons per day of hydrogen.
6 There's a liquefier on site that also had to be expanded
7 for this specific application. This project began in
8 2019 and operations and delivery started last year.

9 So, this has been in operation now for, for a
10 calendar year or so, and we produced quite a bit of
11 liquid hydrogen for these new energy markets. Because
12 it's in Quebec, the electricity used for the
13 electrolysis is almost entirely hydro powered, and
14 therefore a extremely low carbon grid that we're tied
15 into.

16 These are representative of the kinds of
17 scales and the kinds of project investments that are
18 going to be needed by our company and by others in the
19 industry. But, let me talk about some of the challenges
20 that we're faced with.

21 If we go to the next slide.

22 Just to show that it's a real project, I
23 actually have a picture of it, although the sphere is
24 now painted white and has Air Liquide painted on the
25 side. If you go out of Las Vegas to the northwest,

1 you'll see, you'll see our facility there in operation
2 and you'll see our trucks on the highway, leading to a
3 number of locations in California and otherwise.

4 This plant is tied into both the electric grid
5 and the natural gas grid. We then use renewable natural
6 gas and environmental attributes in order to reduce our
7 carbon intensity for the feedstocks. And, our
8 electricity is essentially through the purchase of
9 entirely renewable zero carbon wind and solar credits
10 within the state of Nevada, for example.

11 That allows us to produce low carbon hydrogen,
12 and allows us to be flexible with how our feedstocks are
13 managed and what our customers are demanding from, from
14 transportation fuels and other applications in the
15 region.

16 If we go to the next slide.

17 This is an overall picture of the Becancour
18 site. So, while the previous facility, the North Las
19 Vegas facility is a single production facility, this one
20 actually is multiple production facilities in one. And
21 the reason I want to show it, is because it's a
22 microcosm of what the future of hydrogen looks like.
23 This facility has a steam methane reformer, it's
24 actually in the top left of this picture. It has the
25 new electrolyzer, which is in the blue building at the

1 very bottom, which looks like a warehousing building,
2 but you can see it's tied right to the grid there for
3 example. It also has a waste hydrogen source coming
4 from a chlor-alkali plant, shown in the top right of
5 this picture, where we take a waste hydrogen stream
6 that's impure, we purify it to pipeline spec, and then
7 can liquefy it or put it into our local pipeline.

8 From a supply perspective, we have liquid —
9 you can see the small sphere that's located at the site,
10 and a liquefier on site. We have a pipeline that goes
11 to local industry uses, and then we have trucking. You
12 can see, kind of in the middle of that picture, there
13 are some trucks loading liquid and gaseous hydrogen.

14 And so, the reason I think this is an
15 important picture, is because it shows the flexibility
16 of hydrogen. We're using multiple feedstocks —
17 renewable natural gas, fossil based natural gas,
18 renewable electricity, and a waste feedstock from
19 industry, all as our feedstocks. We have three
20 different production processes, actually four different
21 processes, including purification, liquefaction,
22 electrolysis, and reforming. And then we have three
23 different distribution modes. We have on-truck, we have
24 by pipeline and we have by liquid, and on-truck can be
25 both liquid and gas.

1 So, if you look at all of those different
2 combinations of hydrogen, it really represents the
3 flexibility that hydrogen brings to a region. By being
4 flexible with how it's produced, how feedstocks are
5 managed, and how you're supplying the local industries.
6 It's really a representative of what, potentially for
7 example, a hydrogen hub might look like in different
8 regions of the country.

9 In California that, that availability of
10 feedstocks might be different than it is in Becancour,
11 might be different than it is in Texas, might be
12 different than it is in the state of Washington or other
13 regions. But I think we're always going to find the
14 need for this flexible production and flexible use of
15 hydrogen. And that's why this is an interesting project
16 to show, even though it isn't directly feeding into
17 California. It can be representative of the future.

18 Let's go to the next slide.

19 One of the things that I was asked was to
20 discuss the challenges of using biogas, and the, the
21 cost of purchasing environmental attributes for biogas
22 is one aspect of the challenges. In particular, since
23 there's no RFS approved pathways for hydrogen, even
24 though we're eligible for pathways, without those
25 approvals, we can generate RFS credits. And as a result

1 when we buy EAs, we buy them at the market value, which
2 includes the LCFS and the RFS values for CNG
3 applications, and so we end up at a disadvantage and pay
4 a premium.

5 If the federal EPA passes the RFS pathways,
6 this will actually reverse, because hydrogen will then
7 become the most valuable place to be putting biogas.
8 And so, that's an anticipated change in the market that
9 we would — could look forward to, potentially in the
10 coming years if the current administration approves
11 those pathways, for example.

12 Another challenge is the availability of EAs,
13 the supply is limited today. The Nevada plant that I
14 showed requires essentially the — all of the renewable
15 biogas from two large landfills, or from 20 dairy
16 digesters. So, a fairly significant impact on us. And
17 when we purchased those EAs, it has to be done in large
18 quantities, and they come with expiration dates where
19 you either use them or lose them.

20 Our customers in California are demanding zero
21 CI, because that's what allows them to maximize HRI
22 credits in their light duty stations, for example. And
23 therefore, it's a combination of landfill gas and
24 digester gas that allows us to blend it to a zero CI
25 delivery, for example. And therefore, we have to be

1 creative with how we purchase and how we manage those EA
2 credit systems.

3 The second — the, the next challenge is
4 something that I think people don't really think about
5 upfront, and that is that the value of those credits
6 gets shared and p— along the entire supply chain. That
7 the LCFS and RFS credit value doesn't get passed
8 directly to the customer, because there's also the site
9 operator, the gas producer, the pipeline operator, the
10 credit traders, the hydrogen producers, and the station
11 operators in that, in that credit value chain looking
12 for value.

13 So, go to my next, my next and last slide.

14 One more challenge for biogas is the limited
15 impact of EAs. We know that the LCFS program, for
16 example, doesn't allow for process energy to be
17 considered. Only feedstocks can be considered in the
18 carbon reduction using EAs. This is actually a penalty,
19 not just for the use of RNG, but it's also a penalty for
20 the use of renewable electricity and reducing carbon
21 intensity, in that we have to use grid average, even if
22 we're using renewable credits like we are in, in Nevada,
23 for example. And, and so, for the — a natural gas
24 reactor, the heating, the compression, the liquefaction
25 all of those are not credited with the process energy.

1 And the last thing I would say is, another
2 challenge and this one isn't a CEC challenge as much as
3 it is a challenge just for the industry as a whole. The
4 CARB pathways can be very complex. If you think back to
5 that Becancour plant, for example. If we were to
6 establish CARB pathways, LCFS pathways, for each one of
7 those combinations of the supply chain, there could be
8 dozens of pathways needed for a single site.

9 Because of the combinations of feedstocks and
10 energy usage, because of the multiple supply schemes, we
11 result in these multi—multiples occasion of pathways.
12 In addition, pathways are determined by and require
13 plant operating data.

14 Essentially, you can't generate credits until
15 your performance is established by 90 days of operation.
16 And as we've found in Nevada, and with any large plant,
17 startups can be very challenging and likely don't have
18 good operational data for, for some period of operation.
19 And while these are challenges — and it may sound like
20 I'm, I'm asking something different of CARB, I'm
21 actually — would like to point out that CARB has been
22 exceptionally accommodating as we go through this for
23 the first major plant. Realizing that within the LCFS
24 program, within hydrogen pathways, our plant in Nevada
25 is the first significantly sized plant to come online.

1 We're seeing some of the — some of the early growing
2 pains of going through this process the first time.
3 They've been exceptionally helpful in working with us to
4 go through that.

5 With that, I look forward to the questions.
6 Thank you.

7 MR. ALDAS: Thank you Dave. Thank you for
8 sharing the — some details on your two projects that, as
9 you said, could be representative of the scales and
10 projects that we might see in the future here, as well
11 as your insights on the challenges of using biogas.

12 With that I would like to call on Dr. Robert
13 Do, the President and Chief Executive Officer SHG H2, to
14 share his thoughts and presentation. Thank you.

15 DR. DO: Well, thank you very much for the
16 opportunity to present today. And thank you for the CEC
17 for the opportunity to present as well. We — we're
18 happy that we are selected as an awardee of CEC grant
19 for hydrogen mobility for our project in Lancaster. And
20 I'll give some updates on the progress as we go on.

21 There's a lot of discussions about green
22 energy and green hydrogen today. And you know, what we
23 wanted to share with you is the carbon negative
24 hydrogen. And some of marketing people like to call it
25 greener than green, just because you can come up with a

1 better color.

2 Next slide please.

3 So, you just heard from Air Liquide. What was
4 described there with the SMR. As we know this, the
5 steam method reformer is probably responsible for 95
6 percent of all the hydrogen produced in the US today.
7 And, the way it's done is fossil fuel based natural gas,
8 as you're look at first line there, it goes into a the
9 steam methane reformer.

10 Now remember, you have to burn natural gas in
11 order to, to heat up the reformer. So, there's a
12 combustion at that level in the reformer. So, there's
13 flue gas coming up and CO2 coming up at that level,
14 which is going to be very hard to capture. And then, it
15 goes into the standard steam, water to gas shift system.
16 And then after that, you know, PSA and producing the
17 hydrogen.

18 What we are proposing it at SGH2 is a very
19 similar process, as you can see. Instead of utilizing
20 fossil fuel, we're using biogenic waste product. You
21 know, biogenic residues from either forestry,
22 aquaculture residues, or even, you know municipal
23 residues, as long as they are biogenic. Going to a
24 gasification process, which then generates the same
25 synthetic gas, which is hydrogen and carbon monoxide,

1 and then the same process of a shift converter, and then
2 producing, in this case, green hydrogen.

3 Just reminding the audience that under
4 California regulation, a green hydrogen — a green
5 renewable hydrogen can be made either from electrolysis
6 of water from renewable power or from the thermal
7 conversion of biogenics, which is what we are proposing
8 to do.

9 Next slide, please.

10 So, as we have heard all day today, there are
11 many ways that we need to look at, and many industries
12 that need to look at in terms of reducing CO2. And
13 fortunately, we have a green molecule which is carbon
14 free, which is hydrogen. And, there are a lot of
15 industries that cannot be decarbonized by
16 electrification.

17 So, we need a green molecule, and hydrogen is
18 that green molecule, that you can see here, that we'll
19 be able to look at not only decarbonizing chemical
20 industries, to steel industries, heavy duty, to rail,
21 all the way to shipping, aviation, power generation.
22 And you cannot just do this with electrification alone,
23 with solar and wind. So, the establishment of a green
24 molecule like hydrogen is absolutely necessary in order
25 to reach our net zero goal.

1 Next slide.

2 And obviously, we talked about the urgent
3 issues and there's two issues here, obviously. The
4 transport sector, where you have a massive need for
5 marine all the way to aviation. The other issues that
6 need to be addressed is the amount of waste that we're
7 generating. And what you see here we're looking at 2
8 billion tons of waste generated.

9 So, if there's any question about — is there
10 enough waste to produce hydrogen, well you should just
11 look at the numbers that's waste that's can be generated
12 globally, let alone coming up from the United States. I
13 think there won't be — have an issue finding waste
14 hydrocarbon as a source of hydrogen.

15 Next slide.

16 (Pause)

17 Next slide please.

18 There you go. So, the other thing that you —
19 we all know, the availability of the exciting about
20 hydrogen is the hype into X. And today, there's a lot
21 of discussion about ammonia, a lot a discussion about
22 methanol as potential E fuel sources. And, in order to
23 make these E fuel sources, or to produce ammonia for
24 the, for the fertilizer business, and to green that
25 process, you need hydrogen.

1 So, we are currently working with some of the
2 largest fertilizer company in the world, as well as the
3 — in discussion with the largest shipping company in the
4 world. Because they have now decided that E methanol
5 will be the marine fuel that — to be used for container
6 ships. And I'm talking about Maersk. And to make e
7 methanol, obviously, the big requirement is a green
8 hydrogen.

9 Next slide.

10 (Pause)

11 So why are we talking about green hydrogen?
12 And I wanted to just raise one issue that people wanted
13 to hear about. We always know that hydrogen is present
14 in H₂O, right? Water. And it's abundant. It's an
15 elegant way of utilizing it into hydrogen. But the
16 other hydrogen in nature is in biomass, which is
17 hydrocarbon. So, you have the H-2-O bond, and then you
18 have the H-C-O bond. The challenge of those, is how
19 much energy you need to extract the hydrogen from the
20 HCO bond versus from the H₂O bond.

21 Now, I stole this slide from the DOE. And,
22 you can see here that these are how we say renewable or
23 clean hydrogen are made. And according to DOE, when you
24 look at the left side of the screen, today, this is how
25 hydrogen is made all over the world. Either by coal

1 gasification, which is what India and China do
2 regularly. Or, US with the steam reforming of natural
3 gas.

4 So, we need to decarbonize a sector with CCU
5 or CCS. That would give you blue hydrogen. And the
6 other two ways to make hydrogen, which are renewable, is
7 using renewable source like waste and biomass, like SGH2
8 was proposing. Or, to go with the electrolysis of water
9 with renewable power. Those are the two pathways that
10 have been approved by CEC and CARB.

11 Next slide.

12 Our process, basically, is a continuous
13 process where we use high temperature plasma heat in
14 order to raise the operating temperature of a gasifier.
15 So, as biomass and biomass residue and waste are entered
16 into the gasifier, the high temperature from the plasma
17 heat, which is raised up to 3,500 degrees centigrade,
18 you are able to completely depolymerize the hydrocarbon
19 molecule into the individual hydrogen and CO.

20 And what's beautiful, is hydrogen is one of
21 the most stable molecule at high temperature. And so is
22 carbon monoxide. So, we are able to get a coal gas
23 efficiency of 87 percent and conversion of hydrocarbon
24 into hydrogen. On our website, there's a video that you
25 can see how the process is produced, which we don't have

1 the time to show today.

2 Next slide, please.

3 So, this is an important slide that I want to
4 raise. And I'm not trying to go against electrolysis,
5 but water is an issue. California is in a severe
6 drought, and so are the west coast and many parts of the
7 world. And, utilizing a water maybe doesn't sound a lot
8 when you talk about three to four gallons. But, that's
9 only the water that goes into the electrolysis.

10 To get water from a recycled water plant,
11 which we are doing over in Lancaster, you need to
12 basically clean that water first, and then you have to
13 demineralize that water because — and deionize it,
14 because any contaminants to that water would destroy the
15 electrolytic plate. So therefore, there's additional
16 power requirements and water requirements in order to
17 reach and use the water for electrolysis.

18 So, I think that the water resource has to be
19 a big consideration when you're looking at electrolysis.
20 And in our case, we only use water for process cooling
21 and plant usage in terms administration. So, the amount
22 of water we're using a significantly lower.

23 But the most important point that I want to be
24 able to show — to take out here, is the amount of
25 electricity that you break a water bond. The water bond

1 is like a, a magnet. You need on average 60-kilowatt
2 hour in order to break and get one kilo of hydrogen.
3 Whereby, the hydrocarbon bond, the HCO bond, is a very
4 loose bond, and we only need about less than eight
5 kilowatt hours. So, eight times less electricity to
6 break and remove the hydrogen to generate hydrogen. And
7 that alone tell you a very important part why our cost
8 is so much lower.

9 But the other important part, which is very
10 important, is the availability. We are building a plant
11 that will operate 24/7. We're not depending on
12 renewable solar, which operates only, you know, 25 to
13 maximum 30 percent availability, which is about 92 days
14 a year.

15 We have our plan would operate 350 days a
16 year. That will allow us to produce it on the baseload
17 continually, and that's why we are selected to, to
18 provide hydrogen to the hydrogen stations in California.

19 And then the other piece of resource that also
20 has to be considered, is the amount of land required.
21 We can build one of our module that produces, you know,
22 4,000 tons a year of hydrogen in five acres of land.
23 Five acres of land to fuel one megawatt of power. And,
24 in order to give the same amount, you would need two
25 hundred times the amount of land and solar to give the

1 same amount of hydrogen that we produce. And on top of
2 that being a biogenic system with carbon capture, we do
3 therefore a, what we call, a carbon negative hydrogen.

4 Next slide.

5 (Pause)

6 I think we covered this already in terms of
7 carbon intensity, so we can go to the next slide.

8 So, our company basically will build and
9 operate this plant, and be launching multiple projects,
10 which produced the standard distributed system. Our,
11 our business is a distributed energy. We would think to
12 com— complement the larger utility scale. We're looking
13 at building this plant closer to the demand, and
14 therefore reducing the amount of transport of hydrogen.

15 Next slide.

16 Announcing what we consider today one of the
17 largest baseload hydrogen, we put together, as you can
18 see here, a consortium of some of the la— top
19 engineering firm, like Fluor. We're happy to also
20 partner with Air Liquide to support us with equipment
21 like the PIA, VPSA, even the Cryocap system and capture.
22 We work with ABB in order to do a complete automation of
23 our plant. And, we are also, and with Stork, the
24 largest O & M Company to operate our plant.

25 Lastly, we put together a complete performance

1 guarantee to allow our project to be project financed.
2 And 100 percent of our hydrogen the Lancaster plant has
3 been guaranteed to be off take by Shell and Iwatani to
4 the largest hydrogen refueling station operator in
5 California.

6 Next slide.

7 (Pause)

8 This is a picture of Lancaster. I'm standing
9 next to the mayor, who is on the right corner here in a
10 Toyota Class 8 trucks. The hydrogen from Iwatani will
11 be transported from Lancaster in a hydrogen truck, so
12 it's a closed loop system, and they are going straight
13 to delivery the Iwatani hydrogen stations. Similarly,
14 we're doing the same with Shell so 50 percent of our
15 hydrogen is going to Iwatani stations in Los Angeles and
16 the other 50 percent going to Shell hydrogen stations.

17 Next slide.

18 The Lancaster project is currently going to
19 CEQA. We looking forward to a 16 to 18 month
20 construction, and the plant will be operation by quarter
21 four, 2023. As you — as I have announced earlier, we
22 have received a \$3 million CEC grant for this project.
23 On top of that, we are going through a public private
24 partnership with the City of Lancaster where the CEC is
25 a partner on the project. The offtake contract

1 agreement — 100 percent of our hydrogen is contracted
2 for the next ten years, between 2023 to 2033.

3 Next slide

4 (Pause)

5 — to announce that we are launching a project
6 in the city of Paradise, which is known being infamous
7 burn down to the Camp Fire. There, we would use biomass
8 waste residue and we would convert that working with the
9 Forest Service and the county to convert that biomass
10 into hydrogen. And then, we are working with the Chart
11 Industry Group to liquefy. So, each of these plant —
12 this plant will be producing 12 tons per day liquid
13 hydrogen in the city of Paradise. This plan will be
14 operational by 2024. And with carbon capture, this is
15 the bioenergy with carbon capture for sequestration.
16 So, also a negative carbon hydrogen project.

17 Next slide.

18 So, I'm going to end here. Thank you very
19 much. I think that the next thing that we want to talk
20 about, and the one of the question to raise, is we
21 definitely should remove the word and the rainbow of
22 color — focus on looking at clean hydrogen with a carbon
23 intensity that should be at least 75 percent lower than
24 grey hydrogen, or three kilo of CO2 per kilo of
25 hydrogen.

1 And that would be the definition of clean
2 hydrogen, which I hope will be part of the Section 45X
3 coming out in the — in the new, hopefully, Build Back
4 Better Climate Bill. But that's how they define clean
5 hydrogen, and I think that's the, the taxonomy that we
6 should be following. Thank you very much, and I look
7 forward to some questions.

8 MR. ALDAS: Thank you, Dr. Do, for your
9 presentation and, in particular, for sharing information
10 about the HEA's two process and your projects in
11 Lancaster, and in Paradise. And in particular, I
12 appreciate the analysis in your comparison table with
13 your products and electrolysis.

14 And with that, I would like to call on Nick
15 Connell, with the Green Hydrogen Coalition. Nick is the
16 policy director for Green Hydrogen Coalition, and will
17 talk about developing green hydrogen definition and
18 green considerations.

19 MR. CONNELL: Perfect. Thank you very much.
20 Rizaldo, can you hear me okay?

21 MR. ALDAS: Yes, so we can hear you good.

22 MR. CONNELL: Perfect. All right, next slide.
23 And I would like to thank Dr. Do for setting up my
24 slides here. That wasn't planned, but it worked out
25 perfectly.

1 So, um, really big on the GHC, or the Green
2 Hydrogen Coalition. Our mission is to facilitate
3 policies and practices to advance the production and use
4 of green hydrogen in all sectors where it will
5 accelerate a carbon free energy future. The GHC is a
6 tax exempt 501c3 nonprofit organization.

7 Next slide.

8 We currently have two initiatives, where we
9 are driving policy and commercialization efforts that
10 together, will accelerate North American green hydrogen
11 market. Our first initiative is the Western Green
12 Hydrogen Initiative. This includes 11 Western
13 Interstates, two Canadian provinces, as well as three
14 additional states, Florida, Louisiana and Ohio.

15 I serve as one of the organizers, in
16 collaboration with the Western Interstate Energy Board,
17 as well as NASEO, the National Association of State
18 Energy Officials, and the CEC's Commissioner McAllister
19 is actually one of the vice chairs to the Western Green
20 Hydrogen Initiative.

21 And our second initiative is HyDeal North
22 America. This is where we're trying to drive high
23 volume supply chains to achieve, in some cases, sub \$2
24 per kilogram of hydrogen delivered. Our first
25 initiative is here in Los Angeles. We are currently in

1 phase two of this where, we're looking at additional
2 infrastructure and offtake more on mobility, so looking
3 at aviation as well as maritime, and then also looking
4 at the community impacts and ensuring that as we move
5 forward in a green hydrogen economy, that there's a just
6 transition.

7 Next slide, please.

8 And for my presentation, I really wanted to
9 touch on one foundational policy recommendation — and
10 this is something that Dr. Doe touched on previously —
11 is that, you know, there's an increase confusion. I
12 mean, it's easy for us to talk about the hydrogen shades
13 in conversation, but when we start putting policy
14 together, we need to start looking at it on a
15 quantitative basis. And so at the GHC, we support
16 defining green hydrogen based on a carbon intensity
17 framework.

18 The reason for this, it opens up the debate
19 about competition between different hydrogen production
20 routes, as you heard from the previous panelists talking
21 about biomass, or electrolysis, or biogas, and it allows
22 them to compete as long as they can meet that carbon
23 intensity threshold. In addition to that, it also opens
24 up an opportunity for certification schemes, to where we
25 can start to rigorously account the GHG's arising from

1 both the site of production, as well as the upstream
2 production.

3 And in here, I just included some different
4 considerations when developing definitions. So, does it
5 support feedstock diversity? Is a quantifiable? What
6 is the threshold? And so, Dr. Do touched on the
7 Infrastructure Bill, where he talked about the two
8 kilograms of CO2 equivalent per kilogram of hydrogen.
9 So that's already something that's happening at the
10 federal level as well as other places internationally,
11 including Canada and the European Union.

12 And then, does it consider the lifecycle
13 impacts? Is it technology neutral? So, not basing a
14 definition just on electrolysis or just on biomass
15 production. And how will it be certified?

16 So, next slide, please.

17 So, when adopting a carbon intensity
18 framework, one of the key considerations is setting up
19 the system boundaries when defining green hydrogen. So
20 again, you could keep this color scheme if you tied to a
21 specific threshold. And so here, here's a key example
22 of one way of assessing the lifecycle emissions from
23 feedstock through the point of production.

24 And this is done by the International
25 Partnership for Hydrogen and Fuel Cells in the Economy.

1 This includes organizations around the world, including
2 the Department of Energy. The reason we say well-to -
3 gate — this is mainly because, as we started thinking
4 about green hydro— hydrogen production and use, there's
5 going to be a lot of different end use applications.

6 So, a key example would be the LCFS program
7 where it looks at well-two-wheels, because it's specific
8 for transportation. And once we start moving to a mass
9 economy, we need to start evaluating the lifecycle
10 emissions slightly different. And this is a good way to
11 look at not only the point of production, as well as
12 what's going on upstream to ensure that we're accounting
13 for all those greenhouse gas emissions.

14 And one thing I want to point out, is the
15 infrastructure bill. While they do set a threshold,
16 currently, that definition is only at the point of
17 production. So, it is not looking at the upstream
18 emissions. And so, the GHC, as well as other hydrogen
19 associations, have been working with the Department of
20 Energy and really advocating for them to start looking
21 at it through a well-to-gate assessment. And if you go
22 to our website, you could see a letter that we submitted
23 to the DOE previously in regard to that.

24 So next slide.

25 So, a carbon intensity framework, it is

1 additionally — it's a fundamental to establishing
2 certification mechanisms and standards that can really
3 help move the market initially. And so, some
4 considerations, I won't go through all of them here, but
5 it's — what accounting scheme should we use? How do we
6 get started? And also, are we gonna hurt market
7 development or support network development?

8 So, in our perspective, and I'll share on the
9 next slide is, there's really a way to where we could
10 roadmap ourselves to get from separating, so looking at
11 a booking claim system, to a mass balancing system. And
12 so, the GHC we really support mass balancing. So, this
13 is really linking the physical delivery of that
14 renewable source, be it biogas, biomass or electrolysis
15 through, you know, elec — renewable electricity, down to
16 the point of production.

17 However, that infrastructure and those
18 mechanisms are not in place yet. And so, in the near
19 term, we support leveraging existing infrastructure and
20 systems that have worked for decades in the renewable
21 energy and gas markets to accelerate green hydrogen
22 market development.

23 And as noted from Earthjustice was, you know,
24 when we look at LCFS program, when they're separating,
25 you know, the environmental attributes from the actual

1 production, we're working out different mechanisms to
2 ensure we are actually decarbonizing the grid in the
3 near term, and working to our ultimate long term gro—
4 goal of getting to a mass balance market. And we would
5 be happy to share some of those positions as we are
6 going through it, and you can see our previous
7 regulatory filings as well as our position papers on
8 some of these items.

9 So next slide.

10 And so, I just wanted to leave you with four
11 different requirements that, you know — as we develop a
12 green hydrogen definition, if we look it at — at a kind
13 of carbon intensity framework, we have a sound, you
14 know, a lifecycle mission assessment framework in place.

15 These are the four goals we should really be
16 getting to in time. I do not believe we could get here
17 today because we would kill market growth. And what we
18 want to do is we want to acceler— accelerate market
19 growth, and we need to start working to achieve these
20 things. So having these angles in mind will be very
21 critical.

22 So, one is temporal correlation. So, when
23 that hydrogen is being produced, timestamping it to when
24 that renewable feedstock was delivered to that facility.
25 So, that's one key activity and that's as a graphical

1 correlation, so going back to Earthjustice, where
2 they're taking an environmental attribute from Indiana
3 and they're using it in California. Is that really
4 decarbonizing our grid? And that's a larger question
5 that should be addressed. So, you can always look at —
6 we can do it within the balancing authority, or we could
7 do it within the trading hub for recs, or environmental
8 attributes.

9 And the next is additionality. So, as we put
10 more electro—electrolyzers on the grid, are we
11 expanding our renewable resources such as solar and
12 wind? Or, are we starting to take away from those.

13 And then lastly, is the technological
14 specifications. So, we really need to ensure full
15 transparency information those use — those resources use
16 to produce the electricity, the biogas or biomass, and
17 ensure that it's actually renewable in nature.

18 And so having these four different
19 requirements in place in time will really start to
20 ensure that we have a transpar— a transparent market
21 that really grows the green hydrogen economy.

22 So, with that, I will hand it back over to
23 you, Rizaldo. Thank you.

24 MR. ALDAS: Thank you, Nick. And thanks for
25 efforts at classifying hydrogen based on carbon

1 intensity. So, I think at this point I will pass it on
2 to Vice Chair Gunda for comments and questions at the
3 dais.

4 VICE CHAIR GUNDA: Thank you, Rizaldo. Just
5 kind of looking at time. So, we're at about 4:03, so we
6 have seven minutes or so for a few questions from us. I
7 don't want to delay, but, you know, if we have pressing
8 questions we'll go longer.

9 So, I'll just start off with a couple of
10 questions. So, just kind of this, this discussion
11 around the electrolytic hydrogen, you know, which we
12 focused quite a bit and we heard some comments this
13 morning about thinking through other feedstocks that
14 could provide, you know, more of a negative path. You
15 know, Dr. Do kind of talked about some of that. And
16 also. we had David kind of mentioning, you know, the,
17 the opportunity that having multiple pathways and, and
18 more of a, a comprehensive opportunity — both on the
19 supply side, but also distribution side, and, and kind
20 of the overall process.

21 So, you know, now that we've all heard from
22 each other, I wanted to hear Sarah, Nick, your comments
23 — a little bit on, you know, you've kind of talked about
24 the regulatory structures, but, you know, as we think
25 through, you know, the bold goals of California, you

1 know, having consensus is very important on, on kind of
2 short term and long term. I just want to hear your
3 general agreements and, you know, disagreements. I
4 think would be helpful. So maybe Nick, everybody,
5 please go one by one. But Nick, maybe you can start.

6 MR. CONNELL: Yeah, I think, you know, at the
7 GHC, we support technology neutrality. So, if we could
8 support hydrogen growth through carbon negative
9 resources, or zero-carbon resources, we're all for it.
10 We just have to ensure that it is done correctly and
11 transparently for one, the market, as well as ensuring
12 that we're creating a just transition for those
13 communities of concern.

14 So again, you know, if it's biomass, biogas,
15 if it's electrolytic production, we support it — as long
16 as it really meets a carbon intensity threshold to meet
17 our state's goals by 2045, 2030, in moving forward.

18 MS. GERSEN: Thank you for this really
19 important question. I think it's very important to
20 critically interrogate any claims about a energy
21 resource being carbon negative. A really fantastic
22 resource I could refer you to on that is a petition the,
23 the Coalition of Environmental Justice Groups recently
24 filed with CARB that spotlighted several sources of
25 biogas that CARB has been treating as carbon negative

1 for the purposes of the LTFS program. Which in fact,
2 had wh— would be going forward regardless of the LTFS
3 program, because they'd either been funded through
4 public grants, or had a commitment to construct them
5 because of a legally binding settlement, things like
6 that.

7 Um, I also think it's important to think about
8 economy-wide resource planning. And I think everyone on
9 the dais is very familiar with the idea that biomethane
10 is not going to be a silver bullet for us to be
11 decarbonizing the economy, because the supply of truly
12 sustainable biomethane is so limited.

13 But, what I think is less well appreciated, is
14 the enormous energy penalty being paid if you were to
15 convert biomethane into hydrogen. You would lose about
16 40 percent of the energy in the biomethane you use in
17 that process if you're using bio methane to both steam
18 methane reformation, and as a chemical feedstock for
19 that process. And that, I hope, makes it really clear
20 that converting the energy in biomethane into hydrogen
21 before you can use it is just a — a wasteful and
22 inefficient thing to do.

23 (Pause)

24 MR. EDWARDS: So, so this is Dave from Air
25 Liquide. So, um, I think one of the things that's

1 obvious from the variety of presentations is that the
2 technology neutral route is really important. And, that
3 the mechanism by which we evaluate carbon intensity is
4 also very important. It captures, you know, all of the
5 processes that we've talked about, and it captures the
6 kind of concerns that Sara and others bring up about,
7 you know, what is the real carbon intensity of a process
8 and how do you evaluate that?

9 So, establishing standards, establishing
10 standards that are technology neutral, and making sure
11 that they capture the impact and effects that are
12 important for society and for industry and for the
13 applications is, is really important. One of the things
14 that we haven't talked much about today is, is what's
15 going to drive us toward the ability to bring hydrogen
16 in at the scale that we need? And that's really the
17 economics of its adoption.

18 We rely on the state in the early stages of
19 adoption in order to establish and help bridge some of
20 those concerns we have from an economic perspective, but
21 it will be private investment in private industries that
22 come forward with the huge amount of investments that
23 will allow the energy transition to happen at scale. And
24 at scale is when we have the biggest impact on the
25 environment, and it's when we have the biggest impact

1 the overall impact on society, for example.

2 But establishing those measures very early on
3 what are the carbon intensity pathway evaluations, how
4 are we going to establish technical — technology neutral
5 approaches, allows us then to plan for the future and
6 make those kinds of investments. And that's, that's
7 really the key to, to the economic drivers, but behind a
8 lot of the, the concerns that I think have been raised
9 here today.

10 DR. DO: I agree with Dave. I think the
11 transparency of the, the technology in the LCA and
12 Liquid's system. We're working with University of
13 Berkeley, as well as the Berkeley National Lab. We're
14 brought in experts from all fields in order to look at
15 carbon intensity.

16 And Dave, you're absolutely right. I mean,
17 you can put all your pathways in there. And these —
18 there are new pathway, CARB, basically today. have
19 existing approved pathways. And you can take around and
20 put it in a square hole. So, you know, we have to put
21 in these new are pathways that go through that process.
22 And then you have to wait until your plant is
23 operational for 90 days before you get certified.

24 Now, but the elephant in the room that we
25 still haven't addressed all day today, is what's

1 happening to the LCFS market. Literally it's crashed
2 from \$200 down to 80 something dollars. And from that —
3 so anybody on the supply chain that mentioned is not
4 getting credit because a credit is not only hard to get,
5 but it's dropped down to you know 60 percent of what it
6 used to be a year ago, and because of the massive amount
7 of renewable diesel that's coming in.

8 So, the hydrogen market today is severely
9 affected. And, and as far as economic is go, whether we
10 are carbon negative, carbon neutral, the hydrogen market
11 is driven by LCFS. And the other part is, a lot of
12 people are talking about decarbonizing other sector.
13 Well, power mixing with natural gas going into pipeline
14 — that sector does not get LCFS credit. So, they won't
15 move forward, because there's no incentive to move
16 forward until you have, perhaps, the PTC coming out,
17 which may or may not happen.

18 There is a lot of challenges here for the
19 hydrogen system. If you want to take it about and
20 outside of mobility. And as far as mobility is
21 concerned, I mean, there's a limit that we are very few
22 trucks on the market. So, there's really no demand.
23 Aviation, marine is all talk, so there's no certainty as
24 to off taker.

25 So, for our producer, like Dave, our Plug

1 Power is lucky because they are it directly to their own
2 customers and their own stations, so they are
3 vertically. But for group like us, or Air Liquide, we
4 need to see a bigger market demand. And that demand for
5 green hydrogen, it's just not there for a producer to
6 come out and build these plants. I, I spoken up, I let
7 others chime in.

8 MR. BROPHY: Yeah, I would just add to the
9 least controversial point today is that, we absolutely
10 support completely rigorous and absolutely transparent
11 carbon intensity source for the hydrogen production
12 pathways. They don't really — the colors are shorthand,
13 but we really want a rigorous way of doing it that
14 doesn't have somewhat arbitrary requirements in it, like
15 exclusion of hydro and stuff like that. That's
16 unhelpful.

17 When you're trying to — it really, just should
18 be absolutely neutral and completely rigorous in how it,
19 how it scores the, uh, the pathway. I, I would say our
20 focus is on the big picture. At Plug, we're about
21 replacing fossil fuels with green hydrogen. By 2050, a
22 complete replacement. We're going after diesel first.
23 But, when we're done with these little we're going after
24 natural gas.

25 At that scale, at that kind of, of energy

1 usage, the only resource that you can, can really scale
2 is solar and wind. And so, we're starting with that
3 resource and, and that's the one we believe will scale.
4 And that's not to say all of the other pathways that we
5 talked about today are not excellent ways to make
6 hydrogen. But, in the end game, it will be solar and
7 wind and electrolysis that is the bulk of the hydrogen
8 production, if we're going to seriously replace natural
9 gas and oil.

10 VICE CHAIR GUNDA: Thank you all so much. I
11 have so many more questions, but I'll, I'll pass it to
12 Commissioner Monahan first.

13 COMMISSIONER MONAHAN: Well, I really
14 appreciate this panel, and all the different projects
15 that are directly producing hydrogen. And, I'm curious
16 about the recommendation that Nick has made around the
17 geographic correlation that, that eventually, I'm not
18 sure how soon Nick is recommending this happen, but that
19 green hydrogen tracking systems should have a physical
20 link to ensure that the energy input is involved in a —
21 in the hydrogen, the — versus the book-and-claim that we
22 currently have in the LCFS.

23 How, in this panel, how — I'm, I'm curious
24 about the reaction of — I'm guessing Plug Power would
25 like that, but Air Liquide, in particular, around that

1 recommendation. Dave, what do you think?

2 MR. EDWARDS: Yeah. So, I think, as, as Nick
3 pointed out for the short term, we, we really only have
4 the book-and-claim option, and we need to think about
5 all resources that are available that can be plausibly
6 tied in through those processes, whether that's
7 electricity or, or renewable natural gas, for example.

8 But I think there is some merit to the
9 regional tie-in, and how that brings value to the local
10 investors, to the local society, to local community.
11 It, it — one of hydrogen's real strength is that you,
12 you produce it where you use it, and you use local
13 resources. And that amplifies that impact by doing
14 that.

15 We're not ready to do that yet from an enemy
16 sector perspective. And we would, we would greatly
17 hamper what resources would be available for low-cost
18 low-carbon production today. But, I think if we start
19 aiming toward that as an outcome, we can start
20 conditioning systems and, and policies toward, toward
21 being able to do that. I think that would be a really
22 intriguing idea.

23 MR. BROPHY: I would echo what Dave said. You
24 know, while this California project has a direct
25 connection, that doesn't always work everywhere. And,

1 and so we need flexibility at the start to be able to
2 put together economic hydrogen plants that, that are
3 viable that we can build. And so, flexibility at the
4 beginning, but I think absolutely in the longer term in
5 the medium term, we can aim for, you know, more criteria
6 around how we, how we account for the hydrogen.

7 COMMISSIONER MONAHAN: And what, what's medium
8 or long term? Like, what would be the timeline, time
9 horizon?

10 MR. BROPHY: For us, we would consider the
11 medium term to be late this decade. So, from 2027
12 through the early 2030's, as, as medium term beyond 2032
13 as longer term.

14 MR. EDWARDS: Yeah, I think I would agree with
15 that. From a timeline perspective, all of the
16 investments that you've seen today are likely to be in
17 production for a decade or two or three, potentially,
18 depending on markets and viability. And, and that
19 requires some stability of, of, you know, regulation and
20 investment clarity.

21 COMMISSIONER MONAHAN: It seems like Nick has
22 something to say.

23 MR. CONNELL: Yeah, and I would say too, in
24 regard to a timeline, it may vary. But again, if we
25 look, can we benchmark — like the European Commission,

1 you know, they just released set by mass balancing by
2 2027, and giving a grace period for projects to get
3 there. And so, some time of consideration for
4 California, especially from a regional approach, would
5 be a, a great way to start looking at that and road
6 mapping, like, a long-term plan to get to mass
7 balancing.

8 COMMISSIONER MONAHAN: And Sara?

9 MS. GERSEN: Thank you, Commissioner. Tying
10 in the inputs to the hydrogen production is a really
11 elegant way for identifying when electrolytic hydrogen
12 is truly green. You know, having an equivalent of a
13 bucket of one RPS renewable electricity source power the
14 electrolysis.

15 But when you're talking about things like
16 biomethane, there's really a double-edged sword when
17 you're asking producers to use locally sourced
18 biomethane. Because, your catalyzing the market for
19 locally produced swine and cattle manure gas, often to
20 the detriment of the local environmental justice
21 communities, who see increased pollution in their
22 communities when industrial agriculture responds to the
23 incentive to produce more methane pollution by,
24 surprise, surprise, producing more methane pollution,
25 and doing so by using less sustainable practices for

1 renewal management?

2 So, um, I — I guess this also ties into the
3 previous Commissioner's question about technology
4 neutrality. Focusing on zero emission electrolytic
5 hydrogen is the clearest way to ensure that not only is
6 your hydrogen being produ— produced through a path
7 that's sustainable for the climate, but, it's — it's the
8 only way to ensure that you will avoid detrimental
9 public health impacts on local communities.

10 COMMISSIONER MONAHAN: Great, thank you.

11 DR. DO: I wanted to second Sara's statement
12 about the methane. Because, you know, my — one of the
13 position that is by, by CARB, is that methane has a
14 greenhouse warming potential of 20 times CO₂. But that
15 is only looking at over a 100-year period. And we know
16 the more important part is looking at over the next 20
17 years where methane has an 80-time GWP, according to the
18 UN and IPCC, as part of the COP 26 and the methane
19 capital regulation.

20 So, I think it's important that CEC is
21 reviewing how you're looking at the impact of methane in
22 terms of GWP versus CO₂ over 20 years to be more
23 consistent with the UN policy at the moment.

24 (Pause)

25 MR. FOO: Hey, this is Fritz. I actually had
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1 one technical question, and then maybe a broader
2 question for everyone. The technical question is for
3 Robert. You all mentioned that you heated the plasma up
4 to 3,500 degrees. I'm curious what the energy source of
5 that is? Is that electric, or some other gaseous
6 source?

7 MR. EDWARDS: Yeah, it is electric, classified
8 as an electric process. And, we then actually recover,
9 and through a waste heat to power system, in order to
10 generate the electricity we need to run the torch.

11 MR. FOO: And I just my second question
12 probably for folks, in really just thinking about a
13 tracking system of some kind. You know, do you see that
14 ed— everyone mentioned, kind of, carbon content and
15 threshold. Is that, I guess more, you know, a
16 legislative fix? Maybe, you know, a broader policy fix?
17 I'm just kind of thinking through it. It's definitely a
18 question that's being, kind of, thought through a lot of
19 think tanks. But you know, what are — what is, kind of,
20 the main lever there that is needed? Is it — is it
21 really a legislative fix? I'm kind of curious as to
22 what your thoughts on that are.

23 DR. DO: Well, from, from my standpoint, you
24 know, we — I have a similar form to a PTC that's been
25 paused for clean tax is the, the main piece. In Europe,

1 the discussion has to do with a CFD or contract with
2 differences, which is the amount of CO2 savings that
3 you're getting, and then you get a price on the CO2
4 itself.

5 So, whether it's LCFS or CFB, there has to be
6 a premium paid to pull that carbon savings over green
7 hydrogen, over brown hydrogen, over natural gas, over
8 diesel. And that need to be across the board for all
9 industries, whether you are using the hydrogen savings
10 or CO2 savings for power productions, or reduction of
11 the natural gas footprint, or home heating, or all the
12 stuff that SoCalGas done.

13 There has to be a pay for that CO2 savings.
14 And is it the carbon tax? Or, is it a part of LCFS or
15 an RFS? I think that that has to be the trigger. And,
16 you know, that's, I think, the 40X program that's
17 proposed by the Build Back Better on the climate
18 legislation, something similar like that is going to be
19 the driver to incentivize producers, users, in, in terms
20 of the hydrogen economy.

21 MR. FOO: Thanks.

22 VICE CHAIR GUNDA: Thank you. So I'll, I'll
23 as ask just one quick question to Brenor, and then, you
24 know, hopefully we can pass it on given the time here.
25 And I, I will also just say that I would love to follow

1 up with a few of you to have some follow up
2 conversations on, on thinking through. I'm, I'm still
3 learning this area, and this is really helpful, this
4 particular discussion.

5 So, Brenor, on your — the 120-megawatt
6 capacity that you talked about for the electrolysis
7 project in California. What are — how are you thinking
8 about the interconnection agreements and the queue? Is
9 there an opportunity for taking, you know, the, the
10 large amount of interconnection queue that we have today
11 to potentially marry with some of these, you know,
12 projects, electrolysis projects, and then provide a
13 pathway for both reliability, but also, you know, more
14 advancing the deployment of the renewable

15 MR. BROPHY: That's a really interesting
16 question. The genesis of this project was actually a
17 first solar, solar project that was — held Q positions,
18 but it only held an energy-only Q position, and it
19 turned out that was very challenged to get a PPA,
20 because it didn't have deliverability.

21 And so, a marginal solar project became an
22 excellent hydrogen project. So, hydrogen has what's
23 enable this to go forward. And, and that's a, an
24 interesting point, where the alternative energy delivery
25 of — through liquid hydrogen and trucks, as opposed

1 through the grid, enables a renewable energy project to,
2 to meet the economic hurdles that it's about to.

3 You know, the, the queue. Interpreting queue
4 is, especially in California, is enormously complex.
5 There are, there are many projects that the costs
6 related to interconnections are — can be very, very
7 high. And there's a lot of complexity a lot of time. I
8 think, certainly hydrogen, is a way that either in
9 replacing the off-take of, instead of electrons you, you
10 export protons. Or, as a way to enable additional
11 economics for a renewable plant that would otherwise see
12 curtailment or, or may not be able to get all of the
13 electron off take that it would like.

14 All of those are opportunities where hydrogen
15 can play. I think it's incumbent on organizations like
16 Plug to really reduce the hydrogen part of that equation
17 to practice, to build enough plants to get to a scale
18 where, if pure renewable energy developers, solar and
19 wind developers, can, can see a hydrogen solution
20 that's, that's off the shelf. And also, enough of a
21 hydrogen market, that there's a place for that product
22 to go because just generating the hydrogen somewhere is
23 — it's not enough. You've got to have a path to market.
24 And that's either through pipelines or through
25 liquefaction or something similar.

1 VICE CHAIR GUNDA: And Brenor, just a quick
2 follow up and, and I'll follow up of offline too. Just
3 from a — supporting the net peak period, specifically,
4 the four to nine. Given, and obviously there's a part
5 of it is to, you know, if you're really depending on
6 solar, you don't really have an opportunity to
7 potentially reduce load. But is there, or are there
8 opportunities to support the grid with the kind of
9 system you have during that peak period?

10 MR. BROPHY: Absolutely. So, this plant is a,
11 a hydrogen plant in general. An electrolysis,
12 electrolysis plant can be extremely load responsive, or
13 demand responsive. About 80 percent of our load can be
14 curtailed literally in milliseconds, if we need to.

15 This plant is designed — if you do the
16 calculations, 120 megawatts is actually 45 tons of
17 hydrogen production capacity for a 30-ton liquefier.
18 Frankly, what we're doing is we make hydrogen when the
19 sun shines. So, during the peak of the day, we make
20 additional hydrogen that we store, and then during the
21 on-peak period of 4:00 to, to 9:00 P.M., or the
22 gooseneck theory, the dark — duck curve that we, we talk
23 about.

24 We actually curtail the electrolyzer hydrogen
25 production. And our liquefaction plant runs off

1 storage, the stored hydrogen that we made earlier in the
2 day when the sun was shining. So, in fact, what we're
3 doing, is we're curtailing our load during that peak
4 period. And, we're actually exporting some of that
5 solar energy in the first half of the period when we
6 still have solar. We're exporting it into that market
7 because the prices are very high.

8 So, we are very responsive to time of use
9 energy rates. And, we've designed this project to, to
10 support California's energy grid by not — by curtailing
11 load at peak periods, and actually by enabling energy
12 supply into the grid during those same periods, while
13 still making absolutely steady 30 tons of hydrogen every
14 day.

15 VICE CHAIR GUNDA: And thank you.

16 DR. DO: On the other hand, by — to follow up
17 on that, point. We're talking with some of the peak
18 producers in California who are interested in taking
19 hydrogen and blend it into their turbine during peak
20 hours. But the challenge for them at the moment, is
21 there is no premium for them to pay for the blending of
22 hydrogen. Because now, power includes you know, 20, 30
23 percent hydrogen during this peak time. But there's no
24 method to compensate the, the peak — the peaker power
25 plant for, for utilizing hydrogen and decreasing the

1 carbon footprint. So, that's a regulation that need to
2 be, to be discussed.

3 VICE CHAIR GUNDA: Thank you so much. I know
4 we used up a lot of time. Thanks, Heather for
5 facilitating the broader conversation. With that, do we
6 want to go to the Q&A?

7 MS. RAITT: Sure, thanks. So, Peter Chen is
8 on the line to moderate the Q&A. Go ahead, Peter

9 MR. CHEN: Thanks, Heather. So, I have a
10 question here from Willem Hazenberg, it's directed to
11 Dr. Do. So he asks: "Bloomberg indicates that hydrogen
12 is not a good choice for passenger cars, whereas SGH2 is
13 betting on customers who are particularly committed to
14 mobility. So how do you view the mobility market?"

15 DR. DO: Well, we, we see the mobility market
16 leaning a lot more toward heavy duty. And in, in
17 Europe, we are developing three projects working with
18 large-scale heavy-duty stations that being rolled out
19 throughout Germany and, and in the Netherlands.

20 And so, that's where we see it. And of
21 course, working also, at the Port of Rotterdam is where
22 we're developing projects as well as the Port of
23 Antwerp. Those are the two hydrogen hubs of Europe.
24 And we are proposing to provide that hydrogen for the
25 decarbonizing the port as well.

1 So, there's heavy duty equipment, there's
2 drayage truck that they are using. They are also using
3 green carriage for the movement of containers and, and
4 for marine transport. So, I think that the Europeans
5 are leading the way for heavy duty mobilization ability
6 that are far, far ahead than what we're doing in
7 California at the moment.

8 MR. CHEN: Thanks. Moving on to the next
9 question it's from Bjorn Paulsen. So he asked: "If
10 there's any consideration of underground storage of
11 green hydrogen as a means for long term energy storage?"

12 MR. EDWARDS: So, this is Dave from Air
13 Liquide. I can, I can at least start the conversation.
14 We own and operate the, I think the world's largest
15 underground storage in the, in the Gulf Coast of the
16 United States. It's in a salt dome, it's about the size
17 of a very large city building. It holds enough hydrogen
18 to backup, for example, a nuclear power plant for a
19 couple of weeks for example, if it were used for grid
20 backup. Now, it's not.

21 The — what we're using it for is for pipeline
22 backup for our customers that are using industrial
23 hydrogen. I believe the DOE has looked at California
24 and identified geographically where locations would be
25 ideal for underground storage. I'm not sure how far

1 along the industrial side of investigating those
2 opportunities looks at for power generation and backup,
3 but I know that the, the processes are in place, the
4 evaluations are in place, and the technology has been
5 proven.

6 MR. BROPHY: Yeah, we certainly are looking at
7 underground storage for the longer term. I think
8 California is challenged to the extent that the
9 underground geologic storage here is within depleted
10 natural gas formations, which are a great place to put
11 gas but not if you want to get it back at nine — five
12 ninths of purity to put it into a fuel cell application.

13 So, I think we're a little bit more
14 challenged. But certainly, in the salt — the salts
15 geology of the Gulf Coast and some of the other places
16 in Utah for example, geologic storage certainly is going
17 to make sense.

18 MR. CONNELL: And I would just that HyDeal Los
19 Angeles, one of our initiatives, we're looking at Delta,
20 Utah, for our geologic storage.

21 (Pause)

22 MR. CHEN: Okay, I have one last question here
23 from apprenticeship coordinator. I'm not sure if
24 there's a, a name for this person, but: "Is there any
25 data stating that using—"

1 MR. LUCERO: Dominic.

2 MR. CHEN: "— bio—" Dominic, okay. So,
3 Dominic asks, "Is there any data stating that using
4 biomethane increases incentives or increases pollution?"

5 MS. GERSEN: I think that the best source of
6 information on this is probably a study by the Union of
7 Concerned Scientists, UCS, put out recently. I don't
8 have it at my fingertips, so I highly recommend googling
9 it. And they analyze the enormous revenue opportunity
10 that dairies are seeing from LCFS credits.

11 And I, I think they found that these
12 industrial agriculture operations could expect to
13 receive almost as much revenue from the off gas from the
14 nuclear network from these cows as from the, uh, the
15 milk they produce themselves. Obviously, dairies have a
16 strong incentive to produce milk if they're getting just
17 as much revenue for manure gas. That's a pretty strong
18 incentive.

19 And it's also just really important for folks
20 to understand that methane from manure is not
21 inevitable. It is the result of choice regarding how
22 these industrial agricultural operations manage the
23 manure, and whether or not they're going to take su—
24 sustainable and responsible steps to manage that manure
25 in a ways so that it does not produce methane, or if

1 they forgo those sustainable practices to take advantage
2 of these revenue generation opportunities.

3 MR. CHEN: And I think that's all we have for
4 the Q&A's. I'll turn it back over to Heather at this
5 point.

6 MS. RAITT: Alright, thank you, Peter. And
7 thank you to all the panelists. Commissioner, did you
8 want to say something?

9 VICE CHAIR GUNDA: Yeah, thank you, Heather.
10 I just want to thank all the panelists — Sara, Brenor,
11 Dave, Robert and Nick. Thank you so much for all the
12 comments. Really appreciate you all, both sharing a
13 diverse perspective, but also kind of putting some
14 common threads and some challenges and some potential
15 missed opportunities.

16 And so, Sara, I would appreciate some of the
17 things that you mentioned about the studies if you could
18 docket them if possible, that could — really appreciate
19 that. And also looking forward to having individual
20 conversation with all of you to just kind of learn and
21 think this through. Thanks.

22 MR. CONNELL: Thank you Commissioner

23 (Pause)

24 MS. RAITT: Okay, well, if we're ready, then
25 we can, I think, move on to public comment.

1 (Pause)

2 So, this is Heather. So, it's — if you would
3 like to make a comment, please use the raise hand
4 function in zoom, looks like a high five. We will be
5 limiting comments to one person per organization, and
6 three minutes per speaker. If we have lots of comments,
7 then we may need to limit that to 1.5, one and a half
8 minutes per speaker.

9 Let's see.

10 (Pause)

11 So. First Person is Colby Morrow. Colby, go
12 ahead and you can unmute your phone and make a comment.

13 (Pause)

14 Go ahead.

15 MS. MORROW: Sorry that —

16 MS. RAITT: There you go.

17 MS. MORROW: —tending. thank you, sorry
18 about that.

19 (Pause)

20 VICE CHAIR GUNDA: Colby, we can hear you
21 now. Please go ahead, if you can.

22 MS. MORROW: I'm so sorry. —on my part. I, I
23 d— I was trying to make sure I was mute— it's my hand.
24 Sorry. Can you hear me?

1 MS. RAITT: Yes. So, you don't need —

2 MS. MORROW: Okay. No pro— no. I didn't have
3 anything, sorry about that.

4 MS. RAITT: No worries. Thank you. Alright,
5 we will move on to Robert Perry. Did you have a
6 comment? Go ahead and unmute your line. You can go
7 ahead.

8 MR. PERRY: Yes. Can you hear me?

9 MS. RAITT: Yes, go ahead.

10 MR. PERRY: Okay, great. Fantastic series of
11 presentations and panels. I come away from this with a
12 much clearer idea of where the state of hydrogen
13 production and implementation is.

14 My only, my only comment is, you know, we
15 really need to focus on hydrogen in all aspects of the
16 supply chains, both centralized and distributed
17 applications. I think there are situations where large
18 scale electrolysis offshore, adjacent to the offshore
19 wind farms that are slated to be developed would be —
20 would grant a lot of flexibility, all the way down to
21 the commercial industrial zone within cities, which have
22 a high potential generation capacity. And introduction
23 of electrolysis as a shared facility within a center of
24 these commercial industrial sites which are prone to be
25 more open, receptive, to using medium heavy-duty

1 vehicles that are, are fuel cell based.

2 We, we really need to look at every possible
3 level of, of application because the introduction of
4 electrolysis just confers so much flexibility. And, it
5 really allows us to, to max out the amount of generation
6 that a site can put out. So, that's just the extent of
7 my comment, and I want to thank everybody for the event
8 today.

9 MS. RAITT: Thank you. Next is, Arndt Lutz.
10 Go ahead and unmute you line, and you may comment.

11 MR. LUTZ: Hi. We heard from Brenor how Plug
12 has to use time of day, time of use rates, and to
13 optimize the different electricity schemes to, to make
14 the green hydrogen, or the, you know, zero carbon
15 hydrogen economical. Why, why is it so difficult for
16 the CPUC to just, you know, introduce a hydrogen
17 production rate for anyone in the state that wants to
18 produce hydrogen?

19 And the follow on question to that, or it's
20 not a question more of a comment, is that permitting
21 also needs to be streamlined for hydrogen projects in
22 the state of California. It's, it's just way too
23 complicated to get hydrogen projects permitted. Thank
24 you.

25 MS. RAITT: Thank you for that. If anyone

1 else wants to make a comment, please use the raise hand
2 function to let us know. And, I see one more. And I'll
3 just also mention that if you're on the phone and you
4 want to comment, just press star nine and that will
5 effectively raise your hand.

6 So next is Donald Taylor. And, go ahead,
7 Donald. Unmute — you can unmute from your end.

8 (Pause)

9 Donald, did you have a comment? Do you need —
10 MR. TAYLOR: Can you hear me? Can you hear me
11 now? I'm sorry, I thought — okay. I muted and then
12 unmuted. Okay.

13 So, you know there's some discussion about
14 biogas, and I just wanted to indicate that — like an
15 opportunity to like, Air Liquide and the Apex landfill
16 there in Nevada. Those are fairly rare opportunities.
17 I mean, in California, okay we've got 80 landfills. But
18 it really, the biogas rarely enters on my radar as a
19 source. I mean, I made a lot of money in landfill gas
20 through the years. But really, the amount of resource
21 there is really small. I don't, so I don't really think
22 of that as very much of an issue for hydrogen
23 production. I mean, early on, it's easy for some
24 projects, and it makes a lot of sense. If I was Air
25 Liquide, probably done the same thing.

1 But really, if you look at biomass, not
2 biogas, for example, in California, just the amount that
3 we dispose in those 80 landfills is about 80,000 tons a
4 day. And if you use just the bio fraction of that we're
5 disposing, that will produce about 3 million tons a year
6 of hydrogen. I mean, the conversion rate — if you take
7 a ton of biomass, you can make about a megawatt of
8 electricity. But if you convert that to hydrogen with
9 60 percent efficiency, which is, you know, fairly
10 modest, you're talking about probably 200 pounds of
11 hydrogen per ton of hydrogen. So, I mean from a — per
12 ton of biomass.

13 So, the amount of resource available from
14 biomass in California is tremendous. Biogas is, you
15 know, you're talking about dealing with manure is a
16 local problem, and landfills is a local problem. It
17 isn't really, I don't think, a major source in the long
18 term. And I understand the long-term view, these
19 various methods.

20 We haven't talked about ocean production of
21 hydrogen, wind to hydrogen and electrolysis ocean water,
22 which is probably one of the big ones. So, you know,
23 there are just various other sources that we need to
24 consider, biomass being one of the big ones. Biogas, I
25 don't think that's really on the radar, in my opinion.

1 But, I do appreciate the time to make the comments. I'm
2 sure everybody's ready to go home. Thank you all so
3 much for the comments, it's been really great. Thank
4 you.

5 (Pause)

6 MS. RAITT: Okay, one more — one last call for
7 comments, so raise your hand or press star nine if
8 you're on the phone.

9 I see one more hand up. Mikhael "Mik"
10 Skvarla. Go ahead. I'll — let me unmute you.

11 MR. SKVARLA: Hi, Mikhael Skvarla here, on
12 behalf of the California Hydrogen Coalition. Again, I
13 want to express our appreciation for this long day.
14 We've heard a lot of varying perspectives on different
15 production pathways and uses, and the rest.

16 Ultimately the market will decide its consumer
17 uptake and adoption. It's how the businesses decide to
18 utilize energy, resources for their certain processes.
19 But what we do know, is in the pathway to carbon
20 neutrality we need to provide, kind of, a set of
21 guidelines and allow the market actors to conform.

22 You know, it's the role of the government to
23 ensure that everyone's playing by the rules that are
24 set. And if the path to the decarbonization is, is, you
25 know, applied equitably across multiple industries,

1 giving everyone the opportunity to transition, we will
2 ultimately see what is taken up and what is not taken
3 up.

4 And so, I don't think it's an argument of this
5 production type versus the other production type.
6 They'll all likely be used in various sectors of the
7 economy. And we look forward to continuing to work with
8 the CEC through the IEPR process, and their other
9 regulatory proceedings, to ensure that hydrogen has a
10 fair seat at the table. And, we want to ensure that
11 when we are critical of hydrogen as a energy carrier,
12 that we apply that criticism equitably across other
13 energy resources.

14 Nothing is without a consequence. That goes
15 for electricity, goes for the production methodologies
16 of renewable electricity. The cradle to grave on all of
17 these things is important, which is why I think you've
18 heard pretty unanimously across the hydrogen sector, and
19 folks presenting here today, that a carbon intensity
20 score and pathway is one that is most important for this
21 industry.

22 We know that CHC has introduced legislation on
23 a number of occasions to pursue that, and we'd gladly
24 work with any of our ENGO colleagues to achieve that
25 goal, ultimately, creating parity between hydrogen and

1 the grid as we move forward.

2 With that, I thank you and look forward to
3 following up directly with some of the Commissioners and
4 staff.

5 (Pause)

6 MS. RAITT: Thank you. I don't see any more
7 hands up. So, I think we are done with public comment.

8 VICE CHAIR GUNDA: Thank you, Heather. So, I
9 just want to thank our team, Heather, and your team for
10 an extraordinary day. And, all the staff that helped
11 think through organizing today. You know, just —Jane,
12 Kevin, Rizaldo, Peter, Jennifer, Carey, as well as
13 David, who already left. So, just a, a big thanks for
14 you for providing this presentation.

15 But I also want to thank Commissioner Monahan
16 and Commissioner McAlister's offices for shaping the
17 conversation today, and, and providing their input on,
18 on how best to structure today's workshop. So, thank
19 you all. I really encourage both the participants, in
20 terms of panelists, as well as attendees to please
21 submit comments.

22 At the end of the day, we want to provide a
23 venue to begin to coalesce on key agreements, key
24 opportunities for continued agreement, development — but
25 also clear actions on what we should be doing moving

1 forward. So, thank you all. With that, I will adjourn.

2 Heather, I need your head nod.

3 MS. RAITT: Sure. I, well, can I just make
4 one announcement? I just wanted to put a plug in for
5 all the passionate people that are still on the line.
6 We are — the Energy Commission is accepting nominations
7 for the 2022 Clean Energy Hall of Fame awards, and we
8 encourage folks to, to participate in that. It's a
9 great way to recognize local leaders for their
10 contributions for achieving clean energy future.

11 And so, the information for nominating anyone
12 on that is on our Energy Commission's web page. So, I
13 just wanted to put that plug in. Thank you.

14 And, and then just finally, again, comments
15 are very welcome. Written comments are due July 12.
16 And thank you everybody for being here and
17 participating.

18 (Thereupon the Workshop was adjourned at 4:48

19 P.M.)

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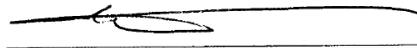
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I do hereby certify that the testimony in the foregoing hearing was taken at the time and place therein stated; that the testimony of said witnesses were reported by me, a certified electronic court reporter and a disinterested person, and was under my supervision thereafter transcribed into typewriting.

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IN WITNESS WHEREOF, I have hereunto set my hand this 17th day of August, 2022.



PETER PETTY
CER**D-493
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Myra Severtson
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