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CALIFORNIA ENERGY COMMISSION

IEPR COMMISSIONER WORKSHOP

In the Matter of:	)	Docket No. 20-IEPR-02
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CALIFORNIA ENERGY COMMISSION

PLUG-IN ELECTRIC VEHICLE CHARGING INFRASTRUCTURE

REMOTE

SESSION 3
THURSDAY, AUGUST 6, 2020

10:00 A.M.

Reported by: Jacqueline Denlinger

APPEARANCES

CEC COMMISSIONERS (AND COMMISSIONER ADVISORS) PRESENT:

Patty Monahan, 2020 IEPR Update Lead Commissioner
David Hochschild, CEC Chair
J. Andrew McAllister, CEC Commissioner
Richard Corey, California Air Resources Board Executive Officer

STAFF PRESENT:

Heather Raitt, Assistant Executive Director, Policy Development
Jonathan Bobadilla
Rosemary Avalos, Public Advisor's Office

PRESENTERS:

Matt Alexander
Eric Wood, National Renewable Energy Laboratory
Dong-Yeon Lee, National Renewable Energy Laboratory
Bin Wang, Lawrence Berkeley National Laboratory

PUBLIC COMMENTS:

Ian MacMillan, South Coast Air Quality Management District
Ray Pingle, Sierra Club California
Stephen Davis, Oxygen Initiative

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P R O C E E D I N G S

AUGUST 6, 2020 10:00 A.M.

MS. RAITT: Good morning. Good morning, everybody. Welcome to today's 2020 IEPR Update Commissioner workshop on Plug-In Electric Vehicle Charging Infrastructure.

I'm Heather Raitt, the Program Manager for the Integrated Energy Policy Report, or IEPR for short. Today's workshop is being held remotely consistent with Executive Orders N-25-20 and N-29-20 and the recommendations from the California Department of Public Health to encourage physical distancing to slow the spread of COVID-19.

Instructions for attending or participating in the meeting were provided in the notice and include both Internet and call-in options. The notice is available on the Energy Commission's website.

This meeting is being recorded. The workshop is being held in four sessions over two days. Welcome back if you were able to join the first two sessions that we held on Tuesday. If you missed them, we will post a recording, a written transcript on our website for all the sessions. Also, presentation from today and Tuesday have been posted.

As always, attendees have an opportunity to provide comments on the material in today's workshop. We will take verbal comments at the end of this session. Also, so for those using Zoom online, go ahead and click raise hand icon to let us know that you'd like to make a comment. And for those on the phone, you can press star 9 to raise your hand. Then we'll open lines during the public comment period.

Alternatively, written comments after the workshop are welcome and they are due on August 27th. Again, the meeting notice provides detailed instructions for how to provide written comments.

And with that I'll turn it over to Commissioner Patty Monahan for opening remarks. Thank you.

COMMISSIONER MONAHAN: Great. Good morning, everybody and welcome to our workshop on Electric Vehicle Charging Infrastructure.

And I am very excited to have today's series of workshops because the CEC is hard at work on -- to meet the requirements of AB 2127, which requires us to evaluate the charging needs to meet California's 2030 goals for transportation electrification. And we -- the team has a number of different studies underway with contractors, some under -- some internal and some with contractors, so today's workshop will be sort of the first opportunity to unveil some of the early results of those analysis and to get -- to get feedback to help us get to the finish line on this final report.

So we may have some other folks joining me on the dais. I think for now, I'm the only one. Is that right, Heather?

MS. RAITT: Yes, that's right.

COMMISSIONER MONAHAN: Okay. So it's possible that Richard Corey, who is the Executive Officer from the Air Resources Board will be joining us and fellow Commissioner, Commissioner McAllister on the CEC. So more to come if they're able to join.

So I want to turn it over to Joshua Cunningham who is, I would say, the ZEV analyst extraordinaire at the Air Resources Board. That's not his formal title, but that's what I like to call him.

Joshua has been really a lead in terms of evaluating what are the numbers in terms of EV deployment and how do we -- how do we reach California's ambitious goals both around zero-emission vehicle deployment, but also to reach a carbon neutral economy by 2045.

So I welcome Joshua. He's the -- his formal title is the branch chief for the Advanced Clean CARB Branch at the Air Resources Boards. And that's the branch that develops and implements the advanced clean cars regulations, as well as other programs to support the growth of the zero-emission vehicle market.

So Joshua, I turn it over to you.

MR. CUNNINGHAM: Right. Thank you, Commissioner Monahan. I appreciate your kind remarks and I'm very pleased to be participating in today's Energy Commission event.

I realize this is a really important conversation to inform necessary future infrastructure, particularly for plug-in technology. The Air Resources Board relies on the Energy Commission analysis for our regulatory developments on mobile sources. Having a good sense of required charging infrastructure is important for us as we set regulatory trajectories for electric vehicles, so we appreciate this partnership.

My goal for this presentation as the Commissioner noted is to present the scale of electrification necessary to achieve our long-term emission targets. Both the climate targets and criteria emission targets have continued to evolve over the past couple of years and the Air Resources Board has to recalibrate our electrification needs to stay on course to protect the public health and our environment. So today's presentation as the kickoff for today's session is to kind of give you a preview of that ongoing analysis. And a lot of the details will be released this fall in our mobile source strategy update.

So if we could go to the next slide, I'll start walking through my information.

So I always like to give some context before we talk about the trajectory for electrification. We need to know where are we today on emissions. So this graphic shows the current emissions inventory using 2017 as a reference, where we have both a robust emissions inventory for NOx emissions and GHG emissions.

And if you look at the left side first, the statewide NOx emissions, transportation sources comprised close to 80 percent, if you add all of those colored slices and the including the light blue off road. The majority of what we're talking about for infrastructure for vehicles is in on-road sectors. And so if you focus in on those portions of the graphic, they represent 45 percnet of statewide NOx emissions, and so they are a critical contributor to ozone formation that we need to be addressing.

On the right-hand side, the statewide greenhouse gas emissions for 2017. Again, transportation plays a dominant role, although not the largest so they provide close to 40 percent when you look at off-road and on-road sectors. If you then add in the industrial fuel refinery emissions, you're over half of the statewide green gas -- gas emissions are associated with transportation.

The one thing I'll note when you're looking at specific inventory for reference, light-duty vehicles are much more of a dominant challenge for the greenhouse gas side and less on the criteria on the NOx side. It's the reverse. Light duty is still a contributor, but the heavy duty, particularly the heaviest classifications, play the dominant role.

Next slide.

So to again set the context, the two primary targets for emissions that are driving a lot of what we do at the Air Resources Board and our partner agencies on the left side. Three or four years ago, the federal government established new ozone standards. The current ozone standard that has established since is the 75 parts per billion ozone requirement. And we have SIPs for the South Coast Air Basin that will show attainment requirements in 2031. But the new standard, which drops it to 70 parts per billion, is going to require further NOx emission reductions that are extremely aggressive with attainment requirements in 2037.

And so over the next year or so, Air Resources Board will be working with the air basins to establish SIPs for that newer requirement. And that is a focus for our updated Mobile Search Strategy coming out this fall. And part of the preview of the strategy is what I'll be showing in the rest of the slide deck.

On the right-hand side, this is something that I know everybody's familiar with, the prior governor established a Carbon Neutrality Executive Order setting that target statewide, economywide, for 2045. And then the existing statute SB 32, 40 percent below the 1990 levels by 2030.

The Air Resources Board is going to be moving forward on an updated scoping plan to establish trajectory and set of strategies for this, and that scoping plan will be rolling out later than Mobile Search Strategy, likely in 2022.

Next slide, please.

So I want to walk through high-level trajectories for where electrification may have to go to meet these targets. Although these scenarios do not show that we are completely meeting those emission targets and so more actions will be needed. I'm going to start with the light-duty sector. This is the program that I have the closest connection to and understanding.

This first graph shows our projected baseline for our current emissions inventory, current programs that have already been adopted by the board, and also relying on consumer choice modeling from the Energy Commission that we're starting to partner with. So we are showing that with current policy actions, that it is likely we will hit the governor's 1.5 million electric vehicle on road target by 2025 and that's assuming a sales growth from today to about 11 percent or so by 2025.

At that point, the zero-emission vehicle regulation for light-duty flatlines in terms of stringency, we see a slight uptick in consumer demand for electric vehicles out to

2030 with other cost reductions. But then we're, in our inventory, projecting that to flatline. So overall message is that we'll only get to about half of the electric vehicles we think we need under the prior governor's target of 5 million by 2030 in current business as usual policies.

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So we began scenario work last year. So this is a scenario we put together a year ago. We'll be providing newer information in a month or two. But it is similar to what we're starting to relook at, and it is a scenario where we looked at extreme sales trajectories for electrification to see if we could achieve the carbon neutrality goals in 2045. This scenario assumed that we would scale up to 100 percent pure electric and plug-in hybrid sales by 2035. So ending conventional vehicle sales by that point.

And you can see that the colors in the graphs present the penetration of those technologies in the on-road fleet new and used vehicles over time. And by 2045, you still have about 20 percent of all the cars on the road are a conventional vehicle or hybrid vehicle using gasoline as their sole source.

So it is not enough. We recognize that this is a trajectory that needs to be further reviewed and that's what we're doing this fall. But a core message that I want to emphasize relative to the 2127 Analysis at the Energy

Commission is that we have to at least get to the 5 million ZEV plug-in hybrids by 2030 if we want to be on this path. And our newer analysis will show we're going to need to be ahead of that, the higher value by 2030.

Next slide, please.

So key light-duty regulatory actions that are new policy initiatives that we're moving forward on, that will start to chip away at this gap from baseline versus where we need to go. We are committing to moving forward on new light-duty vehicle regulations. We hope to go to the Board at the end of next year with our Advanced Clean Cars 2 regulatory package, and a critical piece to this will be our zero-emission vehicle regulation updates. We're taking a careful look at electric vehicle costs that are coming down, technology advancements with models that are coming to the market. And we’ll be establishing a strong trajectory towards these carbon neutrality goals with the ZEV regulation.

But we still need to be pushing conventional vehicles to be lower emissions as well, both on greenhouse gas emissions and current emissions. And so that will be continuing to be a piece to our overall package for Advanced Clean Cars 2.

A new initiative that we're moving forward on with the Statute Senate Bill 1014, passed in 2018, is to establish requirements for greenhouse gas and electrification on Uber and Lyft ride-hailing companies. It's called the Clean Mile Standard and we’ll be proposing a regulation to the board earlier, likely this December. But we're nearly done with our regulation package development and it'll be including very aggressive electrification requirements by 2030 for those companies. And the most tangible implications for Energy Commission plans and infrastructure is going to be the need for DC fast charging in urban and along travel corridors for these high mileage vehicle applications.

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So the second half of the scenarios that I'd like to walk through are the medium-duty and heavy-duty analyses. So this is a much more enhanced analysis that we're doing compared to the 2016 Mobile Source Strategy. Some of these scenarios have already been previewed at the workshop for the Mobile Source Strategy earlier this year but we’ll be finalizing these again, similar to the light duty in the next month or two.

But I want to walk through a couple of key trajectories because for these sectors, this is an extreme transformation and the Air Board is already moving forward on some regulatory actions. But for medium-duty vehicles, these are classifications between 8500 pounds and 14,000 pounds, we're projecting the need to really start electrifying with actions beginning in 2024. And this particular scenario assumes that we scale up to the on-road fleet population being close to 60 percent of the on-road medium-duty vehicles as ZEVs by 2045. And then the conventional vehicles being low-emission vehicle certified to meet our NOx reduction needs by 2037.

One of the data points that we're showing in the upper right-hand side of this graph, it's in small print, but it is that given that we will not have full electrification for this sector by 2045, and you have conventional vehicles, the question of carbon neutrality rests on whether you can see renewable liquid fuels, biofuels, renewable diesel, renewable gasoline, as examples to reach our carbon neutrality goals.

And so we're showing a billion gallons per year demand in these scenarios. For gasoline, this particular scenario results in about a quarter of a billion gallons. For reference today, as many of you probably know, we have about 1.5 billion gallons of ethanol to use in E10 fuels in California. So although this is low, biomass is very limited nationally and internationally. And so it will be a constraint achieving the use of renewable liquid fuels for these conventional vehicles is not going to be easy. And so there -- to do this, we need to push electrification as hard as we can.

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Shifting to the heavy-duty vehicles. So these are vehicle classifications above 14,000 pounds. This is the more complicated sector, given the large number of use profiles and vehicle types. If you look at the far-left hand side, one of the primary transitions that we're seeing from current policy actions is our truck and bus regulation that was adopted a number of years ago. And so in the lower quarter you can see that we're shifting over to our 2010 certified NOx emission vehicles and engines. And by 2023, we’re requiring that the majority of those are shifted to those low-emission engines. So you see a forced fleet turnover to those value -- those vehicles by 2023.

But what's critically challenging is that even though we forced the fleet to be those low NOx engines by 2023, we then need to start transitioning and shifting many of those over to electric vehicles to ensure that by 2045 none of those engines are still on the road. That's both to meet carbon neutrality but also to ensure that these heavy-duty sectors are doing a deep reduction in NOx emissions for 2037.

So this particular scenario highlighting a couple of data points on here shows that by 2037, 44 percent, so close to half of these heavy-duty vehicles will be electric vehicles. And that's through regulatory action and potentially accelerated turnover, which is a heavily challenging policy action.

The colors on the top are showing that in addition to electrification, the Air Resources Board is already moving forward on newer lower NOx requirements at the scale of 90 percent below the 2010 emission requirements or more aggressive than that. And so the orange graphic shows the -- the certain proportion of the fleet is transitioning over to California low NOx requirements. And then we are hoping that the federal policy will move to a federal low NOx engine because the fairly large portion of our heavy-duty Class 8 trucks that operate in California are registered out of state. And so NOx emissions from those are not under California’s control for -- for emissions, particularly in the south coast for Port activity and shipments that move across state lines.

Okay, next slide.

So this is my final slide highlighting a couple of key policies that I've hinted at for the medium- and heavy-duty sectors. We are moving forward on electrification requirements for these classifications, both for new manufacturers and in select cases like fleet at airports. And other select cases we're putting in fleet requirements for on-road operation.

For the medium-duty classifications, as part of our

Advanced Clean Cars 2, we will be considering lower NOx requirements and criteria emission requirements for those classifications, as well as continued efficiency improvements which address greenhouse gas emissions.

On the heavy-duty side, similarly aggressive electrification beginning in 2024. Cleaner diesel technology requirements, like I alluded to with low NOx requirements, and then wherever we can, pushing for renewable fuels. Renewable diesel has entered the market in California as part of our low-carbon fuel standard and we hope to see that scale up.

So I would end with that. I'm hoping that this is provided at a high-level context for the need for extremely aggressive transition to electrification. But that given the relatively constrained time frames over 15, 20 years and the fleet turnover timelines that are commonly longer than that, we don't project we'll be getting to full electrification even by 2045 unless we take additional actions for fleet turnover. And so policy actions now are critical. Review of renewable fuels is critical. And with all of that, infrastructure is an absolute necessity to -- for us to hope that the consumer markets will move forward and change over to electric vehicles.

So at this point I would like to turn it, I guess, turn it back to Commissioner Monahan and I would be happy to answer any questions, as necessary.

COMMISSIONER MONAHAN: Thanks, Joshua. That was a great presentation. I learned a lot and I have -- I do have a number of questions.

I -- can you -- so we're trying to figure out, you know, in general, how can we tailor our investments to the Clean Transportation Program to support both infrastructure and fuel production in the state of California. And one of the questions I had for you is as -- as you -- as you think through what are the optimal ways to prioritize where these fuel should go. And I'm thinking in particular, biofuels. You know, we know we're going to need some liquid biofuels. We know there are some constraints. We know there are sectors that are going to be hard to electrify.

And I'm curious about, for your analysis for the scoping plan, though right now you are looking at just sort of this -- these priority areas in the medium- and heavy-duty on-road fleet. You know, but we have air travel, we have ports, we have -- we have, you know, some of these long-distance trucks that may be hard to electrify. Will your scoping analysis do any sort of priority areas for where liquid biofuels should be directed towards?

MR. CUNNINGHAM: Yeah, that's a really important question and it's not a, I don't I don't have an easy answer, but I'll give you some -- some insights. The Mobile Source

Strategy this fall will probably not dive into that in a rigorous way. We're focusing more on the mobile side demand of the fuels for this fall. But as you mentioned, the scoping plan will be getting into this in a much more rigorous way over the next year and a half as we go into the 2022 scoping plan. I guess two years.

So just some trends that I expect to be playing out in that discussion. One is that within the transportation sector, as we're seeing in the current market conditions for advanced renewable fuels, driven by the low-carbon fuel standard, we’ve seen renewable diesel enter the market. So that's a drop-in fuel. It's not a bio diesel, it can be blended in at varying levels. So that has entered the market. We're very excited about that being driven by the low-carbon fuel standard requirements. Renewable jet fuel has entered the market now, too, in very small volumes. I think San Francisco SFO is starting to see use of that. So we're very excited to see both of those.

What we have been surprised and disappointed to see is that renewable gasoline, which will be a drop-in fuel, has not entered the market at a competitive level. There are technologies out there, but they're still extremely costly and so unfortunately we're not seeing that. In terms of biomass going to a drop-in fuel, we are not seeing it moving into gasoline in the foreseeable future.

And so strictly from a fuel production cost development, that is kind of dictating where biomass is going for liquid fuels today. Now that could change in the future based on technology progressions, but there's a consistent trends with that in terms of where we think liquid fuel demand will continue to be.

Jet fuel is probably where we're going to need to see liquid fuel usage longer term and that not -- may not necessarily be dictated by a top down policy, it may just be the demand side. But aviation will be willing to pay more for renewable fuels because there are very little options for them to electrify. And so I could see renewal jet fuel being a high usage long-term renewable diesel continuing to grow because of the long-haul Class 8 trucks. And then renewable gasoline is just really an unknown at this point.

And so there are questions now about whether low-carbon ethanol should be relooked at. E85 for light-duty vehicles in addition to electrification, but that has its own challenges for infrastructure rollout. So at the moment we're focusing on electrification for light duty.

Hopefully, that provides some sense. I guess the other trend I'll just quickly mention is that there is going to be competition on the nontransportation sources. So industrial facilities, particularly cement and other high-energy intense facilities, you know, it will be hard for them to electrify process activities and so we anticipate there's going to need to be renewable natural gas or even potentially renewable hydrogen for some of those select industrial facilities. So there will be some competition for the fuels in those sectors, but those are kind of high-level answers to your question that hopefully will play out in the next two years from the scoping plan.

COMMISSIONER MONAHAN: And I was curious when I saw your charts for medium-duty vehicles and heavy-duty vehicles, and I know they were a little bit, you were looking at different factors, but I was surprised to see higher, what appeared to be a higher penetration of electrification in the heavy-duty sector versus the medium-duty vehicle sector. And I've always thought of the medium-duty vehicle sector as actually something that's kind of optimal for electrification and I was wondering if you could just walk me through that.

MR. CUNNINGHAM: Yeah. These are just scenarios at the moment but they are driven by where we think the most optimal need is when we're looking at both pollutants. For the NOx emissions, particularly in the South Coast Air Basin, the heavy-duty vehicle classifications have a much more dominant role than medium-duty vehicles. And so if we're going to be targeting regulatory actions for accelerated fleet turnover where we put really onerous requirements on fleets to purchase electric vehicles, we have a bigger impact if we focus on the heavier classifications just because you then are addressing not just carbon neutrality but the 2037 NOx reductions.

So some of that is being driven by where we feel if we're going to put strong policy actions where we can get a bigger impact for health benefits.

COMMISSIONER MONAHAN: That's very helpful. And I'm excited to hear about the timeline for the light-duty vehicle regulations.

One -- one, I think we just have a few more minutes left. But one question about the light-duty vehicle analysis. The plateauing of vehicles, EVs, presumes that the market won't go there anyway. You know, and there's some analysis from BNS and others that indicates that, you know, by 2025 and definitely by 2030, most light-duty vehicle classes will be cheaper than their internal combustion counterparts by 2030.

And -- and there will be some market uptake, just because of cost reductions. What’s ARB’s view on -- on whether the market -- the EV, on when the EV market will just take off without regulatory mandates?

MR. CUNNINGHAM: Yeah. That's a really core question that we are looking at with our regulatory analysis. So we are studying when we think cost parity will occur. That will depend on the battery size. So the heavier, you know, the light trucks, it'll be a later point, longer range, battery electric vehicles, a little bit later point. But I think it is quite likely for passenger cars, the middle range vehicles, you're going to see cost parity within this decade, maybe mid-decade.

So the -- we do anticipate that natural market growth will start to occur. I think what we're including in our -- in that graphic I showed for our baseline is up to 2030 in partnership with your agency's Consumer Choice Model, we are projecting slight overcompliance with the ZEV regulations. So for the first time in our inventory, we are projecting some natural consumer growth above minimum compliance with the regulation up to the 2030 point. And so we -- that's included in my graphics.

But for our official inventory, we didn't want to project for the baseline beyond 2030. So we just flatlined the market sales at that point. I -- just speculating, that I would expect as costs do decline past 2030 that natural market growth would start to take off after that point. It is dependent on infrastructure and consumers concerns with battery warranty and other natural market inhibitors, but I think it is likely that the natural market would grow faster than what I'm showing in my baseline graphic. But we felt it was important to just plateau at that point for our reference without speculating too much.

And then certainly for us to meet the 2045 carbon neutrality natural market, growth is not going to be enough. We still do believe that with cost parity coming, we're -- we're still going to have to put pressure on the market with regulations.

COMMISSIONER MONAHAN: Yeah. And I'm not debating that, that's for sure. I actually believe that I mean the only reason we have electric vehicles thriving today is because of the zero-emission vehicle mandate that California put in place decades before anybody else was even talking about this. So it's -- it's clear that the leadership of the Air Resources Board and manifested most recently by the adoption of the Clean Trucks Regulation, the Advancement Clean Trucks Regulation which for the first time in the -- in the -- in world regulatory history has set a course for having all new zero-emission trucks by 2045.

So I just, you know, kudos to you and your team. Agree that we’ll need strong regulation to ensure that we meet aggressive targets. And it's more just that if we're all working to a point where hopefully the market will just take off. And in the three Cs, cost, consumer awareness, and convenience, which means a convenient infrastructure for refueling your vehicle, are all three pieces that need to come together in order to have that market acceleration.

So Joshua, thank you so much. Really appreciate your coming and providing this information. Look forward to deeper analysis when you're -- when you're looking at how do we meet our 2045 carbon neutrality target. So we'll invite you back once that analysis is done.

MR. CUNNINGHAM: Great. Thank you, Commissioner, and thank you, everybody. We really appreciate our partnership with the Energy Commission.

COMMISSIONER MONAHAN: Thanks, Joshua.

Heather, I'll turn it over to you to introduce our next presenter.

MS. RAITT: Great. All right. And thank you again, Joshua. So I'd like to go ahead and introduce Matt Alexander. Matt is an air pollution specialist in the Electric Vehicle Infrastructure Unit and he leads the Energy Commission’s light-duty modeling efforts.

So Matt has some introductory remarks and then he'll introduce the remaining speakers. So go ahead, Matt. Thank you.

MR. ALEXANDER: Thank you, Heather.

Good morning, everyone. I hope you're all doing well. It is my pleasure today to help kick off the second day of our Charging Infrastructure IEPR Workshop. Joshua just gave a great overview of CARB’s work on the electric vehicle side, and now I'm going to introduce our work on the charging infrastructure side to support these vehicles.

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I'd like to begin by taking a retrospective look at one of our landmark infrastructure investments, the Electric Vehicle Infrastructure Projections Model and its impact on California's charging infrastructure. EVI-Pro developed in collaboration with the National Renewable Energy Laboratory, projected the charging infrastructure needed by 2025 to support 1.3 million plug-in electric vehicles, providing the number, type, and location of chargers at the county level.

It also critically provided load profiles based on the model's charging demands, an example of which is shown here on the right. An immediate impact of this work was seen in former Governor Brown's Executive Order B-48-18, as this analysis informed the call for 5 million zero-emission vehicles by 2030 and 250,000 chargers by 2025, including 10,000 DC fast chargers.

And at a broader level, EVI-Pro really opened people's eyes to the impact of electric vehicle charging, especially on the grid. As well as the level and scale of charging infrastructure that would be needed, and the value of infrastructure demands modeling for planning efforts.

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As a result, our policy leaders decided to expand these infrastructure assessments to additional vehicle sector areas of analysis and time frames. Here you can see the signing of Assembly Bill 2127 and SB 1000. The former of which is the focus of today's workshop.

As others have already noted, AB 2127 directs the CEC to assess the charging infrastructure needed to support 5 million zero-emission vehicles, and a reduction of greenhouse gas emissions of 40 percent below 1990 levels by 2030.

SB 1000 tasks the CEC with assessing whether light-duty charging infrastructure deployment is disproportionate. Furthermore, EVI-Pro and Executive Order B 4818 spurred the evolution of the Infrastructure Deployment Strategies Concept in the 2018 ZEV Action Plan developed by the governor's office.

On Tuesday, Noel Crisostomo walked through our infrastructure deployment strategies through the lens of interoperability. But now I'm going to look at this through the lens of infrastructure demand modeling and how this permeates across all the pieces of the infrastructure deployment strategies.

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Let's begin fundamentally with the models themselves. Conducting infrastructure demand modeling is the first step towards supporting planning efforts at the state and local levels, as these analyses help us understand what chargers are needed to meet our goals. This includes number, type, and location of chargers as I explained in my description of EVI-Pro. These results also highlight projected load and grid impacts.

As we will see later this morning, the impact of charging loads, especially in medium and heavy duty are anticipated to be on the order of several gigawatts. And it is critically important to have these types of models and projections to inform relevant stakeholders, such as utilities, of these potential impacts.

While the models that will be discussed today are largely focused at the statewide level, there's also an important place for modeling efforts focused at the local level. This was exemplified with our EV Ready Communities Blueprint Challenge, which funded blueprint projects in nine different counties. These projects highlighted the benefit of localized studies which allow for more specificity and tailored inputs and outputs that may not be feasible to incorporate at the statewide level.

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By supporting planning efforts, infrastructure demand modeling can subsequently lead to determining implementation pathways. Within the models, scenarios and sensitivities such as smart charging and different rate structures can be leveraged to evaluate the potential for minimizing grid impact. At the same time, stakeholders who have been alerted to the potential grid impacts can begin exploring these mechanisms to mitigate the impact in practice.

Infrastructure demand modeling can also quantitatively capture the benefits of standardization and interoperability by improving utilization amongst electric vehicles and charging stations to optimize the size of the charging network.

Finally, the statewide and local charging needs determined in the previous step, provide a framework for communities to find the charging solution that is the best fit for the local environment and use case. Every region is different with unique characteristics, such as population density, housing composition, grid characteristics, and more that require tailored charging solutions from a portfolio of options available in the market.

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Modeling results and development of implementation pathways in turn helps spur the market. The infrastructure demand modeling sends critical market signals for needed infrastructure with help -- which helped direct investment regionally, as well as by technology, use case, and more. Furthermore, with growing EV adoption and charging demands, it is increasingly important to transition to private capital and investment to allow the market to flourish and become self-sustaining, which is currently being explored by Tim Olsen’s Clean Transportation Private Finance Initiative.

Infrastructure demand modeling can also aid in investment planning for these stakeholders to build upon public programs and find favorable investment opportunities. The modeling analyses and results also create unique opportunities for business model innovation, particularly with grid integrated and best fit local solutions as I described in the previous slide. These innovative solutions can address the needs as well as the warning signals identified by infrastructure models.

I'd also like to note that we are collaborating with the CEC’s Energy Research and Development Division on their Empower Innovation effort to elevate these types of innovative solutions. Empower Innovation serves as a networking portal driving California’s clean energy economy by informing entrepreneurs in local communities about funding opportunities and information connecting them to potential project partners. I'd encourage you to follow the link here to find out more information.

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All this culminates in figuring out how to actually bring these charging infrastructure projections to life. At the statewide level, infrastructure demand modeling quantifies the need for a complete ecosystem of manufacturers, suppliers, and trained installers to build out the network and close charging gaps. As a complement, it also enables long run infrastructure and grid planning, as described earlier, as well as operational analysis, resulting in reliable and quickly energize infrastructure.

And as we heard in Tuesday's workshop, it is critical to engage with communities at the local level to maximize the acceptance and success of deployed charging infrastructure. Tara Lynn Gray noted how communities have data, storage, and inputs that we may never even know or think about. These are incredibly valuable to inform modeling efforts and appropriately assess needs.

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Combining these four pieces informed the collection of innovative infrastructure deployment strategies shown here. This process of analyzing charging needs that can be scaled across the state intends to transition the market to a self-sustaining ecosystem that brings electric transportation to all. Critically, the feedback loop on the right side of the figure highlights how this is a continually evolving process. With this context in mind, I'd like to dive deeper into the focus of today's workshop, assessing needs.

Next slide, please.

As I mentioned before, the AB 2127 directive consists of numerous components, which the CEC is addressing through various efforts. I will begin with the existing chargers portion. Some of you may have attended our Counting Chargers Workshop last month, which is an effort led by Tom Lopez aimed to better account for public and shared private chargers in the state. And those of you who attended Tuesday's workshop heard Tiffany Quang walk through our SB 1000 analysis, which assesses whether light-duty charging infrastructure deployment is disproportionate.

As of now, these efforts are focused on light-duty infrastructure, but there is the possibility that these could expand to other vehicle sectors in the future.

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Oh, perfect. The CEC is also tasked with looking at the future chargers needed through our modeling efforts. On the light-duty side we have EVI-Pro 2, the successor to the EVI-Pro model I described earlier, EVI-Pro RoadTrip which focuses on DC fast charging demand to enable interregional long-distance travel, and the Widespread Infrastructure for Ride-hailing EV Deployment model, also known as WIRED, which focuses on charging demand from transportation network companies.

We are also looking at infrastructure needs for medium- and heavy-duty vehicles through the medium- and heavy-duty electric vehicle infrastructure projections, also known as HEVI-pro. And finally, we are addressing other electric vehicles in the off-road, port, and airport sectors. So these analyses are in earlier stages compared to the others I just mentioned.

Together, these future infrastructure analyses form of family that we call Expanded Electric Vehicle Infrastructure Projection, since they cover the full suite of vehicle sectors.

Next slide, please. Oh, I think we might have skipped a slide there.

Lastly, across all vehicle sectors, the CEC is tasked with looking at charging hardware and software, make-ready electrical equipment, and other programs to accelerate the adoption of electric vehicles.

On Tuesday, Noel Crisostomo discussed the charging hardware and software components as well as other programs to accelerate adoption of electric vehicles, such as TERPA. While Micah Wofford presented on the EDGE tool he’s developing, which will help analyze the make-ready electrical equipment needed.

Combining all of these pieces together creates the framework for our AB 2127 assessment and contextualizes how our individual analyses fit in and connect with each other.

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However, the main focus of today's workshop is the future chargers piece of AB 2127. As I just described, we have a number of key modeling efforts in this area and today we have the opportunity to hear from the principal modelers for the light-duty and medium- and heavy-duty on-road analyses.

Next slide, please.

I'd like to conclude my presentation by providing a bit more context for our Expanded Electric Vehicle Infrastructure Projections work. This circular flow chart illustrates the process flow for these analyses. And starting at the top, these analyses begin with developing the key scenarios, forecasts, and inputs for the model.

For those of you who attended the Energy Assessments Division's Demand Analysis Working Group meeting a few weeks ago, I highlighted how we have coordinated with their team on a number of key points in this area, including the vehicle forecasts and attributes. Since these modeling efforts take a policy achievement orientation to determine the charging necessary to meet our air and climate goals, we are also closely coordinating with California Air Resources Board's EMFAC and Mobile Sources Strategy teams on forecasting and addressing the critical regulatory, economic, and climate constraints associated with these analyses.

Finally, we've principally worked with our collaborators at UC Davis, NREL, and Lawrence Berkeley National Lab to better determine the travel and charging behavior of drivers to use as assumptions and inputs in our models. These inputs feed into the charging choice and charging control modeling. This is the heart of the modeling assimilation, as we will learn more about in the presentations today on EVI-Pro, HEVI-Pro, and TMC modeling. The outputs of these models provide projections of the charging infrastructure needed, as well as load profiles associated with the charging demand.

Next is geospatially aggregating and disaggregating load, which Micah discussed in his presentation Tuesday on the EDGE tool. This tool will help planning entities focus deployment strategies and infrastructure investments in order to meet several key goals, such as charging need associated with electric grid impact minimization, air quality improvement goals, EV travel demands, and equitable infrastructure deployment.

EDGE is critically dependent on utilities for accurate and detailed data, as well as understanding their process for interconnection. These results and insights can influence site level planning, as well as distribution and transmission planning.

A key goal of all of this analysis is to bring it to the public to inform planning in California and similar analyses outside of California. As we'll hear from Siobhan Powell this afternoon, there are unique ways to make these types of analyses accessible, invaluable throughout California as well as other states and even countries.

And finally, it is critical that these analyses are iteratively updated through a feedback loop. The AB 2127 directive calls for analyses at least every two years. And this process will allow us to incorporate new learning, data, and analyses, such as those that Ria Kontou will discuss in her presentation on Quantifying the Tangible Value of Charging Infrastructure.

While I've highlighted a handful of our immediate collaborators in this slide and how they fit in, it will be increasingly important to engage with a variety of other stakeholders as well, including electrical corporation, local publicly-owned electric utility, state and local transportation and transit agencies, charging infrastructure companies, environmental groups, and automobile manufacturers.

I hope this provides a valuable framework for us to continue these collaborations and engage on these efforts in the future.

Next slide, please.

That concludes my presentation. We now have a great plate of presentations this morning on three of our key modeling efforts and I will introduce each of our speakers before they present. Thank you.

So moving right along into our presentations. I'd like to first introduce Eric Wood. Eric Wood is a research engineer at the National Renewable Energy Laboratory in Golden, Colorado. Working in NREL's Center for Integrated Mobility Sciences, Eric has a decade of experience integrating real world travel data into the analysis of vehicle infrastructure and energy storage systems.

Eric, please take it away.

MR. WOOD: Yeah. Thanks, Matt. Just a quick confirmation that people can hear and my audio sounds okay.

MS. RAITT: Yep, you sound great.

MR. WOOD: All right, perfect. Thank you.

Yeah. So I'd like to start today off by offering a thanks to the Energy Commission for being given the chance to present today. I also offer some thanks to colleagues that have contributed to this work, both those listed on the opening slide here, at NREL as well as some of the collaborators that Matt just mentioned, including the Air Resources Board, the Public Utilities Commission, UC Davis, Lawrence Berkeley National Labs, Stanford, and the University of Illinois.

I truly believe that California's leading the nation on the path to transportation electrification and it's humbling to be able to contribute to the growing body of research on the role of charging infrastructure and enabling this transition.

Next slide, please.

So what is EVI-Pro? EVI-Pro is a two-step simulation model that first estimates charging demands from light-duty plug-in electric vehicles, or PEVs, and then designs a supply of workplace and public charging infrastructure capable of meeting the simulated demand. EVI-Pro was originally developed in 2016 through a collaboration between the CEC and NREL and has since been applied to estimate statewide infrastructure needs aligned with California zero-emission vehicle goals.

Now I've modeled several elements of the transportation system during my time at NREL, and from that experience I think it's important to emphasize that while models are useful tools for better understanding physical systems and human interactions, they're not magic. A model is only as useful as the quality of data and thought put into its design, which is why with EVI-Pro we are working with CEC to make ongoing improvements, including leveraging new data being observed in the field as it becomes available.

Next slide, please.

To that end, I will be presenting results from the second California installment of EVI-Pro, which I’ll refer to as EVI-Pro 2. Statewide results of the original EVI-Pro 1 analysis are shown at right, overlaid with historical data showing the actual trajectory of California’s PEV fleet size on the horizontal axis and public charging infrastructure on the vertical axis.

Pursuant to California Assembly Bill 2127, evolving market and technology conditions warrant updating this statewide infrastructure assessment at least every two years. So CEC, with the supportive of NREL, UC Davis, and other state agencies, has set out to refine EVI-Pro 2 to reflect increasing PEV market share, evolving vehicle and charging technology, and observe charging behavior.

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EVI-Pro 2 has been updated to reflect recent PEV trends, including elevated shares of battery electric vehicles, relative to plug-in hybrids, longer electric ranges, and decreased access to residential charging. Additionally, new models are being developed to address segments of charging infrastructure not natively considered by EVI-Pro, including fast charging to support long-distance road trips, electrification of transportation network companies, and medium- and heavy-duty charging infrastructure. Each of these areas will be addressed later in today's workshop.

Next slide, please.

The 2030 PEV fleet composition in EVI-Pro 2 relies on inputs from CEC and the Air Resources Board. This hypothetical fleet is composed of 14 exemplar vehicles which are visualized in a three-dimensional plot with nominal electric range in the horizontal, driving energy consumption rate on the vertical, and the size of each marker proportional to the fleet size of the given segment. At a high level, this hypothetical 2030 fleet is comprised of 68 percent battery electric vehicles and 71 percent sedans.

Next slide, please.

One of the key model inputs to EVI-Pro 2 is the assumption for percent of vehicles with access to reliable overnight residential or home charging. While many present-day PEV owners have access to a charger in their personal garage, the state's electrification goals require that PEV ownership be a viable option for all of California, not just high-income households living in single family homes.

Unfortunately, data on residential parking options and electrical access as a function of resident’s type is scarce. To help address this data gap, NREL conducted a statewide survey of California residents, including PEV and non-PEV owners to help estimate the state's residential charging potential. As expected, results indicate a strong sensitivity between present day access to residential electrical infrastructure and housing type. But perhaps surprisingly, the survey also revealed that investment and parking behavior potentially also play large roles.

For example, only 32 percent of vehicles surveyed from residents of single-family detached homes claim having existing access to electrical infrastructure where their vehicle is currently parked. However, for the same group of respondents, surveyed residential access increases to 87 percent when assuming investment in new electrical infrastructure and modifying the households’ parking behavior.

Now bear in mind there is reason to believe a causal relationship exists between a consumer’s potential access to residential charging and their vehicle purchase decisions. Thus, for EVI-Pro 2, some assumption needs to be made regarding who are the most likely PEV adopters by 2030.

Next slide, please.

NREL’s survey results were used to calibrate a PEV likely adopter model with the -- with the population of California households described using data from the U.S. Census. This likely adopter model is applied to the five residential access scenarios shown on this slide. The percent of plug-in electric vehicles with access to residential charging is then plotted as a function of PEV fleet size. As access to residential charging was found to be one of the significant variables in the likely adopter model itself, you can see that for every scenario, residential access to charging decreases with increasing PEV fleet share.

This highlights that as the PEV market continues to expand in California, greater attention must be paid to investing in residential charging access for those with the potential to charge at home, including at single family homes and investing in charging infrastructure away from home for those without the potential to charge at home, including those in multifamily housing.

Based on this analysis, EVI-Pro 2 is currently assuming that 82 percent of potential -- of the potential 5 million PEVs in 2030 could have access to residential charging. This assumption is consistent with the green line scenario that assumes existing access with parking behavior modifications.

Next slide, please.

Charging behavior in EVI-Pro 1 was based on a theoretical approach that attempted to maximize charging at home for those with access while simulating charging away from home on as necessary basis. The charging behavior approach for EVI-Pro 2 has been updated to consider observed charging behavior from existing PEV owners. These observations come from a recent report from UC Davis in which thousands of California PEV owners were surveyed regarding their charging habits. Researchers at UC Davis have long been the leaders in collection analysis of PEV data in

California and their expertise has been an invaluable resource in development of EVI-Pro 2.

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Continuing the theme of incorporating more observed data into EVI-Pro 2, we now turn our attention to the supply side of the modeling effort. In order to estimate the supply of infrastructure necessary to meet the simulated demand, event-level data has been provided to NREL from charging network companies operating in California, as well as across the U.S., including over 7 million individual charging events dating back to 2016.

This data is visualized by showing the average number of daily charging sessions per charger on a quarterly basis. While observed L2 utilization is relatively stable over this period, fast charging utilization has been much more dynamic, particularly in California. This variability is potentially attributed to charging network companies attempting to match the supply of their network to rapidly evolving demand brought about from new PEV sales, including the surge of Tesla Model 3 sales starting in 2018, and fluctuating demand from PEVs serving in transportation network companies like Uber and Lyft.

Next slide, please.

This brings us to preliminary infrastructure results from EVI-Pro 2. Based on the assumption that 82 percent of

PEV owners in 2030 will have access to residential charging, we estimate that 3.4 to 3.8 million plugs will be necessary to meet demand at single family homes with an additional one hundred fifty to three hundred thousand Level 2 plugs being necessary at or near apartment buildings.

Demand for Level 2 charging away from home is estimated to require up to 358,000 while-at-work plugs and up to 413,000 while-in-public plugs. Finally, simulated demand for fast charging is estimated to be met with twenty-nine to forty-three thousand plugs.

In total, the preliminary plug estimates from EVI-Pro 2 sum to 0.56 to 1.1 million plugs being necessary outside of single-family homes in order to meet charging demand from 5 million plug-in electric vehicles by 2030.

These preliminary estimates are visualized on the right side of this slide for public L2 and fast charging infrastructure. Note that the PEV fleet size trajectory is generated based on the aggressive forecast from CEC's Energy Assessments Division and is applied to EVI-Pro 2 in an attempt to have infrastructure deployment lead vehicle sales, as was the case in EVI-Pro 1.

Relative to EVI-Pro 1, we can see EVI-Pro 2 heightens the trajectory for growth in public Level 2 infrastructure, while the trajectory for fast charging infrastructure has lowered. The simplest explanation for this shift can be found on the supply side of EVI-Pro 2 in which assumptions for utilization of public L2 and fast charging infrastructure have been adjusted based on observed utilization from charging network companies.

The more complicated explanation is on the demand side of EVI-Pro where we're assuming higher shares of long-range battery electric vehicles, lower levels of residential charging, and multiday charging behavior, competing factors that I'm unfortunately running out of time to address during this presentation.

Next slide, please.

So with all that being said, I'd like to conclude with two points. My first takeaway from this work is that significant uncertainty remains. Results presented today are preliminary and we're continuing to work with CEC and UC Davis to refine our approach. Feedback from this audience is welcome. Charging behavior in technologies are also continuing to evolve every year and ongoing research to collect new observations is critical. I'd like to highlight the data provided by UC Davis, as well as the charging network companies that have supported the development of EVI-Pro 2. This data is critical to ensuring modeling projects are reflective of the real world.

Next, a clear trade-off exists between providing infrastructure while at home or while away from home. While high levels of residential access are likely a safe assumption in the near term, based on characteristics of likely adopters, it's clear that this will not always be the case, particularly if California is to achieve some of the more ambitious transportation electrification goals. Investment should anticipate the need for expanded residential infrastructure and infrastructure away from home for those without access to charging where they live.

I think ride-hailing can be something of a wild card in these conversations with the potential to bring about sudden and dramatic changes in charging demand. However, it's an area that remains fluid, particularly in the area of COVID and something that our collaborators at UC Davis will discuss later today.

And -- and how have I made it this far into the presentation without mentioning COVID? We are meeting remotely, after all. The analysis presented today relies primarily on data and assumptions that predate COVID and the pandemic. While we have observed previously unthinkable disruptions to transportation during the pandemic, it is unclear which behaviors will persist going forward. We'll closely be following the research that is tracking these behaviors in real time, including the great work being done out of the 3 Revolutions Program at UC Davis, and plan to update EVI-Pro accordingly.

And that brings me to my final point. As an engineer, it is second nature for me to lace findings with uncertainty, caveats, and conditionals. However, despite all of the uncertainty that I've discussed here, I think that the takeaway is consistent. Significant infrastructure growth remains necessary in order for California to meet their goals for zero-emission vehicles. Just as the ZEV fleet needs to accelerate, so does the investment in residential, destination, and fast charging infrastructure.

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And with that, I'd like to leave everyone with a nice picture of NREL's campus. Thank you for your time and attention, and I'd be happy to address any questions at this point.

COMMISSIONER MONAHAN: Great. Thanks, Eric. And I do like that last slide. It's very inspirational.

So thanks for all your analysis and support. I am curious about if you were able to do any analysis specific to the used vehicle market into the charging behaviors unique to that sector.

MR. WOOD: Right. So I think the short answer is probably no. The vehicle forecasts that we're leveraging from CEC and the Air Resources Board, I'm actually not sure if it includes tracking for the used vehicle market to help us try to understand what the size of that market is.

I guess I'll also take the opportunity to highlight that I don't know that a lot of work has been done trying to observe charging behavior for the used vehicle market for plug-ins either. But we certainly acknowledge that it's something, you know, worthy of further consideration, particularly as the market continues to mature.

COMMISSIONER MONAHAN: Yeah. I think for us, that would be a good evolution, maybe, in the 3.0 version of the analysis because, you know, we need to make sure that EVs are accessible to everyone. And that's a big focus of our work and a big focus in the work of the Air Resources Board and other agencies is, okay the first vehicle owner is -- any vehicle actually, any new vehicle tend to be wealthy people. And then the vehicle gets put into the used car market and then, you know, other folks who are perhaps more, you know, lower income, disadvantaged communities can get access to these vehicles through the secondary market. And so that's going to be something of acute interest to us going forward is just being able to evaluate how do we support the charging needs for this used vehicle market.

I think one of the pieces that kind of surprised me, actually, is the high level of home charging that's expected in 2030 and that piece of it, I am concerned that we have half of the state that, you know, doesn't -- that lives in apartment buildings, that doesn't have access to single family homes and how do we make sure that those families also can get access to the benefits of electric vehicles.

And especially as by twenty -- you know, 2025 or 2030 when these vehicles are actually cheaper than internal combustion vehicles, and we want lower-income families to be able to capitalize on the economic benefits of electric vehicles.

So I think that's going to be an area, I'm sure, that UC Davis is all onboard with evaluating this in collaboration with -- with you, NREL, and others I think is -- is something we care, we are going to care a lot about.

One -- another question I had for you is, is how are you seeing innovation in charging services playing into your model?

MR. WOOD: Uh-huh. Yeah. Yeah. So the -- I'm trying to think like the innovation in charging services that you're talking about. So the -- the model right now assumes that consumers are attempting to maximize their use, primarily of lower cost charging and lower cost electricity, which usually ends up, you know, resulting in them trying to minimize their use of DC fast charging.

And so, you know, if there were -- were business models that were brought along that, you know, lowered the cost of charging away from home or lowered the cost of fast charging through subscription services or other kind of business approaches, that is something that I think we could reflect in the modeling that we do.

But we would certainly want to track and see what the success of those business models looks like in the real world as, you know, I think our experience has been that it's very difficult for charging away from home to compete with overnight charging at home for those that have access, to your earlier point.

COMMISSIONER MONAHAN: Thanks, Eric.

And I'm sensitive to time. It looks like -- Heather am I right, we need to move to the next speaker?

MS. RAITT: Yeah, that's right.

Actually, I was going to do a quick poll and then move to the next speaker. If that’s -- if you’re ready to do that, that’d be great.

COMMISSIONER MONAHAN: Okay. Great.

All right. Well, thanks, Eric.

MR. WOOD: Thank you so much.

COMMISSIONER MONAHAN: Appreciate all your work.

MS. RAITT: Thank -- thank you, Eric.

Okay, so we'll just do a quick poll. So in response to COVID-19, we've been holding our IEPR workshops remotely rather than at the CEC or another facility. And so we’d just like to get a quick sense of what people are thinking about the remote workshops versus in-person workshops. And so if you can give us some feedback. We'll just wait a few more seconds. Just wondering if people are liking them better, or not so much, or if you're new to them and can't really compare, that's -- just let us know that too.

All right. So all right, we can ahead and close it.

Great. Well, looks like most people, the biggest answer is that most people are liking them better. And it's also fun to see that we have quite a few new people to IEPR workshops. So welcome, I hope things are going well for you.

And with that, I will go back to Matt. Thanks, everybody, for participating.

MR. ALEXANDER: Thanks, Heather.

I'd now like to introduce our next presenter, also from NREL, DY Lee is a Research Engineer at NREL focusing on Electric Vehicle Adoption and Charging Infrastructure Analysis. DY has 20 years of experience conducting research in both academia and industry with a broad background in robotics, automotive engineering, public policy, and transportation.

With that, DY, please take it away with your presentation.

MR. LEE: Thanks, Matt. Can you hear me? I'm having some trouble with starting my video, but hopefully you can hear me.

MS. RAITT: We can hear you great, DY.

MR. LEE: Okay. All right. Thanks, Matt.

First of all, I'd like to thank the CEC for the continued support and guidance on this project. Also, I'm grateful to the opportunity to participate in the discussion today.

Next slide, please.

The motivation for this analysis is to examine the following questions, how many and where do we need charging stations for electrified road trips over the next decade? And beyond charging station, therefore what are the potential grid impacts of charging activities related to road trips?

To tackle those questions, we have developed a new simulation tool, called, EVI-Pro RoadTrip. Unlike the existing EVI-Pro model, the RoadTrip is exclusively focused on long-distance travels of 100-plus miles and based on waypoint charging paradigm. In the RoadTrip model, we account for all types of road trips happening in California on a typical day. Intrastate, out of state, domestic, and international road trips made by personal light-duty battery electric vehicles are all included in the model and analysis.

Slide Number 3, please.

The RoadTrip model consists of four major components such as travel volume and pattern estimation, energy use and charging simulation, station design, and hosting capacity analysis. The model is designed for integrated analysis of three interdependent energy systems such as transportation, refueling infrastructure, and electric grid. The RoadTrip model is built upon coordinate level, spatial analysis, and minute by minute temporal simulation. And we aggregate the results to lower resolution as needed.

Slide Number 4, please.

The first step of the analysis is to estimate the volume and pattern of electrified road trips. For this, we utilize Caltrans California Statewide Travel Demand Model, or CSTDM, that provide origin and destination pairs between traffic analysis zones or TAZ. As only a fraction of the overall road trips is electrified, we downscale the road trips from the CSTDM based on the electrification projections made by CEC's Energy Assessments Division, USCIA, and International Energy Agency.

For BEV adoption, we incorporate two different scenarios, aggressive and low. Aggressive scenario is for statewide BEV adoption target 3 million by 2030. And additionally, to account for potential impacts of the ongoing COVID-19 pandemic, we also evaluate low BEV adoption scenario.

For aggressive adoption scenario, it is estimated that there will be about 40,000 electrified road trips per day in California by 2030. And then -- and then the whole spatial pattern is illustrated on the right side.

Next slide, please.

With origin and destination pairs from the CSTDM and other sources, we simulate road trips using Open Source Routing Machine. An example of simulated road trip is shown at the bottom left. This road trip from the southern border to San Francisco, the Routing Machine provides about 5,000 data points between the origin and destination. For each of those data points, we estimate energy consumption and charging demands and we repeat the same process for each and every road trip.

The chart in the middle shows aggregated energy consumption rate for all road trips simulated for 2030. We differentiate vehicle types, such as short-range cars, long-range cars, and SUVs, as well as their model years.

As is shown at the bottom right, we also incorporate different DC fast charging technologies for different vehicle types and simulation years.

Slide Number 6, please.

Once we identify energy consumption and quest from charging demands along the routes for all road trips across our road network, we then cross the charging demands to station. In the example at the bottom left, overlaid with a map showing land use types in the background, to accommodate the ten white box representing charging demands, near the City of Healdsburg we identify the optimal location of charging station with the shortest distance between white box and station, as well as people or land use types, including commercial sites represented in red color here. The area chart in the middle shows the distribution of land use sites for all simulated charging station in 2030.

In addition to the station siting, another important part of station design is to determine the size and capacity for these to be used charting road and event profiles over the course of the day for each station. In this example station on the right posting about 70 charging events throughout the day, the station is supposed to have at least 10 plugs, or connectors, to accommodate peak simultaneous charging demand that peak around 1 p.m.

Slide Number 7, please.

The chart on the left shows the network-wide required number of plugs for three different generation years and three different BEV adoption scenarios. The required number of plugs per station may depend on target plug utilization rate during peak hours. To account for that uncertainty, we incorporate lower and upper bounds using 100 percent and 25 percent of utilization rates, respectively.

So, for example, if a station has 10 simultaneous charging events during peak hours, lower bound would lead to 10 plugs, and upper bound 40 plugs, having 75 percent of redundancy during peak hours.

All in all, in 2030 our simulation indicates that approximately 3,000 to 11,000 plugs would be -- could be required to accommodate electrified road trips. Also, it should be noted that over time, more powerful and powerful chargers would be needed.

The map on the right shows the spatial distribution of the required plugs for road trips and that deficit by TAZ in comparison with the existing infrastructure today. Some of the charging demands for road trips in downtown or urban areas may be observed by the existing infrastructure, but most of the network expansion would be needed along the interstate highways and rural areas between the south and north population centers and along the -- along the eastern and southern stakeholders.

Slide Number 8, please.

In this slide, the chart on the left shows network-wide charging load profiles in five-minute intervals. Our simulation shows that the total peak load will be around 90-megawatt for aggressive BEV adoption scenario in 2030 and 50-megawatt below BEV adoption. In general, the peak load occurs around 2:00 p.m., and the general shape of charging load profile here seems to align with solar power generation.

You can look at the load profiles from many different angles. The chart in the middle shows the breakdown by BEV types, and the chart on the right illustrates how different types of road -- road trips contribute to the overall load profiles in different ways.

Next slide, please.

When it comes to targeting simulation, one of the important factors is charging behavior. As a main utility of these fast charging is speed. For baseline simulation, we assume that drivers will want to minimize the time spent for charging on top of driving. For these time penalty minimization behavior, we implement two rules. First, drivers will charge their vehicles only up to the level of SOC that provides reasonable charging power over speed. For example, 80 percent. Second, drivers will not charge their battery more than they would need to get to the final destination.

As an alternative, sort of extreme scenario, we also consider always topping off behavior as some gasoline vehicle drivers always top off the gas tank in gas stations. In this scenario, drivers only charge up to 99 precent of SOC, whenever they plug-in. And to extend the time duration in charging stations drivers spend significantly because as you can see in the chart, the marginal gain of the energy per unit of time diminishes significantly in higher SOC.

Also it is worth mentioning that the charging power curves shown on the left have spread out shapes over the -- over the SOC demand, but different automakers adopt these when charging power curves. With that being said, what if we use Tesla’s Version 3 like spike in charging curves, as illustrated on the right. What is -- what is the impact in terms of charging infrastructure requirements and station design?

Next slide, please.

In terms of the impact of charging behavior and technology, as shown on the left, our results indicate that charging behavior may lead to drastically different load profiles, as well as network size. On the other hand, as can be seen on the right, charging technology or charging curves may not have a huge impact on the load profiles or network size. Nevertheless, it is interesting that the plug composition may change significantly depending on what charging technologies are used.

Slide number 11, please.

The last part of the results that I'd like to show today is hosting capacity analysis. In a case study that includes Southern California Edison territory as well as some of the adjacent areas. Here we estimate task by task capacity deficit utilizing the EDGE Model that has been presented from Tuesday.

As can be seen in the map, our analysis shows that some of the areas along the interstate highway connecting the south and north, not metropolitan areas. As well as southern borders may require grid upgrades to accommodate charging demands for electrified road trips. However, I'd like to emphasize that this is a preliminary result based on the data with limited quantity and quality.

Next slide, please.

Although the RoadTrip model present today is a state-of-the-art simulation tool, it may have numerous limitations, especially in representing real worldmatter. For more rigorous and realistic analysis, there are needs for high-resolution real-world data that can help characterize electrified road trips more accurately in terms of driving and charging behaviors.

Secondly, our analysis indicates the importance of immense degree of the integration efforts. For example, we believe that proactive green impact mitigation strategies, including solar plus energy storage, intelligent network control would be beneficial.

Regarding for our analysis, the network would have to accommodate high power dispensers in the near term and an upgrade for additional electrical capacity would also be needed. Therefore strategies such as future proofing and maximizing interoperability of today's charging equipment will be desirable.

Lastly, to better inform charging station network management, more holistic and integrative analysis is necessary by bringing different models together and looking at the entire electric vehicle fleet.

Next slide, please.

As mentioned earlier, there is a critical need for real-world data for more accurate characterization of driving and charging behaviors. Also in this very first version of the model, there are some elements that are treated as independent, whereas in reality they may be interdependent and connected. So example, we need to account for mixed use of existing charging stations for road trips as well as short distance travels. Similarly, we want to internalize the existing charging infrastructure in the station network design process in the model.

Furthermore, we plan to incorporate potential interactions not only among long-distance travelers in terms of charging, but also between drivers and the station network. These will allow us to evaluate the impact of various behavioral and technological factors including station condition, connected and automatic vehicles, coordinated charging, mobile charging stations, onsite energy storage, and et cetera.

That's all I have for today. Thanks for your attention. I'd be happy to answer any questions.

COMMISSIONER MONAHAN: Great. Well, thank you. Fascinating data.

Well, I have a few questions. I'm -- I want to just start with a super basic question which it sounds like you were modeling not 5 million electric vehicles, but a lower number for the -- a previous IEPR analysis by the CEC. Did I -- did I get that right?

MR. LEE: Yes. Three million. Three million battery electric vehicles by 2030.

COMMISSIONER MONAHAN: I'm sorry. Say that -- say that again.

MR. LEE: Three million battery electric vehicles by 2030. And we also evaluated low BEV adoptions scenario considering the potential impact of COVID-19 pandemic for low --

COMMISSIONER MONAHAN: How would they analysis change? Would it just be a scale up if it were to evaluate 5 million electric vehicles?

MR. LEE: Yes, we are capable of evaluating 5 million vehicles as well. But my impression was that CEC wants us to evaluate 3 million BEVs for this round of analysis.

COMMISSIONER MONAHAN: Yeah, I think what we -- maybe we could talk with the team more about that, whether we should do an additional analysis with the 5 million EV target potential we're required by 2127. So I think that we can have a separate discussion about that.

I was curious about your finding that charging behavior matters a lot. The topping off versus, you know, just getting sufficient charge for the trip that you want to take. Do you have any analysis that would indicate which scenario would be more likely or which, you know, what would the breakdown would be of the topping off versus the just enough for the -- for the trip driver?

MR. LEE: Uh-huh. That is good question. My -- I think the time penalty minimization would be more realistic for the -- most of the road trip travelers for EV drivers. And always topping off is more like extreme scenario that we wanted to include in the analysis.

And we also did separate analysis for the hybrid approach combining time penalty minimization and always topping off. And the result indicates that the impact is very small. It is very similar to time penalty minimization. So again, always topping off is very extreme case.

COMMISSIONER MONAHAN: I guess I don’t -- I mean, it's a really interesting research question because of the -- there is a time value of money in terms of not wanting to -- and there is some uncertainty when you're an EV driver about, well, what is the range? I know as an EV driver, it depends on how fast I’m driving and if I'm using air conditioning. And, you know, so there's some behaviors as just topping off in order to account for any extreme driving behaviors or weather conditions that you may encounter.

So I guess that's an area maybe just for additional analysis going forward. A good study always creates new studies, and I think this is no exception.

So my last question has to do with the overlay of your -- the load profiles with the -- with our generation, electricity generation and the fact that we're curtailing a lot of renewable energy and appears it's 2:00 p.m. peak charging time would actually overlay pretty good with -- well with what -- with the -- with our renewable energy production, particularly in the middle of the day.

So is -- how much of the load -- I mean, I'm assuming you're going to be over, you could overlay those two and see areas of where we're going to have some challenges in terms of having a grid impact that we want to avoid. Is that going to be part of your analysis to overlay what's actually happening on the electricity production side in California?

MR. LEE: At this point that part of the analysis is not planned, but we can certainly do that down the road. It will be interesting analysis, I think.

COMMISSIONER MONAHAN: Yeah, I think that -- I mean, because where we want to get to is a place where electric vehicles provide, you know, help absorb renewable energy production in the middle the day. There -- our chair likes to call it EV happy hour where all the EVs plug in at the time that we want them to where they're going to provide a grid service and that they don't charge at times when we will otherwise have to -- have to have more baseline generation. So say when the sun sets.

I think that that'll just be really helpful for us as we think through well, how do we make sure that we have vehicle grid integration that really supports both our clean transportation and our cleaning grid goals at the state.

MR. LEE: Yeah, sounds great. That will be very exciting. An interesting analysis.

COMMISSIONER MONAHAN: Great. Well, thank you. I think my time has actually gone over. So we have a busy day. Thank you so much.

MR. LEE: Thank you.

MR. ALEXANDER: All right. Thank you, DY.

Before I introduce the next presenter, Commissioner Monahan, I just wanted to make a quick clarification on the vehicle forecast for EVI-Pro RoadTrip. This is using the exact same forecast as Eric presented, but EVI-Pro RoadTrip is only focused on battery electric vehicles. So that's why we see the 3.1 million.

COMMISSIONER MONAHAN: Oh.

MR. ALEXANDER: So this does not factor in the additional plug-in hybrids --

COMMISSIONER MONAHAN: I see.

MR. ALEXANDER: -- since those aren't using the DC fast charging. So to a lot of --

COMMISSIONER MONAHAN: I really appreciate that. Appreciate that clarification on that.

MR. ALEXANDER: Yeah. And then also for the always topping off charging behavior, I think that was also a good extreme case to see, you know, drivers might be worried about having charging in the future along their drive so they might want to charge up all the way just to be safe. But I'll pause there and introduce our next speaker.

So we have Dr. Bin Wang presenting on our HEVI-Pro model. Dr. Bin is -- Bin Wang is a research scientist at Lawrence Berkeley National Lab. His research interests include transportation electrification, energy system modeling and analysis, and high-performance computing techniques for the transportation and electric grid systems.

So with that, Bin please take it away with your presentation.

MR. WANG: Thanks, Matt for the warm introduction. And I really appreciate CEC to give us opportunity to work on this amazing project.

And today I'm going to talk about the Medium- and Heavy-duty Electric Vehicle Infrastructure Projection. As mentioned earlier, the acronym for this project is HEVI-Pro.

Next, please.

And here's HEVI-Pro team from Berkeley Lab site.

Next, please.

According to the Advanced Clean Trucks Regulations from the California Air Resource Board, there will be an increasing share of zero-emission trucks. So in California, starting from the year 2024, the success for implementation of this regulation will lead to a full transition to the ZEVs in the long term. And in the meantime, the Assembly Bill 2127 calls for the CEC to project the charging infrastructure needed to decarbonize trucking and to reduce the impact of diesel air pollution over the entire state.

Under this initiative Berkeley Lab is working with the CEC to develop the tool called HEVI-Pro through the applied research funds from the Clean Transportation Program. Specifically in the HEVI-Pro project, the tool we developed will project the charging infrastructure needed to support the medium- and heavy-duty electric vehicle charging behaviors. Specifically, the tool will determine what type of chargers are needed and quantify how many chargers of each type will be deployed in each county across the state.

This is a relatively new project that focus on the medium- and heavy-duty vehicles. And on the other hand NREL's EVI-Pro tool will primarily focus on the light-duty vehicles with a gross vehicle weight of less than 10,000 pounds.

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In order to ultimately determine the charging infrastructure need and the load profiles for the MHDVs, we are considering a number of metrics and factors in that HEVI-Pro. For example, we are considering the location of the chargers to be deployed. I would consider the accessibility and the power ratings of the chargers. This information will be useful to characterize the charger configuration.

Next slide.

Besides the charger configuration, we are also dividing the trips of MHDVs into a number of categories, depending on the vehicle usage patterns and the specific vehicle application types. For example, it will be characterized based on if -- whether or not it has a fixed route, it has fixed time, or the vehicle has to return to base periodically, like the transit bus or the school bus. So those features will be of great value for us to characterize driving charging and potentially the parking patterns for the MHDVs.

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The technical approach we are taking in the Phase 1 project is called top-down approach which basically takes the external MHDV projection aggregated at the county level as inputs into HEVI-Pro tool. And in the second step, we disaggregate the county level projections into individual trip level statistics and we -- those statistics will be informed by the real-world truck operation and logging data set collected from our partners. And in the last step, we will provide the infrastructure assessment to determine the quantity and types of chargers needed at county level.

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Specifically in the first step, the MHDV projections are taken from a number of different sources. For example, the vehicle population by county and the hourly based energy consumption profiles are taken from the EMFAC tool from California Air Resources Board. And the projections of the electrified MHDV adoption rates are taken from the Mobile Source Strategy from the CARB also. And we also taking inputs from the South Coast Air Quality Management District for the South Coast outpacing vehicle projections.

And lastly, we integrated the electrified powertrain features of the future -- of the future MHDVs, including the energy efficiency parameters, regenerative braking technologies, as well as a duty cycle specific payload profiles. On the right-hand side, the picture shows the example EMFAC projections.

Next slide, please.

In the second disaggregation step, we are leveraging the data sets we collected from our partners to describe the trip statistics such as how many trips per day and when will the trip start and when will the trip stop. This statistics are used to derive the time-based trip activity distributions. Those distributions for each vehicle type will be considered in the probabilistic decision-making mechanism in the simulation shown on the right-hand side. The simulation will determine the results of the charging activities for each vehicle type and the corresponding charging infrastructure need.

Next slide, please.

And finally in the infrastructure assessment step, we are considering a number of battery sizes, powertrain configurations, as well as the charger configurations. In the forthcoming analysis, we plan to integrate signals from the energy markets, operational data sets, as well as grid constraints. For example, the circuit capacity parameters at the circuit level by interfacing with the EDGE model.

Next slide.

And here comes our preliminary results. We have successfully deployed our first scenario and the HEVI-Pro tool is able to generate this preliminary results. In summary, in order to support the statewide total 133,808 battery MHDVs in California by 2030, the state has to deploy at least 67,365 50-kilowatt chargers and will have to deploy at least 10,527 350-kilowatt chargers as a higher power level ratings.

I want to highlight a number of assumptions in this preliminary model as we only consider two type of chargers with 50-kilowatt as a baseline standard charging technology and the 350 kilowatt as a higher-level high-power charger -- charging technology. We also assumed that the MHDVs will prefer the higher power 350-kilowatt chargers during the daytime in order to minimize the charging time and make the vehicles ready for next trips as soon as possible. Also we assume those electrified MHDVs will follow similar duty-cycle patterns as traditional vehicles powered by the internal combustion engine.

Coming back to the results on the left-hand side, Los Angeles County, based on the initiate to scenario accounts for 17 percent of the total charging infrastructure demand. There are five counties from the south, including Los Angeles County, San Bernardino, San Diego, Riverside, and Orange County among the top 10 counties with the most charging infrastructure demand. Three of those counties are from the north, including Alameda County, Santa Clara, and the Sacramento County. Kern County and Fresno County are from the central. Among all the chargers needed about 14 percent of them will be the 350 charger with higher power.

I want to emphasize that this is our first preliminary results which is subject to change as we keep gathering more data to describe the activities of MHDVs so the results will become more realistic in the later phase of this project.

Next slide, please.

And here is the geospatial distribution of the charger counts by county and by the power capacity.

Next slide, please.

And this is all the energy consumption profile of the electrified MHDVs when they are driving. Apparently, most of the energy was consumed during the daytime.

Next slide, please.

Here is the example of statewide load profiles aggregated at the statewide level. And the peak power happens at 3:00 p.m. around 900 megawatts. If we take a look at the specific vehicle type on the right-hand side, we can find the load profile is quite different by different vehicle types. For example, the bus. Buses, the charging load of buses will be relatively lower during the morning and the afternoon rush hour. The drayage truck and medium-duty trucks will have relatively higher load profiles during the early morning.

Next slide, please.

We also compared the results of different representative counties in California. For example, the Los Angeles County and Alameda County in the coastal area, as well as Butte County in a rural area. We can find the component of drayage truck load -- load profile play a significant role in the coastal counties. But it's a relatively lower penetration in the Butte County scenario. However, the Butte County has slightly higher penetration of heavy-duty tractor trailer charging load. And if we take a closer look, we can also find the agricultural charging truck -- charging load in the Butte County load profile.

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So to summarize our preliminary findings, there will be roughly 67,000 50-kilowatt chargers and 10,000 350-kilowatt chargers needed to support the electrification of MHDVs by 2030. And accounting for the ZEV scenarios to meet the air quality standard, the South Coast basin, including Los Angeles County, San Bernardino, Orange County, and the Riverside County demand roughly 35 percent of the total charging infrastructure needed in California.

As shown by the data analytics, the wide variation of MHDV charging patterns reflect the diversity of vehicle type, trip purpose, driving, and parking behaviors. We need to do further characterization of those vehicle types by collecting more realistic data from our partners. And specific vehicle types like drayage trucks, they show great potential for smart charging. Because when we look at the driving and parking behaviors, they have returned to base travel patterns which are relatively predictable. So that -- and associated the charging power of such truck types is much higher than other truck types.

And in the end, I want to highlight that this is our preliminary results, and this is subject to change. We will keep gathering data to reinforce our analysis in the forthcoming months.

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Regarding the next steps, we will develop bottom-up modeling approach to incorporate those temporal and special dynamics mentioned earlier. For example, we will consider the fixed-route, return-to-base, and nonfixed route applications in using our agent-based medium-duty, medium-, heavy-duty activity simulations and we will explore the operations and flexibilities of the MHDVs to see how the smart charging and optimization program can improve the cost effectiveness of the medium- and heavy-duty vehicle grid integration.

And we will also incorporate the EDGE model to investigate the electricity impact on the electricity grid. And the EDGE model will provide insights at the circuit level which will be a great value to the follow-up work.

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And finally, I really want to appreciate the help from a number of partners who support our project by data or existing model. And special thanks to CEC staff who, staff who have helped us gather a lot of data, you know. And due to the limited amount of data in this project, we really look forward to working with our future partners in this exciting project and hopefully this results will benefit the state and as well as industrial sector of California.

And thanks for your time.

COMMISSIONER MONAHAN: Great, Bin. Thank you. And I agree with you. This analysis is really cutting edge. I mean, we don't have a lot of data. Most the -- most the analysis on charging needs and profile puts focus on the light-duty vehicle sector so this medium-duty vehicle sector’s particularly important.

It -- it's great that there are so many partners in this work. I know that it was initiated before the Advanced Clean Truck rule was finalized by the Air Resources Board. Does your -- how much does the data that you have align with that regulation? Or was this because this was initiated before the regulation, is -- are the two somewhat divorced in terms of analysis?

MR. WANG: The projections we are using in heavy project are pretty recent. They are from multiple sources, as I mentioned, including CARB Mobile Source Strategy, Advanced Clean Truck rules, as well as South Coast outbasing, you know, projections. So they are pretty recent and recently updated in the past few months.

COMMISSIONER MONAHAN: That’s great to hear.

Do you have a split between MDEV and HDEV in terms of the expectation for 2030?

MR. WANG: Yes, I do. We have a couple of categories, you know, developed based on the original EMFAC categories. EMFAC has obviously more vehicle category, depending on the vehicle class of the -- of the vehicle weight of the vehicle as also -- and also the trait purpose. And we summarize those roughly more than 30 types of vehicles into six or seven, you know, aggregated the vehicle types used in HEVI-Pro.

COMMISSIONER MONAHAN: Uh-huh. And I'm curious, the data that you found, I mean, it's great to hear that light -- light-duty trips the middle -- charging in the middle of day seems like it's going to be for many trucks, that's going to meet their needs. And that's just when we have overproduction of -- we have a lot of renewable energy produced. So that's when we want vehicles to charge.

What are the vehicle types that are not going to be following that behaviors? I couldn't get all the information on. You had a lot of slides that were actually -- I’ll read through them more carefully later.

But the -- which are the vehicle types for the areas of the state that we don't see charging behaviors that align with when we have renewable energy produced in California?

MR. WANG: Yeah, this is a good question. We also realize the issue -- this issue during our study, one of the good example is a bus, school bus, urban bus. Those bus charging load really depend on the operational pattern during the morning and afternoon rush hours. Usually we don't have a lot of flexibilities to charge the, you know, charge the buses. So we can see, you know, it's relatively, you know, lower charging profile in the morning from 8:00 a.m. to 10:00 a.m. Also, you know, from like a 3:00 p.m. to 6:00 p.m., you know, when the renewable generation is high, but, you know those, buses are, you know, we'll have to, you know, running on the road, instead of deploy to charge.

COMMISSIONER MONAHAN: Great. I have one last question and then I think we need to move to public comment.

The 50-kilowatt charger versus, you know, a larger charge. I was curious about that because that surprised me that there would be so many more 50-kilowatt chargers needed than high-powered chargers. I think of heavy duty as more amenable to high powered charging. And, you know, just staying in the light-duty vehicle Sector 2 as trips were taken the need to have charging available for vehicles taking long trips in the middle of the day, wanting to top off.

I’ve also heard from -- in our IEPR workshops with some fleets around, you know, the thinking is like hey, we need to charge when we need to charge, we don’t care about grid impacts, and we want to charge fast. And so just what you're thinking is in terms of the charging needs.

MR. WANG: Yeah, great question. We select the 50-kilowatt charger as a baseline standard charger for this study as 50-kilowatt DC fast charger is common technology right now in the market. But they -- there are, you know, emerging products to be released soon, you know, ranging from 125-kilowatt up to multiple megawatts.

COMMISSIONER MONAHAN: Uh-huh.

MR. WANG: But the challenge is that, you know, high power charging technology can enable faster, you know, power consumption, you know, power charge into the battery, but, you know, the power ramp up -- ramp up rate will be much higher than the regular 50-kilowatt charger. So it's a great, great challenge to the grid operators.

You know, it's not because so many of them are charging but just because one single charging session can be -- can do much more damage to the grid than the regular chargers.

COMMISSIONER MONAHAN: Uh-huh.

MR. WANG: And also, you know, we will have to consider the vehicle applications and the specific duty cycles because some vehicles, they have to charge the, you know, at high power before they make themselves ready for next trip. So this consideration, you know, will be different case by case by different vehicle types, you know, so --

COMMISSIONER MONAHAN: Yeah. It's probably worth it, so you know, getting this -- the next version. I'm not sure if it will align with the timeline that we have for 2127 but this worst case, like what if all this, you know, what if there is just very high-power charging at nonoptimal times a day, what -- what do we need to prepare for to have the right policy environment so that behavior doesn't happen?

MR. WANG: Right.

COMMISSIONER MONAHAN: Anyway. Well, thank you very much. I really appreciate your analysis. And I do think this is cutting edge. It's going to be really important as California moves forward with its clean -- Advanced Clean Truck Rule that we understand what the grid implications are, make sure that we are tailoring our policies to minimize any negative impact. So really important analysis. Thank you.

MR. WANG: Thank you, Commissioner.

COMMISSIONER MONAHAN: Heather, I'm going to turn it over to you and the IEPR team for public comment.

MS. RAITT: Great, thank you.

And thank you, Matt, and Eric, and DY, and Bin for those presentations. And we'll look forward to hearing again from you this afternoon, you'll be joining our panel. So thank you in advance for that as well.

So moving on to public comment. If you're using the Zoom online platform, you can go ahead and hit the raise hand icon to let us know that you'd like to make a comment. And if you're on the phone, press star 9 and that will raise your hand to let us know that you comment -- you'd like to comment.

And Rosemary Avalos from the Public Advisors Office is I believe on the line to help us with the public comments.

MS. AVALOS: This is Rosemary. I'm having a little bit of issues. Can you hear me?

MS. RAITT: Yes, we can. And if you -

MS. AVALOS: Okay, thank you.

MS. RAITT: -- if you have a -- if you drop off by accident, then I'll just pick up where you leave off. Thanks.

MS. AVALOS: Okay. Thank you, Heather.

I will first call on attendees using the raise hand feature in Zoom. Please state your name and affiliation and spell your first and last name. Also, do not use the speakerphone feature because we may not be able to hear you clearly.

Ian MacMillan, your line is open.

MR. MACMILLAN: Yes, good morning. My name is Ian McMillan. I'm a manager -- a planning manager with the South

Coast Air Quality Management District. My name's spelled I-A-N, M-A-C-M-I-L-L-A-N.

I really appreciate the opportunity to -- to speak here. Really appreciate all the work that's been done by Energy Commission and the partnership, we've, you know, had over this, especially this last year and really diving in and thinking about what are the air quality needs in Southern California in our region? What are our attainment needs, what are the needs for our local communities?

And there's a lot of really exciting and great work happening here. In particular, looking at the heavy-duty and medium-duty needs given the significant challenges there with emissions from those -- from those sources. I did just want to note that, you know, there I think is while some great work has been presented here, you know, it is ongoing. I think we're going to continue to have to look at some of these scenarios. I know that some of these analyses that are -- of these scenarios that are shown are maybe not quite aggressive enough when we start thinking about what is needed for attainment.

You know, the -- some of the dates that are shown here, for example, with the 2031 is a key attainment date for Southern California. But there hasn't really been any talk in any of these so far about our 2023 attainment date. We need a 45 percent reduction in nitrogen oxide emissions by

2023 beyond the existing baseline. That's a really significant challenge. We're facing federal sanctions if we don't hit those -- those targets. And it's the same thing and 2031, same thing and 2037.

So there's a lot of multiple overlapping attainment needs that are here. I think we're going to have to keep, you know, digging in and trying to look at some different scenarios of what might be needed from the grid. What is that fuels mix that's needed to try to meet attainment? Especially given that, you know, the vast majority of emissions are from on-road vehicles, or mobile sources rather and whole off-road and on-road and this medium-duty, heavy-duty sector. We really got to keep diving in on it.

So looking -- looking forward to continuing to work with you all to develop these scenarios and really appreciate all these really amazing tools that you have. I think this is really great work.

And with that, I'll end my testimony. Thank you.

MS. AVALOS: Thank you, Ian.

Our next commenter is Ray Pingle. Please spell your first and last name and announce your affiliation. Your line is open.

MR. PINGLE: Hi, this is Ray Pingle with Sierra Club California. My name is R-A-Y, and then P-I-N-G-L-E.

First of all, I just have to say, I am just totally blown away by the comprehensiveness and professional excellence of all of these presentations. I mean, it really gives me huge hope that we -- that we’re going to have the infrastructure we need.

I’d just like to make a few quick comments and then will provide some written comments later. But on Eric's presentation I'm, again, just very impressed to see the maturation that’s already occurring from EVI-Pro 1 to EVI-Pro 2. And on certain assumptions, such as the ratio of BEVs to plug-in hybrids, I'm glad to see that trend change in EVI-Pro 2. But I would recommend that it be considered that that percentage change going forward be even stronger for BEVs. I think the economics for BEVs, the range issues are going to be dealt with. So I would change that assumption quite a bit.

Same thing with the battery range assumptions. I think those range assumptions, while they’ve been adjusted, are going to be longer sooner and that'll affect things.

The other -- the other question for Bin Wang’s presentation, which again I just thought was really excellent, is and basically echoing the comment just made by the first person there from the Air Quality Management District is that I think some of the assumptions in terms of the demand that's going to come from the number of vehicles that need to be charged are probably too low and that overall there -- it should be assumed, some scenario assumption should be made for much higher adoption of electric vehicles in all categories than what's assumed in these presentations, and how might we deal with that.

And with respect to the medium- and heavy-duty vehicles, the assumption I believe was 173 -- 137,000 by 2030. And while that might track with what the Act rule requires as a minimum baseline when the fleet rules get done by CARB within the next year and a half or so, those numbers are going to go way up. And if you look at the resolution that the CARB board passed, which approved the Act rule, it had in there some very aggressive targets, not only the whole fleet zero-emission by 2045 but things like first and last mile delivery, refuge trucks, and government fleets to be 100 percent zero-emission on the road by 2035. So that will require a lot more charging infrastructure. So my most important thing I think is to revisit what the demand requirements are going to be.

And again, thanks to everyone working on this, you're doing an awesome job. Thank you very much.

MS. AVALOS: Thank you.

The next commenter is Stephen Davis. And please state your first and last name and spell your name and affiliation. Thank you.

MR. DAVIS: Yes, hello. This is Stephen Davis, S-T-E-P-H-E-N. And I'm with Oxygen Initiative.

And just real quickly, I want to thank the Commission for putting this on and congratulations to all these presenters. It's been fantastic stuff.

I want to just quickly say a couple things. First, to give you a little background, my experience curve with ISO 15118, which, you know, much of the success of execution on revolution scale adoption and simplicity for the end user hinges upon these technologies for VGI, as well as customer simplicity, have demonstrated with Mercedes Benz and RWE in Germany, as well as partnering with the Energy Commission and UC San Diego to demonstrate the ISO 15118 standard.

That work began back in 2011 and we've been, you know, having these processes and IEPRs going on for the last, that I've been a part of, for eight years now. And I really want to emphasize that out of this has to come something very different than what we've been -- we've been doing. We need to for the sake of this -- the planning horizons of the automakers, we have to state very, very emphatically, standing on the -- standing on the top of the hill, we have to shout it that we are ready now to make sure that we're creating a homogenous ecosystem for their vehicles to connect to.

That is the one thing that the automakers need from us, since we are California, is a clear signal. That they are -- their investments in this technology are going to be matched at our point of regulation, which is the station. And, you know, at the risk of sounding negative about it, I don't -- I don't want to, but we've been here for several years now talking about VGI and talking about interoperability standards. What the problem has been is that we've yet to send a clear signal to the rest of the world.

So that's my comment. Thank you.

MS. AVALOS: Thank you. Okay. I want to give a reminder for those on the phone to dial star 9 to raise your hand.

And are there any other comments?

All right. Seeing that there are no other comment, I will go ahead and hand over the meeting to Commissioner Monahan.

COMMISSIONER MONAHAN: Great. Well, thanks everybody. Really excellent series of presentations and I hope you all are able to come back in the afternoon. We start at 2:30 and we'll continue rolling out some of the early results of the 2127 analysis of California charging needs for 5 million electric vehicles by 2030.

So hope you can return. Thanks, everybody.

(Thereupon, the Hearing was adjourned at 12:02 p.m.)

--oOo—

REPORTER'S CERTIFICATE

I do hereby certify that the testimony in the foregoing hearing was taken at the time and place therein stated; that the testimony of said witnesses were reported by me, 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 10th day of December,2020.

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Jacqueline Denlinger
AAERT CERT # 747

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IN WITNESS WHEREOF, I have hereunto set my hand this 10th day of December, 2020.

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Myra Severtson
Certified Transcriber
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