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CALIFORNIA ENERGY COMMISSION

STAFF WORKSHOP

In the Matter of:	)	Docket No. 19-IEPR-04
	)	
	)	
	)	STAFF WORKSHOP RE:
2019 Integrated Energy Policy	)	Electric Vehicle
Report	)	Charging Infrastructure
	)	Assessment (AB 2127)
	)	

CALIFORNIA ENERGY COMMISSION (CEC)

CALIFORNIA ENERGY COMMISSION

THE WARREN-ALQUIST STATE ENERGY BUILDING

ART ROSENFELD HEARING ROOM, FIRST FLOOR

1516 NINTH STREET

SACRAMENTO, CALIFORNIA

THURSDAY, MAY 02, 2019

1:36 P.M.

Reported by: Peter Petty

APPEARANCES

CEC STAFF PRESENT:

Noel Crisostomo
Micah Wofford
Marc Perry

CALIFORNIA AIR RESOURCES BOARD:

Kathy Jaw
David Quiros
Craig Duehring

PRESENTERS/PANELISTS:

Marshall Miller, University of California at Davis
Ian MacMillan, South Coast Air Quality Management District
Chay Thao, San Joaquin Air Pollution Control District

Public Comments:

Bonnie Datta, Siemens
Chris King, Siemens
Tod O'Connor, CLEAResult
James K. Dumont, Grant Farm
Michael Nicholas, ICCT

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P R O C E E D I N G S

MAY 2, 2019 1:36 P.M.

MR. CRISOSTOMO: All right. Good afternoon, everyone. We'll get started now. Sorry for the bit of delay.

My name is Noel Crisostomo, I'm an air pollution specialist at the California Energy Commission. I'm working with my colleague Wendell Krell on the assessment of charging infrastructure under AB-2127 which was passed last year. Just to start with some welcome and introduction information.

In case of an emergency, please follow Energy Commission staff across the street out toward the back door where we will go to Roosevelt Park. And I think many of you know this, there are bathrooms right across the hall in that corner.

So just a quick review of the agenda for today. We'll have presentations from experts in the off-road, port, and airport electrification sector from across the state. We'll start out with definitions and energy use of off-road transportation electrification segments from the University of California Davis.

Next, the Air Resources Board has brought three managers across the divisions to talk about the various off-road, port, and airport electrification regulations that are driving demand.

Third, we have representatives from the South Coast and San Joaquin Air Push and Control Districts to talk about their regional strategies to address air pollution emissions from the sectors.

And lastly, we'll conclude with a colleague of mine from the Fields and Transportation Division who will provide lessons from investments in the Alternative and Renewable Fuel and Vehicle Technology Program in medium and heavy vehicles that are operating at ports and in the off-road arena.

We'll have time for public comments afterward and also clarifying Q&A for each of the presenters. And we'll hopefully close by around 5 p.m.

So as you come to speak and ask a question, please head to the podium in the middle of the room and speak to the microphone introducing yourself and your organization.

Micah is helping manage remote participation. They're muted for now, but please raise your hands to ask a question or use the raise hand icon to ask a question where we will unmute you.

We'll have questions after each of the major sessions outlined in the agenda and to facilitate open discussion. Depending on time, we will not be strictly moderating the time of Q&A but please defer to our discussion during your comment and consider others who might be waiting in a queue.

Just to note, this workshop is being recorded and transcribed so it's important that you use a microphone. And these will be added to the IEPR Docket 19-IEPR-04 which pertains to transportation, and all these presentations will be posted online afterward.

So continuing with the table setting, I will review our legislative mandate under AB-2127 and describe at a high level our framework for the charging infrastructure assessment. For those of you who were able to attend our workshop in March, this will be a bit of a review but it's important to reiterate here. Then I'll close with objectives for the workshop and then transition to our speakers.

So AB-2127 was codified as Public Resources Code 25229 which directs the Energy Commission to lead a biennial statewide charging infrastructure assessment to meet California's 2030 decarbonization and ZEV deployment goals.

Micah, there is a chat saying no audio?

MR. WOFFORD: Yeah.

MR. CRISOSTOMO: It is for a couple of people. Wendell, if you could check with Jerry.

Because Section 25229 became effective at the beginning of this year, our goal is to publish the first full assessment by December 2020. And as described during our March workshop, we're -- we are pursuing a phased approach. This first phase will be housed as part of the 2019 IEPR, of

which transportation is a key focal point. And this step in the assessment will entail capturing a snapshot of our current research implementing this code currently.

The assessment is anticipated by the end of 2020 and it'll serve as a baseline upon which future analyses will build where changes in policy or technology or the market are expected. And I'll describe how we're planning for that dynamic on the next slide.

This code directs the Energy Commission to expand upon its Electric Vehicle Infrastructure Projections first published in 2018. These are commonly known as EVI-Pro by shorthand in which our projection found that for nearly 1.5 million electric vehicles in California, there would be a need for roughly 240,000 Level 2 chargers at multi-unit dwellings and destinations and at least 10,000 DC fast chargers.

However Section 25229 requires the Commission to quote, "analyze all necessary charging infrastructure" to a greater depth beyond the number of chargers. These are -- these include an element to analyze the necessary make ready electrical upgrades, the designs of charger hardware and software, and other programs to accelerate EV adoption.

In addition, the code broadens the analytical scope to include infrastructure for all road-based vehicles, highway vehicles which we interpret to mean interregional

fast charging. But we're here today to analyze the potential needs of the off-road, port, and airport electrification applications.

So we must examine under this analysis existing and future needs throughout the state including at low-income communities. And during this analysis, we're required to gather input from public stakeholders. So thank you for coming.

As we expand our infrastructure projections and in response to our directives, in March we described how regulatory and policy actions drive the supply of and can facilitate the adoption of EV technologies and less charging. Starting in the left-hand side, much of the demand for electric infrastructure is generated through Air Resources Board's regulations on vehicles which are needed to reduce greenhouse gas emissions and air pollutant emissions. This leads to a market facilitation effort like the Energy Commission's planning analysis and incentive's in charging infrastructure and for example the Public Utilities Commission's regulatory oversight of utility investment in electric infrastructure.

However, it's important to recognize that the needs for infrastructure will be subject to market forces and whether or not the solutions that are offered are compelling for customers. In addition, there may be factors that are

hard to account for due to the variability of that factor, for example, travel demands across regions, transaction costs and real estate costs, or factors that are simply unknown at this time, new technologies or mass market customer reactions, for example.

Therefore at this early junction, we consider our effort to analyze technology and conduct modeling of the needed charging infrastructure throughout the state as one that will be informed by and an informant to the state's estimations of future outcomes and one that is necessary cyclic to learn about how drivers and other systemic factors start to interact and evolve over time.

Thus our goal is to collaborate with you to conduct an applied analysis that is useful to the market and policymakers alike. We need to leverage information and feedback from many stakeholders to form the basis of this independent assessment that meets the requirements of the law. And so these may include EVI-Pro-like transportation demand models. However, given the broader and deeper scope, these will also likely include technology surveys and site-specific assessments for vehicle modes that operate more independently of an overall transportation system.

Lastly, we recognize the role of the assessment as a key in answering key pressing questions at several other agencies' related efforts regarding the adequacy of existing

charging infrastructure and the future needs for infrastructure as the market expands. And of course these will change over time. And so if you're interested in engaging with us as a stakeholder to provide your expertise, whether you're an automaker or charging service provider, an agency to help us develop scenarios and assumptions, please make sure to take your name down on one of the clipboards near the foyer so that we can contact you and work with you.

So our objectives of the workshop are to really understand these emerging sectors electrification off-road, port, and airports. I'll describe these learning objectives that my colleagues and I numbering in the dozens across the Commission at the Fields and Transportation Division, Energy Assessments Division, and Research and Development Division. Everyone who is working on those sectors was brought into helping to scope this workshop.

And so given the diversity of vehicles and equipment within each of the sectors, off-road, port, and airport, it's important to characterize and define the applications and how energy is used with our first presenter from Davis. And to understand how the vehicles and equipment move goods and people, we wanted to consider these sectors in tandem, not just individually. Specifically, there's interest in the scoring where in the transportation system individual modes are connected to one another which may help locate where

charging is possible or feasible.

So for example, consider one case of how a container of goods might be shipped eastward from a port via a drayage truck to a distribution warehouse. If pantograph or wireless charging was available to the truck as the goods left a port but also at the warehouse where the truck could eventually charge while it was unloaded, one could assert that providing charging at the warehouse might be useful to trucks that would otherwise not be able to complete their duties only on electric power.

So in other words, by thinking about the whole system, we may consider a warehouse charger as part of a port electrification effort despite not being physically located. And so we encourage creative ideas about systemic and holistic thinking during this workshop.

In addition, a third goal is to identify key drivers of demand. The first two that are listed are perspectives from the federal, state, and local levels and the strategies that will be implemented. We've assembled representatives from three divisions at the Air Resources Board and representatives from South Coast and San Joaquin Air Quality Management Districts to provide their perspectives on this.

Another demand driver may be coming from reflecting that although the focus of this assessment is charging and electric transportation, there are other potential demands

for low carbon alternatives including renewable natural gas via fuel and hydrogen. And so we want to be cognizant of those options as competitors to electric.

And furthermore, as demonstrated with the earlier presentations from the EIPR if you were able to join this morning on how batteries have been able to drive down greatly in cost and the new vehicle categories that are enabled, we want to make sure that we're aware of EVs on the horizon in emerging applications including aerial drones, rail, recreational vehicles, or others.

So we discuss -- we welcome discussion about the tradeoffs considered in these sectors and emerging applications given the iterative cycle that described previously. And again, we'll conclude the day with some practical operational lessons learned from the ARFVTP's investments thus far.

And so with that, I will transition over to Marshall from UC Davis to give his presentation.

Marshall, the floor is yours. And could just use the keyboard or that.

MR. MILLER: That's fine. Yeah. Okay.

Thank you, Noel.

So I'm going to talk about a study that I will be doing -- or I am doing with Aspen Environmental for the CEC on off-road transportation electrification. I did a

similar -- or we, I and Aspen did a similar study about three years ago and the hope was that this time we do it, that there's much better data available than there was three years ago. It was actually extremely difficult to get stock data for a number of the sectors that we looked at.

So basically the study purpose is to estimate the total electricity demand for off-road vehicles and applications from now through 2030, essentially ten years from now. The study we did three years ago included nine categories, and I'll talk about those, and we've added potentially five new categories to those seven. And the -- in the study, we are going to look at producing a low, medium, and high scenario for electricity usage for each category for those years.

So the 2015 study looked at these seven categories, truck stop electrification, trailer refrigeration units, industrial forklifts, cargo handling equipment, ground support equipment, utility work trucks, and shore power. And we -- hopefully, we will add some set of these. It's not clear exactly how much we will manage to get through in this study, but Locomotives Class 1 and I'll talk about more details in terms of the vehicles or equipment in these various categories. But industrial equipment, construction and mining, commercial harbor craft, motorcycles, and I put a question mark by that because we haven't even yet decided if

we want to include that in the study. It's -- obviously, they're not really off-road, but they -- it's one of those vehicles that kind of fall through the crack of normal on-road. So if we can do that, we will include that. So as I say, it's -- it's probably a subset of all of the vehicles or equipment in those categories that we will actually include in the study.

Okay. So this, I just want to go through the details. I'm not going to do this very quickly, but I mean anyone can look at the slides and see exactly what equipment is part of each sector.

Here is airport ground support equipment. So there are things like tugs, baggage tugs, belt loaders, bobtails, forklift, lifts, and things like that. And basically what we do is we look at each category and consider it separately in terms of its stock, its likelihood to be electrified, how much energy it uses, and so on. So we make an accounting for each of these equipment or vehicle types within a category and then we sum it up for the category itself.

Again, continuing with the old truck stop electrification, that's one group, utility work truck's one group. Forklifts, Classes 1 to 5; 1 to 3 are electric, 4 and 5 are not. And what we do is try and understand the growth of electric versus a diesel or gasoline or propane and the probability that new forklifts instead of being purchased in

Class 4 or 5 as nonelectric might be purchased as an electric forklift in the future.

Then we look at TRUs and we generally have three categories of those. In terms of horsepower under 11, 11 to 25. Greater than 25, and then there's out of state TRUs which we generally view as over 25 horsepower.

There's shore power and we have four ship types container, reefer, passenger, and tanker. And then within the port of cargo handling equipment, we have the RTG cranes, forklifts, and yard tractors.

Okay, in terms of the new equipment or new categories, I don't know if I'll go through -- I won't go through all the list here but you can see there's actually quite a bit. This comes out of the ARB Orion database. So in the industrial category, there are a number of equipment or vehicle types. Commercial harbor craft, again, a bunch of different ferries, vessels, boats, and so on.

And again, we're probably not going to do all of these, we won't have time. The goal would be to try to identify which ones are likely to be electrified in the next ten years or much more so than other categories so that we're trying to get the dominant use of electrification in these various categories.

And then construction and mining has, I don't know, 20 types of equipment or vehicles. So again, we will almost

certainly not look at every one of these, try to identify which ones maybe make the most sense to electrify or manufacturers are looking to electrify those and then focus on those and make an estimate of the electricity demand there.

Okay. So I want to talk a little bit about the methodology of how we go about estimating the electricity demand. I'll give some very brief results from last time to see you can kind of see what they vaguely look like. And then I think there's a couple of more slides at the end.

Oops, I don't want to skip that.

So for the methodology, basically we try to understand what the present fleet stock is for each equipment type or vehicle type within a given category. And so that's either vehicles or applications. And again, we separate category by each vehicle type, bobtails, belt loaders, forklift classes and so on.

Then we're going to estimate the stock growth through 2030. We estimate -- and by estimate, in theory, there may be data on this and hopefully there is a lot of data. The activity either in vehicle miles traveled for a vehicle or an hours of operation for equipment and the fuel economy, miles per kilowatt hour for the electric vehicle, kilowatt hours per hour for an electric application.

And then the -- probably the hardest part of all of

this is to make an estimate of the percentage of vehicles or applications that will be electrified in the fleet between now and 2030. And a number of these sectors or specific areas already have some significant amount of electrification. So some of them may start at some modest level or even high level, like forklifts, but will likely increase between now and 2030. So the goal is to try to understand what that percentage is year by year between now and 2030.

I say we -- in the past, we assumed the linear increase from the present through 2030 trying to understand what regulations there are, what industry is thinking about doing, so we try and get a sense of over the next ten years maybe what might be the market penetration for electric vehicles, if we think it's going to start at 5 percent and go to 30 percent. Likely, we would just assume a linear increase unless there's some reason to believe otherwise. If there's some particular regulation that kicks in in the middle of that period, then maybe there might be modest increase and then a significant increase once that regulation kicks in.

We look at current reports, recent activity, regulations in particular, and we discuss with the stakeholders, you know, group -- people at ports, industry making the vehicles or applications to try and get an

understanding of what to expect over the next ten years.

Okay. In order to actually do the calculations, this is pretty simple, straightforward. For vehicles, the electricity usage is simply number of vehicles times VMT, times -- divided by miles per kilowatt hour, and that will give you the number of kilowatt hours over the course of a year.

For the applications, it's essentially the same thing, number of pieces of equipment times hours of usage and electric mode times kilowatt hours per hour.

In some cases it's kind of nice because we actually get data for the entire energy use for the whole year. That's rare but there are some studies that make those estimates so we don't have to think. It's just here's the data for the -- in terms of either -- well, electric energy usage for the entire year for this particular type of equipment or vehicle.

And then for the variation of these inputs by year, obviously there's stock increases, we believe that stock will increase from now through 2030. We believe that the percentage of electrification, either there will be no electrification or if there is, we believe that likely percentage of electrification will -- sorry, electrification will increase maybe year by year, but certainly between now and 2030. In general, unless we have a reason not to and in

the past study we did not have that reason, the fuel economy and the usage, the activity, we will hold constant across this ten-year period.

So we make three scenarios, low, medium, and high. The dominant variation in those scenarios comes from an estimate of the actual percentage electrification of the vehicle or the equipment. And that's done basically by reading reports, looking at regulation, and mostly talking to the stakeholders, the companies, the ports, and so on and try and understand really what do they think is going to happen. Sort of what -- what is a minimum, what might be a maximum, and this sort of middle level.

And so that's a difficult thing to do. It's -- it's -- I won't say it's a complete guess, but it's obviously, we're making a clear estimate of what we think the bounds are on what you might see.

So then we also project the low, medium, and high scenario for stock growth. Three years ago on the last study we did we basically just looked at the Moody's Analytics for California, their projected economic growth, and we just assumed that stock growth would follow economic growth. If there's some reason to believe otherwise, if ARB, for example, says no, we actually know in this sector you're going to see -- we think you're going to see double the growth of the economy or whatever. We have to decide whether

we use that rather than the simple economic forecast. But as I said, three years ago we just looked at the economic forecast and that's how we did the scenario growth. And there's a low, medium, and high economic forecast. So we use those three to generate those scenarios for stock growth.

So then in terms of trying to estimate the low, medium, and high percentage of electrification, you can do it a number of ways. The medium, the middle part, is -- would generally be our best estimate. You know, what do we really think is going to happen. And so we talking to people, looking at reports, regulation, and make that guess.

The low one, generally we try to think this is a lower bound, maybe not an absolute lower bound but close to that lower bound. You're really not going to see electrification less than that. And the high one is always difficult because you can always get higher. So basically it's aggressive assumptions, you know, clearly above the medium or middle. But it's unclear how we -- well, it's not unclear. It's clear that that's not such an easy thing to estimate. But we do make that estimate. So that gives us the low, medium, and high forecast.

So this is actually a graph from our last study taking the off-road electricity demand together. This is of the seven categories we looked at. And you can see the low, medium, and high demand forecast from 2015 to 2025. This is

in gigawatt hours. And I'll show you -- so you can see the blue line goes a little above 2,000. This next curve is for just industrial forklifts. And the blue line is at about 1700, 1750 or so. So electric forklifts dominate the electricity demand. And it's sort of for two reasons. There's a lot of them, over 100,000, and they're very -- they're already very highly electrified. There's -- the electric forklifts are actually the majority of forklifts in the state.

So that's just not true of the other categories. The electrification percentage is much lower, the number of vehicles tends to much lower, our applications tends to be much lower. So, you know, we expect, again, we'll see the same thing, the forklifts will dominate the electricity demand.

I didn't mention this earlier but another thing we happened to do is estimate the avoided petroleum usage so we just basically do that by saying as we extrapolate out if we believe that for the next year instead of ten new vehicles being diesel vehicles, they turn out to be electric vehicles. We calculate the diesel usage, petroleum usage of those ten vehicles for that year what it would have been and we say that that was avoided. And we add up all the avoided petroleum usage year by year as we go out and we get these numbers again low, medium, and high.

So I was asked to sort of say a few things on what we expect for the new study compared to the old study. Well, maybe it's pretty obvious, but we do expect higher estimates of electricity usage than from the previous study. And there's really two reasons for that. I'm not sure actually which -- I mean, they sort of were coupled and related. One is ARB in the past few years has actually started to either implement or think strongly about new regulations for off-road categories. And I'll talk about some of those on the next slide. But for many off-road categories, ARB is actually going to try and regulate at some level the, you know, the electric penetration of vehicles applications in these categories.

As I said, related to this is something that four years ago I'm not sure maybe five, but three to five years ago, the estimates of battery cost were quite a bit higher than they are now. And when I say quite a bit higher, to those of us who have been watching and studying batteries, I run a battery lab, we've used battery cost in a lot of our models. The projections of battery cost are sort of stunning. In some sense I would say they're not necessarily believable.

We did a study a little over ten years ago for ARB and we for lithium ion batteries, we came up with a number of $220 per kilowatt hour for the whole pack. And at the time I

thought that was really aggressive and that was or a mature battery, say 2020, 2025 in high volume. $220 per kilowatt hour. If you look at projections today, many people talk about $80 a kilowatt hour in 2030, that's for the whole pack. There are some projections that are even more aggressive than that. So that difference is just stunning. And battery -- energy density is expected to get up to perhaps, you know, from maybe 200, you know, watt hours per kilogram now up to 500 by 2030. And the battery people just think that's going to happen. That's not sort of a hope, a desire, whatever, that's a projection that they're very confident with.

So the point is battery technology is just increased by leaps and bounds and in a large part to the cost, I think people are assuming that at least in the near to midterm in many of these applications both on-road and off, that battery electric vehicles will become cost competitive much quicker than otherwise anticipated.

And if you had actually asked me eight years ago which you think is sort of going to lead, fuel cells or batteries, I would have said fuel cells. Now without question at least near to midterm, it's clear that it's battery electric for vehicles, for applications, whatever. Twenty years from now I don't know. But certainly five, ten years batteries will dominate in these -- in these applications.

So I mentioned that there's -- there's new regulation and here's a set of examples. There's a measure for zero emission airport ground support equipment. There's a measure for zero emission operations for ships at-berth. Zero emission operations for TRUs. Zero emission off-road forklift regulation. Cargo handling equipment regulation. There's also new reporting regulations. The nice thing about new reporting regulations and these have in many cases already kicked in. As I mentioned, three years ago finding stock data for a lot of these categories was sort of a nightmare. I almost felt funny in the path I took to make my estimates of what the actual stock was.

The hope now is that because of a lot of reporting regulations that the actual data is quite a bit better and we can at least go to that data and say if not perfect, this is a reasonable place to start to assume that the stock, these numbers for stock for today are reasonable and then we extrapolate and so on.

Okay. This next slide is on sort of a different topic. But Noel sort of suggested that this is an important topic and related and it's something that we at UC Davis have actually spent a lot of time thinking about. So I'll just kind of go through this and if it's -- some people want to discuss it, I guess that's fine.

So the bottom line is that ARB is responsible for air

quality standards and for reductions in greenhouse gases and fossil fuels. In some cases, those two requirements align with each other. In other cases, they don't necessarily. And so as you think about over the next say ten years, what technology should be used to meet these standards or requirements. There may be tradeoffs, there may be -- one path may sort of go against another path. For NOx reduction, so this would, you know, for trucks and off-road vehicles. NOx reductions are critical. Low NOx, natural gas, and cleaner diesel can make significant, certainly low NOx natural gas can make enormous reductions to NOx emissions for vehicles.

These are generally at a modest cost. Certainly modest compared to ZEVs, to battery electric vehicles or fuel cells. And as I mentioned, significant NOx reductions. Unfortunately, a lot of these technologies either have zero or fairly modest greenhouse gas reduction potential. For natural gas, if it's renewable natural gas, yes, you can have quite significant. But if it's just fossil nature gas, it's rather modest, if any at all, greenhouse gas reductions, depending exactly how it's used.

In terms of greenhouse gas reductions, ZEV technologies are obviously the standard. The problem is certainly starting, they're very high cost and they also require renewable fuels. Natural gas reformation produces

hydrogen, you get some reductions in greenhouse gases. But nowhere near what's necessary to meet the goals that we've laid out for the future of the state. So you have to get renewable fuels that requires activity and infrastructure and probably increased costs. The ZEV technologies themselves have very high cost. But ZEV technologies reduce greenhouse gases -- again, assuming renewable fuels -- and criteria pollutants to essentially zero. Again, depending exactly on the fuel pathway.

So you have two paths you can kind of go down. You can go down the less expensive but significant NOx reduction path or you can go down the more expensive ZEV path to get even higher reductions. And the question is do those paths sort of -- do they bump against each other? Are they problematic with each other? To some extent they could be. If you're asking how to get the biggest bang for the buck in NOx reductions, that's low NOx -- low NOx, natural gas, or cleaner diesel, without question the cost savings of the reduction in NOx per dollar or whatever is much better than for ZEV technologies.

But if you go out to maybe 2032, at least ARB suggests that without these ZEV technologies, they can't meet air quality goals and they certainly can't meet greenhouse gas reduction goals, again, excepting renewable natural gas.

So -- oh, and the other issue that's really

problematic is if you start down below NOx natural gas path, infrastructure, fleets, purchasing vehicles and having those vehicles in their fleet, and a turnover period of 15, maybe more years can significantly delay the introduction of ZEVs.

So this is a problem that some people want near-term results, some people -- well, everybody wants near-term and long-term results. But some people will push very hard for near-term results. You know, people are dying. Air quality needs to be reduced, we've got to do what we can about that, we have limited dollars go for the NOx productions, the cheaper NOx reductions. But then there's the 2030 goals of greenhouse gases and 2032 goals of criteria pollutant reduction's air quality.

And so these paths, as I say, sort of adversely affect each -- or can adversely affect each other. So I'll leave it there. And I guess there can be some questions or discussions about either our study or that last slide, you know, the two paths.

MR. CRISOSTOMO: Thanks, Marshall, that was an informative presentation.

One of the -- looks like really key actors that will drive adoption is your assumed percentage. And you said that it'll come from interviews with stakeholders and considerations of how demand will be affected by regulatory efforts.

I'm wondering if given what you're describing about battery cost and the -- not necessarily believable and stunning reductions that you're seeing, is there a way -- how are you thinking about changing that percentage according to considerations of potential cost parity within the time frame that you're forecasting?

MR. MILLER: Probably not at all. And the reason for that is that I will defer more to what ports are doing, what airports are doing, what companies are expecting, they will have a better sense of, you know, what their internal goals are, what their plans are for the next five or so years.

Also talking to sort of experts say at ARB that have followed these technologies and the various areas where they'll be used. That will really inform my decision of the percentage.

Cost -- cost parity is kind of a tough thing. In some cases, for example, three years ago, there was a study done at the LA airport and they looked at fossil -- well diesel verses electrical equipment and from their study, they just showed right then they felt that there was -- the electric equipment was actually cost, would cost less. And because of that, they had a particular plan to roll out, you know, the significant amount of electric equipment.

But it wasn't so much, you know, for me that electric equipment would cost less, it was that they had decided to

move forward partly because they felt it would cost less. But it was their decision to say yes, we're going to move forward and purchase a lot of these that informed my, I won't say guess, but my estimate of the percentage for electrification.

MR. CRISOSTOMO: Okay. Thank you for that.

Maybe you could kind of elaborate maybe with other examples about how the decision making at the customers is perhaps based on education or how big their fleet is or how knowledgeable they are of alternative technologies.

So based on your interviews, how -- how might you consider the potential tradeoffs of electric versus other fuels from an operational standpoint in terms of operations maintenance or safety benefits from like quieter operations, is that a consideration in your interviews?

MR. MILLER: Generally, no. We actually at UC Davis are doing -- have done and continue to do what we call fleet choice. Purchase decision choice studies or we have a model of decision choice for trucks. And we include all of that in there and many other factors. It's enormously difficult to do. Fleets are much more varied than like light duty vehicle consumers and how they make purchases. And so it's very difficult to talk to a relatively small number of people. I don't have a chance to talk to a lot of people in these areas and make decisions based on that. I really try to get from

them what do you think you're going to do? I don't care why so much but -- I mean, we can talk a little about why but in your mind, are you going to purchase a few percent? Do you think in ten years -- you know, often I'll talk to people, for example, at the port, so these aren't the people that are directly doing the purchasing but they know the people very closely were doing the purchasing, they talked to them, they have strategy at the port and so on. So they have estimates of what they think the ramp up will be. And I really depend more on that than sort of trying to understand why that's the case.

MR. CRISOSTOMO: Any questions from the audience? Marshall? Bonnie. Please.

MS. DATTA: I'm Bonnie Datta with Siemens --

UNKNOWN SPEAKER: Microphone, ma'am.

MR. CRISOSTOMO: Make sure that the mic is green.

MS. DATTA: There it is.

Bonnie Datta from Siemens. Thank you, Marshall.

In your listing of the new categories, did you consider taxis? Because in Asia they're already going to pilot what they're calling electric vehicle -- electric vertical takeoff and landing in urban areas.

MR. MILLER: We considered what CEC asked us to and I listed the categories that they asked us. So we're not going to consider anything outside that.

MS. DATTA: Speak with CEC about --

UNKNOWN SPEAKER: Is the mic off again?

MS. DATTA: Yeah. We should probably speak with CEC, then.

MR. KING: Hi, Chris King with Siemens.

Should electrification levels converted into petroleum equivalence, and aren't you also going to show those in terms of GHG reductions and NOx reductions?

MR. MILLER: No. No.

MR. KING: That's all under petroleum. So.

MR. MILLER: Yeah. It's -- I mean, it's actually I think fairly easy to do if you know how many gallons of --

MR. KING: Then you should do it, right?

MR. MILLER: Well, you can talk to the CEC about what they think that all should be.

MR. CRISOSTOMO: To be clear, I'm not the contract manager for this, but I'm taking notes down.

MR. KING: I was being facetious. But it would help -- one of our thoughts on this whole exercise, if you will, planning effort is helping use its input to help prioritize the spending. And clearly GHG emission reductions and other emission reductions are one of the factors you want to look at and prioritizing spending and incentives and subsidies. So --

MR. MILLER: Oh sorry, go ahead.

MR. KING: Go ahead.

MR. MILLER: Well, I would just say. So it's easy to take the reductions in diesel usage in terms of gallons and convert that to greenhouse gas emission avoided. The problem is that isn't -- that doesn't tell you how many fewer or how much less greenhouse gas would be admitted because there is the electricity usage for the vehicles that have replaced them. And depending on the electricity mix and so on, there's still emissions due to those. So -- and that's not such a trivial calculation.

MR. KING: Right. Yeah. That of course depends on the generation mix. Thank you.

MR. CRISOSTOMO: Any other audience questions before we transition to the panel of ARB speakers?

Okay. I hear none. I guess Kathy, Craig, and David. Can you transition? So we'll start with Kathy and then if David and Craig, you could sit up here and then -- or you could speak through here.

UNKNOWN SPEAKER: Can we all just sit right here?

MR. CRISOSTOMO: Yeah, whatever you'd like.

So there was a WebEx question. Micah is going to try to unmute you so that Marshall can respond.

Do you want to -- let's see. Yeah, grab a mic.

MR. WOFFORD: Okay. So the question is from Nehemiah Stone. The question is: In considering the adoption rate

for commercial vehicles of any type, did you account for the amount of time it takes to charge an EV battery versus the time it takes to pump gas or diesel for the same miles or number of hours?

MR. MILLER: No. The assumption is that if airports or ports or any group is going to adopt an electric vehicle, that they will make sure they have the appropriate infrastructure and the time necessary to do the charging. That may be slightly problematic for them, but in talking to the various groups, we assume that they've taken that into account and that's just part of their operations and that won't make it more difficult for them or preclude them from actually reaching the percentage that they think or they expect to reach over ten years.

MR. CRISOSTOMO: And Micah, if you could read the name of the person into the record.

MR. WOFFORD: Oh, sure. Yeah, just for repetition, that question was from Nehemiah Stone.

MR. CRISOSTOMO: Okay. Now we have a panel of managers from the Air Resources Board.

Just to provide a quick introduction, first we'll have Kathy Jaw, manager of Sustainable Transportation and -- manager in the Sustainable Transportation and Communities Division. David Quiros, manager in the Transportation and Toxics Division. And then Craig Duehring, manager in the

Mobile Source Control Division speaking about regulatory drivers for electrification in freight and off-road.

And you have control of the presentation.

UNKNOWN SPEAKER: We do.

MS. JAW: Thank you, Noel. Good afternoon, my name is Kathy Jaw, and I'm the manager of Transition Assistance Training Section out of California Air Resources Board.

I'm going to begin -- I'm going to begin ARB's presentation with an overview of mobile source strategy. Later my colleague David and Craig will present our programs in more details.

The California Air Resources Board, CARB, is charged with protecting the public from the harmful effect of air pollutions and developing programs and actions to fight economy changes, specifically over the coming decade, California will need to attend federal air quality standards for ozone in the South Coast and San Joaquin Valley in 2023 and 2031 and find particulate matters standards in 2024 and '25.

Reduce greenhouse gas emissions 40 percent below 1990 level and petroleum use up to 50 percent, deploy 5 million zero emission vehicles. All this by 2030. And we also need to derive 50 percent of our electricity from renewable resources by 2030. We're also tasked to minimize the health risk such as risk from diesel particulate matters in our

local communities.

To achieve all this, reduction from mobile sources are key to meeting our goals. Mobile sources include both on- and off-road mobile sources. For example, cars, trucks, and buses are considered on-road mobile sources. Off-road mobile sources as Marshall pointed out cover wide range of vehicle, vessels, and equipment such as locomotive, ocean going vessels, and off-road equipment like forklifts.

Showing in the chart on the right, the mobile sources are the largest contributors to the formation of ozone, greenhouse gases, emissions, and toxic diesel particulate matters. Consequently, significant cuts in pollution from mobile sources will be needed to meet our goals.

In the following three slides, we'll get into more details how various mobile sources contribute to greenhouse gas, NOx, and diesel particulate matters.

Direct emission from transportation account for 41 percent of statewide greenhouse gas emissions. Adding the fuel production to support transportation is responsible for 50 percent of greenhouse gas emissions. Of the transportation sectors, passenger vehicle account for about two-third of the greenhouse gas shown in the charts on the right.

A criteria pollutant, mobile source account for close to 80 percent of statewide NOx emissions. While heavy duty

trucks off-road -- heavy duty trucks and off-road only contribute about a third of the greenhouse gas emission within transportation sector, they account for 85 percent of NOx emissions within mobile sources.

Diesel particulate matter is component of exhaust from diesel engines. Since diesel engines are widely used in both on- and off-road heavy duty sector or heavy duty application such as trucks, trend, constructions, agriculture, and maritime. They account for about 90 percent of statewide diesel particulate matters. The development of mobile source strategy is an integrated planning process. We need to understand existing regulations and standards and emission contribution from various sectors.

We conducted detailed technology assessment to evaluate the capability of technology and feel that are becoming available today and advancement now are expected to occur in the near future. The assessment will also need to evaluate market readiness, cost, environment benefit, and current deployment challenges.

With this understanding, we conduct a scenario analysis which provide a framework for coordinating -- coordinated air quality and climate assessment by analyzing the types of technology, fuel, and energy source -- energy sources that we'll ultimately need to make up our vehicle equipment fleet by the end of next decade.

The mobile source strategy proposes a suite of measures that present -- represent a course set of actions to drive technology development and deployment. In general, for light duty passenger vehicle, the strategy focus on expanding ZEV technology and continue to push for widespread ZEV penetration. We need to curb -- we need to curb vehicle miles traveled by small growth in promoting share mobility and active transportation.

For on- and off-road heavy duty sectors, there's zero emission technology everywhere visible in near zero emission with a renewable fuel everywhere else. We need to expand the use of cleaner renewable fuel in the sectors that are anticipated to continue -- to continue operating on combustion technologies. Wherever feasible, we encourage zero emission technology such as fuel cell electrifications which is a focus on our following presentations.

Thank you. And I will now hand the mic to Dave.

MR. QUIROS: Thank you, Kathy.

My name is David Quiros and I'm a manger in the Transportation and Toxics Division at ARB. And that's the division that oversees a lot of the freight programs. And I specifically work in the branch that oversees a lot of the marine programs and the cargo handling equipment programs.

So I'm going to go over some slides that talk a little bit about freight specifically and then get into some

of the specifics that might be helpful for this AB-2127 process. Some of these slides are going to look very familiar to what was presented at the March 2019 board hearing where my colleague Andre Freeman gave an informational update to our board about the status of a lot of the freight actions that are underway and in California.

This slide shows some of the three categories of air pollutants that we try to get out. Kathy showed a lot of the state goals that have different targets for zero emission equipment. And it really boils down to getting reductions in air toxics that support AB-1617 programs in regional air pollution like ozone and fine particulate matter PM2.5, and then also the greenhouse gases that support our scoping plan and also the short-lived climate pollutant plan as well.

And the thing is that when we go to zero emission equipment, that means electrification in many cases and that gets at all three of these types of pollutants. Whereas the cleaner combustion technologies that we've used to achieve reductions to date primarily focus on the first two, the toxics and the criteria pollutants.

In 2000, ARB adopted the Diesel Risk Reduction Plan, and following that about five, six, seven years later, a freight-specific emission reduction plan was adopted that has resulted in controls over a wide variety of equipment types. Everything from trucks, ships, to equipment operating at the

ports and harbor craft that assist some of the large ocean going ships in the ports and also in other areas throughout the state of operations. And a lot of these reductions have been possible due to CARB standards, emission standards, investments from equipment manufacturers to the operators of the equipment, an essential component to getting these reductions from all these source categories has been the incentives that have been put forward at the local, state, and federal levels.

This chart shows some of the emission reductions associated with those actions over the last 20 years. This shows four pollutants from the year 2000 to 2035, those would be projections out into the future. The key message here would be that we've seen a reduction in the criteria in the tailpipe emissions. Not so much on the greenhouse gas emission side because cleaner combustion technologies, except for some of the later truck greenhouse gas and trailer greenhouse gas standards have not resulted in the greenhouse gas reductions that we expect and need within the state.

And also the residual NOx and PM emissions are at levels that need to be further controlled to attain federal air quality standards and also protect public health.

As we move forward to adopt zero emission components of various freight regulations and other mobile source programs, we recognize that it's not just the equipment, but

it's also the infrastructure that needs to help support the successful deployment of a lot of these technologies.

We have a lot of different goals and in order to achieve some of these goals, we recognize that we do need to have an adequate infrastructure system and a lot of the infrastructure that we need will be both for charging and for just directly grid connected equipment. And we also recognize that the infrastructure needs and the charging connections and the power capacity will vary widely depending on the type of equipment we use and also where we're using it. So those are a lot of considerations and unknowns that we are developing as a regulatory agency on the equipment side and need to be working cooperatively with CEC and CPUC to ensure the adequate infrastructure is available for when we roll out the equipment.

As I mentioned, there's a lot of data needs that we have and a lot of data needs are needed for the AB-2127 assessment. We have goals of 5 million ZEVs by 2030 and the Sustainable Freight Action Plan has goals of 100,000 zero emission capable pieces of freight equipment by 2030 as well. And to achieve those goals, we're going to be adopting regulations, we have incentives, and we also have a lot of assessments that we've done irrespective of the regulations that are coming.

For example, the CARB tech assessments that were

posted in the 2015 to 2018 timeframe have a lot of information about the status of the technologies and the types of infrastructure that were available at that time. And those reports may be useful in developing the infrastructure assessment under AB-2127.

Also CARB and CEC have funded a lot of demonstration projects and zero emission projects that have an infrastructure component. Some of those are beginning to look at not just plug in conductive charging but wireless inductive charging to the extent that those charging methods are the ones that are going to be used widely. Those may be interesting projects or useful projects to reference as part of this assessment.

CPUC has a lot of data collection for the utility transportation electrification projects that might be useful to be referenced. And then at the local level, we also have a lot of port led action plans. For example, the San Pedro port has their Clean Air Action Plan that was updated in 2017. The port of Oakland has their seaport 2020 and beyond plan. The port of San Diego has an air quality plan that's going to be setting ambitious zero emission goals. And the adoption of equipment is going to be fostered by a lot of assessments of what technology needs are, what infrastructure needs are, and those would be very helpful documents. And things that we're tracking at the state level as we put

together a lot of the regulatory requirements.

This slide lists selected CARB freight strategies that we're going to focus on and also some strategies at the airports and strategies that are going to be used for on-road heavy duty trucks. I'm going to go through these with one slide in detail up through cargo handling equipment. And then locomotives doesn't have a slide here today but it some -- one of the source categories that we think is going to have some electrification. We recognize that locomotives contribute a significant amount of health risk and also ambient air quality or other emissions contributing to ambient air quality concerns and that CARB does have an MOU with some of the major railroads for the South Coast to require a Tier 2 average. And we are funding a lot of demonstration projects to further reduce emissions from that source category.

Although we're really not sure to the extent of what types of electrification would come out of that source category so we're not going to go over it in detail and have a slide on it today.

The first sector that I'll focus on is the ships at-berth regulation that we have. The ships already have a compliance obligation today to use shore power at many California ports. And our agency is in the process of amending that regulatory proposal to include more ports, more

visits, and more vessel types. As a result of those amendments, a total of 1250 unique vessels are going to be anticipated to be affected by the regulation and to be using shore power. And the amendments that are undergoing right now are only going to add 85 additional unique vessels that are likely going to use shore power. So the majority of the electrification for vessels at-berth has already occurred. And that's been largely successful over the last ten years, it's been a lot of work. But there are some observations that we can offer and perhaps different considerations that might be useful for some of the other freight categories that are less electrified at this point.

Although CARB wasn't directly involved, something that is worth noting is that most of the connections are standardized and a lot of the shore power systems manufacturers have collaborated to develop an ISO standard that is used at most ports. And that wasn't something that CARB was directly involved with, it just happened as a result of the regulation.

Some of the -- despite the use of shore power and decent amount of compliance with the program, commissioning some of the new systems has been a barrier in some cases and the at-berth group was suggesting that facilities to the extent that they can be standardized would be helpful to preclude issues from occurring with further electrification.

So as we look at other freight categories that are not as electrified, standardization is something that we should be targeting.

Some of the more unique aspects to the at-berth rule are the logistics associated with getting the vessels plugged in. Not all the vessels are the same size and they're growing over time, so the configuration at the berths are going to be different depending on which vessels come and what other vessels are there when a new one arrives.

When failures with the shore power connection do occur, departure often specialized and will take quite some time to be ordered. Although this is a more international lower volume, it's still larger emission category. So with some of the other categories like transport refrigeration units where there's a larger amount, that may not be the case.

And then another consideration is that there have been some power outages that have been reported that affect compliance with the regulation. And some of these we've received complaints or comments that it might be due to the increased load associated with using shore power. Although it's possible that some of those outages would have happened anyway, additional infrastructure planning couldn't hurt the resiliency of the system overall.

As a result of the new regulation that's being

anticipated to phase in between 2021 and 2029, there are -- let me see here. So we anticipate that one completely new shore power berth installation at the San Francisco cruise terminal is going to be needed which would include an additional shore power need for that area at the berth. And then we also expect that there are going to be five new vault installations combined at the ports of Los Angeles and Oakland. And that extra capacity may need to be served by something upstream but relative to what has been done thus far, it's a smaller component. But once we begin to add additional source categories at the ports, there may need to be more integrated planning to accommodate the increase load.

Another category that operate at the ports and elsewhere are harbor craft and this includes passenger and freight vessels like ferries, tugs, barges, dredges, and a lot of other vessel types as well. Statewide we think there's about 3500 vessels and the regulation for harbor craft has been in effect since the late 2000s and will be fully implemented by 2022 at which point new requirements that we're currently developing will go into effect beginning in 2023 phasing in likely at least through 2030 but the exact dates have not been set yet.

Marine engines are typically diesel powered and the emissions levels of those engines are substantially higher than what at Tier 2 or Tier 3 or Tier 4 off-road engine would

be. And we know that the off-road standards are not as stringent as the cleanest on-road truck standards. So in other words, the Tier 2 and Tier 3 engines that are used in Marine vessels are substantially higher emitting than a truck per unit horsepower per hour of operation than some of the trucks are on the road.

So there's a need to further control them. And in many cases the current regulation already requires the cleanest diesel technology. So the mindset of this program is to get cleaner diesel equipment wherever we can and then also keep in mind that electrification or other zero emission options are available and to push in those areas where possible.

So the amount of electrification as a result of the harbor craft amendments is not entirely clear at this point. There are just a couple vessels with battery systems on board where we anticipate there might be some charging but the amount of energy per -- per location is going to be very small at this point.

Ferries are an area where we have seen some development in other areas in -- across the globe. For example, on this slide there is a Norwegian ferry that uses a battery electric charging system on both sides of a fjord in Norway. And in our discussions with the charging company, the capacity of that specific charger I believe is 1.5

megawatts and it still is unable to keep up with the charging needs for that vessel over a drought.

Within California, there's a lot of different types of ferries. There's ones within the bay area that high speed transportation ferries between different regions of the bay. There's ferries in Southern California that go out to Catalina Island over a much larger range. And the needs or the ability to transition those to zero emission is not entirely clear at this point.

Transport refrigeration units or TRUs is another higher volume number of freight equipment. They are the -- they're the diesel engines that work on the generator sets that are on the back of refrigerated trucks to transport meat, produce, pharmaceuticals, frozen goods, et cetera. And we think there's about 200,000 of them that operate within the state.

In 2025 we anticipate a phasing of new requirements that would require either the TRU to have a plug-in capable system or the entire TRU to be zero emission, depending on the truck configuration.

A unique challenge with TRUs is that unlike ferries that may go to one location or two locations to charge or transit buses that might return to home base at the end of the day, these will operate at a large number of facilities throughout the state so the infrastructure needs -- need to

be clearly defined and need to be available in order for the emission reductions to be achieved.

And then the last equipment category within the freight system that I'll cover right now are cargo handling equipment. CARB has a regulation for requiring the cleanest available engines a retrofit controls on the diesel engines on mobile equipment that operated the ports and the intermodal rail yards. And at some ports like the ports of LA and Long Beach, there's a fraction of electrification that's already occurred due to a lot of the incentive programs and also just the general movement to clean up emissions associated with the local Clean Air Action Plan.

There's about 5,000 pieces of equipment statewide that's just at the ports or intermodal rail yards. And although the current diesel regulation is fully implemented, we are soon to begin development of the zero emission requirements that we anticipate taking effect starting in around 2026. The ports of LA and Long Beach have a goal of 100 percent zero emission cargo handling equipment by 2030. And a lot of the equipment types in our technology evaluation that was posted to our website as well as our ongoing tracking we recognize is available today such as the yard trucks, the RTG cranes, and some of the container handling equipment. An area that we see an opportunity for further technological development in the zero emission arena is some

of the bulk handling equipment.

So that concludes my portion. I'm going to turn control over to my colleague Craig Duehring.

MR. DUEHRING: Thanks, David.

So I'm going to follow up with what David already started, a continued discussion on some regulatory efforts at the ARB, the California Air Resources Board is looking at and moving forward with. David already showed you the list so I'm just going to keep going on that list.

This is a regulation not so much focused on off-road, but it's certainly within mobile resource control division as one of the bigger ones that we're currently working on. This is the advanced clean trucks in zero emission fleet regulation. We are -- well, first of all, the regulation itself is going to be a sales requirement on truck manufacturers themselves. They would be required to start building zero emission trucks in the 2024 model year and then going out to 2030, ramping those requirements up.

Really substantially, actually, about 50 percent of vehicles produced by the electric -- by the truck manufacturers would have to be electric by 2030. We estimate those -- well the population of trucks affected by this is about 1.5 million trucks in California but only about 70,000 would be required to be zero emission by 2030.

And then the second part of that is fleet rule policy

that would -- that would require fleets, companies that own these -- these types of trucks are companies that contract for services that use these types of trucks would then also have to start purchasing zero emission vehicles to meet our mandate. So we're looking at it from a manufacturer's standpoint, we're also looking at it from an ownership standpoint. But that's -- that's what our focus is on.

And the infrastructure required for this, we see early, early adoption of the infrastructure is going to be pretty much at the -- at the facilities where the trucks are located, right? We call it overnight depo charging. But it's really focused on fleets that have a large number of vehicles, they return home at night, they charge up, and then they use them during the day.

Although we do see as the technology advances and the battery tech -- as the vehicles can go further and further, there's no reason why infrastructure should not be available more from a public standpoint like the gas stations and diesel stations we see today where the vehicles can go out during the day, they can -- they can do some work, they can get some opportunity charging along their route, and then continue their -- their operations and their return back to base. So that is the advance clean truck rule. We are going to the board the end of this year, hopefully that will be approved and it'll be in effect very shortly.

There is another rule that's already been to the board but it's heading back for a second approval this June. It's the airport shuttle bus. Well, airport shuttle rule. And that's a rule that requires the -- both on airport and -- well, let's see, I better use the terminology correctly. I didn't write it down. So it's on airport and off airport shuttles that actually would be required to start -- be electrified. The population of these shuttles are -- we estimate right about 1,000 units. So all of the airports that have their own shuttle services or the airports that where companies like rental companies and parking facilities would visit the airports, all of those shuttles total up to about 1,000 in the state of California.

We -- the regulation would require starting 2027, about a third of those shuttles would have to be electric by 2027. The next key date on that would be 2031 where two-thirds would have to be electric and then we would -- we're looking for full electrification of all of those shuttles that visit or operate on airports by 2035 to be 100 percent electric.

So again, the charging -- the charging infrastructure needed for that, mostly, you know, these shuttles are -- range anywhere from passenger vans all the way up to in some cases you've got transit-like buses that operate as well as in some cases some 60-foot articulated buses. So charging

would vary but we anticipate due to the duty cycle, charges would be around 50 kilowatts or more.

So for ground -- for airport ground support equipment, we're in the early stages of working on this regulation. We are -- it is identified in our mobile source strategy and our state implementation plan to electrify a certain percentage of these vehicles. We are -- right now we anticipate or we believe there's somewhere around or greater than 7,000 pieces of equipment at all the airports here in California. And these are vehicles that service the airport, right? So these are the tankers that fuel the -- the cargo loading, the passenger loading vehicles that actually operate at the airport.

Our goal is to -- and again we're in the early stages of this -- but our goal is to get to about 60 percent of these pieces of equipment to be electric by 2032. And realizing that there's a wide range of vehicles that fall into this -- there's literally 23 different categories of vehicles that fall into this -- into this group of vehicles. But again, we're looking at 60 percent.

Charging rates for this type of operation, we're looking at -- some of these -- some of these vehicles, they -- they're based on their duty cycle, they need more batteries, they actually need more charging. So some of the larger chargers, Level 3 and up chargers would be probably

used at these facilities. And the charges will be used for multiple pieces of equipment, right? So that's what we have for airport ground support equipment.

For forklifts, again this is a concept that we're in the early stages of developing. The focus -- the focus for our efforts is looking at forklifts that are rated at 8,000 pounds or less. We estimate that there's approximately about 100,000 of these forklifts in the state of California. And as Marshall already touched on, a good portion of these are already electric today. We -- you know, somewhere around 50 percent new purchases of forklifts are already purchased as electric forklifts.

So we again, we're in the early development stages of this. We are looking to get another 10,000 forklifts of those 100,000 -- well, 50,000 are already electric. We're looking to get another 10,000 of those forklifts to be electrified by the 2030 timeframe. So I'm looking at the infrastructure -- so these are definitely worksite specific charging needs.

Smaller charges might work in some cases if we look at fast charging. Some larger chargers might be needed. But this a great application for just, you know, overnight charging. Oh, and by the way there is -- another program that we're working on at the Air Resources Board, very similar to the HVIP program for on-road, there's an off-road

voucher program where we're going to make funding available. We're going to start $40 million annually beginning late this year. So we're going to try to incentivize the purchase of not just forklifts but any off-road piece of equipment.

So that really wraps up our focus here at ARB. When we look at next steps, obviously we're going to continue to work with CEC and their pursuit of the AB-2127 goals. We do want to maintain focus on developing zero emission in use and zero emission equipment manufacturer requirements. We have several policies and strategies in place as we've been talking all day about mobile source strategy, the state implementation strategy, the freight -- sustainable freight strategy. Several strategies in place. We're going to continue moving forward with those strategies. And, you know, as we do that, we want to make sure that the infrastructure is a part of the solution, right? Looking at the standards, looking at the infrastructure availability, working with the utility companies, working with the Energy Commission to make sure that as we move forward, the opportunity for these pieces of equipment, the ability to use and efficiently use these electrified piece of equipment is in place.

And finally, you know, this is collaborative -- we want to continue to collaborate and engage facilities, utilities, the utility companies, other agencies in the zero

emission planning discussions. So we're -- we've got a pretty good start but we still have a long way to go. But that's -- that's where we're at.

So we do have some contact information. If you need to get a hold of either one of us three about any of the programs we're working on, feel free to contact us.

And I think we can turn it over to Noel.

MR. CRISOSTOMO: Thanks, everyone, those were really informative detailed pack of slides.

I have some questions. If you could go back to Slide 13.

UNKNOWN SPEAKER: Yeah, we'll get there.

MR. CRISOSTOMO: The question is: Your forecast shows limited reductions in greenhouse gases. And that was given present control measures. So those -- these graphs do not assume implementation of the measures that you just described; is that correct?

MR. QUIROS: That's likely correct, although I'll need to confirm and follow up with whomever asked that question.

MR. CRISOSTOMO: Okay. Yeah. It would be good to understand if that projection is assuming existing technologies and the lack of implementation of the measures that you just went through. Okay.

Related to the technology assessments, I haven't read

those. Can you speak more to which sectors those are covering? Are there assessments for all the areas that you just described?

MR. QUIROS: The assessments are quite broad and encompassing. I would say that just about every sector that we covered has something said in the tech assessments. There's probably ten to -- ten-ish different reports that cover the mobile source and for each sectors that we covered today.

MR. CRISOSTOMO: Okay.

MR. QUIROS: And the strategies that are discussed in those aren't just electrification, they also include other zero emission options and opportunities for emission reductions which is the focus of those assessments. For example, there's one on harbor craft that even talks about different types of paints that can go on the bottom of a vessel to prevent algae growth or other microorganisms from increasing the hydrodynamic drag on the vessel. That's outside of the scope of this AB-2127 evaluation but they were a broad sweep at trying to determine what type of emission reductions opportunities lay within each of those sectors.

MR. CRISOSTOMO: Okay. So related question. Are the assessments a like a primary source of information related to duty cycle which would be necessary to calculate the kW charger size associated with each vehicle type or use case?

MR. QUIROS: There may be some discussion of duty cycle as it relates to opportunities for using different types of technologies. For information on activity, the best place to go is probably the sector-specific emission inventories or the vision modeling.

MR. CRISOSTOMO: Okay.

MR. QUIROS: Kathy, do you have anything to add to that?

MS. JAW: Yeah, I think -- I think Marshall point out that there's an Orion emission inventory for off-road. That's probably the best and most comprehensive emission inventory that's -- that source for that right now.

MR. CRISOSTOMO: The Orion database?

MS. JAW: Yes.

MR. CRISOSTOMO: Okay.

MS. JAW: Vision does cover some portion of the off-road sectors, but maybe not as comprehensive as that.

MR. CRISOSTOMO: Okay. Thanks.

Marshall, could you speak into a mic?

MR. MILLER: So we've looked at the Orion database and there's a lot of great information in there. But I do have one question. So you select vehicle's equipment by fuel type, you know, diesel, electric, whatever. If you select electric, you get zero. As far as I can tell at least from the online, there's no inventory for electric vehicles in the

entire database. So I mean, I guess I could follow up with someone at ARB to figure that out but our hope was that the stock was great but that it would also say the present percentage of electrification in those sectors. But what I see is zero. So I don't know if that's just I'm screwing up or it's not there.

MS. JAW: I probably have to get back to you on that particular one. I know like in terms of the emissions because we -- our mobile source emission inventory in general is the tailpipe emissions calculation so it's not output emission for electrified equipment. But I'll have to get back on --

MR. MILLER: Do you think it would be a way of getting at the stock of electric vehicles or applications?

MS. JAW: That's probably -- I need to get back to you on that one. But I think there's underlining calculations.

MR. MILLER: I'll follow up with you. Okay, great.

MR. CRISOSTOMO: I'm glad that we're making these connections.

Another question. To clarify what you meant by commissioning for the ships at-berth on Slide 17. Was that a matter of these ships not being able to use other plugs at other ports? You mentioned commissioning. David.

MR. QUIROS: In regard to commissioning, my

understanding is that when a vessel was first used at some locations there were some delays associated with getting everything approved for hooking into shore power. Although the specifics about what vessel that was and had it been used elsewhere, I'd have to follow up with the at-berth group and direct that information back to you.

MR. CRISOSTOMO: Yeah, you mentioned a standardized system, is that related to that exact same issue?

MR. QUIROS: Don't know. We'll follow up.

MR. CRISOSTOMO: Great. Cool.

Are there any questions from the audience?

Let's do -- let's -- keep your hands up, let's 2 and 3.

MR. MACMILLAN: Do I need a mic?

MR. CRISOSTOMO: Yeah, either that one or up at the podium.

MR. MACMILLAN: Hi, this is Ian MacMillan with South Coast AQMD. Appreciate all the presentations.

Quick question on forklifts. I think some of this might be for ARB folks and some might be for Marshall.

One of the things that we've seen on the forklifts as we've been going out to a lot of sights is that there's some facilities have found that electric is not the path they want to go, they actually want to go hydrogen and it actually makes business sense today for them to do it for a variety of

reasons and it's just their own business needs. And I'm just kind of curious on thinking about some of the regulation. I'm assuming it's probably technology neutral that you would be going with that. I was thinking about 10,000 new forklifts that would probably be zero emission might mostly be electric but maybe not.

I'm just thinking that we know that hydrogen is something that we've seen out in the field. And I think one of the things that thinking about on some of the discussion that you had about sort of the petroleum usage. I think a lot of these forklifts from what we've seen based on sort of the freight side on -- not on industrial sites, necessarily, but where all the forklifts are operating indoors, none of those are going to be diesel anyway, so those would only be propane if they were indoors, if ever. So just one thing because it's such a huge fracture of the population of electrification making sure we're clear on the diesel versus other source of petroleum products.

MR. DUEHRING: Yeah, that's a good point, Ian, and I'll just follow up on that. We do know that there's about 5,000 hydrogen powered forklifts that are in operation today and we only see that number growing.

So, yeah, we're obviously going to be agnostic on how we -- how we develop our requirements but how we get to zero is it's not -- from our standpoint, we need to get to zero,

right? And then it's up to the industry to determine what the best technology is for their application.

MR. CRISOSTOMO: Yeah, if you're next, please come up to the podium.

MR. O'CONNOR: If the light's on, is that on? Thank you.

Craig, can you --

MR. CRISOSTOMO: If you could introduce yourself.

MR. O'CONNOR: Tod O'Connor with -- yes, please. Thank you. Tod O'Connor with CLEAResult.

And on page 25 on your forklift presentation, you mentioned that CARB will initiate a $40-million incentive program for off-road equipment. Will there be similar incentive programs for other categories you mentioned in your presentation?

MR. DUEHRING: Yeah, that's not strictly for off-road, that is for -- I'm sorry, not strictly for forklifts, that is for the whole off-road sector.

MR. O'CONNOR: Well, what about on-road? The --

MR. DUEHRING: So on-road, there is a program already in effect. It's called HVIP, hybrid and vehicle incentive program.

UNKNOWN SPEAKER: Heavy, heavy.

MR. DUEHRING: Heavy. There you go, it's more for heavy vehicles. And that will subsidize the purchase of

electric and in some cases low NOx operations.

MR. O'CONNOR: What about charging facilities?

MR. DUEHRING: So HVIP right now does have some money available for charging. I don't know exactly how much but I can certainly get you in contact with the program manager. But we do realize the charging is part of the solution, right? So we do have some money, part of the purchase voucher, incentive voucher would include additional funding for charging.

I don't know that much, this is a brand new one for the off-road --

MR. O'CONNOR: Okay.

MR. DUEHRING: -- I'm not sure how they're going to approach that but they'll probably model it right after the on-road program.

MR. O'CONNOR: Great. Thank you.

MR. DUEHRING: You're welcome.

MR. CRISOSTOMO: While James is walking up, any other questions?

MR. DUMONT: Hi, good afternoon, James Dumont, the Grant Farm. Thank you for hosting these workshops today, I look forward to working with you all in the future.

We represent the Port of Long Beach on many of their zero emission projects as both the grant managers and grant writers, as well as many of the port terminal operators. And

beyond that we've been working with the Port of Long Beach to draft the port community ED blueprint that will be released this month in its final form. It should be a roadmap that helps the other ports in California and of course Long Beach begin transitioning to zero emission to meet their Clean Air Action Plan goals.

I have a few questions and comments. Is there anybody in the CPU -- from the CPUC in the room in attendance today? Excellent. Thank you. We're glad you're here because we need a lot of help. You'll see shortly we have about 200 pieces of equipment at the Port of Long Beach in Los Angeles that will be deployed in the next two or three years. With those charging standards, we're looking at a minimum of 50 kilowatts and at the top end we're looking at 300 kilowatt hour charging. And when aggregated together, we're looking at a base load in the next three years of a new additional load of 10 megawatts, and more realistically in the range of 20 megawatts in three years.

This will cause severe -- severe or critical great impacts if not managed properly. So we need to jump ahead of this rapidly to make sure that what we're doing to reduce emissions doesn't cause adverse impacts to the economy locally and Southern California large.

In recognizing the costs that are associated with our infrastructure projects at the Port of Long Beach,

Mr. Duehring, you said that there's no reason infrastructure should not be available in something along the lines of similar to current gas stations. I have two reasons for you. CapEx and OpEx. Specifically when taking into account of demand charges versus labor cost, we have to waive the two if we're going for speed for charging to meet the extensive demands that this high powered electric vehicles will require.

And then CapEx, as we start to unveil the charging stations necessary to meet this 20-megawatt demand for equipment in the next three years, we're going to have significant upstream costs that goes far beyond what we think of as a $30,000 50 kW charger or a $200,000 what, 150 kW charger. Now we're looking at millions of dollars in upstream switch gear and substations. So these costs need to be somehow accounted for in the near future because there's a lot of challenges we need to overcome. And I look forward to working with you in the future to help try to find out what solutions might be on the tale for this. Thank you.

MR. CRISOSTOMO: Thank you, James, Tod, and Ian.

Any other questions before we take maybe a ten-minute break, we're running some time early.

Okay, hearing none. Or, Micah, any questions from WebEx?

Okay. Thanks. Let's try to be back in our seats at

3:30 so that we can remain on time.

[Off the record at 3:19 p.m.]

[On the record at 3:32 p.m.]

MR. MACMILLAN: I appreciate the opportunity to speak here today. Really look forward to this effort by CEC. We really think this is a really critical effort as we think about our air quality attainment needs down in South Coast and look forward to continuing to engage with you all as part of this.

So I'm going to be making a little bit of a pitch today as some request as part of these efforts from CEC to really look into what is needed for attainment down in South Coast, and it's a little bit different than what we think has been planned for in the past. And we think this is a great opportunity to really start thinking a little bit more about some of our unique challenges down there.

So just briefly here on the second slide, South Coast AQMD, we're the Regional Air Pollution Agency for the Greater Los Angeles Metropolitan region which includes the ports of L.A. and Long Beach as well as the Inland Empire Region where you have about a billion square feet of warehousing maybe a little bit less than that right now. A number I was just citing for folks is that we have roughly 40 percent of the population of the state and we also have about 40 percent of the containerized goods for the nation comes through our

ports. So we have 40 percent of the state for people, but of the nation, for goods. So we are certainly a goods hub.

When thinking about some of the really -- the key challenges that we have -- so if you're on Slide 3, the bar charts on the left are showing Nitrogen Oxides, NOx. The reason we focus so much on NOx is that this is the key pollutant that drives our ozone problems in South California. And in addition, on our fine particulate matter, if we address NOx for ozone, we're going to take care of a lot of these particulate matter issues that we have as well.

And so what we see is that under baseline conditions, sort of existing regulations like CARBs, truck and bus rule, that's already on the books that we're going to see some pretty substantial reductions in NOx which is a very good thing.

What I'm showing here on this chart is 2023 and 2031 and the reason we're picking those dates is because those are our key attainment dates under Federal Clean Air Standards. We need to meet those two dates for ozone attainment.

But what we know is that the reductions needed to get to attainment are really dramatic. 45 percent reduction by 2023 and a 55 percent by 2031. NOx is, you know, form for the -- product of combustion and so when we look at, well, where is combustion actually occurring? This pie chart on the right shows that it's almost all mobile sources down in

South Coast, right? And some of this was touched on in some of the ARB slides in the previous session.

This next slide, Slide 4, dives a little bit deeper into where these emissions are coming from in a little bit more detail. And you see that same 45 percent and 55 percent reduction that's needed. But we see each of the individual categories that are here, you know, whether it's heavy duty trucks or ocean going vessels, aircraft, what have you, that are contributing to this inventory.

And you can start imagining, you know, what does it take to actually get to attainment? And we can just start subtracting out entire categories. So let's subtract out all trucks. Let's assume all trucks are zero emission. Well, that doesn't do it. Let's subtract out all light duty vehicles. Well, that still doesn't do it. Let's subtract out all buses, still aren't there yet. How about getting in to the off-road sector, right? And that's all zero emissions. It's a tremendous challenge that we have down in Southern California to meet these air quality standards.

So the pathway there is zero emission. We think near zero has certainly a very critical role as well. But this is a really serious challenge and we know that infrastructure planning is really key piece of this.

I want to walk through some of the key activities that are going on down in South Coast right now. So at South

Coast AQMD we are, you know, again a regional air pollution agency. We have limited authority when it comes mobile sources. Most of the mobile source authority lies with either EPA or CARB but the South Coast we do have some authority when it comes to mobile sources. Primarily through indirect source rule authority as well as with government fleets.

So recently our board directed staff to work on some facility specific sectors that's summarized here on Slide 5. In particular, looking at warehouses and railyards and to pursue formal rulemaking to try to craft some rules that would address those kinds of facilities. And then also on ports and airports to pursue more of a contract based approach where we would develop some memoranda of understanding with each of these individual players, you know, the ports of L.A. and Long Beach and then the five big airports down in Southern California to try to reduce emissions from mobile sources from those sectors.

Here on Slide 6 just a tiny bit more detail. So for these MOUs with the ports and airports, the ports. Really it's trying to focus on, you know, the ports have their Clean Air Action Plan. They just recently approved -- not so recently now, November 2017 I believe is when they approved their third iteration of the Clean Air Action Plan.

What we are attempting to do now is to try to get SIP

credit and this is just an accounting process that has to be done with EPA, it's very important, but it's a lot of paperwork. But what we're trying to do is make sure we can actually get the SIP credit so that the emission reductions that are projected from the Clean Air Action Plan are actually realized. So there's a lot of hard work going on there.

Two key programs is part of that. One is their next iteration of the Clean Truck Program. The Clean Truck Program has a couple of goals in there. One is on 2020, another is in 2035. They're trying to get to zero emission trucks by 2035 but they're also -- the way that they're doing that is through some new trip -- I'm sorry, truck rate that trucks that are say tradition diesel would pay a higher rate to get into the port than trucks that are for example, zero emission.

This rate is supposed to begin in 2020 and that will first focus on near zero emission trucks would have a lower rate compared to tradition diesel. And then by 2035 that would push towards zero emission. The rate itself has not been set yet but we're working with the ports through that process.

Secondly, their cargo handling equipment, we heard some discussion of that again in the previous session from CARB. But one of the pieces of the Clean Action Plan is

asking the terminal operators to provide some procurement planning projects for what they think they're going to need for all their cargo handling equipment just through natural turnover. And so we wanted to work with the ports and the terminal operators through that procurement planning process to see what can be done to get that as clean as possible.

When it comes to the airports, they're in a little bit different position. They have many programs on their own, but not quite packaged all together like a Clean Air Action Plan through the ports.

So, first that's what they're doing is calling it Air Quality Improvement Plans, I believe that's the latest terminology for it, but it's the same concept, it's a Clean Air Action Plan for each individual airport. And we will be going through again, the same process with those airports that we will be going through with the ports of developing an MOU to make sure that any emission reductions that are part of that would be SIP creditable.

And when we're saying SIP creditable, that means that it's essentially above and beyond existing regulations. So if CARB is going through its own GSC rule or airport shuttle bus rule, it would need to be emission reductions above and beyond what those regulations would already do.

Both these -- the ports and airports MOUs are currently scheduled to go before our board in November.

We're still going through the hard work of developing all those. There's a public process for that. But we're -- we are scheduled to go in November with, you know, obviously later implementation.

The last bullet point on this slide is on Indirect Source Rules. So I'll touch a little bit more on warehouses later on in this presentation but the idea is to craft a regulation that will direct -- will focus on these indirect sources. And an indirect source is really just a facility that attracts mobile sources. And so that's where we drive our authority.

We are scheduled to bring this to our board late this year, at least that's what we're currently scheduled for, and we know that infrastructure could be certainly a key component of any part of rule that we might do.

Moving on to Slide 7 here, AB617 is a new program that is just being implemented throughout the state. South Coast is -- we have three, what are called, Year One Communities where communities are designated throughout our jurisdiction and then there's a lot of community outreach and -- but more specifically, monitoring plans and emission reduction plans that are developed for each of these communities.

The three Year One Communities are San Bernardino and then Empire where you have railyards and warehouses, we have

downtown L.A. which has a lot of warehouses as well as all the freeways and then we have -- I'm sorry, not downtown, it's East L.A., and then we also have the port region in Wilmington and Carson where again, where a lot of freight facilities and the ports themselves.

And so we are working with communities right now, to develop community emission reduction plans, those would be going for approval sometime later this year. And then with implementation over about a five-year period.

And then more communities will be designated next year and then the following year and then the following year. So there's this really new big focus that's mandated by the legislature on how to address community impacts. It's looking more at toxics than anything but certainly there's going to be a lot of crossover when it -- coming to things like mobile sources and where we're going to get emission reductions.

This next slide, Slide 8 is another really important part of what the Air District does so we administer a lot of incentive funding. I'm not with our incentive funding group but I do know that, you know, we do a lot of work in this space. We work with CEC on many projects as well. There's sort of two key aspects to this incentive funding; the first is really trying to lower the cost for commercially available products. So whether that's near zero engines that are

available today or some electric applications for some vehicles, maybe it's infrastructure.

So we really focus on this. A lot of this has a been done through the Carl Moyer program previously through Prop 1B. Carl Moyer funding has recently been increased through state legislation, we're anticipating about $60 million a year just in South Coast that would be, you know, for dominantly for mobile sources.

AB134 was onetime state funding of a little bit more than $100 million just to South Coast to again, a lot of this is focused, for example, on trucks. SB856 was a similar one-time funding $245 million statewide; we will administer a portion of that. VW mitigation again, several hundred million dollars there.

So there are these large chunks of funding that are sometimes one-time funding, sometimes perpetual funding that our agency administers on a project by project basis to try to get these emission reductions. So in thinking about the forecast, regulation is a big piece of it but incentives are also another critical piece of turning over vehicles.

The other area that we're also focused is on technology demonstration and advancement. This is pre-commercial applications and so tying to, you know, really bring those new technologies to market we do about $14 million a year in funding for these new technology projects.

I'm trying to leverage that with a lot of agencies including CEC and we've had a lot of real success there.

I have a little bullet point on the bottom of this slide. We anticipate that if we are going to get to attainment, you know, that 45 percent reduction or 55 percent reduction that I was mentioning earlier, we need at least a billion dollars a year in subsidy to turn over the fleet. And that's just looking at vehicle costs.

And so we, you know, we think we need at least a billion dollars a year and we're very actively trying to identify ways to increase funding at the federal level, at the state level, at the local level to try to get these cleaner vehicles on the roads and in off-road applications as soon as we can. And so we know funding is a really big piece of this.

I wanted to pivot up right now and just talk a little bit about some of the specifics down in South Coast when thinking about how to develop forecast and some of the things we've been looking at. So here are on Slide 9 are just some rough approximations of what is the population of vehicles in each sector and a lot of this is from CARB data but I was just trying to put some numbers out there to get a sense of what it might look like. You know, it's maybe 11 million cars or a little bit less than that, that's what folks have traditionally thought about down in Southern California, you

know, the cars is the problem.

But as I showed on some of those earlier slides, cars are only a small fraction actually of our inventory now. It's really the freight sector that is dominating where the NOx emissions are coming from. And a lot of that is going to be the trucks and then as well as the off-road.

Sorry, one of the other points I wanted to make here too, when thinking about the charging needs, you know, there's the various goals that are out there. For example, the 5 million ZEVs and the executive order that if that's focused mostly on light duty, understandably the -- that might be an understandable place that it would -- that the goal would be.

But when thinking about what are the charging needs, if only 10 percent of that was focused on heavy duty. Well, that 10 percent is probably a greater charging needs then the remaining 90 percent on the light duty. Just the vehicle size on these are so large, in many instances we're -- we heard a little bit before from CARB on ships, if you imagine large off-road equipment, if you imagine trucks, the charging needs are often an order of magnitude higher than they are for the light duty side. And so, it's just something to -- that we want to be mindful of that the electricity needs that are out there are significant when thinking about the -- this population of vehicles that are shown on this graph.

I wanted to talk a little bit, too, so there's sort of this real need for a lot more planning for infrastructure -- electrical infrastructure because of all those vehicles and because of our attainment needs.

But there's also some significant constraints that we need to be aware of. So one, for example, when we look at the trucks that are out there, there's a lot of independent owner operators and so on all these pie charts you see on the left side, there's just -- that the vast majority actually of fleets are only one truck, right. But if you look at, you know, the chart to the right, it's just present the data in a slightly different way. Where do most of the trucks lie? Well, then that's a little bit different, right. There's a lot of large fleets that are out there that have a lot of trucks.

But it's just something to think about with the business model. Where do these trucks reside every night? Where do they dwell? Are they actually able to charge in a location? That's one thing that especially down in Southern California the hub and spoke model are thinking that there's truck yards where there's a lot of trucks that just sit overnight. That's not always true and in many cases is not true. And so thinking about what is the business model? How does charging actually work that's -- some more thought needs to be put into this.

As one example, I have on this next slide, Slide 11. I want to walk through just some, you know, some of the warehouse population in Southern California. And so this is based off of data from Coast Star. And so if we look at warehouses greater than a half a million square feet and that is a very, very large building. I don't know if anybody's been in a building that big, but these are very large structures, all right, half a million square feet.

There's a 250 of those in our jurisdiction right now mostly in the Inland Empire, they're little green dots that are showing up here. If we look a little bit smaller, 200,000 to 500,000 square feet, you add about another 1100 facilities. If you get even smaller, 100,000 to 200,000 square feet, you're at 1500 facilities. And then if you get even smaller than that, you're probably adding about another 30,000 if you're getting down to the 10,000 square feet. So there are a lot of facilities that you might call warehouse facility that are in our jurisdiction.

I'm thinking about all their special needs as far as what their site constraints are. There's just -- it's a very different framework when thinking about how does infrastructure work in this environment.

I also want to mention cold storage. It's a special sort of application where you have facilities that already have a very large power draw because of all their air

handling and cooling needs and now if they're going to be bringing TRUs as well as electric trucks, that's also just another consideration.

Getting to this -- towards the end here so Slide 12. As we've been going through our warehouse indirect source rulemaking, we've been talking a lot to industry stakeholders trying to get a lot of understanding of how the different operations are that are out there.

And you know what, we've been talking to a lot of these operators about is -- and many of them actually want to go electric. They're trying to go electric already. But often, and this is just sort of an observation we've had, a lot of the people that are trying to do this within that business, they're the fleet people. And the fleet people know trucks, right? They understand how trucks work, they understand how the maintenance works. They have no concept of how to do infrastructure and they are now in the position of trying to figure it out. And this in not inconsequential, in my view. This is something that a training and understanding of what is needed to do infrastructure is -- that specialized expertise that just needs to be grown.

And what we are hearing pretty consistently is that, you know, for so long policy has focused on the vehicles, understandably, and how do we get the cleanest vehicles. And now really as the vehicles are becoming available it is the

understanding that infrastructure is the hardest part. That's something that people are still trying to understand and figure out how to do.

And cost is obviously one of the things that we've heard before and that's an understandable concern. Rate structures are, you know, as we get into the weeds, how do the rate structures actually work. The ones that are proposed that are out there right now, they are not going to work in all cases, they work in some cases, but not all. So that's just more is going to have to be done to figure out how that's going to work on a wide -- wider basis.

On the electric load, I have just a couple examples that we've heard from talking to two specific warehouse operators. The first one, they have a relatively normal size facility package delivery. They currently draw about a meg -- one and a half megawatts just for their automated operations, a lot of conveyor belts that's pretty typical in a warehouse operation, nothing too special there.

But they said if they just wanted to bring in a few electric trucks, not many at all, they'd have to triple that load and that's one building and that's going up to, you know, maybe four and a half megawatts for a single building that just -- and that's not for their entire fleet.

Separately when thinking about -- and this was actually -- I should say this is after they've -- this is not

just a back of the envelope, this is some pretty detailed calculations that they did. They talked to their utility providers, talked to truck manufacturers trying to really look at this in detail because they wanted -- they want to actually do this.

Another facility is a cold storage warehouse operator that they're looking at both electrifying for TRUs as well as electrifying their truck fleet. And they think that they might need at their -- just single building, 10 megawatts extra. These are not in substantial energy needs and this is just again two examples and I showed before that there's thousands of these facilities that are out there.

One natural thought is well, why can't you use solar, right? Why can't you just put solar panels on the top to take care of some of that load and offset some of it? And solar actually has its own challenges when coming to warehouses.

And that's -- there's part of it is that the scale of adding all this solar, it's not just adding, you know, a couple dozen solar panels on somebody's house, it's essentially utility scale. And warehouse operators are not in the business of being utility. Often warehouse operators don't even have the ability to put it on, that's up to the owner of the building. And the owner of the building again, is not interested in being a utility, they're interested in

owning a warehouse. So again there's just some knowledge that has to be created on how to do this in a business case and a business model that has to make sense when thinking about, you know, are there other ways to get electricity to these facilities.

The other extra constraint that's important for warehousing is that we've heard that there's concerns about the roof itself. Can the roof take the -- can the structure actually take those extra solar panels that has traditionally been a problem for older buildings not necessarily for the newer buildings. But that's something, you know, it can be engineered, there's extra cost there, but that's something to be considered.

But roof penetrations we've heard is actually a significant concern that's different for the goods moving industry. If you have a leak in your house, that's a problem nobody likes it. If you have a leak in a warehouse, that's maybe millions of dollars of damage because you're storing high value goods. And so roof penetration is a concern that we've heard.

Parking is also an issue. Again, thinking about dwell time where trucks actually going to be sitting or forklifts or off-road equipment. Is there space at a facility that these trucks can actually stay for hours at a time and maybe dozens of trucks would need to stay for hours

at a time. Some sites have that space, many do not. So it's just another constraint that's out there.

So -- I'm sorry, for my last slide, Slide 13, just want to kind of, you know, the -- touch on some of the constraints and some of the real challenges that out there, you know, we recognize CEC, there's a lot of really important goals that CEC is looking at and they all have a lot of very significant societal benefits. If we get to achieving these goals, there's some really -- a lot of good will come of it.

But want to make the pitch that air quality attainment really needs to be put -- if it was our way at the top of the list, but we understand that there's others that are out there, but it really needs to be one of the top priorities. But -- and part of that is that there is a societal goals and it's the societal benefits of meeting air quality standards, right.

We think that we would avoid 3,000 premature deaths every year, that's a pretty important goal. We think that there is some pretty significant monetized health benefits from achieving air quality standards.

But on top of that, the only -- one of those only goals that's out there, this is the only one that I'm aware of that actually has a mandated stick, right. It's not just the carrot of societal benefits, it's the sanctions that come from not meeting air quality standards. Our region faces

some pretty significant sanctions, loss of federal highway transportation funding. Considering that this is the gateway to all the goods coming in on the West Coast or the majority of the goods coming in on the West Coast, losing highway transportation funding is a pretty important repercussion.

Significantly increase cost for air permitting. This is also important when thinking about power plants that this is -- the costs are going up substantially. We might lose local control over air quality regulation. So these are some pretty big sticks that are going to be coming through the federally mandated sanctions under the Clean Air Act.

And so the -- just thinking about, you know, when we've been talking to a lot of these businesses that want to go electric and what are their experiences, you know, they obviously are working hand and hand with their local utility, they rely very heavily on their local utility. But when we've talked to these utilities and that's, you know, SCE has a program they're just about to roll out now as part of their SB-350 application. And that SB-350 application is projecting about 8,500 vehicles by 2023 that would be electric as part of a $350 million application. And that is their big plan right now. They have some other plans that are on the books maybe to 2030 of trying to look at, you know, even further transportation electrification.

But it is nowhere near what we think we're going to

need for attainment. The planning that needs to be done for attainment is significantly greater than what's on the books. And what we've heard from all of the utilities is they rely on the Energy Commission's forecast when they do their own planning for what their needs are. And so we're really, really hoping that Energy Commission can help on some scenario planning of looking at what are some potential scenarios and thinking about from some of the earlier session. Marshall was mentioning a low, medium, high, scenarios on the off-road side. We think that one of those scenarios at least one of those scenarios really should look at attainment. What are the attainment needs?

And there's obviously a lot of different pathways that are out there. You can have near zero pathways, hydrogen, electric. In reality it's going to be a mix, right. We all know that there's going to be a mix depending on what the various duty cycles are. But we expect that there will be hundreds of thousands of trucks and off-road equipment not including any light duty vehicles that would be needed by 2030 timeframe to get to our attainment goals. And it's significantly higher than what has been planned for right now. So we're really -- really asking for CEC to help do some of that scenario planning for us because the needs are significant.

And with that, I'll pass on the baton.

MR. THAO: And our message is pretty much --

UNKNOWN SPEAKER: Microphone, sir.

MR. THAO: All right, can everybody here me? Okay. I think so.

And I think you'll hear our messaging is very, very similar to South Coast as well. We have the same significant need for vehicle -- electric vehicle infrastructure -- charging infrastructure as well.

Before I start, I just wanted to thank CEC for inviting us to this event as well, to share our perspective on the need in the San Joaquin Valley for the electric vehicle charging infrastructure.

And as Ian had mentioned earlier, you know, as far as attainment purposes, it's very important for -- from a health perspective but there are consequences that if, you know, we're not able to provide a plan that demonstrates attainment or not able to meet our commitments in the plan, it would have devastating impacts -- financial impacts on valley residents and businesses as well as losing -- loss of local control on it. So it's something that's very, very important to us. And we do look forward to working with CEC and especially also with the California Air Resources Board and other agencies and other stakeholders to find a solution to -- for attainment, and especially for electrical vehicle charging infrastructure as well.

So just to give a little bit of a background where we're at, a little bit of what we're doing. The district and along with CARB, we've adopted numerous attainment plans over the years. You know, as a result, you know, there's -- we have some of the toughest stationary, mobile -- and mobile regulations in the nation. We've adopted nearly 650 regulations, you know, many of them are groundbreaking rules that service models for others. For example, like we currently do have an indirect source review rule to reduce the emissions from mobile sources even though we do not have jurisdiction over mobile sources.

So creative rules like to get additional emission reductions. As a result, stationary source emissions that are under our jurisdiction have been reduced by over 91 percent and so, that's very significant. We have a strong incentive program, so we're $2.2 billion in public and private investments. We do see over 145 thousand tons of emissions. And because of all the -- these significant investments by valley businesses, residents and the stringent regulatory programs by the District and by CARB, you know, the air quality in the valley has improved significantly. And we are now in attainment of federal PM 10 standard, the one-hour ozone standard, and also the 24-hour PM2.5 standard of 65 micrograms.

And -- this chart is just giving some sense of how

much reduction has been. If we look at from -- back from 1980 and dropping down to 2018, you can see that there's significant reduction even as a top bar there you'll see all the on-road mobile sources, that's dropped down significantly. Other mobile sources and stationary sources especially has dropped down at least 91 percent there. So.

So there's significant reductions, however, we're still having a lot of difficulty meeting these ambient air quality -- federal ambient air quality standards. Just recently we had adopted our 2018 PM2.5 plan to address these that was adopted by our board in December and in November and in January the California Air Resources Board adopted it as well. And so it covers these three standards here.

And it's -- the plan itself is going to require and is shown that we're going to be able -- that we need to reduce NOx in the valley by 66 percent from 2013 to 2025. And it -- and so this is -- this plan itself is demonstrating expeditious attainment for all these standards. So if you see the dates here, I mean, these are just right around the corner, 2020, 2024, and 2025 for each of these standards, respectively.

And it really includes just a huge comprehensive suite of both regulatory requirements amendments and also a very large amount of incentive-based measures in there which I'll go into a little bit further detail in the following

slides.

And in addition to this, you know, we still have the 2015 ozone standard that was recently promulgated. And on that one there's going to be significantly more additional emissions that we're going to need to get. And as Ian had mentioned, one good or bad thing is that NOx when we're talking about mobile sources and all of this, we're really trying to get NOx reductions. And NOx is a precursor for both ozone and a precursor for PM2.5. And so that's the main component that we're going after. So fortunately for -- we're getting those reductions for PM2.5 and then those will also benefit ozone as well.

And just to kind of get an idea of how big this mobile source portion of it is. In order for our plan to demonstrate attainment for the PM2.5 by the 2024 -- 2020, 2024, 2025 dates, CARB is making a pretty big commitment to get additional reductions from the mobile sources of 32 tons of NOx per day and additional one ton per day of PM2.5. And it's primarily these categories of accelerated turnover in trucks and buses, off-road equipment, and ag equipment through incentives.

And so trucks and buses it's estimated that that would require an incentive of $3.3 billion and that's about 33,000 trucks. Off-road equipment about $170 million including construction equipment, forklifts, and TRUs. And

then of course we have other -- in terms of incentives, there's also local incentives that's going to be needed to turnover like charcoal where we're getting the direct PM2.5 reductions and residential wood burning as well.

And so coincidentally, very similar to South Coast, this is going to require approximately $1 billion per year as well. So if we're looking at -- from our time frame it's five years so, we're estimating the total cost to be roughly around $5 billion in needs for incentives.

And in fact, CARB had a -- also adopted to support this plan here, they adopted the San Joaquin Valley supplement to the 2016 State Strategy in October of 2018 and it includes the state's commitment to secure and provide the necessary emission reductions.

And so, you know, all of this as you see as a part of the plan in order for us to be able to get to -- in order for us to reach attainment within those very short timelines. A lot of these emission reductions are going to need to come from mobile sources. And they're very -- they're going to be critical to this attainment.

And the other part of it is, you know, over 85 percent of the NOx in the valley is from mobile sources, and 40 percent of that are from heavy duty diesel trucks. The other part of it which makes it very difficult to the valley is that we are also home to two main transportation

corridors, I-5 and Highway 99 in connecting the Northern and Southern California that carry up to 80,000 trucks per day.

And near all the containers are transported between sea ports through the valley are from heavy duty diesel trucks. In addition to that, the valley is also a grow location for warehousing, distribution, and other related logistics businesses. And so it's just -- those emissions are just growing.

And because of the short timeline, we are really not just pursuing one type of technology in the near term, whatever is available we will go for it. And so, for example like even diesel we're supporting it along with South Coast and CARB for example, like the Achates near zero opposed-piston diesel engine that development of that and the demonstration of that, we're helping support that.

All the near zero natural gas, we are all -- we're trying to get that moving as soon as possible. As many of you know, the recently -- couple a months ago the 12-liter natural gas engine is now certified and that can be into the used in Class 8 heavy duty vehicles. And so we are providing incentives for that and will be providing incentives for infrastructure for that.

And so, in addition to that, you know, we'll -- so, we'll do that and we need that as soon as possible. So we're putting efforts into there. And then with zero, we're also

putting as much effort as we can into that as well. We can't really just rely on and hope for just one technology. At this point, we are grabbing everything that we can. Just as an example, so in addition to that, you know, we've put in a lot of effort to zero emission projects including electric forklifts, ag, UTVs, dairy feed mixing, of course passenger vehicles, this entire list here of -- as falls to residential clean green yard machines, commercial yard care, even providing create and plug-in electric vehicle resource centers and things like that.

And then also for demonstration product -- demonstration products from cap and trade funded zero emissions demonstration projects, doing battery electric locomotive and associated cargo handling equipment demonstrations.

We have a recent project for replacing all the diesel-powered freight equipment at Frito Lay in Modesto -- in the Modesto facility with zero, near zero technology. The electric equipment includes heavy duty trucks, yard trucks and forklifts, it also included a high lift capacity, battery electric forklift demonstrations at the Port of Stockton. And so there's just a -- there's a wide variety of projects that we are pursuing right now for near zero as well for demonstration.

And the conclusion is very simple here is that, you

know, we do need the electric vehicle charging infrastructure that we need to ensure that there is sufficient in the San Joaquin Valley in order to make sure that we attain our -- the federal air quality standards. It's going to be critical to it.

Now as far as all the details of the statistics and going through all of that, I think that's something that will need to be worked out. And in fact, even the study of freight that's going through the valley, we have a recent board item that we had taken to the board and the board approved of is to do a study on inland ports and included in that study is to better understand the flow of freight throughout the valley and how -- what steps that we can take to reduce emissions from that.

And again, this is one of those things where and it's very similar -- it's the same -- very similar situation that we face with even near zero like natural gas now that the, like the larger vehicles the heavy duty, the Class 8s are available. There's still uncertainty I think for most fleet operators of this equipment. Part of that uncertainty comes down to the cost of the fuel, comes down to the refueling of that fuel -- of the availability of refueling stations and all of that.

So I think it's very important -- that's going to be a very similar situation with zero electric as well, in that

we, I think we're going to need to get those infrastructure out there -- can't really just wait for the vehicles to be out there and then put those infrastructures in there afterwards. It needs to be out there for fleet operators to feel comfortable to start investing in those technologies.

Again, especially for a Class 7 and a Class 8 long haul which is one of the primary targets that we've been trying to find a solution to.

So that concludes my presentation and we'd be happy to answer any questions you may have.

MR. CRISOSTOMO: Thank you both for those staggering numbers that we have to address. But thanks for posing that challenge for us to recognize. It's really important for us to understand.

Let me start with a few clarifying questions. In one of the interesting points in your presentation was about this recent experience from surveys for a few customers who have gone electric, how do you think we could quantify the infrastructure needs similar to how you've quantified the billion dollar per year extra cost in -- on the vehicle side.

And so I'm sure you had to do an analysis of the first cost of conventional technologies versus the zero emission options. But obviously these customers are unique and the -- will have good upgrade requirements that are individual to them, they'll have operational characteristics

that are unique. How do you think we can work together to use data like this to quantify how much infrastructure we can build?

MR. MACMILLAN: That's a great question. I don't have a ready answer right now. I think there -- work is needed on trying to figure out what is that methodology. I think there's some work that could be done to just -- similar to what was presented before, you know, how many kilowatt hours per mile and kilowatt hours per hour, that gets you sort of how much is needed on an annual basis. But then the next really important step is what -- how does that fit within a business environment. So are you delivering, you know, whatever it is half a megawatt to -- or half a megawatt hour to a truck, are you doing that in 15 minutes or are you doing that over 10 hours?

And then what happens if you do that for 50 trucks at one site? And there's real differences in what the power needs are going to be and exactly how to come up with that answer, I don't have it right now, but I think that's something that we need to be working on and then thinking about.

So we're certainly open to having more conversations with you on that, but I don't think we have that methodology worked out for ourselves yet.

MR. CRISOSTOMO: Chay, do you have any thoughts on

the same question?

MR. THAO: No, I think for us it's a very similar situation. You know, when we look at the potential emission reductions and all that, it's more of a from a 30,000-foot view, you know, we see that, okay, these are all -- these are the estimated emissions here in the valley from these sources. If we were to be able to get a replacement and reduce estimating, like let's say like 33,000 heavy duty trucks and buses, this is what we think the reductions would be and this is what we need, but that's actually the simple work right there.

I mean, the real work comes down to okay, now let's actually really evaluate the area and understand the businesses within the valley or within South Coast and those and understanding them on that part of it. Where they're at, how they operate, and then we'll have to figure out from there. So very similar situation as with South Coast.

We'd be happy -- we're looking forward to working with you on that and other agencies and CARB to figure all of that out.

MR. CRISOSTOMO: Yeah, this is perhaps more of a comments but I think the analysis that you are describing about taking the inventories and identifying the locations and understanding how the indirect source rule which I'm still learning a lot about air quality regulations but if

they -- would the site that is subject to the indirect source rule is the goal to have the emissions that are associated with that facilities operations, the mobile source emissions be subject to zero emission requirements?

MR. MACMILLAN: So, I'll speak about some of the rulemaking that we're doing. San Joaquin obviously has their indirect source rule which is a little bit different in that theirs focuses on new development. We're looking more at the warehouse side that's on existing building stocks so it's some slight differences there.

But yeah, the idea is that I'll be trying to address the emissions from mobile sources that are attracted to that facility. So, for example, at a warehouse, the truck trip, right. Not just within the fence line of the facility but it's also that truck as it's traveling to and from that warehouse. Exactly how that works -- that's we're still going through rulemaking on that but, you know, you can imagine some complications where the warehouse owner is not the same as the warehouse operator which is not the same as the fleet owner.

MR. CRISOSTOMO: Yeah.

MR. THAO: Yeah, our's -- our indirect source rule has been in effect for over ten years now and it is a little different. We are looking at new developments and it doesn't really require specify any type of technology but does have

for example, like if you have like during a construction there's an average that you're trying to get the fleet to drop down the NOx reductions to -- and it's up to the facility -- or it's up to the developers to find a way to get to that part or of course they also pay an indirect source fee to get reductions elsewhere.

MR. CRISOSTOMO: Thanks for that clarification. So I was listing that among the inventories, the other datasets that you're using to identify sites. I'm hopeful that by engaging with facilities to learn about their operational experience and perhaps do an architect analysis archetypical analysis of what could be indicative for a certain type of facility type.

We can start to meld these different data sources together with what CARB has, with what we have, and with what you have to do an analysis.

Do you have any suggestions for how to better engage the facilities, the warehouses, the people who would be subject to regulations or be interested in programs in developing that data?

MR. MACMILLAN: Certainly we're doing a lot of outreach as part of our rulemaking or part of our MOU development, you know, we have various contacts of -- we could share certainly of various people in industry whether it's, you know, specific businesses or trade associations

that, yeah, we could certainly share.

And I don't know part of that, too, is thinking about the process moving forward what's the right way to try to think about developing methodology and, you know, how much of that is technical staff work versus how much of that needs to have public process. And we're open to how that works -- how you think that works best.

MR. CRISOSTOMO: And same question, Chay.

MR. THAO: Yeah, you know, I think ours is going be very similar to like although in other ways have we reached out for example, like for near zero, for natural gas and all of that to reach out to industry.

You know, we have been pretty robust outreach team to -- whenever we have a program or anything like that to reach out to industry. And we do have contacts with them through those incentive programs and through all the other regulations that we have implemented and have worked with them. So we have a close relationship with industry with ag businesses and the community to reach out to them so definitely I think we could find a way to get to them.

MR. CRISOSTOMO: I want to offer my ARB colleagues any opportunities for questions before we open it up to the audience. Anything come up that is new or interesting to speak to? Okay. Audience members, any Q&A? James.

MR. DUMONT: This one's for you, Ian. I guess Chay

could also answer most likely.

You mentioned that there was the risk of losing access to federal highway funds. Is that only a threat in the 2030 NAA -- NAAQS or is that something we might face in 2023 as well?

MR. MACMILLAN: That would also -- it's any -- yes. It's also potentially 2023.

MR. DUMONT: Okay.

MR. THAO: So that's not because you failed to attain and then you get sanctioned. It's when -- if for example, there's a couple different criteria. Let's say you don't submit a plan that's approvable, then that's -- by a particular deadline date, that's one. If you don't satisfy -- so you make commitments in the plan and you don't satisfy those commitments, that could be another trigger for it. So. So there's a couple different triggers on that.

MR. CRISOSTOMO: I had another -- oh.

Micah, go ahead.

MR. WOFFORD: So this question is from Nehemiah Stone for Ian.

So you just mentioned the need for large PVE on warehouses and that owners and operators are not and don't want to be utilities. Similar issue existed with multifamily buildings and was solved by third party companies installing and owning the systems and then giving the users a fixed rate

while selling the excess back to the IOU. Could this same model work for those warehouses?

MR. MACMILLAN: Certainly. I think that's a great point. I think that's one model. I think my main point is that those models are still emerging and more of those business models need to be developed and there's probably more than one solution. But that's certainly a viable solution. So.

MR. CRISOSTOMO: Are the air districts doing any technology assessments along the lines of looking out to the future similar to CARB's technology assessments?

MR. THAO: Are you referring to like -- because we have several, I mean, demonstration projects.

MR. CRISOSTOMO: In addition to the demonstrations, looking out further forward.

MR. THAO: Right now our main focus has been trying to get these -- to demonstrate these projects further and getting some ideas from their end and then but not really a -- other than, you know, we've looked at it from a planning perspective. But I think it's almost like a little premature without the -- getting these projects demonstrated and having a better understanding from there before we even look farther down the road on that.

MR. MACMILLAN: I'm just follow up on that. So we also do obviously a lot of demonstration projects on some

obviously with the Energy Commission.

We have participated in some of the tech assessments with CARB and so we're actually coauthor on some of those but that's all, that would be on CARB's website where all those are. So.

MR. CRISOSTOMO: Okay. Any other kind of concluding comments that you want us to hear or any other questions for speakers?

MR. MACMILLAN: I'll just say I really appreciate this opportunity and we definitely look forward to working with you or whomever else, other agencies, and other stakeholders as we go through this. We think this is a really critical time as technology's advancing really quickly and trying to make sure that the policies that are set from air regulators that can kind of fit within that. And it's -- there's some things are within our purview and some things another agency's purview. And so we definitely look forward to working with you guys on -- as it progresses.

MR. THAO: Yes, and I'd like to reiterate that as well. And wanted to thank CEC and CARB and everybody else who's also attending this and to have us be here to provide our perspective on it.

And it's something that is very important and critical to San Joaquin Valley as well as far as electrical charging infrastructure and to attainment of federal air

quality standard. So we definitely look forward to working with all of you moving forward here.

MR. CRISOSTOMO: All right. Thank you, Chay and Ian.

Let's transition to our final presentation. And I'll introduce my colleague from the Freight and Transit Unit in the Fields and Transportation Division, Marc Perry.

MR. PERRY: Hi. Thanks to everyone for still hanging around and being here this late in the afternoon. I'm going to try not to blow everybody's eardrums out. I've -- I'm used to talking to hundreds of people without a microphone. So I apologize if I blow your ears out on the Internet.

Good afternoon, my name is Marc Perry, an Energy Commission specialist working in the Fuels and Transportation Division in the Freight and Transit Unit.

And I'm just going to briefly discuss some of the investments that the ARFVTP or the Alternative and Renewable Fuels and Vehicle Technology Program is recently made in off-road and on-road, medium and heavy duty vehicles in fueling infrastructure, and provide some observations and some lessons learned. I forgot to set up my --

Between 2014 and 2018, the Energy Commission has had about four solicitations for advanced freight vehicle infrastructure projects. These solicitations have resulted in nearly 20 projects demonstrating advanced technology vehicles and infrastructure at the ports of Los Angeles, Long

Beach, San Diego, and other locations. And will continue to deploy several zero and near zero emission medium and heavy duty vehicles like yard trucks, drayage trucks, gantry cranes, top handlers, and forklifts as well as installing chargers, charging and refueling infrastructure for battery electric and hydrogen vehicles.

The Energy Commission is demonstrating these technologies at the ports because the ports are a good environment to test these vehicles and the results can be replicated in other sectors.

Moreover, the Energy Commission regularly engages with sea ports in California through the Ports Collab -- Energy Collaborative which provides a forum for the Energy Commission and the ports to come together to discuss important energy issues, mutual challenges, opportunities for transitioning to alternative and renewable energy technologies.

The Energy Commission funds these projects because transportation in general accounts for 41 percent of all greenhouse gas emissions in the state and medium and heavy duty vehicles account for 26 percent of those transportation emissions.

The following slides are examples of the vehicles that we funded with the ARFVTP. These are just two battery electric trucks, BYD yard tractors they were delivered the

Dole fresh fruit and they're being demonstrated at the Port of San Diego.

These are two of the five yard trucks that TransPower received from Kalmar Gliders and then they went ahead and installed their own battery electric powertrain. They're also being demonstrated at the Port of San Diego and other locations throughout the Central Valley and even here in Sacramento.

The Energy Commission is also funding nine Cavotec electric rubber tired gantry cranes for use at the SSA Marine Terminal at the Port of Long Beach and numerous battery electric drayage trucks as well.

At the Port of Los Angeles, we are funding certain off-road vehicles like this battery electric container handler on the left. And in addition to some more battery electric drayage trucks and day trucks that will be delivering freight throughout the -- in and around the Ports of Los Angeles and Long Beach.

Off the ports and a little more visible are the Energy Commission funded projects that have demonstrated these battery electric transit buses like this Proterra bus and the charging station for the San Joaquin Regional Transit District. These technologies used in transit buses have also proven to be replicated in other sectors like vehicle deliveries -- or delivery trucks and school buses.

The Energy Commission has also been funding -- has been funding all of these vehicles for testing and demonstration but we really haven't been touching on the fueling infrastructure, the chargers. The technology providers, fleet owners, trade groups, stake -- old stakeholders and end users have worked together to get the vehicles in place but they're not always aware of the potential high costs of purchasing and installing the charger -- the charging infrastructure.

As the end users have started installing their own chargers, they had to address the challenges and they provided the Energy Commission with learned -- lessons learned like that the electrical load impacts for medium and heavy duty chargers, the labor and equipment costs to install the chargers, the lack of standardization of the charging equipment in the medium and heavy duty sector, the anxiety to committing to an known older technology as newer technologies are constantly emerging, and the challenges associated with the charger installation of development and timelines.

Many alternative fuel, freight and fleet vehicles require specialized fuel infrastructure, while light duty battery vehicle -- battery electric vehicles use standard Level 1, Level 2, or DC fast chargers that could be assumed within a typical residential or commercial building's electrical system. The industrial medium and heavy duty

electric vehicles require a charging system that use significantly higher voltage and power levels per charger.

I'm still on this one, I'm sorry.

This is a picture I took of some of the BYD chargers recently installed at EverPort Terminal Services at the Port of Los Angeles. They might kind of look like ordinary car chargers, but they're not. These are for BYDs 19,000-pound yard trucks with 217-kilowatt hour batteries and they can tow up to 83,000 pounds. And those chargers can charge those trucks in less than three hours. A Nissan LEAF by contrast has a 40-kilowatt hour battery and a maximum weight limit of 4,400 pounds.

A Level 2 light duty or the car charges typically operate on a single phase 120 or 240 volt. Each of these medium and heavy duty chargers however requires three phase 208 or 480 volts to charge it. The Level 2 car chargers use about 20 to 40 amps, whereas these heavy duty chargers require around 89 to up to 300 amps. And where Level 2 chargers use 6 to 19 kilowatts, the medium and heavy duty chargers require at least 50 kilowatts to possibly more than 600 kilowatts of power depending on the needs of each vehicle. Basically a light duty DC fast charger is only a trickle charger for these heavy duty vehicles.

Many locations aren't prepared to handle these electrical loads so if they want medium and heavy duty

chargers, they'll have to upgrade the infrastructure and those costs can easily skyrocket.

The price of a single charger and just the charger can range from zero dollars because the vehicle seller might provide the charger with the purchase of each vehicle up to hundreds of thousands of dollars per each charger.

And it's not just the charger that cost the money either there are permitting fees, the trenching and construction costs, the third-party certification and other construction related costs. If the electrical infrastructure requires upgrading on the customer side of the meter on the property, these upgrades can cost at least $20,000 for the equipment and labor.

One company was surprised to find that to handle the installation of five medium and heavy-duty vehicle chargers, it would need to purchase a $400,000 transformer.

And one of the projects for which I'm the agreement manager had an end user installing chargers at the Port of San Diego that put the electrical capabilities beyond its infrastructure. The San Diego Port Tenants Association, Dole, Port of San Diego, and San Diego Gas and Electric worked together to be awarded funds to upgrade its electrical system from SB-350 funds, Clean Energy and Pollution Reduction Act, they needed additional help.

And the local utilities need to invest -- upgrade

these grid substations as well so they can handle the increased electrical demand. The utilities whether investor owned or publicly owned will most likely have to upgrade their substations. The transformers and improve other infrastructure from the grid up to the meter to handle the increased load. And those upgrades can cost anywhere from $150,000 to $400,000 per address.

And then there's the chargers themselves. Many heavy and duty -- medium and heavy duty powertrain and charging manufacturers have yet to standardize their electric vehicle charging equipment. They use specialize charging systems that could be significantly more expensive than their light duty counterparts. And while there only about two or three different types of light duty charger plugs, there are at least seven different medium and heavy duty charger plugs and receptacles with only two of those being standardized under SAEJ3068 which defines electrical connectors and control protocols for electric vehicles.

Those chargers that aren't standardized are proprietary technology and they're used in conjunction with a specific vehicle powertrain manufacturer. In most cases the computers on the chargers are only able to talk to the battery management systems on the vehicles if they're from the same powertrain company or OEM. For example, even if the plugs and receptacles were exactly the same, a TransPower

converted Kalmar truck would not be able to charge on a BYD charger and vice versa.

This raises the issue of end users having to install multiple brands of chargers that are specific to a vehicle and that can take up a significant amount of land and cost more money.

For example, an end user might be able to get away with using two or three chargers for five demonstration vehicles but if each of those vehicles have different charger plugs and receptacles, then a company will need to purchase five different chargers.

Currently being used on transit buses, are emerging hands-off charging methods. These unlike the cord, plug, and reciprocal chargers however are standardized. An example of those would be the vehicle mounted pantograph where the charging connection extends from the vehicle to the infrastructure. The cross-rail connection which is like a pantograph except the connection extends downward from the infrastructure. And the enclosed pin and socket connection which is very similar to the mid-air refueling technique used in military aircraft.

The purpose of these is to top off the buses at transportation centers when they only -- when they have a few minutes to wait before resuming their routes.

These technologies are effective enough that they're

being considered for opportunity charging at select multimodal freight facilities.

Another popular method of charging buses is now making its way into the ports and other locations and that's wireless charging via inductive charging and magnetic resonance charging.

The charging infrastructure is built into the ground or in some cases on a pole that extends over the bus or truck and the vehicle parks very close to the charger, extends a receiver near the infrastructure so that the electricity can be transmitted from the charger to the vehicle batteries without having to plug in a cord.

The main difference between inductive charging and magnetic resonance charging is that the inductive charging requires that the vehicle charger be very close to each other -- vehicle and the charger be close to each other. Whereas, the magnetic resonance can be -- can recharge batteries from a greater distance however, that's going to come with a greater energy loss.

Inductive charging technology is being -- currently being demonstrated at two locations at the Port of Los Angeles.

Many of the lessons learned regarding project development and construction timelines -- or have been learned regarding those. As the slide shows, a charger can

be installed in as little as a few weeks or as far out as over a year. Here are some of what we've learned, some municipalities require different permitting, all of the installation projects require a building permit. However, one city might require a city engineer sign off another might require a fire department permit. Each municipality has its own permitting process and each permit that needs to be signed off has a time element involved and possibly an added cost.

Always a lesson learned are construction delays. These can be due to supplies not being available or fires, floods, earthquakes, just regular rain that stops construction, and any other unforeseeable reasons. Many of the ports are also a public agency and they have strict subcontractor bidding requirements and contract approval procedures that can take a significant amount of time to complete that process.

Some locations like the Port of Los Angeles through the City of Los Angeles require a third-party safety certification like that of underwater -- underwriter laboratories also known as UL. Sometimes they require additional changes that can also cause delays.

This isn't just for the equipment, but the equipment in place. For example, the BYD chargers that I showed earlier, the chargers themselves have been UL certified.

However, once they were installed in place, they were required to get another UL certification for the chargers in place as opposed to just the chargers.

And they required a longer charging cord which has set back a delay because they're only made in Germany and there's not a lot of them right now so it's taking a bit of time to get them into the port and have those up and running.

Charger installations can also use -- can limit the use of space. Adding in five chargers can easily remove 10,000 square feet of container storage area or driving through space.

Many places haven't gotten rate structuring agreements yet, either with their local utilities to reduce the cost of their electrical bills. It's best that, you know, you go over your electrical tariff options provided by your local utility before charger installations so you can decide what works best for your needs.

Thank you for sticking around this late in the afternoon and being a part of this. This covers the basics and we continue to learn new lessons as the projects progress. I will now answer any questions or comments if you have any. And if you think of something after the workshop is over, feel free to contact me at the email address on the slide, Marc.Perry@energy.ca.gov. Thank you.

Any questions?

MR. NICHOLAS: I know people want to get out of here, it's late. I -- could you go back to the cost -- sorry, Michael Nicholas -- yes, Michael Nicholas, International Council on Clean Transportation. Could you go back to the cost slide where you show those different things about the transformer, those three costs at the bottom?

MR. PERRY: Oh, yeah.

MR. NICHOLAS: Yeah, and so, what kind of transformer costs $400,000? I've never -- I've kind of been looking a little into this recently and can you give any more specifics on maybe what can draw cost a -- drive the cost up to something like?

MR. PERRY: I don't actually have the knowledge on that one, it was a report that I read. It was a CALSTART report. It was behind the -- it might have been not just the transformer itself but everything --

MR. NICHOLAS: Okay.

MR. PERRY: -- involved with the construction.

MR. NICHOLAS: Maybe like entrenching, pads, you know, all the rearranging. Okay.

MR. PERRY: Trenching -- yeah, entrenching pads and rearranging. And also for five different chargers and when they're -- each charger is getting up there. They probably wanted a megawatt of --

MR. NICHOLAS: Yeah, I mean, but, I mean, megawatt

transformers I don't think cost more than seventy to eighty thousand dollars, but I -- that's just some of the numbers I've looked at. So probably was more in the arrangement of --

MR. PERRY: Yeah, the utility equipment and the labor.

MR. NICHOLAS: Yeah. Okay. Yeah. That was my only question. Thank you.

MR. PERRY: Okay. Anybody online? Nope. Thank you very much. Hand it off back to Noel.

MR. CRISOSTOMO: Any general public comments? So hearing none, these prompts will be available for you to provide comments on the workshop in writing afterward. I'll just read them through here.

So as we consider the infrastructure assessment, what other applications in these sectors have -- might we consider within the 2030 planning horizon including those that weren't specifically discussed here today.

Second, how might the AB-2127 analysis consider balancing the factors like cost, air quality attainment, and other technologies in the zero emission and near zero emission space.

And third, what topics would be of greatest interest of other stake -- to stakeholders and how can the Energy Commission prioritize your analyses given clearly the very

broad and large amount of electrification that is necessary to meet our goals.

So we'll let people offer those ideas and other comments during written files into our docket that will due May 17 by 5:00 p.m. And as I eluded to earlier during our discussions with panelists, we'll continue to conduct outreach with customers and other stakeholders to understand what key analyses you'd like to see conducted in AB-2127.

As you submit, please use our 2019 IEPR docket and the online filing system. This is already in the notice. If you have an immediate comment, but these slides will be posted online within the next day or two.

Just so that you have this on your radar, additional workshops on this topic may be scheduled and hopefully you're already on our service list to receive notifications about this effort which will be ongoing.

So if there are no other public comments, thank you for sticking with us through the day. I know some of you were here earlier. And we look forward to continuing discussions on this topic. Have a good evening. Thanks.

(Thereupon, the hearing was adjourned at 4:45 p.m.)

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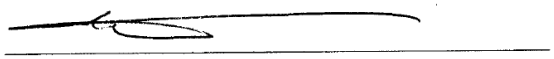
REPORTER'S CERTIFICATE

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 certified electronic court reporter and a disinterested person, and was under my supervision thereafter transcribed into typewriting.

And I further certify that I am not of counsel or attorney for either or any of the parties to said hearing nor in any way interested in the outcome of the cause named in said caption.

IN WITNESS WHEREOF, I have hereunto set my hand this 28th day of May, 2019.



PETER PETTY
CER**D-493
Notary Public

TRANSCRIBER'S CERTIFICATE

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

And I further certify that I am not of counsel or attorney for either or any of the parties to said hearing nor in any way interested in the outcome of the cause named in said caption.

IN WITNESS WHEREOF, I have hereunto set my hand this 28th day of May, 2019.

Jill Jacoby
Certified Transcriber
AAERT No. CERT**D-633