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CALIFORNIA ENERGY COMMISSION

STAFF WORKSHOP

In the Matter of:	) Docket No.
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	) STAFF WORKSHOP RE:
2017 Integrated Energy Policy Report	) Revised Transportation Energy Demand Forecast
	)

STAFF WORKSHOP ON
REVISED TRANSPORTTION ENERGY DEMAND FORECAST

CALIFORNIA ENERGY COMMISSION

THE WARREN-ALQUIST STATE ENERGY BUILDING

FIRST FLOOR, ROSENFELD HEARING ROOM

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SACRAMENTO, CALIFORNIA

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10:02 A.M.

Reported By: Gigi Lastra

APPEARANCES

Commissioners Present

Robert Weisenmiller, Chair

Janea Scott

Karen Douglas

CEC Staff:

Jesse Gage

Siva Gunda

Sudhakar Konala

Mark Palmere

Heather Raitt

Joint Agency Participants:

California Air Resources Board (CARB, ARB):

Joshua Cunningham

I N D E X

P R O C E E D I N G S

December 4, 2017 10:02 a.m.

MS. RAITT: Okay. So we can go ahead and get started. Welcome to today's IEPR Commissioner Workshop on the Revised Transportation Energy Demand Forecast. I'm Heather Raitt the program manager for the IEPR.

Quickly go over a few housekeeping items. If there's an emergency and we need to evacuate the building, please follow staff across the street diagonal to Roosevelt Park.

And -- okay, sorry. And so please be aware that our workshop is being broadcast through WebEx conferencing system today and so the workshop will be recorded. We'll have an audio recording in about a week and a written transcript in about a month posted on our website.

We'll have a series of presentations this morning. At the end of the presentations we'll open it up for public comment and limit comments to three minutes per person, please. You can go ahead and fill out a blue card and give it to me if you did want to make comments. And for those on WebEx, just use the top function to let our WebEx coordinator know that you'd like to make comments, and we'll open the phone lines at the very end.

And materials for this meeting are posted on our website and available at the entrance of the hearing room.

Written comments after the workshop are welcome and are due on December 18th.

With that, I'll turn it over to the commissioners. Thanks.

CHAIR WEISENMILLER: Good morning. This is sort of as we're winding down this IEPR, we're sort of dealing with the last two forecast workshops, today's and then later on the 15th. Obviously, the forecast is one of the key things in the IEPR since it's used by the state agencies for planning purposes. And at the same time, you know, this IEPR's got a lot more focus on the transportation forecast and I think it shows it. So anyway, thanks for being here.

COMMISSIONER SCOTT: Good morning, everyone. This is Commissioner Janea Scott. I want to echo the Chair's comments and say thank you very much to our lead team on the Transportation Energy Demand Forecast. They have done a robust job working with our Demand Analysis Working Group to get some good information from utilities and others about what they see coming in the transportation electrification, especially, forecast and so that's incredibly important, it gives it a robustness that I don't think that we had previously. So I'm excited to see that. I wanted to thank folks for that and look forward to the presentation.

COMMISISONER DOUGLAS: Just real quickly. Good morning, it's good to be here. I know a lot of work went into this effort, so I'm looking forward to the seeing the presentation as well.

MS. RAITT: Okay. So the first presentation is from Siva Gunda from the Energy Commission.

MR. GUNDA: Good morning, Chair, Commissioner Douglas and Commissioner Scott.

Welcome, everyone, I'm Siva Gunda, I'm the manager for the Demand Analysis Office of which the Transportation Energy Forecasting Unit is a part of and we are statutorily mandated to produce an objective California Energy Demand Forecast.

For those of you who might not be aware of the entire process, in order to produce the overall forecast, the Demand Analysis Office works on multiple sectors, commercial sector, residential, and so on, and transportation is one of our key sectors. The Transportation Energy Forecasting Unit is led by Aniss Bahreinian as a technical lead, and we've done a bunch of models that are both developed internally and some we rely on labs. We buy bunch of our inputs from different contractors as well as labs and produce some of the internals, some of the inputs internally to run the models.

I'm a little sick so if I'm not clear, I will

repeat myself. Thank you.

So in order to begin the presentation, I just wanted to first thank the different staff that are going to present today. We have Sudhakar Konala who will be presenting the ZEV analysis which has become a more and more important part of our forecast. We have Mark Palmere who's going to present the overall vehicle demand forecast which is an important part of our demand forecast, it's a step in the process. And we'll have Jesse Gage who will be wrapping up the staff presentations with the overall fuel demand forecast. I would like to also extend my thanks to Joshua Cunningham from ARB who's here to talk about some of the mobile strategies that ARB's seeking.

So in order to kick off my presentation, I'm going to just talk about some of the key takeaways from this year's forecast. As most of you might know, we have done a preliminary forecast presentation in June. And since then, based on the comments we received from stakeholders as well as the direction we've received from both internal leadership as well as external leadership and talk leaders, we've taken a bunch of steps to ensure we take into account some of the uncertainties that are taking on in the marketplace and then redone our forecast.

So some of the key takeaways are, and no surprise, electric vehicles are really gaining in

popularity. As for our forecast, we've developed three different scenarios, mid, low, and high. And in the high scenario, we expect the light-duty vehicles to be as high as 4.2 million [ZEV] vehicles stock on the road.

The second takeaway point is really the cost which really drives the -- both the adoption of the vehicles as well as consumer preferences. So we believe the cost of driving zero emission vehicles will continue to decline. It's today about 7 cents a mile and it's going to continue to decline rapidly as we move forward, steadily as we move forward.

As far as battery electric [vehicle] prices, as we developed our forecast, one of the key assumptions and a key pieces that we believe will drive the adoption of the vehicles in really the vehicle price and which is largely dependent on the battery prices. And we've looked at a bunch of different battery forecasts that are done both by independent entities as well as consulting firms like Bloomberg. And based on a robust stakeholder process, we've decided on some of the scenarios for the battery prices.

We believe that the battery prices will go down from about $225 per kilowatt hour today to roughly about $100 a kilowatt hour by 2030. We also believe that the hydrogen vehicle and fuel demand will continue to rise.

Basically we -- as the infrastructure continues to grow and California invests in more hydrogen fueling stations and the prices overall going down, we believe hydrogen vehicles will gain in popularity. As per our results, we have about two hundred to -- 200,000 to 350,000 vehicles on the road in about 2030.

We also have a rapid increase in electric consumption from the transportation sector. As the overall transportation -- as the overall electricity demand goes down, the last pieces that's really adding to the increase in electricity demand is the transportation. And we forecasted about 1200 thousand gigawatt hours of consumption by 2030 which is a six-fold increase from today.

We also see in the results that the overall fuel demand, fuel economy for different vehicle technologies will continue to rise. That's some of the things that went to assumptions. As to overall demand for gasoline decreases, as the electrification increases, you still see efficiency gains across all technology classes. And the gasoline demand will continue to decline. So based on our forecast, we see about 20 to 22 percent decline in gasoline consumption by 2030.

So quickly, kind of talking some of the key activities we've done since the preliminary forecast.

Based on the comments we received from stakeholders as well as guidance and comments received from the commissioners, we developed a transportation subgroup for our Demand Analysis Working Group. For those of you who do not know about the Demand Analysis Working Group, it's a way for us to continuously gather stakeholder input as we develop our demand forecast for California. Typically all the IOUs, our sister agencies, CPUC, ARB, and a few manufacturers do attend these DAWG meetings. And in order to capture some of the inputs from the DAWG group, we developed a subgroup for transportation. And we've done two separate meetings, one in-person meeting and one webinar to basically give multiple choices of what the different scenarios for electric vehicle attributes could be. And then we based on the stakeholder input, we finally decided on our attribute assumptions for this year's forecast, the revised forecast.

Another important thing that we've done is take a look, a hard look at the ZEV preferences. As you develop the forecast, one of the key assumptions that impact the penetration of ZEVs in California in our forecasts is really the preferences, the consumer preferences. The models we use at the Commission are different from the models that are used by various other forecasters. The general popularity of forecast methodologies out there are based on the S-curve, kind of a Bass curve kind of model

that you're looking at top down analysis of a macro adoption. Here at the CEC, the models that we use are primarily based on choice. So we do a bottom up analysis. We look at the overall stock -- we first project the overall stock for the next 15 to 20 years, our forecast period. And once we do that based on economic and demographic variables, we then split our segment, that overall stock, into different technologies based on what we believe the choices of the consumers will be. So that's an important distinction of our models. And hence, any incorrect assumptions in the consumer preferences really affect our segmentation forecast.

So in order to do a good job this year and combine the more popular methodologies out there which is the Bass kind of model which is the S-curve model, our technical lead Aniss kind of came up with the hybrid model where we are taking the year to year increase in the adoption of the vehicles and adjusting the consumer preferences based on that adoption. So we're increasing our preferences similar to a Bass curve. So that kind of affects that really increase our overall forecasts. And we believe it's a much better way to do it than what we've done in the past which is just increase it by an X percent based on our best assumptions.

And the last thing we did since the preliminary

forecast is really look at updating our inputs which are economic and demographic forecast variables. We also updated our attribute variables since then, and also incorporated the announcements that we've seen, that came about from various automakers.

This has been a moot point, so we just added this slide to just make sure everybody's clear on what we're talking about. So we're -- when we talk about the different technologies around electrification or electric drives, we look at four different technologies. We have the plug-in hybrid electric vehicles. We have BEV which is battery electric vehicles. We have plug-in hybrid fuel cell vehicles as well as fuel cell electric vehicles. So when we talk about ZEV vehicles and PEV vehicles, we just wanted to make sure we kind of communicated how we group them.

So the first three which is the plug-in hybrid, the battery electric vehicles, and plug-in fuel cell vehicles, together combine and form the plug-in electric vehicles. This is basically the vehicles which are plugged in in some shape or form. The ZEV vehicles are those vehicles which have zero tail[pipe] emissions. So carbon emissions. So those are basically the battery electric vehicles, the plug-in fuel cell vehicles, and fuel cell electric vehicles.

We also wanted to just make sure we kind of communicated the direct electrification issue. So from an internal combustion engine all the way to full electric drive, the overall electrification is split into broadly three groups. If we look up literature from IEEE, you kind of look at what they call the microelectrification, mild electrification, and full electrification.

So in micro, you're looking at those cars or vehicles which just use start-stop electric and then very low, low grade regenerative braking. When you look at the full electric drive, you're looking at full regenerative braking as well as a full power boost. So as we, you know, move in to more and more understanding of the electrification and study better in the future forecasts, the overall electrification transportation, the important definitions that we believe we need to be consistent with.

So just kind of jumping in to our overall demand cases, we in order to be consistent with the California energy demand forecast, the workshop which is on December 15th, we have what we call the common demand cases. So of the three demand cases, I present low-level electric demand, high electric demand, and medium or mid electric demand cases. So when we do the transportation demand cases, we have to choose a combination of variables, the different input variables that give us the highest

electricity demand, the lowest electricity demand and mid case.

So to the right of the slide you have a table there. I just want to highlight some high-level things. From a model input standpoint, the population [and] income. So in high-demand case for electricity, the population is a high demand. A scenario that we use. Similarly for income. For population and income, the same variables are used for all different sectors. So for transportation forecast, for commercial building forecast, residential forecast, all the different sector-level forecasts we do, those are the common variables. As well as the fuel prices, the fuel prices are the same across all cases. So the fuel prices for high-demand forecast for transportation, we use high it's similar. But the only thing you want to look at is the electricity prices. So the electricity prices work in the reverse order. So for low electricity prices, we believe will be the highest demand for electricity. So that table kind of captures most of our inputs.

This is kind of a large table here I just want to walk though. This is what came out of our DAWG working group, the subgroup. In order to really capture the variability of different attributes in PEV vehicles, we used an entire DAWG meeting, it was a full-day meeting to

talk about various scenarios that we should consider for taking into account the different levels of -- the different values of the attributes. So some of the inputs that we've highlighted here are what we believe are the inputs that drive -- or have significant effect on the forecast. So to the left-hand side on the table are the inputs that we solicited input on.

So the first one is preferences. As I mentioned a few slides ago, basically everybody agreed in the DAWG meetings that preferences should increase in some shape or form to capture how the market is behaving. And as I said, in order to do that, we really kind of took into a hybrid account -- hybrid approach where we're changing the preferences based on year to year adoption. So if the adoption of vehicles has increased by 2 percent in the previous year, the preferences would increase relative to that.

So the other important things to the left of here are the battery vehicle battery prices which really drive the vehicle prices. There has been a certain consensus amongst all the attendees that there will be some sort of parity between internal combustion engines and electric vehicles in and around 2030. So at the same time, there was kind of a discussion around -- the uncertainty around that as well. So in order to do that, we've looked

different battery price scenarios. And the way we've developed vehicle price is basically take into account the battery price and then add what we believe the prices of the rest of the car or the vehicle would be. And that's primarily done by Sudhakar and he's going cover that in his presentation.

So for the high scenario here as you see we used the Bloomberg bottom up approach, and that settles to about $89 per kilowatt hour in 2030. We also kind of tried to capture the uncertainty around rebates in our approach. And if you look down here, so we have our rebates continuing through all the way through 2030 in aggressive and bookend scenarios but really ending in 2025 in other scenarios are state rebates.

So after we took into consideration the different inputs from the stakeholders, we came up with five different scenarios. So the low, mid, high, aggressive, and bookend. And once we've settled on these things, we didn't really run the numbers because we didn't want to produce the numbers and then settle on the inputs, the forecast number and settle on the inputs. So we just looked at the input variables and we presented those values again in a webinar. And based on, you know, reflection on these -- on the different inputs we received, the staff finally recommended the low, mid, and high scenarios for

this year. So those are the three cases we settled on for this year.

So the values that you see in aggressive and bookend, we ran them as an exercise, we captured them in our staff report which was docketed this morning, but we didn't use them in our forecast, that's not what we're going to use in the forecast.

To just give a sense of the numbers in the high-demand forecast, the PEV stock is about 3.9 million. And the ZEV stock, if you look at the ZEV numbers, that'll be 4.2 million. And as you move forward, bookend, you have about 5.9 million vehicles PEV vehicles in 2030.

We also kind of try to identify what the additional state rebates would be, it would require, so if you look at the last ex -- the last row, the cost of state rebates to extend the rebates from 2026 to 2030, in the aggressive and the bookend scenarios will be an additional 7.1 billion and $8.2 billion.

So finally just kind of giving a snapshot of our overall models slide -- we tried to present this in a variety of different forms. We feel like this should be in here, but it's also kind of -- it has a lot of clutter on it. So we're just going to giving a sense here, the top layer is what is our inputs and the bottom layer is our outputs, and the middle is what we capture the different

models and the attraction of them. So just kind of going from the very top down, so our key input variables are economic and demographic variables and the fuel price forecast as I mentioned earlier.

To the left of the slide is our California Vehicle Survey results. That's really where we capture the consumer preferences both in the commercial vehicles as well as personal vehicles and that's an important driver of our models. This is how we believe we capture the emerging preferences and the trends and preferences in the marketplace.

As you move to the very left -- very right of the slide, you have at the high level the regulatory impact. As it came about in previous presentations as well, our model is a demand side model so we do not directly account for regulatory impact or the policy impact, so we don't have a line item in our models where we just say different policies. But we do capture them indirectly through our vehicle attributes. So the vehicle attributes are a reflection of what the policies would make happen in the marketplace. And typically the vehicle attributes are developed by our staff in conjunction with -- with the contractor.

This year for vehicle attributes on the light-duty side, we've worked with NREL and then heavy-duty side

we work with H-D Systems. So those are the two sides.

So ultimately as the models are run, as I mentioned earlier, at a high level the first thing we do is to forecast the overall stock of the vehicles. So that's the first thing we do. So we basically use an econometric model to say based on the economic and demographic forecast, this is what we believe the stock would be. And after that, we segment that into different fuel technologies based on the consumer preferences. And hence a midpoint of our overall modeling activities is really developing the vehicle forecast which Mark is going to cover. And then once we have the overall vehicle demand forecast, we then develop the transportation energy demand forecast.

The last slide here for me, I just wanted to capture this uncertainty in the market. As you know, forecasting is pretty incorrect science in some ways. There's a lot of uncertainties. The staff do a remarkable job in trying to capture as many of those uncertainties as possible into our forecast models. But the important thing is there's an end date on when we stop collecting our inputs and when we run our models. This year for the revised forecast, we've completed all our -- we finalized all our inputs by September and then we added models and finalized the results by early October. So anything that

happened since then might not have been captured as inputs into our models. So we just want to acknowledge that there is a lot of uncertainty here and moving forward, we just hope to do a better job in capturing those uncertainties.

But just to give a little bit of sense of what happened since then. In November we have Tesla that came up with the semi trucks which definitely was something we did not consider. You have Dyson who came up -- the vacuum cleaner company which announced that they would produce electric vehicles. We also have India came up last week with the new charging standards for the country. In November, we also had Singapore, for example, said they're going to cap the private ownership of vehicles. And from a Europe standpoint along with UK and France, Netherlands also joined the phasing out of ICE by 2030.

So basically you have extremely uncertain moving points in the forecast. And we believe we tried to capture most of the uncertainty and then took the best -- best educated, I wouldn't say guess but an estimate on our inputs and throughout our models.

So I'll just open to more comments and as we move forward in forecasting and creating more forecasts in the future, we'll continue to evolve our process to make sure the uncertainties around this market are captured.

In closing comments, really the uncertainty in

our forecast comes from our kind of can be deduced to basically then we believe is the inflection point. If we all think about the standard S-curve in our low forecast, the inflection point chose to happen somewhere in the 2020 phase, so the market is still early on, the inflection of the market adoption will really happen in 2019, 2020. In our high case scenario, it's happening right now.

So in the aggressive and the bookend scenarios that would have been that the inflection has already happened in 2017. So that's really where it is and that changes the slopes of adoption and the number of vehicles we forecast.

So thank you. Any questions?

CHAIR WEISENMILLER: I was going to -- yeah, actually was going to say great job.

I was going to, basically as I've been going through the comments on the IPER so far there's been at least two topics where people have raised questions about the forecast. One is rooftop solar community choice aggregation with some extents have. And so I think what we'll do is next year -- and probably be on an annual update cycle for these three where we can get some data under our belts going forward and sort of I was going to say simplify the discussion at this stage, you know, and how we've captured everything that's changing as you said

in the ball at this point.

So anyway, I think that's -- you know, some if you look at rooftop solar a lot is going on in that space in the community choice aggregation. So again, I think as you start thinking through the planning for next year, think of some -- thinking more of simple updates as opposed to going back through all the methodology and just saying, you know, we have new data, let's crank through the forecast at that stage. But certainly there's a good chance that there were things you didn't quite get to this year to sort of encapture those. Thanks.

MR. GUNDA: Thank you, Chair.

MR. PALMERE: Thank you, Siva.

Good morning, Commissioners, stakeholders, and members of the public. I'm Mark Palmere, an [Associate] Energy Specialist in the Transportation Energy Forecasting Unit.

As Siva discussed, our vehicle demand forecast uses inputs such as fuel prices, preferences, economic, and demographic data and vehicle attributes to forecast an output of vehicle stock or more simply, the number of vehicles on the road each year, as well as transportation fuel demand.

So I'll be giving a brief overview of some inputs that our model uses and the stock calculations we develop

from it, as well as highlighting some key insights. In order to forecast details about vehicle stock, we must understand these inputs and how they change over the forecast period.

So gasoline prices. Because gasoline prices are historically volatile, our forecast represents possible levels of volatility. These prices are based on the Energy Information Administration's nationwide gasoline price forecast, but represent California prices as they've been adjusted to account for the Low Carbon Fuel Standard or LCFS as well as various state taxes.

One recent hurdle for the EV market penetration has been cheap gasoline prices in the recent past, but our forecast indicates a future price scenario with increased favorability for EVs. Fuel price forecasts allow us to calculate cost per mile, which considers fuel price as well as fuel economy and considers the different costs of driving a vehicle of each fuel type.

Now since this forecast considers light, medium, and heavy-duty vehicles, let's first look at how the cost per mile trends differ among those distinctions. In the light-duty vehicle realm, electricity is projected to have the lowest cost per mile while hydrogen's cost decreases dramatically during the forecast period.

Electricity is also the cheapest of the various

fuel types for medium-duty vehicles. Think of package delivery vans or the truck in green up there. For larger trucks, what are known as heavy-duty straight trucks and refer to large or unarticulated trucks, that is, trucks with no trailer, so that's the second picture there, electricity is seen as a less viable option. Taking electricity's place as the most appealing alternative fuel option is diesel-electric hybrid, with natural gas trucks also forecast to become cheaper per mile than diesel as soon as next year. And finally, for heavy-duty tractor trailers, natural gas offers the lowest cost per mile currently.

But there the big story in recent weeks is of course the introduction of the Tesla semi as Siva mentioned. There, Tesla intends to offer electricity at 7 cents per kilowatt hour on its Megacharger network. But as Siva said, unfortunately this announcement was made after our forecast was completed so we could not reflect the development for this forecast.

Similarly, the Nikola Motor Company is offering 1 million miles of free hydrogen for their planned fuel cell electric semis. However, concerns about the practicality of this plan prevented us from considering it in our current forecast.

So here we have specific cost per mile

protections for light-duty vehicles focusing on midsize cars, as they're one of the more popular classes. Note that this is not a fleetwide average but the cost of fuel per mile driven for cars of a particular model year.

The hydrogen price scenarios are prepared by the National Renewable Energy Laboratory, or NREL, and reflect the reduction in the costs of hydrogen production.

Electricity, which shows moderate decreases throughout the forecast, is prepared by our own supply analysis office. And gasoline and diesel are based on EIA prices where rising fuel costs in the mid case outweigh fuel efficiency improvements, leading to a gradual increase in cost per mile over time. That combined with electricity's cost per mile decrease means we expect to see electricity cost less than half -- less than half of the cost of gasoline per mile as soon as next year.

We will also look at medium duty trucks as they are one of the more common types in the freight sector, and they offer many different fuel type options. Electricity prices, cost per mile prices, are basically flat, while other fuels follow more or less the same trajectory as gasoline and diesel did for light duty, showing an increase mostly in line with fuel price increases. So therefore, electricity gets relatively cheaper throughout the forecast. And it starts out as the cheapest option, but it

only gets more relatively cheap even though it's so low.

So before we can look at fuel types, we're going to look at stock, but we're going to have to answer a relatively straightforward question: how many vehicles will be on the road each year? We calculate overall stock as a function of economic and demographic inputs with personal stock influenced by population and per capita income, and commercial stock influenced by gross state product, which indicates economic activity.

Now this chart shows the growth of the light-duty vehicle population. So here we're looking at the stock from the present up to 2030 in our three cases, high, mid, and low demand. You may notice that the mid and low cases forecast similar overall vehicle stock. That's because we have three cases but we use only two population forecasts. The Moody's household forecast for our high case and the Department of Finance household forecast for our medium and low case -- mid and low cases.

Still, there's value in having three cases instead of two, which comes later when we look at fleet composition. Because while income and household trends predict the number of vehicles purchased, attributes and preferences determine the type of those vehicles. Taken together, these inputs give us the composition of the vehicle stock on the road throughout the forecast. We'll

focus on the mid case here, as it represents what we believe to be the most likely scenario. There gasoline is projected to remain the predominant technology throughout the forecast. However, when we look at the share of ZEVs and PHEVs, we see that there's a tenfold increase by the end of the forecast.

And another way to look at vehicle numbers is by changes in annual sales, that last slide was overall stock, this is new vehicle sales in each year. This year we expect to see about five percent of light-duty sales to be ZEVs while in 2030, that number jumps to about 16 percent. You'll notice the dips starting in 2026, so that's the result of how we modeled it. Because while the future status of California's Clean Vehicle Rebate Program or CVRP is undetermined, as was mentioned in Siva's big scenario slide, we expect the rebate to end at some point in the future due to EVs becoming more price competitive without the incent -- become more price competitive without the incentive, and the increase in the cost of the program as a result of higher sales.

So staff used feedback from DAWG, the Demand Analysis Working Group, and for the mid case chose 2025 as our best most reasonable assumption for this end. And for sure, this dip shows the effect policy can have on and does have on our vehicle purchasing decisions.

As for freight technology, this forecast considers many new powertrains in the sector including ZEV technology such as hydrogen fuel cell, battery electric, and catenary electric. The latter technology, which is shown at the bottom right of the slide, has been tested in Southern California and is considered a competitive option in scenarios favorable to electrification.

And with that, we do see increases in alternative fuel MDV sales. The increases in the low case are somewhat modest but still impactful, reaching 40 percent of new MDV sales by 2030, while the increases in the high case are large for alternative fuels and ZEV in particular. Not only are about 60 percent of new MDV sales in 2030 forecast to be alternative fuel vehicles, about a third of those AFV sales are in the battery electric category.

And finally, here is alternative fuel heavy-duty vehicle stock. This which includes both trucks and buses, but since the market for buses in completely different due to being publicly funded entities, the ZEV analysis portion that Sudhakar is going to cover will include a separate look at just buses. But overall, natural gas remains the largest of the alternative fuel vehicles, but we do see inroads made by electric which include battery and catenary electric in the bus market and just catenary electric in the truck market as they become more cost competitive.

That concludes my presentation. Thank you all for listening. Up next we're pleased to welcome Joshua Cunningham from the Air Resources Board who we thank for being here and who will be speaking on mobile source strategies to address climate and ozone requirements.

MR. PALMERE: Do you have any questions?

CHAIR WEISENMILLER: No, we're good. Thanks.

MR. CUNNINGHAM: Okay. Thank you.

Good morning. Thank you for having me. I appreciate the opportunity to present Air Resources Board and our forecasts.

What I'm going to present today briefly is a summary of the gap in our inventory on where the key transportation strategies today and current policies get us and the gap that we have to meeting our ozone and climate targets. But I'll spend the bulk of my presentation talking about the current scenarios and projections we have for how we want to close that gap. But I'll be talking at a high level so I'm going to convey some of the key strategies we've talked about in our mobile source strategy that was realized last year for feeding information on our SIPs and then also the scoping plan that's being finalized this year. Both of which are harmonized in terms of the key strategies that we're looking to.

So this graph shows the inventory as we project

in current programs and then the gaps. If you look at the left side, that represents NOx emissions in the South Coast from all sources, not just from mobile source. This includes stationary, point area sources. What I'm showing here is the breakdown by sector so you can see the mobile sources, the light duty, the heavy duty, and other mobile which includes rail, aviation, and marine, Continue to convey those, collectively those mobile sources continue to convey the bulk of the NOx emissions in South Coast.

Light duty is expected to drop dramatically as a proportion of that inventory, largely as a result of our light-duty regulatory LEV programs for NOx tail pipe. That of course is dependent on whether those programs are successful and industry is successful in getting the on-road emissions to meet what we require. But you'll see that if that is true, we continue to have off-road and heavy-duty sector problems for NOx.

The stars there in 2023 and 2031 represent where the South Coast has to get to meet Federal National Ambient Air Quality Standards. The lower one in 2031 is the 75 part per billion requirement where NOx is the primary precursor for the Ozone formation.

What we're not showing here is the new standard that the former EPA set of 70 parts per billion, that hasn't been finalized by the EPA yet but that would expect

to create a new requirement in South Coast for probably around 2037 or 2038, beyond the current planning trajectories.

On the GHG side, this is at the statewide level. On the right-hand side these are our current projections for baseline again. All sources, this is consistent with what's going into our scoping plan now. A different story for transportation where light duty continues to play a fairly large portion of inventory even out to 2050 in the baseline case. So this represents our current programs if they were to flatline in stringency at 2025 for our grams of CO2 per mile requirements for automakers as well as our EV requirements. Our stringency goes up in 2025 and then flatlines at that point.

Heavy duty and off-road, you're starting to see some growth here in these sectors as population expands and freight activity expands in California. Not surprisingly, as you well know the targets for the state in climate change in 2020, we're fully expecting to meet the AB32 requirements. 2030 with the new SB32 statute, the gap is shown there to be sizeable and the scoping plan is starting to address how we're going to tackle that. And then the 2050 Governor's Executive Order, a very large gap which as you know is going to require a lot of new policy actions.

These are core messages that are in the scoping

plan that's being finalized I believe this month to convey qualitatively some of the key strategy we want to take to address those gaps. I'll highlight that these are the similar messages we have in the mobile source strategy that was highlighted last year. We want to promote vibrant communities through good planning efforts to ensure that we're tackling reducing vehicle demand for VMT as well as mode shifts to walking and biking. We want to ensure that we're continuing for new actions on regulatory incentives to move beyond the current programs to work with industry to get technology to move out more rapidly. We want to continue to better understand some of the new trends in the mobile source sector. The autonomous vehicles, connected, and ride hailing trends are all things that are happening very rapidly real time and we don't have those accounted for in our current projectionsand We need to understand how that is going to roll out in future years but clearly they are trends that we're going to have to grapple with.

Moving forward on freight and goods movement to ensure that we have actions to better align the system's efficiencies there and then finally making sure that we're looking at some of the new modes that are moving out, particularly high-speed rail for pulling VMT off the road network.

Okay. Moving into some of the quantitative

analysis that we've done. Before we do any of the scenario work, of course we have to look at where we think the impacts are going to be coming from current programs. This graph is something that you may have seen, this was published in our midterm review report from the Air Resources Board in January this year. It shows our updated projections for the light-duty vehicle, electric vehicle sales under the ZEV regulation.

I'll highlight the text box there, we get this question a lot. The updated minimum compliance values here represent what we think the industry would have to do to minimally comply with our regulation, but it does not represent where we think the market is going to go. We are confident that the governor's target could still be met of reaching 1.5 million. But to minimally comply with a regulation when we've relooked at the industry's credit banks for the current regulation as well as the longer range vehicles where they get more credits per car which is a good thing in terms of technology evolution. We do project that the cumulative sales to 2025 likely could be closer to 1.2 million. And again, we see that the market can go on beyond that point as Siva and others have presented already this morning for your demand forecasts.

We do have a couple of cases we've looked at mid, high, and slow technology that had to do with confidence

that we see for the technology growing out. Longer range electrical vehicles if they are successful will get more credits but also drive more sales. Slower technology rolled out if the technology is not as successful or if the costs remain high for consumer demand, you'll get automakers having to use more of their credits in the credit bank and less cumulative sales in total.

So when we take in that case the light-duty projections and then other heavy-duty projections from current programs and we start to move into scenario forecasts, I'll just highlight that over the past couple of years we've tried to be consistent with our different efforts. For the future years beyond baseline, we continue to use the vision modeling tool, that was what went into the mobile source strategy in 2016 which is where our current light-duty forecast scenarios were first published. That was then moved into the scoping plan scenarios so that the light-duty and the heavy-duty strategies in this year's scoping plan were actually developed a couple of years ago in the mobile source strategy, so going into 2018, we do intend to start updating those projections and we look forward with working with your staff to ensure that we're as aligned as we can. The-- particularly the starting point for the midterm review assumptions that came out of our regulatory report were not in that older scenario so

we'll start by uptaking those. Our EMFAC inventory which is being released in the coming months for the official EPA submittal is now being updated, both of which were not in these older scenarios. So we'll start by updating those and then looking to some new scenario strategies that we want to consider.

This is a graphic from those planning efforts you've likely seen before on the left-hand side. This is one potential set of electric vehicle strategies in terms of sales forecasts that would get you to success for the 2050 GHG and long-term NOx requirements. I'll emphasize as you know well too that there are many paths to get there, but all of them do rely on significant actions on both the technology rollout which is what the graph shows but also fuel carbon intensity reductions on the supply side and activity reductions for vehicle demand.

But this particular scenario projected out by 2050 reaching 100 percent sales for light duty of some form of an EV. So that's pure ZEVs and plug-in hybrids. We took a relatively balanced approach in the later years of one-third sales of all three of those categories knowing that there's a fair amount of uncertainty of where the market's going to go between those three. Future scenarios may start to look into specific cases. But I'll emphasize that it reached 100 percent sales by 2050.

Your staff has already highlighted this morning that there are more aggressive actions being talked about in some of the European countries. And rumors in China, we are certainly looking at those pretty carefully too. I'll note that none of those are based on regulatory drivers yet. Those are the markets, those are targets at the national or in some case city level which can be influential but we're trying to understand implications for industry actions and we'll keep close eyes on those. But certainly some of those jurisdictions are talking about trying to get 100 percent sales by 2030 which is much more aggressive than we're showing here.

We don't think that's necessary to get to the current California climate and ozone targets but we are aware that there are some conversations about trying to move to a more aggressive climate target than the current 2050 80 percent. So that might be relevant in that case.

The right-hand side shows some of the trends in a more narrow window. We're starting to talk to the automakers for the light-duty side on our future Advanced Clean Cars regulations which we expect to go to the board with, by 2020, for a 2026 start point. So we've started to talk to them about the scale of transformation for the light-duty sector. So if you were to take these sales in the scenario and then also look at the fuel and the VMT

trajectories, that scenario projected about a 50 percent reduced GHG emissions for new vehicles over that ten-year window from 2026 to 2035 which is very aggressive and further NOx reductions.

A final few set of slides on input values. This is an area that we'll continue to try and share notes and ideas with with your staff. The fuel economy assumptions that went into our scenarios which were developed a few years ago. At the time our scenarios were put together, we were relying on the National Academy's 2013 study so clearly that's old and we want to identify some newer projections. But the National Academy's looked at a lot of technology assessments and historic growth rate for fuel economy for different technology categories. So this shows where they projected out all the way to 2050 by categories.

The plug-in hybrid growth rate there grows at a bit of a faster pace in later years as a function of not just the engine efficiency improvements but also the electric VMT proportion going up. And so the aggregate fuel economy equivalent for that vehicle type would improve as it's shifting more of its VMT to the electric side.

And I'll just close with our aggregate projections here for the well-to-wheel greenhouse gas emissions reductions in the scenarios that went into the two planning efforts. This represents light duty and heavy

duty combined so it's not all of transport but it is the on-road sectors. And the key message here is to try and show that as those combined on-road sectors reach close to their equal share of the reductions, that the dominant chunk of that is coming from the vehicle technology rollout but then also important emission reductions also from the fuel supply. We did project very high renewable penetrations for all fuel types. And then the vehicle activity reductions with community development plays an important piece too.

So I'll finish there and happy to take questions.

CHAIR WEISENMILLER: Great. Thank you. Thanks for coming over.

I was just going to ask one thing when the Governor, Mary, and I were in Beijing in June and met with the Ministry of Science and Technology, they certainly they're among the drivers from China on the vehicle side, so certainly and we did an MOU there in the airports and on point on that one.

Just going to ask you just to make sure going forward you share with our staff what's going back from China on the vehicle side.

MR. CUNNINGHAM: Yeah, of course. Yeah, what China's doing right now is very impressive. You know, their decision to finalize an electric vehicle mandate with

their NEV requirements is going to have we think dramatic positive effects globally in terms of bringing the cost down for manufacturing and sales for EVs. We have to look carefully, of course, at the vehicle types that are sold in that market to see if they're applicable here but it'll reduce costs on the component level in a very good way. But for sure we'd be happy to make sure we're aligned with your staff as we study those market trends.

CHAIR WEISENMILLER: Yeah, the other country that's doing impressive things, you know, is India. I feel like the mobility report that was produced by the Indian government RMI which, obviously it's a different set there because they're not as locked into the automobile culture as we are, but still very impressive goals there going forward on mobility.

MR. CUNNINGHAM: Yeah. Yeah. As I noted, we're trying to track a lot of these announcements and presidential targets including Europe and at the mayor level in the cities. And we want to observe the trends, but we're also trying to get a sense of which of those regional stringencies are going to have impactful rollup in the near term. And we see the China efforts are probably going to have a bit more certain impact just because of the ability for them to implement those requirements in a rapid pace. And then some of the cities because they have local

signals and jurisdictions to restrict sales could probably have some pretty impactful impacts on sales. We've already heard from a couple of the European automakers where they're starting to see residuals -- residual price trends going down for diesel vehicles already because of local actions by the mayor of Paris and others to just state that they're going to not allow diesel cars into the cities.

So it's just to point out that we'll look at India as well, different markets and contexts.

COMMISSIONER SCOTT: Joshua, I just want to say thank you very much for being here and also sending your team over when we did the preliminary forecast as well. I think it's really helpful for us to hear from Air Resources Board, kind of where you are, how you're assessing the scenarios and to make sure that to the extent possible our agencies are kind of speaking with the same voice because we do all have the same goals. I very much appreciate your collaboration and partnership with the team.

MR. CUNNINGHAM: Sure. Thank you, Commissioner.

MS. RAITT: Thank you. Next is Sudhakar Konala from the Energy Commission.

MR. KONALA: Good morning, Commissioners. My name is Sudhakar Konala and I'm going to be talking about the light-duty vehicles and specifically ZEVs.

So I just want to start out by giving a brief

overview of my presentation. I'm going to start out by providing an overview of the vehicle market and specifically I'll talk about light-duty vehicle electrification where it is now and where it's headed. Then I'm going to talk about battery electric vehicle range including where we are today in terms of the range that is available in vehicles as well as what we think will happen in the future.

After that, I'm going to shift to discussion about battery electric vehicle prices which are largely determined by estimates of battery costs and vehicle range.

Finally, I'll discuss the results of the zero emission vehicle forecasts that we performed. And also discuss how our results show regulatory compliance.

So I just -- sorry. I just want to start out by discussing some recent trends in light-duty vehicle electrification. I just want to make a note that there are four powertrains that are sometimes considered of having some level of electrification. Those include hybrids, plug-in hybrids, battery electric vehicles, and fuel cell vehicles. The degree of electrification for each powertrain varies. Siva went into more detail on this. But these are the powertrains that I would like to look at in this slide.

So here I have two charts. The chart on the

right shows historical sales of hybrid, plug-in hybrid, and BEV sales. I didn't include fuel cell vehicles just because I didn't have 2017 data and 2015 and 2016 even if I put fuel cell vehicles, it would be hard to see. But the main point from that slide is if we look at 2017, PEVs, which are battery electric vehicles and plug-in hybrids, the share is increasing. And it's up to 4.5 percent of 2017 sales, and this is through September 2017. As you can see, that's up from virtually nothing eight years ago. So that's a significant increase already. And this increase has occurred despite an extended period of lower gasoline prices.

At the same time, if you look at hybrid sales, we can see that sales of hybrids are more sensitive to gasoline prices and possibly to cannibalization from EVs and PHEVs. So we see a decline in the hybrid sales between 2013 and 2016.

So I've covered what we've seen so far, but a lot has changed in 2017 and that includes automaker announcements and their plans for future vehicle offerings. So throughout the year, our staff closely followed all the different announcements and we created a list of every single automaker and the announcements. Here I'm highlighting some of the major ones. I'm not going to go through each one individually but most of the major

automakers out there have put out plans to include some form of electrification into their vehicle offerings. And this include hybrids, plug-in hybrids, and battery electric vehicles.

The most aggressive of them probably has been Volkswagen as a result of the diesel emissions scandal. They have really gone full throttle into electrifying their vehicle fleet as a result. So they say that they will electrify their entire model portfolio by 2030. It could be earlier but by 2030 they guarantee that they will. I just want to point out that these announcements are up to date as of October 1st, 2017. There had been some announcements afterwards. The strategies listed, though, are OEM's global strategies. They really don't specify their strategy by country, so it is possible that not all of the models and vehicles that they are describing will be available in the United States. Some of them could only be available in Europe, others could only be available in China. But overall, it is a positive move for the market, including for the market in the United States.

So as we follow these automaker announcements, we use that information to help with projecting inputs for our models. One of the important inputs is number of zero emission vehicle and plug-in hybrid electric vehicle models. So Energy Commission staff, we collected media

reports and OEM announcements throughout the year and we use this information to project the number of ZEVs and PHEV models through 2022.

From that information, we think that there's going to be over 125 models available five years from now compared to like less than 25 models available in 2015. So it's a significant increase. And the rate of announcements is accelerating. If you look at the ZEV midterm review released by the Air Resources Board, they had a list of about 80 models. So just this year, we've seen a 50 percent increase in the number of announcements.

So while the number of models is important, it is not the only thing that drives the adoption of zero emission vehicles. One important factor is BEV range with consumers preferring to purchase vehicles with longer range. So here I have a chart of historical BEV sales by range. And as we can see, between 2014 and 2017, the share of BEVs that have a longer range of at least 200 miles or more, they've increased significantly. In 2014, they represented only 20 percent of BEV sales, and this is California's specific data. In 2017, it's almost up to 60 percent. And this is just three models we're looking at. The Model S, the Model X, and the Chevy Volt. Three models represent 60 percent of sales. That shows you how much range matters to people when they're buying BEVs.

So in accordance to what we're seeing in the real world, we've adjusted our forecast. In 2015, our forecast pretty much held BEV range constant throughout the forecast period at about 115 miles. For the 2017 forecast, our low and mid forecast, the range that we forecast is 240 miles, average range by 2030. And the high forecast we're over 280 miles. So this represents a significant move on our part as we incorporate what's happening in the market.

Here I have a chart of the BEV range by vehicle class. These are the specific inputs that go into our model. What's important here is not any individual line, but the overall trends. Between 2015 and 2020, we think there is going to be significant increase in range across all vehicle classes. And this just continues the trend that I showed two slides ago. After 2020, we have range growing at a more moderate rate. This isn't any specific announcement from automakers but more of an assumption made by the team as we see that range is adequate enough. So in 2020, we believe automakers will switch to trying to drive down costs. So.

Okay. Next I am going to move on to battery electric vehicle costs, or specifically battery pack costs. Okay. To understand BEV prices, we must first understand batteries which are the most expensive component of the overall BEV price. Batteries can make up to -- can make up

more than a third of the total vehicle price. This figure shows external estimates of battery pack costs from several well known sources. Prices are displayed per kilowatt hour of battery capacity. Battery prices today are already significantly lower than what they were just a few years ago. Although they're not shown on this chart, in 2010, they were at $1,000 per kilowatt hour. In 2015, that number had gone down to about $350 per kilowatt hour. Today, in 2017, we estimate cost of between $200 and $250 per kilowatt hour. By 2030, the price of batteries is estimated to fall between $73 and $120 per kilowatt hour.

So in comparison to these estimates, the solid olive green lines represent projections made by the Energy Commission staff after a thorough literature review of all these external sources. Our low energy demand case has a price of about $120 in 2030 and our high demand case has a price of about $89 per kilowatt hour as Siva mentioned earlier. As you can see, the Energy Commission's estimates align well with the external sources that we reviewed. And essentially we used these sources to inform our estimates.

Now having covered battery prices, I wanted to show you applies -- a slide of BEV prices. So this slide shows BEV prices by vehicle class which -- and are the specific values that are used as input into our transportation models. Overall, BEV prices are projected

to decline over time. However, based on automaker announcements, BEV prices are expected to increase in some vehicle classes over the next couple of years. This represents automakers' announcements of their expectations to release more premium and luxury brand vehicles with longer range because of essentially what has happened with Tesla.

Many of the premium and luxury brand manufacturers, they have seen the success of Tesla's vehicles and they're trying to compete with that. And that is reflected by higher vehicle prices in our projections early on. But if you -- if we take the longer term view, BEV prices are projected to fall significantly as the growth in range slows and battery -- as battery costs continue to decline, the vehicles, the overall price is continues to decline.

The more -- the important point I want to make about this is that there is a delicate balance between BEV range and price. All of us would like an extremely long-range battery electric car at a cheap price. But the economics currently don't allow for it, especially -- so we have to use the best information that we have available which was that thorough literature review we did of battery pack cost estimates.

So even though battery costs are falling,

currently average prices of BEVs are rising and this was reflected by a statement made by the International Energy Agency. So to get a better review of the relative cost of a battery electric vehicle, the Energy Commission Transportation staff has decided to use a new metric to show the reletive of decline in BEV prices. And I will talk about it in the next slide.

So the metric, we call it battery electric vehicle price per mile of range. And as you can see over time, this is decreasing. We define price per mile of range as simply the battery electric vehicle price divided by the battery electric vehicle range. The relative price -- this metric is essentially the relative price of a BEV when holding range constant.

As the figure shows, price per mile of range is projected to decline sharply over the forecast period for all BEV classes. And the decline is sharpest in through 2020, actually. So although in the last slide we showed an increase in price, when we look at it as price per range, the decline is sharpest in the early years.

Finally, having spoken about vehicle prices, I also wanted to touch on the effects of leasing battery electric and plug-in hybrid electric vehicles. During the DAWG transportation subgroup meeting, several stakeholders requested that we look into leasing and how it could affect

sales. So after the forecast was finished, we decided to do so. So here I have lease terms and loan payment information about the Chevy -- a Chevrolet Volt that I took from Chevy's website as of October 2017. So I'm directly comparing a 39-month lease for the Volt compared to a loan that you could get from GM to buy the same vehicle. I assumed the same down payment for the lease and the loan and then calculated the monthly payments from information available on the website. And for the loan, I also added the federal tax credit that one would receive after purchasing the vehicle as well as the estimated resale value of a three-year-old Volt at the end of the lease.

As you can see from a financial perspective, leasing a Volt is more expensive over the 39-months that a comparable loan. So in terms of the transportation models, there doesn't seem to be too much of an advantage to a lease versus a loan. This is something that we want to continue to look in to. However, there are certain instances where leases could still help with BEV and PHEV sales. And those instances include as a way of risk management. Currently technology is rapidly evolving so leasing could help relieve some of that I guess -- just the uncertainty that consumers have about a newer model with longer range coming out. In this way, they can avoid that risk of holding on to a vehicle that's technologically out

of date in a few years. By leasing, they can give the vehicle back.

Secondly, not all consumers can take advantage of the federal tax credit because they might not -- they might be low income households that don't pay enough in taxes. In that case, leasing would also make sense. So there is more reason to look into leasing going forward. But in the long-run, we believe that looking at the price of the vehicle as we currently do reflects the competiveness of BEVs. And we don't believe leasing will give BEVs or PHEVs advantage over other vehicle technologies.

Having finished my discussion of vehicle prices, I just want to get into our vehicle stock forecast. This is pretty straightforward. So we obviously had three cases that Siva discussed. In the low case, our forecast shows approximately 2.8 million ZEVs and PHEVs on the road by 2030. In the mid case, our forecast projects 3.6 million vehicles. And the high case, our forecast projects 4.15 million vehicles.

A couple of things I want to point out. The discontinuation of the state rebate which Mark talked about, we can see the impact in stock here by the change in the slope of the curve of the high and mid cases. This shows the importance of government incentives and policies and the affect removal of those can have on vehicle sales

and stock.

A second thing I want to point out is how our numbers compare to estimates made by the California Air Resources Board in the ZEV midterm review. While this is not a measure of compliance, I will get to that later, you still can compare the stock numbers. So even in our low case, our low case projects 1.6 million vehicles in 2025, so we're above all three of the projections made by ARB.

Another point I'd like to point out is the high case in 2030. We're really close to the 4.2 million number that the Air Resources Board mobile source strategy targets.

Now I'm going to talk about fuel cell vehicle stock. And essentially this is projected to grow as well. As vehicle prices fall and as the cost of driving fuel cell vehicles also drops. In the low case, we project 196,000 vehicles in 2030. In the mid case, 288,000. And the high case, about 330,000. The discontinuation of the state rebate, you can see that in the change of the slope of the curve as well just like the ZEV forecast in the previous page. The final point I'd like to make is that even in the low case, we are in the same ballpark range with ARB's AB8 projection based on vehicles -- automakers' projections of fuel cell vehicle sales. So in the low case, we are close to that projection or slightly above it. And the high and

mid case, we're well above it.

Having discussed the forecast, I would also like to move on to regulatory compliance. So the Energy Commission's Transportation Demand Forecast. We strive to assess marketing demand for ZEVs and generate a forecast of sales. But we also need to see if we're meeting all of California's regulations. We do this by converting our forecast of ZEV sales to ZEV credits. We do this using a modified version of ARB's ZEV calculator. And using this modified calculator, we check that the forecast results are in compliance with California's ZEV regulation.

Here I have included a chart of projected ZEV credits in our low case. The dark blue shows the required number of ZEV credits, and the light blue shows how many credits car manufacturers earn in our forecast. I would like to point out that these are projections and they -- the required number of credits, they -- they change depending on the forecast. So our required number would not necessarily be the same as ARB's if their forecast of vehicle sales is different. So for our forecast, these are the required numbers. The main point, though, out of all of this is that the forecast projects compliance not only in the low case but in all cases.

I'd like to end the presentation by shifting away from light-duty vehicles and talk about transit vehicles,

specifically transit buses. We also did a forecast of transit bus stock. And what we found was that ZEV share grows for transit buses. This forecast was done by staff. It looked at announcements by transit agencies as well as state goals as stated by ARB and their advanced clean transit program. We took into account the current population of bus stock and the normal replacement rate for transit buses which is generally 12 to 18 years. We also looked at pricing of different vehicle types for transit buses that was published on ARB's website. And we saw that battery electric buses are fairly competitive, especially since federal policy covers 80 percent of [the price of] all transit bus vehicle purchases.

Given all these factors, we project the transit stock and we see battery electric vehicles gaining popularity among transit buses. Although this forecast only shows stock through 2030, if it really accelerates after 2030. So. But that will be for a future IEPR.

This concludes my section of the presentation. I would -- oh, sorry, I had one more slide.

Okay. So the key takeaways from my section are that BEVs are expected to have more favorable characteristics such as longer range and lower prices and more availability. This is due in part to the effects of California's ZEV program and decreasing cost of lithium-ion

battery packs. There's definitely a statewide shift towards transportation electrification. And given a stable policy and regulatory environment, our forecasts projects that California is making good progress towards its clean energy goals.

And with that, I will take any questions you might have.

CHAIR WEISENMILLER: Thanks. The only thing I was going to say, the other -- one of the other aspects in China along with the push on light -- well, it's a sub satellite duty and buses is taxis, you know, a number of cities are basically trying to in the next couple of years get to all taxis being electric. And I don't know if we have a specific part of our forecast which is taxis, I'm not even sure if they would be more, you know, Lyfts, Uber, than taxis per se but.

MR. KONALA: We do have a model called Other Bus which incorporates demand response and taxis, but I don't have any of the results, I don't know them off the top of my head.

CHAIR WEISENMILLER: Okay. If you can dig into that a little bit, that would be good.

MR. KONALA: Okay.

CHAIR WEISENMILLER: That was great. Thanks.

MR. KONALA: Thanks.

MS. RAITT: So next is Jesse Gage from the Energy Commission.

MR. GAGE: Good morning, everyone, we might get you out for lunch after all.

So far we've looked at vehicle stock, trends in cost per mile, and projections for various other attributes for light, medium, and heavy duty with a particular focus on zero emission vehicles.

We are just about ready to dive into what has traditionally been the overall goal of the forecast, that is fuel demand itself. But first we have one last piece of the puzzle to discuss, fuel economy. Then and only then can we get a picture of fuel demand for conventional and alternative fuels as well as natural gas. High-speed rail is a rerun as the California High-Speed Rail Authority hasn't published a new business plan since our preliminary workshop in June but we will quickly do a recap.

It should hopefully not be a surprise that we forecast significant improvements in fuel efficiency across the board between now and 2030, particularly -- partly in response to CAFE standards as well as improvements and technology. For our sake of an apples to apple comparison, we are narrowing the current slide to compact cars. You can see improvements over the 13-year period range from about 8½ percent for fuel cell electrics up to over 35

percent for diesel.

Let's zoom out on fuel economy to get the grand perspective for the overall fleet economy. This slide depicts historical and projected sales-weighted light-duty vehicle fuel economy by model year. In other words, the points for say 2020 reached for strictly to the sales weighted fleetwide MPG of model 2020 vehicles sold in 2020.

In the historical data, you can see the divergence of California's fuel economy versus that of the nation as a whole starting a couple of years after the first data points are available for California. After our base year of 2015, the low case more or less follows the trajectory of the fleetwide fuel economy we've seen for the last decade or so. This increase is again in great extent to improvements in ICE efficiency spurred by CAFE, but also due to people switching even in the low case to hybrids and alternative fuel vehicles.

One last point. I'm sure you've noticed the dip in efficiency in 2026. This stems from the discontinuation of state rebates for light-duty PEVs which you'll recall Mark explained in Slide 18 and Sudhakar amplified.

Now for our fuel demand starting with the conventionals and gasoline as it's still the heavy hitter. Gasoline consumption has seen an uptake over the past few years as gasoline has been relatively cheap and as

California dug out of the great recession. Our forecast suggests that this trend will reverse course and soon begin to decline with about a 2.7 billion gallon reduction in annual consumption by 2030 compared to the present, which is a rate similar to that which the EIA has forecasted in their most recent annual energy outlook. The reasons leading to this decline have more or less been the focus of this workshop over the past two hours or so, so I'm not going to belabor the point here.

In contrast to gasoline, diesel demand increases modestly, following the growth of California's economy. This increase is tempered by an increase in fleet fuel economy and market penetration of alterantive fuels most prominently by natural -- most prominently by natural gas in the medium and heavy-duty sectors.

Additionally, 2021 marks the anticipated implementation of the proposed U.S. EPA, NHTSA, phase II greenhouse gas and fuel efficiency standard for medium and heavy-duty engines and vehicles.

Finally, jet fuel consumption is held relatively flat. Efficiency gains are offset by continued growth in plane miles traveled.

Given the large amount of time today discussing plug-in hybrid and battery electric vehicles as well as the decline in gasoline consumption, it should be no surprise

to see electricity taking off. Electricity consumption due to transportation is forecasted to rise up to 16,000 gigawatt hours by 2030 in our mid case. This accounts for not only light-duty vehicles but also battery electric buses and medium duty trucks, catenary electric transit buses, light and heavy rail, and various electrification projects in the off-road sector, among other things.

Note that as with the previous workshop, I'm excluding high-speed rail from this slide. We'll cover it separately in the next one. Also you can again see the effect of the 2026 sunsetting of state rebates manifesting itself as a bit of a kink in the growth rate. Which is what, the fourth time you've seen that now? So there you go.

With such a meteoric rise in electricity use, the increase in natural gas and alternative fuels may look tamer. However, significant gains are forecasted in all these fuel choices. Natural gas consumption for transportation grows 22 percent over the forecast period due to increased market penetration in the heavy-duty sector. While ethanol sees steady increases due to consumers opting to fuel their flex fueled vehicles more with ethanol.

Last but not least, we see hydrogen consumption begin to show up on the radar catching nearly up with E85

by 2030 at about 61 million GGE. Coincidentally, the conversion from GGE to kilograms is just about one to one so if you want to think of that as, you know, about 60 million kilograms, feel free to do so. This uptake stems from increased hydrogen refueling station availability, lower prices for producing hydrogen, and the rollout of a broader range of fuel cell vehicles.

And finally if, somewhat anticlimactically, the forecast for high-speed rail is unchanged since our June workshop. But to recap, the California High-Speed Rail's 2016 business plan details two distinct stages of HSR. The system is currently slated to open with a so-called valley to valley line in 2025 shown here in red connecting San Jose to a station just north of Bakersfield. This is followed in 2029 by an extension north to San Francisco and south to Anaheim. Again, this forecast was received directly from the California High-Speed Rail Authority and stems from their 2016 business plan. Their next business plan is due next year and typically it's published in April.

That wraps up my segment and the presentation as a whole. I'd like to extend a quick thank you on behalf of our team, to our supervisor Laura Zaninovich, Charles Smith from the Fuels and Transportation Division, and Matt Coldwell up in your neck of the woods.

If you have any questions on my segment I'll be happy to fill before we turn to the team as a whole.

CHAIR WEISENMILLER: No, sir, this is good. Thanks.

I guess the one thing I was going to ask about and maybe we catch up later is, you know, that the federal government has agreed to finance the conversion of Caltrain going from San Jose to San Francisco from diesel to electric.

MR. GAGE: CalTrain?

CHAIR WEISENMILLER: Yeah.

MR. GAGE: Yes.

CHAIR WEISENMILLER: And I was just trying to -- I'm not familiar with the timing, but where that fits in?

MR. GAGE: I will have to look up that. I know we've -- go ahead.

MR. KONALA: I looked in it, so 2019.

CHAIR WEISENMILLER: Okay.

MR. KONALA: So that's when it starts. I think. I don't remember the end the date but we have it in that forecast too.

CHAIR WEISENMILLER: Okay. Great. That's what I was checking. Thanks.

Now again, I'd like to thank folks -- yeah.

MS. RAITT: That concludes our presentations. We

can go on to public comment if it's okay with you.

CHAIR WEISENMILLER: Yeah, that would be good.

MS. RAITT: So I don't know if anyone in the room wanted to make comments. I didn't get any blue cards.

Okay. And we do have one person on the WebEx who had some questions and I'll go ahead and read them and if staff wanted to field any right now, otherwise just encourage you to follow up with the person after the workshop.

So, okay. If I can read this. So the first is from Michael Nguyen. He asks: Why does the greenhouse gas emission forecast for electricity sector seems to be flat throughout the forecast period? I thought that the RPS should drive the electricity generation greenhouse gas emission downward during this period.

It says as a follow up on the above question: Under worse case scenarios, what would be the increase in peak demand and if significant, EV population are charged during nonoptimal period? What are the required system upgrades needed to support this forecast peak demands?

MR. KONALA: I believe that part of the presentation was from ARB, so Joshua -- Joshua is not here. So.

CHAIR WEISENMILLER: He's not here. Also some of these questions will get into more of overall demand

forecasts looked at on the 15th.

MS. RAITT: Okay. And the last one I have here are: What are the possible impact scenarios of electrification of mobile greenhouse grass emissions on California's electricity system?

What are we doing in our transportation electrification strategies to minimize dispatching fossil-based peaker generations during -- excuse me -- during nonoptimal peak demand periods? For example, significant population of EV are charged.

CHAIR WEISENMILLER: Well, yes, the good news is that actually with the selective vehicles, you have a big impact on air quality. Much bigger impact than the peakers ever would. So yeah, it's something in which certainly encouraged staff follow-up, but it seems the premise is backwards.

MS. RAITT: And then I'd just also just left the staff contact here for anyone who has any follow-up questions.

CHAIR WEISENMILLER: That's good.

MS. RAITT: Oh, excuse me, there's one more.

So we'll go ahead and open the line. Gopal Duleep (phonetic), are you on the line? Go ahead.

MR. DULEEP: I'm sorry, I didn't have a question, I was just on the line.

MR. RAITT: All right. Thank you.

So if we don't have any questions, I think we're done. And just a reminder that written comments are welcome and they're due on December 18th.

CHAIR WEISENMILLER: Go ahead.

COMMISSIONER SCOTT: I did want to just make a closing remark.

MS. RAITT: I'm sorry.

COMMISSIONER SCOTT: No worries, no worries. But you can put the -- when the comment's up are due, I think that would be great.

I just -- I wanted to say really very much thank you to the staff for putting together a great staff draft of this report. I appreciate the clarifications that they added in. We went back and forth quite a bit on something like the mid -- the high, mid, and low demand case because in some examples because it's the electricity, it's backwards from what you're thinking on the fuels and to put, making sure -- backwards isn't quite right. But it's not inherently obvious when you're thinking of the fuels, and so to make some of those clarifications throughout the report.

An acknowledgment of the uncertainties, we recognize that the charging is changing quickly, the ranges are changing, the batteries are changing. And being able

to incorporate that, I think then did a really good job putting that into the scenarios. And there was a lot of thought and care that went into understanding transportation electrification and zero emission vehicles which I very much appreciate.

I very much appreciate our good collaboration with ARB, I'm sorry that Joshua had to go before the end, but I'm make sure to shoot him a quick note and say thank you to him again.

It was really important for us to properly incorporate this mandate and I think working closely together with ARB and our team, we got that done well.

I wanted to say thank you to our Demand Analysis Working Group for assisting us on this. I think on the transportation electrification site, it's a different set of people that typically engage with us on that group.

And with that, since we have our comment period up, I just wanted to note that I would love to hear from some of the OEMs or folks like BYD or for Terra, some of the charging companies to give us additional insight if they were willing on the great work that the staff has done in kind of assessing what the types of models look like, how fast charging is going to change, things like that.

And I think that we have raised the level of robustness on the alternative and renewable fuels up to

where we have it with our conventional fuels and internal combustion engines. And I know that that took a lot of work and so I just wanted to say how much I appreciated that before we -- before we wrapped up. So thank you.

CHAIR WEISENMILLER: No, that's good. Just following up for a second. I think the other thing in the woods is really nice is that particularly thinking that big matrix in your original presentation is again is putting us much more in the position to connect policies and assumption into the outcomes which again, I think we all know forecasting is really difficult, particularly about the future, but the more we can understand the interrelationship between results and policies, the better. Thanks.

COMMISSIONER SCOTT: I'll just jump in and say briefly that this certainly is a challenging set of technologies and policies and market dynamics to get a handle of but getting a handle on forecasting is obviously never easy and never exact and it is helpful. So thanks for your good work on this.

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CHAIR WEISENMILLER: So this meeting is adjourned.

(Whereupon, at 11:36 a.m., the workshop was adjourned)

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

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CER-915

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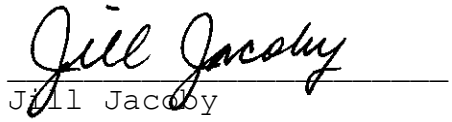

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