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IEPR COMMISSIONER WORKSHOP ON

ELECTRICITY AND NATURAL GAS DEMAND FORECAST FOR 2021-2035

REMOTE VIA ZOOM

THURSDAY, DECEMBER 2, 2021

Session 2: Transportation Forecast and Demand Scenarios Project

2:00 P.M.

Reported by:

Martha Nelson

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P R O C E E D I N G S

2:00 P.M.

THURSDAY, DECEMBER 2, 2021

MS. RAITT: All right. Well, good afternoon and welcome to the 2021 IEPR Commissioner Workshop on the Electricity and Natural Gas Demand Forecast for 2021-2035. I'm Heather Raitt, the Program Manager for the Integrated Energy Policy Report, or the IEPR for short.

The workshop is being held remotely consistent with Assembly Bill 361 to improve and enhance public access to state agency meetings during the COVID-19 pandemic by allowing teleconferencing options. The public can participate consistent with the directions provided in the notice for this workshop.

This is the afternoon and final session. To follow along with today's discussion, the workshop schedule and presentations are available on the Energy Commission's website. Just go to the 2021 IEPR and you can find them there.

All IEPR workshops are recorded, and the recording will be linked to CEC website shortly following the workshop. And a written transcript

will be available in about a month.

Attendees have the opportunity to participate today by two different ways, asking questions or upvoting questions submitted by others through the Zoom Q&A feature, or making comments during the public comment period at the end of the afternoon, or by submitting written comments following the instructions on the meeting notice. And written comments are welcome, and they are due on December 16th.

And with that, I'll be pleased to turn it over to Commissioner Andrew McAllister, who is the Lead Commissioner for the 2021 IEPR.

Go ahead and thank you.

COMMISSIONER MCALLISTER: Thank you, Heather. I really appreciate, again, the morning was great. And I'm looking forward to another couple of great topics this afternoon. And again, thanks for all the diligence by you and your staff and all the different presenters this morning and the ones to come now.

I don’t want to take up too much time, but I just wanted to just kick us off, the two sessions here in the afternoon, Transportation Energy Demand Forecast. And we talked to -- had

some interesting conversation about how this can fit in, sort of in a more integral way, into the rest of the forecasts and the broader transition conversation, which I think is absolutely right.

And we're really fortunate to have Commissioner Monahan, the Lead on Transportation her at the Commission, with us. And I'll give her the microphone for, I'm sure, will be more extensive comments here in a little bit, and Vice Chair Gunda, who is the lead on -- that oversees the Energy Assessments Division, and also the forecast in its entirety, so happy to have both of them again with us on the dais. And I think that's it for Commissioners. I believe so.

So with that, looking forward to the Transportation Demand Forecast, and also the Demand Scenarios Project which is really innovative and I think will help us turn over the right rocks in the right moment and look sort of more with -- over the horizon a little bit further and inform a whole bunch of different work that's happening across the Commission, so really relevant topics.

So with that, I'll pass, I suppose, to Vice Chair Gunda first, and then Commissioner

Monahan.

COMMISSIONER GUNDA: Yeah. Thank you, Commissioner McAllister.

Just want to echo your thanks, again, to the IEPR Team and the entire staff for pulling this workshop together. Yeah, I just really enjoyed this morning's workshop. We don't get a lot of opportunities to just kind of have a discussion like we did this morning. It was just -- it's just really, really good to have those discussions going and wonderful to have that conversation.

Also, I appreciated Commissioner Monahan's kind of overarching comment on, you know, the ability to take the forecasting products, you know, as I was thinking through lunch, you know, taking it from purely planning products to more of policy products, you know, where we can crosswalk them and have the ability to have the speak in multiple, you know, kind of forums and ability to have those policy discussions based on the planning products. So I really appreciated Commissioner Monahan's insights into that, and Commissioner McAllister, your leadership, as always, both the building

space and, broadly, the analytical space.

I'm really, really looking forward to the Transportation Demand Forecast. I know, really, I know the staff have put their heart and soul into improving the Transportation Forecast over the last several years. I think we were in transportation electrification where we are in the building electrification today about five years ago. And there is a lot of thinking that the Transportation Team has done, you know, that could widely be used in the forecasting today.

And also really looking to -- forward to hearing from Mike and Anitha on the progress on the demand scenarios. And I think that's an integral part of what CEC is going to produce as a library of products moving forward for the broader policy considerations in the state.

So with that, I'm going to pass the mike on to Commissioner Monahan.

COMMISSIONER MONAHAN: Well, I, too, really enjoyed the conversation earlier today. I hope we can continue with that level of discourse just to kind of elevate, how do we, you know, develop a new lexicon of terminology that really fits across all the sectors so we don't have

these siloed disciplines anymore? And that's what we're trying to achieve in the state of California.

And I'm, you know, you guys have heard me talk about it but I'm just going to say it again, you know, the progress on transportation electrification is truly global in nature and it's unstoppable. And the question is just how fast?

And what we're trying to do here in California is create the right conditions for transportation electrification to flourish. And I think what we'll see in the Demand Forecast is we've got more work to do to make sure that we can accelerate progress. Because if we don't, I mean, the climate is at stake to have global warming emissions. And while technology is making leaps and bounds of progress, and particularly battery but fuel cell technology is also evolving, we have this opportunity to capitalize on it.

And I'm thrilled by this opportunity. I feel like the new vehicles coming to market, like the Ford F150 that allows us to charge our homes when the power goes out, you know, we talk about

transportation electrification as a distributed energy resource and now we're actually seeing the products that will let us do that.

So looking forward to the presentations this afternoon and to continuing to deepen sort of our analytical work on transportation electrification. I think as Vice Chair Gunda mentioned is how do we move from these Demand Forecasts into the policy realm, or how do we integrate them?

And we have an analysis on charging needs that's dictated by AB 2127 that says you, CEC, analyze what charging needs are needed in order to meet our state goals, which is a very different question than what we're answering here today.

And so, you know, this disconnect, I think, between what the results of AB 2127 tells and what the results of today's analysis, there's room for improvement in ensuring that we have the right policies in place to drive the market transformation that we need.

So with that, I'll stop. Look forward to --

COMMISSIONER MCALLISTER: Yeah. We have

these incredibly bodacious -- audacious cycles. And you know, the forecast making is very grounded in kind of where we have data, and analytically, and kind of in that sense a little conservative; right?

And so this idea of market transformation taking off kind of rapidly is something that's very difficult to include in a forecasting, and so that's where we really get -- where, you know, it would be nice to sort of take an endpoint and see what type of initiatives would be necessary to get to that endpoint, and maybe it was set by policy, so kind of doing a scenario along those lines. And you know, on the building side it's 3232, and all sorts of initiatives on the transportation side.

So I agree, this is a really fertile space to work with Staff and sort of figure out what kinds of products the tools can be used for and what they're most appropriate for; right? Because that won't be all products.

So -- but really, yeah, it's great to have this cross-Commission involvement in this because it's so vital.

COMMISSIONER GUNDA: Yeah.

COMMISSIONER MCALLISTER: And I have to -- I will just say, I have to leave around 3:30 or a little before so, unfortunately, I'll miss that piece of it but will, obviously, watch and get briefed later.

COMMISSIONER GUNDA: Yeah. Thank you, Commissioner McAllister and Commissioner Monahan.

I think, you know, just adding or just kind of emphasizing this for myself, I think an important element has been, you know, the reasonableness of the forecast and how can we use those products for, you know, the transmission planning, and then the potential rate impacts? And how do you ensure that we provide that for the benefit of infrastructure buildout?

But then you have this broader question as, Commissioner Monahan, you and Commissioner McAllister are pointing out, which is, you know, the market transformation needs to occur and we need to understand the gap, and we need to understand, you know, what levers we have to pull and the policy translation required from these products. And I think you would -- I mean, at least from my advantage point, the demand scenarios is getting at that, the demand

scenarios work. And I'd love to hear your feedback today as we go through this.

With that, I'll pass it to Heather to kick off the presentations.

MS. RAITT: Great. Thank you, Commissioners.

So, yes, we'll start out this afternoon with the Transportation Energy Demand Forecast. And we have three presentations from Energy Commission Staff, so we'll hear from Aniss Bahreinian, Jesse Gage, and then Bob McBride. And then after we've all the three presentations, we have a little bit of time for discussion with the dais with the presenters.

So first, go ahead, Aniss Bahreinian. She is the Senior Transportation Forecaster for the Energy Commission, and so go ahead, Aniss. And just a reminder, if you could say next slide, so we know when to advance your slides for you?

MR. BEHREINIAN: Sure. Good afternoon, Commissioners, stakeholders. My name is Aniss Bahreinian and I work in the Transportation Energy Forecasting Unit. And I will be presenting the total transportation energy demand today.

Next slide, please.

As Heidi Javanbakht showed this morning the general outlines of our scenarios and showed energy rate, in transportation we have multiple fuel types, as many of you know, and multiple fuel prices are being used. Notice here that our Transportation Electricity Forecast is integrated into Total Electricity Demand Forecast and, therefore, we should be using the same inputs as the Demand Forecasting Unit does. That is why our population and income are exactly the same as what is used in the Demand Forecasting Unit for consistency.

But if you look at the two columns on the left, you will see that we have two sets of prices. And each set, actually, has multiple prices. We have petroleum fuel prices that includes gasoline, diesel, E85, and jet fuel. And then on the righthand side we have electricity, natural gas, and hydrogen prices. We are grouping it into these two categories.

And for the high demand case, what we do, we use the high income and the high population but, also, we are using the high petroleum fuel prices, that is high gasoline, diesel, and E85

and jet fuel prices, and combine that with low electricity and hydrogen prices. The reason for that is that we want to generate the maximum ZEV Forecast so that it provides us with highest Transportation Electricity Demand Forecast so that it is integrated into the total Electricity Demand Forecast in the high case.

In the low demand case, we do the opposite of that. We are combining the low population and income with low petroleum fuels prices. The lower are the petroleum fuel prices, then the lower will be the demand for electricity because there will be fewer electric vehicles on the road, and we combine that with high electricity and hydrogen prices.

Why do we do this? Because they're a substitution. And our models, particularly the light-duty vehicle demand models, they represent about seven fuel types and electricity is only one of those seven fuel types. And the model accounts for substitution between different fuel types.

So Commissioner Monahan promptly noted the substitution and the similarities between additional advanced fuel substitution and what we

are doing in transportation. The models are designed to capture the substitutions between different fuel types, including fossil fuels, but it also accounts for the substitution between different ZEV fuel types. If you have a consumer who has higher preferences and buys an electric vehicle, that means that that consumer is not buying an FCV (phonetic), and not buying a diesel vehicle or a gasoline vehicle. There is substitution that is working here and we are accounting for all of that substitution.

So the transportation energy demand cases are designed around transportation electricity demand. However, we are accounting for and we are forecasting all of the different fuel types as you can see in the appendix. We are also forecasting all of the different fuel type prices as, again, you can see in the appendix.

Next, please.

We're going to start by looking at 2020, where we are right now. These two graphs are showing the distribution of transportation energy by sector and by fuel type. You can see on the graph in the left-hand side, distribution by sector, that about 65 percent of transportation

energy is used by light-duty vehicles in 2020. That is followed by 16 percent for medium- and heavy-duty vehicles, and about 14 percent by aviation.

When you look at the graphs on the righthand side you will see that very consistent with the light-duty vehicles. Since light-duty vehicles mostly are using gasoline, we could see that gasoline consumption is also about 65 percent of total transportation fuels, followed again by diesel, which is used by medium- and heavy-duty vehicles, and jet fuel which is used for aviation.

The little pie chart on the right shows the electricity. And as you can see, electricity in 2020 has about half a percent of total transportation energy. But if you move to the next slide, please, we can see the changes between 2020 and 2035. I only picked three of the sectors, light-duty vehicles, medium- and heavy-duty vehicles, and rail. In the other picture, you also saw the -- in the previous graph, you also saw off-road and aviation. But in these two graphs we are just focusing on these three sectors.

In 2020, as you can see on the graph on the left-hand side, we had about 13.5 billion GGE -- and we have converted everything, by the way, to GGE so that we could put them next to each other -- is used by LDV. And, clearly, you can see that gasoline is dominating the light-duty vehicles. Diesel, on the other hand, is dominating the medium- and heavy-duty vehicles. And you can see that both in 2020 and in 2035, that is the case.

So by 2035 in the high case, we can see, still, gasoline is dominating light-duty vehicles and diesel is dominating medium- and heavy-duty vehicles. And, of course, there is rail that is using only diesel.

But if you note on the graph on the righthand side, you can clearly see that the role of diesel is declining in light-duty vehicles. And the scales look the same but if you pay attention to the numbers you are going to see that there is actually a decline in gasoline consumption for LDVs and, at the same time, there is an increase in electricity demand for light-duty vehicles.

You can see the same behavior for medium-

and heavy-duty vehicles. You can see a little bit more electricity in the medium- and heavy-duty sector, and you can see that gasoline demand is going down, although diesel seems to be steady there.

When it comes to rail, rail is growing. And notice that the electricity that is shown here for rail includes what is used for light rail, as well as heavy rail. And, of course, it also includes, in 2035 at last, it is including the high-speed rail, as well.

If you can move to the next graph, please?

So what we see here is actually responding to what Commissioner Monahan pointed out in the morning, that higher electrification does lower the energy intensity of transportation.

On the graph on the left-hand side we will see total transportation energy demand in Btu which shows, more or less, steady, although if you look at the high case, which is the green line to the top, you could see a small decline in total transportation energy measured in Btu.

But if you look at the graph on the

righthand side you can clearly see that there is a decline in energy intensity of a mile traveled, which is mostly due to higher electrification, as pointed out this morning by Commissioner Monahan, but it also improves fuel economy.

Now this is happening because at the same time that transportation energy demand is remaining, more or less, steady in terms of Btu, the total VMT, as will be shown later in the presentation by my colleague Bob McBride, total VMT is increasing, which is why we are seeing the decline in transportation energy per mile or energy intensity of a mile traveled.

Next slide, please.

This graph shows Total Transportation Electricity Demand Forecast. Again, it includes light-duty vehicles. It includes medium- and heavy-duty vehicles. It includes light rail. It includes heavy rail. It includes, also, the high-speed rail. So when we are looking at total transportation electricity demand we can see that it is increasing from about 5,000 gigawatt hours in 2021 to a minimum of 20,000 gigawatt hours in 2035, in the low case, and it can go as high as 45,000 or 47,000 gigawatt hours in 2035 in the

high case.

So there is actually an equivalent of a fourfold increase even in the low case. And it is about ninefold increase in the high case. So clearly, we can see that electricity is gaining grounds in transportation energy in California.

If you can move to the next slide, please?

Now this is hydrogen. And what we should point out, that our transportation hydrogen demand is only reflecting hydrogen for light-duty vehicles and for medium- and heavy-duty vehicles.

We know, for instance, that in Germany, they are about to, or perhaps they have already started, operating hydrogen rail. And we also know that airbus is increasingly confident about their hydrogen planes to be coming to the market in about 2035.

But in our Transportation Hydrogen Demand Forecast, we do not include anything for rail or -- for rail or for aviation in California yet. Maybe next year we will do that but not in this forecast. So it is only representing Hydrogen Demand Forecast, including light-duty vehicles, as well as medium- and heavy-duty vehicles.

You can see that even in the low case, we are seeing some increase from about 2 million kilograms of hydrogen to about 20 million kilogram of hydrogen in the low case. And in the high case it is moving from, again, 2 million in about 2021 to about 190 million kilogram of hydrogen in 2035. So there is an increase. It is not as much as we have in electricity but, still, we are seeing growth in hydrogen demand in California.

If you can move to the next one?

And this graph is showing Transportation Natural Gas Demand Forecast. And if you note here, transportation natural gas demand continues to grow to 2025, and after that it starts going down. Again, it is the substitution at work here. The reason for the decline that we see in the later part of the forecast is that these are -- EVs are increasingly replacing natural gas, both in public transit, but also in refuse trucks and elsewhere.

So transportation natural gas, we don't use it in light-duty vehicle at all. It is all medium- and heavy-duty vehicles, whether they are buses or trucks, we are only seeing it there. So

for the first few years, through 2025, we see that the force of economic growth pushes transportation natural gas demand higher. But after that, it starts declining again due to the substitution that takes place between different fuel types.

Please note that all of our Transportation Energy Demand Forecasts, they only -- they do not include fuel use by military. It also doesn't reflect fuel use for marine movement. So those two sectors are excluded from our forecast. So anyone who is looking at this and is planning to use them, please keep that in mind, that we do not include military and we do not include marine movement in our transportation, not yet anyway, maybe later on. But we do include all of the government vehicles whether they are local, state, or federal that are on the roads in California, but those are usually civilian forces, not military.

If you can move to the next slide, please?

I'm presenting this Transportation Energy Demand Forecast but we really have a very strong team of forecasters who are generating these

different forecasts in different sectors and for different purposes, whether it is fuel prices that are generated by Ysbrand van der Werf. Mark Palmere and Elizabeth Pham worked on attributes. And at the same time, they also worked on light-duty vehicles. Bob McBride and Alex Lonsdale worked on medium- and heavy-duty vehicles, as well as EV load shape. And Jesse Gage is our leading expert on DMV data but he also, in this year, he also generated a lot of the LDV forecast. And I am just one of those.

Thank you very much. And if you have any questions, I'll be happy to answer it now or later.

MS. RAITT: Great. Thank you so much, Aniss.

So next up is Jesse Gage.

Go ahead, Jesse.

MR. GAGE: Thank you, Heather.

As Heather has mentioned, I'll be covering the light-duty stock portion of our Transportation Forecast with a focus on zero-emission vehicles. We'll start with a very quick overview of the various scenarios as we're looking at the ZEV forecast as a whole and seeing

how it stacks up with official policy. Then we will break it down by fuel type.

Unfortunately, I won't have time to cover anything but the top-level results here, thus some additional supplies slides on vehicle classes and battery classes have been relegated to an appendix which can be seen at the end of the main deck if you download the PowerPoint.

Those of you who have followed our Transportation Forecast over the year have seen Aniss present this overview of our inputs probably nine, ten times over the years, so I'll spare you the gory details this time.

But briefly, our three core scenarios, the low, the mid, the high, and our two, shall we say, what-ifs, the aggressive and bookend, cater to increased adoption of the zero-emission vehicles through greater customer acceptance and preference for ZEVs, increased incentives, both in dollar amount and availability, and advancements in technology favorable to ZEVs, in particular, battery price and vehicle range.

Note that the core scenarios are what go into the overall Electricity Forecast. The aggressive and the bookend, they're sort of an

extra thing.

Next slide, please.

So let's start with overall ZEV stock which, in the core scenarios, range from 3.1 million in our low scenario to 8.3 million in our high case in 2035, with the mid scenario at 5.4 million. The year-over-year growth is approximately 9.5 percent, 14 percent, and 17 percent in the low, mid, and high scenarios, respectively. Meanwhile, the aggressive scenario reaches about 12.5 million in 2035. And the bookend ends just shy of 13 million.

Next slide, please.

So how do these scenarios stack up against the various policy bills over the years?

As a refresher, there are three major executive orders looking to shape zero-emission vehicle sales. Former Governor Jerry Brown signed Executive Order B-16-2021 in 2016 which called for 1.5 million ZEVs on the road by 2025. Governor Brown then set a significantly more ambitious goal two years later, this time targeting 5 million ZEVs by 2030 as part of Executive Order B-48-18.

Most recently, under our current Governor

Gavin Newsom pulled out the big gun, Executive Order N-79-20 with the goal of eliminating light-duty internal combustion engine sales entirely by 2035. Now that executive order doesn't come with a hard target of how many ZEVs need to be sold by the end. But just in case 5 million wasn't ambitious enough for you, ARB's Mobile Source Strategy suggests we'll have 7.8 million ZEVs by 2030 if we're to meet that executive order. And we've also seen 13 million by 2035 bantered about as a target.

In this table, we have total ZEV for our five scenarios at these policy milestones. The first row, 1.5 million by 2025 is, at this point, frankly, pretty hard to miss, almost a formality. And even our low case hits the mark. And that's borne out by current data. According to our ZEVs stats data portal, and if you don't know what this portal is, please see me after class, there were about 630,000 ZEVs on the road at the end of 2020. And we're on track for a quarter million ZEVs sold this year. So even if there was zero growth in sales, we'd still hit over 100 -- 1.5 million in four years.

Five million ZEVs by 2030, however,

that's a taller order. And we see here that business-as-usual isn't going to get us there. That said, it's not completely unthinkable as long as we're willing to increase our efforts to increase ZEV adoption. Otherwise, this goal could be delayed by five years, or even longer, if things start to slack.

As for 8 million in 2030, 13 million in 2035, that's a lot. Even our bookend case falls a little short here, suggesting that we need a significant change in how we do business to even come close.

Next slide, please.

As we start to break down the ZEV Forecast by fuel, the forecast scenarios for battery electrics do not terribly dissimilar from total stock at first glance. The core scenarios see a range of just under 2 million to 5.5 million by 2035. And the aggressive and bookend cases are neck and neck at about 10 million each. The average year-over-year growth is slightly higher than the total ZEV stock in each scenario.

Next slide.

The Plug-in Hybrid Forecast is where we start seeing large diversions from the forecast

as a whole. Uptake of PHEVs is nowhere near as robust as with BEVs in any scenario. And, in fact, the bookend and aggressive scenarios have fewer PHEVs than the high case. This is due to PHEVs being outcompeted by BEVs due to lower battery costs, higher range, and greater incentives.

Next slide, please.

For the last piece of ZEV stock picture, the forecast for hydrogen fuel cell electric vehicles are -- they're sensitive beasts. At the present time there are only two FCEVs on the new car market, Toyota's Mirai and Hyundai's Nexo with the Honda Clarity Fuel Cell being discontinued last year. This is not terribly great for encouraging adoption of FCEVs. And getting this segment up to speed is going to require manufactures to step up and develop more models in the light-duty segment. And so far, automakers, especially in Europe and America, are not keen to bite.

Our forecasts range from 100,000 to 450,000 FCEVs by 2035 with the bookend scenario, in particular, assuming greater availability of FCEVs across the market segments.

Next slide, please.

Finally, I wanted to stack these forecasts together to get the relative market share of ZEV and PHEV technologies. Increasingly favorable range and battery prices throughout our scenarios will ensure that battery electrics solidly outsell PHEVs regardless, as they are doing now, but this is amplified in the aggressive and bookend cases with their much lower battery prices. Meanwhile, the FCEV market will remain rather niche, barring significant changes at the manufacturer end and consumer levels, as I had mentioned.

And with that, that's all I've got, and I can hand it over to Bob.

MS. RAITT: Thanks Jesse.

So, Bob, if you wanted to go ahead and present on rate? Thanks.

MR. MCBRIDE: Here I am. Can you hear me?

MS. RAITT: Yes. Thanks.

MR. MCBRIDE: Yeah.

MS. RAITT: Go ahead.

MR. MCBRIDE: Okay. Scroll back. Hi. Good afternoon, Commissioners, stakeholders,

fellow staff, colleagues from our sibling agencies. I'm Bob McBride and I lead the Medium- and Heavy-Duty Vehicle Energy Demand forecasting, the topic of this presentation.

Next slide, please.

Today, I'll talk about work to improve our identification of truck, bus, and motorhome body types, just so we can assign vehicles to the right classes. Changes to the Air Resources Board Hybrid and Zero-Emission Truck and Bus Voucher Incentive Program, which we will now call HVIP, a summary of key inputs and assumptions for the truck choice forecast, a closer look at the market penetration for ZEVs and NZEVs among the drayage trucks. We'll look at new trucks purchased overall and, again, at ZEV and NZEV and internal combustion vehicle stock forecasts.

Two glossary terms here. ZEVs, for purposes of this presentation, include battery-electric vehicles and hydrogen fuel cell electric vehicles. And I refer to plug-in hybrids interchangeably as PHEV and NZEV, or near ZEV. Last, a peak at total energy use and vehicle miles. Other forecast components, like growth and goods movement and the economy in general,

are handled using the same methods are recent IEPR forecasts.

One note. The assumptions built into light-duty vehicle choice and truck choice are slightly different. In the medium- and heavy-duty side we have a regulation, Advance Clean Trucks, which we bake in compliance through 2035 in all three cases, so that's slightly different.

Next slide, please.

In February, CARB released a new Emission Factors Model, EMFAC 2021, and associated web database that changed how trucks are classified. The weight classes were broken out in more detail and some new categories introduced to capture improved assessments of drive cycles over the current -- over the previous classes.

Also, we now have access to the Data One VIN decoding table data, which is proprietary data we purchased. We're showing truck-related body types here, but bus and motorhome body types are also covered in all three sources. We mapped body types to the EMFAC categories and fuel types to the DMV data. We've cleared out more unknown and ambiguous body types.

Next slide, please.

The HVIP Program simplified their system for setting up voucher amounts. Yay. Easier for us. So now all trucks and buses in a given weight class receive the same amount up to $120,000 for Class 8 and less for lighter vehicles. One exception is port drayage trucks targeted to be 100 percent ZEV rolling stock by 2035 in the proposed Advanced Clean Fleets regulation. These will receive $150,000.

We're holding the flat rates constant to 2024, then reducing the voucher amounts in two ways thereafter. First, after 2024, vouchers are assumed to start from 65 percent of the 2021 amount for all of our cases, low, mid, and high. Second, we scaled the ZEV of NZEV voucher amount, even the -- this applies, also, to the Carl Memorial grants for low NOx.

The amount in each class, according to the trend in the incremental purchase prices which is the price of the vehicle relative to some default fuel, usually diesel for heavy-duty and gasoline for medium-duty, we arrived at 65 percent as the lowest percentage, helping all three cases have met compliance with the Advanced Clean Trucks regulation.

Next slide, please.

Here's a high-level description of some key inputs. We've baked in a number of regulations, including Innovative Clean Transit, Advanced Clean Trucks, the Zero-Emission Airport Shuttle regulation, and the Regional Truck and Bus regulations in the South Coast AQMD. The HVIP incentive vouchers for ZEVs and NZEVs, or PHEVs, and Carl Moyer Program grants for low NOx are included.

Beyond what I described on the previous slide, we made a simplifying assumption about Carl Moyer Program grants for the low NOx drive train (phonetic) since the grants depend on the vehicle miles of the vehicles being retired, and we haven't modeled that until now. Not so simple.

Hydrogen pricing was forecasted by the National Renewable Energy Lab based on runs from a couple of their models using inputs our Unit is provided. We're using electricity price forecasts for commercial users developed in our office for the California Electricity Demand Forecast. Battery pack prices drives the lion's share of decreases in the purchase price of

battery electric trucks, so we used a consultant, ICF, to develop low, mid, and high trends in battery pack prices.

The resulting trajectory is actually really similar to our own internal Battery Pack Price Forecast we did for light-duty vehicles but with a five-year lag. The five-year lag is evident in the pricing difference between models of battery electric vehicles that have optional larger battery packs offered today.

On a related note, to estimate hydrogen fuel cell electric trucks purchase prices, we used data from the ARB Advanced Clean Fleet's discussion copy. We simplified vehicle fuel economy to a single case based on EMFAC 2021 data. We found that using three cases for fuel economy confounded the case-by-case trend in market shares and fuel types and all the cases crossed, and it's much clearer this way.

For this IEPR, we assumed that the range of battery electric trucks does not preclude applications in longer drive cycles. The truck classes adopting battery electric trucks early in the forecast tend to be depot-based fleets that will have access to overnight charging. The

exception here is drayage trucks are assumed to first populate the shorter drive cycles. Later in the forecast we assume available charging away from depots at railyards and warehouses.

Next slide, please.

Now we turn to the forecast results.

Next slide.

We can't get away in any forecast without one crazy graph, so here we are. The choice model produced this pattern of ZEV and NZEV adoption across the three cases. Until 2030, battery electric adoption is about two years ahead.

Oh, and by the way, the solid line is the mid case. The big dashes are the low -- the high case. It doesn't show up so well in the legend. And the short, dashed lines are the low case. Red is electric, blue is hydrogen, black is PHEV diesel, which we have.

Until 2030, battery electric adoption is about two years ahead of hydrogen fuel cell electric, reflecting the earlier availability of these trucks. After 2030 the PHEV climbs to about 20 percent share, gradually, which reduces the market share of both the battery electric and

the hydrogen fuel cell electric in that period. Since we're looking at two different plug-in types and both show a significant gap between low and high case market penetration, the range of expected charging demand will also be significant.

I've lost my video but I can still continue as long as I'm being heard, so I will.

So next slide, please. I'll assume we're on slide eight unless somebody speaks up, so I'm sort of flying blind but I think we can do this.

Vehicle miles traveled --

MS. RAITT: It says, "Truck and Total MD." Sorry.

MR. MCBRIDE: What's that?

MS. RAITT: I'm sorry.

MR. MCBRIDE: So you --

MS. RAITT: I was just going to tell you --

MR. MCBRIDE: The --

MS. RAITT: -- I was going to tell you, it says, "Truck and Total MD-Heavy Duty Miles -- Vehicle Miles."

MR. MCBRIDE: Yes, so slide eight.

MS. RAITT: I'm sorry to interrupt. Go

ahead.

MR. MCBRIDE: Yes. No, that's good. Thanks.

Vehicle miles traveled, they're VMTs, through the indicator of fuel use, here we show truck VMT with dashed line between 21.8 and 22.3 billion this year, and the total for medium and heavy VMT includes buses and motorhomes, and the solid lines at about 23 to 23.5 billion this year. Demand for goods movement and general services drives growth and VMT in the trucks, and just the growth in the economy drives motorhomes and buses, variation between cases arises from differences in our econ demo dataset. There, I got my video back. Yay. We expect somewhere between 14 percent and 30 percent higher VMT in 2035 compared to 2021.

So next slide, please. Thank you.

To satisfy the demand for VMT, new trucks are purchased and used trucks imported at the same time older times retire and leave California. This is also true for buses and motorhomes. I don't know about the used motorhomes being imported but I do know about the trucks.

In 2021 we have been about 930,000 or 940,000 trucks and about 1.1 million total medium and heavy vehicles. By 2035, between 1.2 million and 1.36 million trucks, and 1.37 million and 1.51 million total medium and heavy vehicles are expected on California roads.

Next slide, please.

In 2021 we estimate 21,000 to 26,000 new trucks will be purchased, rising to between 52,000 and 64,000 as approach 2035. Before 2024 the number of new trucks purchased is clearly lower than would seem normal considering the annual VMT at normal retirements.

But driving the shortfall is the CARB truck rules requiring trucks -- statewide truck rules requiring trucks without diesel particulate filters and selective catalytic reduction to retire or leave the state by 2023.

In anticipation of this requirement, fleets are importing trucks built since 2010 that have the required equipment. Larger interstate fleets will tend to rotate newer trucks into the state and older ones out. The smaller pool of new trucks purchased, given the market share, will slow the transition to ZEV somewhat in the

next couple of years. But the ZEVs and the NZEVs, PHEVs purchased before 2024 will enjoy a bonus increment to the Advanced Clean Truck Credits they earn, so that should counteract the used truck phenomenon somewhat.

Next slide, please.

Here we see two cases, the mid and high, for the on-road stock of ZEV and NZEV truck and buses stock throughout time. I said stock twice, yes. The earlier introduction of battery electric models and the fact that we do not yet see hydrogen fuel cell electric in as many truck classes together point to a huge numerical advantage to the battery electric, as you can see. But recall that the share of battery electric and hydrogen fuel cell electric drayage trucks is anticipated to be roughly equal around 2035, so dilemma.

Also note that about half the fuel consumed by trucks is in the tractor-trailer or semi-tractor classes, it's the same two terms for the same thing, the big trucks, so the 18-wheelers, well, so while medium duty trucks and heavy-duty straight trucks go primarily to battery electric, the semi-tractors are more

evenly divided between battery and hydrogen electric.

Finally, note that the gap between the mid and high cases for battery electric is much smaller than the same gap for hydrogen fuel cell electric, so this is 2035, the right side. While the total number of ZEV trucks increases significantly in the high case over mid, the gap between mid and high case for battery electric is far smaller. Even though battery electric has more favorable conditions in the high case than it does in the mid case, the competition from hydrogen is stronger in the high case.

Slide 12. Next slide, please. Goodie.

Here we see the total of internal combustion truck stock, incl gasoline, diesel, natural gas, propane, and both gasoline and diesel hybrids. Numbers rise through 2026 between three and nine percent depending on the case. From 2027 to 2031 the internal combustion trucks counts are fairly flat, despite the growth in the demand for VMT and rising total truck stock. After 2031, we expect the ICE truck counts to decline due to retirement and the increasing shares for ZEVs and NZEVs.

If you could please go back to slide eight for a minute? Is that eight? I guess. Here's a -- I think it's a little -- maybe it's farther back. The numbers may have changed. What we want is the total stock. Well, that's all right. Let's just leave that be. There it is.

So we see a reminder of the growth in total medium and heavy-duty stock, so plant those slopes in your mind.

Now go to slide 13, or the next one from where we were. Yeah, there we go.

Overall, energy consumption in medium and heavy vehicles declines to 2035. Two factors drive this.

First, internal combustion engines become more efficient, at least through 2027, due to the NHTSA EPA Phase 2 Fuel and GHG Standards which were still in place.

Second, the ZEV and NZEV fuel types appearing later in the forecast appearing later in the forecast are considerably more efficient, even before we consider carbon intensity of fuels. This decline means it will progress towards GHG goals simply on the basis of total

energy consumption, not of actually the carbon intensity of the fuels involved, which is the major improvement.

Slide 14. Next slide, please. Sorry. And your numbers are different, so I should stop doing that.

We're calling battery electric plus hydrogen fuel cell electric VMT here the clean miles. For this slide, we don't include the portion of all electric miles for the PHEVs just because it's a little problematic to do that. The metric was suggested by a focus group of stakeholders in an Air Resources Board project, so we thought we'd provide these trends, the data is close at hand. We anticipate medium and heavy-duty clean miles reaching between 4.5 and 7 billion by 2035.

Next slide, please.

Thank you for your kind attention. This work is expanded in scope over the last few years. Since -- with the help of Alex Lonsdale, we've increased our capability as a team, also significant assistance from Jesse Gage in the Truck Classification Department.

And with that, I don't know who we hand

it over to.

MS. RAITT: Thanks Bob. So, yeah, we have some time for conversation with the Commissioner.

COMMISSIONER GUNDA: Yeah. Commissioner McAllister, were you going to speak? Please. You're muted, I believe.

MS. RAITT: Commissioner McAllister, I think you were double muted and now you're just -- your computer might be muted, so -- oh, you're still double muted. Oh, well. Sorry.

COMMISSIONER GUNDA: All right. We're going to get started, Commissioner, and then maybe you can chime in?

So, yeah, I mean, how about we just pass it to Commissioner Monahan first and kind of get her thoughts?

COMMISSIONER MONAHAN: Well, thanks, Aniss, Bob, Jesse, and the whole team. Heidi, I know, has done a lot of work before she left, and now Quintin is helping with this work, and it really has evolved with time. And I just appreciate the syncing that's gone on with the entire team of folks working on this issue.

I do have some questions. And Aniss, I

hope you can come back on because there were some -- this is the first time I've seen -- and I'm sorry, my dog is just -- I've been trying to get her to stop barking and she just loves to bark right when meetings start. But the slide on the actual energy use in the 2035 high case, it's hard to read because I think the scale is so small for electricity. I was actually surprised that the scale was so small for electricity and I'm trying to figure out why that is on the light duty front.

You know, it looked like in the high case we were talking, I think it was 12 million. Is that right, Jesse, 12 million by 2035 on the light duty?

MR. GAGE: Somewhere around there.

COMMISSIONER MONAHAN: Somewhere thereabouts. Thereabouts. So 12 million, right. We currently have about 30 million light duty vehicles.

MR. GAGE: Yeah. That was the aggressive bookend. I think that --

MR. MCBRIDE: I think 19 for the high.

MR. GAGE: -- the high case was about 8 --

COMMISSIONER MONAHAN: Eight million?

MR. GAGE: -- 8 million.

COMMISSIONER MONAHAN: Oh, maybe it was 8 million. So right now we have about 30 million passenger vehicles. I didn't see a slide. And Jesse, maybe you just know this. What is the -- are we like -- you know, there's some that have said we have saturated the passenger vehicle market. There's other that are indicating, well, no, there's still room for growth. What does our model say in terms of 2035, like what's the passenger vehicle fleet in 2035? So what share would 8 million vehicles be of the 20?

MR. GAGE: Well, if I may consult my crystal spreadsheet here? We have a table. Give me a second here.

COMMISSIONER MONAHAN: Um-hmm. Take your time.

COMMISSIONER GUNDA: There is a slide that shows bar charts with the percentages. Would that be helpful to bring up, Jesse?

MR. GAGE: No, that was a stacked chart of just the ZEVs themselves.

COMMISSIONER MONAHAN: Yeah, those are the ZEVs. So, well, but anyway, my point is, and

maybe we could talk, we could think about this at a later point, too, is that -- and it's hard to tell from the scale. But if, you know, 8 million, if it were the current fleet, that would be, you know, like --

MR. GAGE: That's out of a predicted --

COMMISSIONER MONAHAN: -- more than a third -- a little less than a third of the whole fleet. And so if a third-ish, maybe 25 percent, of the fleet went to battery electric vehicles, it seems like the energy would be higher than what was showing up on that graph. That's what surprised me, that it was so low, but it's hard to tell because the graph -- I'm just looking at the graph on the screen and it's hard to tell, actually, what the value is --

MR. GAGE: Yeah.

COMMISSIONER MONAHAN: -- on that --

MR. GAGE: It's 8 million --

COMMISSIONER MONAHAN: -- (indiscernible).

MR. GAGE: -- 8 million out of 38 million.

COMMISSIONER MONAHAN: Out of 38 million? Okay. All right. So you can look at, you know,

25-ish percent. But that means that we should be seeing the 25 percent-ish switch from diesel to electric. So it's just something, maybe, we could -- we could talk about this offline just so I can understand how the numbers align.

Sometimes it can be hard to tell when you're looking at just a graph on a computer, but it did seem like the wedges were pretty tiny for electricity and I was like, why are they so tiny in 2035 in the high case? It seems like they should be higher than that.

Of course, as we talk about it, EVs are more efficient, so it's about a third less energy -- I mean two-thirds less energy compared to gasoline and maybe that why. But maybe there's some way we could demonstrate in a graph like what would be the energy use in the high case if those vehicles were, instead, just internal combustion. I think that would give us a visual for what the actual like shift is away from diesel -- I mean away from gasoline and diesel towards electric.

MS. BAHREINIAN: I think you're referring to the petroleum reduction as a result of adoption of electric vehicles. And we can come

up with some kind of back-of-the-envelope computation for that. The model, currently, doesn't have that as an output, but we can do some kind of post processing and come up with a number that would reflect what energy consumption would have been if this was all petroleum, if these were all ICE vehicles.

COMMISSIONER MONAHAN: Yeah, I think that will -- because, otherwise, you look at these charts and you're like, gosh, all this work and we're barely making a dent, you know? So I think I we are making a big dent, so let's figure out a way to visualize that progress.

MS. BAHREINIAN: Sure.

COMMISSIONER MONAHAN: And I also had a couple questions for you, Bob, around those diesel PHEVs, which surprised me that they were competing so well. They're very expensive. PHEVs are expensive which is why, in the light duty market, one would think they would go down, and that's what we're seeing, because they're way more expensive. And they actually take away some of the benefits of the electric drive. Why is that different in drayage? What makes drayage so special?

MR. MCBRIDE: So I actually had the same question last night and looked, drilled into the model, which separates groups of trucks by bins of vehicle miles. So there's one for zero to 20,000 miles, 20,000 to 40,000, and so on. And when you get out in the 30,000s the cheapest vehicle is actually hydrogen if they have that, and then electric, and then the PHEV is the most expensive. So they don't show up until the highest mileage bin.

So if there's a drayage truck going 140,000 a year, they're going to have a higher fraction of PHEVs because, one, I mean, that ended up serendipitously because that means they're a lot of miles per day, so there would be charging issues, but PHEV gets around those as well.

Yeah, I did -- they were not doing well with any of the normal conception of vehicle miles. You had to -- it was the set of ones that went, say, over 60,000 to 80,000 miles a year and up, they showed up there. Yeah, that was -- that's pretty interesting stuff.

And the caveat is we don't even have a good -- we don't have any HVIP offerings of PHEV

trucks yet. There aren't really on the road, so the estimate of what the fuel economy of those things and what they're actually going to cost are a little wonky, or I would expect them to be a little wonky, so grain of salt. But --

COMMISSIONER MONAHAN: Yeah. I think --

MR. MCBRIDE: -- I think that the right pattern.

COMMISSIONER MONAHAN: -- I think we should take a grain of salt on that one, actually, because it's counterintuitive.

MR. MCBRIDE: Yeah. I --

COMMISSIONER MONAHAN: I have a hard time imagining why they would, and especially that set.

MR. MCBRIDE: Yeah. Sure.

COMMISSIONER MONAHAN: So --

MR. MCBRIDE: If you think back where we were, say four years ago, where we were seeing battery electric succeed was in the same case, the really high mileage vehicles.

COMMISSIONER MONAHAN: Yeah.

MR. MCBRIDE: So that's -- that much is sensible. Whether the prices are realistic of not, that's another question.

COMMISSIONER MONAHAN: Yeah.

MR. MCBRIDE: And nobody is going to be able to answer that right away. Somebody has to build a few of these things.

COMMISSIONER MONAHAN: Yeah. And, also, we're in the state of, I mean, so much transition happening on technology generally, battery tec. I mean, I'd be surprised if we didn't see solid state by 2028. So these, I'm just saying, I mean, there's -- that there could be like some game-stuff changer battery technologies around the corner that could really change the equation when it comes to the analysis that we do.

MR. MCBRIDE: Yeah, the solid-state batteries and such.

COMMISSIONER MONAHAN: Yeah.

And also, I mean, when we look at what Jesse's tracker shows, which it stays near and dear to my heart, you know, we're in this phase right now.

MR. GAGE: It's a team effort. It's a team effort.

COMMISSIONER MONAHAN: All right. Well, to the whole team, it's awesome and we're going to keep building it out. But it shows more of

this, you know, this kind of curve rather than what -- than this curve. And we'll see if we can get a nonlinear. I mean, I think infrastructure will be the biggest barrier to that.

I'm done with my questions. Vice Chair Gunda or Commissioner McAllister?

COMMISSIONER GUNDA: Yes. Thanks Commissioner. Just a couple of kind of high-level questions.

So I think same kind of track of question that we talked this morning, the large infrastructure budget that we had, you know, kind of how were we considering the impacts of the kind of ZEV package that we had last year in kind of the forecasting, I mean, like where are we seeing those?

And then second thing is, you know, on the electricity supply side, that the best projects, especially the best projects, we are talking about a large amount of global supply change delays on the battery side. I just wanted to get, you know, thoughts from the staff, if you're tracking how the supply chain on either the chips or, you know, potentially the battery systems themselves could affect the overall dance

kind of good.

MR. MCBRIDE: I have a little bit of information since I'm in the market for a used truck, a used car for my daughter. They're expected to be difficulties with the supply chain into 2023 anyway, so that's a real issue. And it's definitely still very strong. Used prices have not come down. And that means that new cars aren't available, but that's pretty anecdotal.

COMMISSIONER GUNDA: Go ahead, Aniss.

MS. BAHREINIAN: What -- sure. I think it was during the -- it was an assumption that, at that point, I was looking at the prices, and used vehicle prices. And at that time, the prices have gone up by about 45 percent, those were the used prices. I don't know what it is now. At that time I was looking at those prices.

But when we were generating the forecast, for the most part the assumption was that supply chain is a temporary phenomenon, and so the prices that we have included are really prices that are sort of ignoring these or they came out before all of these. They don't necessarily reflect it.

However, what I can say is that when it

comes to, definitely, when it comes to light duty vehicles, what matters is the relative prices. So even if all the prices of used vehicles and all the new vehicle prices have gone up, if the relative price of electricity -- electric vehicles compared to gasoline vehicles remain the same it doesn't have too much of an impact on our forecast because of the way the model works.

So it is the relative prices that matter more or the same as the absolute prices. If all prices are going up by the same percentage, then the relative prices would remain the same and it wouldn't have too much of an impact in the choice of the vehicles.

Now whether or not people are going to be able to buy vehicles, that would depend on where the prices are because if your income does not go up but the price of the vehicle goes up, then the number of vehicles sold on the market is going to be going down.

So we haven't really incorporated the supply chain impact on prices into the forecast.

COMMISSIONER GUNDA: Thank you. Thank you, Aniss.

Again, I just want to take the

opportunity, Aniss, Jesse and Bob, and then entire team, Alex, thanks so much for all the work.

If I can have just one additional question on the preferences?

When is the last time -- what's the latest data on the preferences we have for the light duty? I mean, I see that for the low side we're using the consumer preferences from 2017. And then for mid, high, aggressive, and bookend, we increase that with the growth. I just wanted to check in, you know, what's the latest vintage of data we have on the preferences?

MS. BAHREINIAN: We don't -- I can share that data with you later. But at the present time, when we are keeping the preferences constant, we are -- whether it is the new ones or the old ones, we continue to keep them constant for the low case, assuming that people are not going to gain greater preferences for ZEVs. And we only, as you know, you know very well, we don't change that for other vehicles, only for ZEVs. But in the high case the higher is the market share. These vehicles preferences keep growing with the market share.

COMMISSIONER GUNDA: So thank you. I know we can dig into this a lot but, you know, really nice to see the forecasting team transportation going to get to talk to you one of these days, so great.

MS. BAHREINIAN: (Indiscernible.)

COMMISSIONER GUNDA: To Commissioner McAllister.

MR. COLDWELL: Hey, Vice Chair Gunda, can I just -- I mean, part of your -- one of your questions didn't -- wasn't addressed about the infrastructure package and how that's reflected.

So, obviously, that's kind of an ongoing effort and we don't have the exact details on what that's going to look like yet. And I think Commissioner Monahan actually asked us this same question here pretty recently about if we plugged in some of the -- like the incentive levels that are being discussed at the federal level and to our models, what would the effect be on the forecast?

And I think, you know, once we have better -- once we have some clarity on what those incentive levels are, that is definitely something that we can do. We can, you know, look

at those, plug those into the model and see what happens, and we can certainly share that with you offline. I jus wanted to make sure that that was addressed.

COMMISSIONER GUNDA: Thank you, Matt. Thank you now.

Oh, go ahead, Commissioner Monahan, just quickly.

COMMISSIONER MONAHAN: Matt, I'm glad you popped on. Thanks for jumping in.

MR. COLDWELL: Yeah.

COMMISSIONER MONAHAN: Yeah. I mean, this is where we've reached the we-don't-know. And we hired NREL to do some analysis for us and, I mean, we don't know. I think that's the -- it's like you know it's a barrier, you know it's a major barrier. But then quantifying what that means for the market almost -- I mean, there's so much speculative work that has to go into that analysis. And this is where, as analysts we go, oh, my god, this makes you crazy. How can we analyze our airbags (phonetic) if we don't know that? We do know how many charges wee need for a certain number of vehicles; right? I mean, that we can analyze. But then what's the impact on

this one charger in terms of driving the market? It's beyond me. I don't know that and that pains me.

COMMISSIONER GUNDA: Yeah. Absolutely, Commissioner Monahan.

COMMISSIONER MONAHAN: That pains me.

MR. COLDWELL: Yeah. Absolutely. It's a topic that's ripe for a lot of discussion next year, so I'm really looking forward to digging into that.

COMMISSIONER GUNDA: Yeah. Matt, I think, just from my kind of closing off, you know, for passing off, thanks for adding that.

MR. COLDWELL: Yeah.

COMMISSIONER GUNDA: I think, you know, the question for me is definitely coming from, you know, the need. And I think the demand scenarios work, you know, was kind of, you know, both getting at the policy side but, also, looking at ultimate ways of analyzing, you know, what should some of the infrastructure investments and long-term investments should be using?

So given that there is kind of that, you know, market transformation, and then the

inflection happening in the transportation, knowing those would be helpful from the system design perspective, as well, so thank you so much for jumping in on that.

MR. COLDWELL: Yeah. That's probably a really good transition to the next presentation, too.

COMMISSIONER GUNDA: Yeah. I know, yeah, Commissioner McAllister probably has a question. Go ahead.

COMMISSIONER MCALLISTER: So, yes, I'm back. Sorry about that. I had a Bluetooth problem which meant my mouse didn't work, so that was kind of a problem.

So I just wanted to say I really appreciated these presentations. I mean, it does really seem like we're at an inflection point here, particularly for the EVs. And in all these different market sectors there's so much technological possibility. But again, you know, not enough kind of visibility onto the actual market to have like a price elasticity of really sort of understand how it's going to respond to any given initiative, so it was really great.

And I also wanted to commend. We talked

about having, you know, a Btu, a cross-sector Btu metric. And I saw that you all did that in one of your slides and sort of took a broad view of the whole transportation market across all fuels. And I think that was a nice kind of unifying message.

But really excited about the possibilities here. And this playing field just kind of doesn't have any lines on it, so you know, what's it actually going to look like when more people get out there and start playing? It's going to be very interesting. And I know that the team has access to a lot of data to pay attention to that kind of, you know, in the very short term, so that's great.

I think I'll stop there. I just want to appreciate all the staff for -- I agree with Commissioner Gunda that, over the last few years, this sort of level of the analysis in the Transportation Forecast has really come -- has really blossomed, so I wanted to just thank everybody for that.

COMMISSIONER GUNDA: Thank you, Commissioner McAllister and Commissioner Monahan.

So with that, I will try to transition to

the next set of presentations on the demand scenarios, so to Heather.

It looks like, Mike, take it away, please.

MR. JASKE: All right. The very first slide, please.

So good afternoon, for the record. I'm Mike Jaske, working in the Energy Assessments Division. And my colleague, Anitha Rednam, will give an overview of a new capability being developed at the CEC. And during Anitha's portion of the presentation, the last half, essentially, she'll show you the design of some scenarios that we're in the process of finalizing in preparation for the actual quantification projections.

These scenarios build directly upon the AAEE and AAFS work that Ingrid Neumann described this morning. And, of course, most especially in the higher numbered more aggressive scenarios that she described.

This project is aspiring to develop and assess scenarios of the sort that Commissioner McAllister raised this morning, sort of thinking a little outside the box, not as constrained,

perhaps, by firm knowledge and be a little bit more speculative. And it also brings together the buildings and transportation sectors that Commissioner Monahan was urging.

Because we have accelerated this presentation originally scheduled for December 16th to today, our scenario designs are not yet final but they're certainly close enough that she'll gain a good appreciation for where we're headed.

Second slide.

The Energy Commission has periodically undertaken scenario projects rather than forecasting projects. Generally, these efforts have focused on some particular topic that we're striving to achieve insights rather than be a basis for any kind of actual procurement decision making. And sort of unfortunately, these efforts have frequently utilized a consultant to do the work. And so while we, the staff, can guide what the consultant does, we're not, you know, necessarily getting tools or staff skills and capabilities that endure. And so we are, essentially, embarking upon a new effort to build that capability within the Energy Commission.

Next slide.

And what is the motivation for that now as opposed to some other time? And these bullets are, essentially, a sequence of the logic that leads to that decision to make -- to develop this capability.

So, clearly, the majority of policymakers are in agreement that we need massive reductions in GHG emissions by the mid-century, partly to actually contribute to global warming mitigation but, also, to show other jurisdictions in the country and around the world that it's possible. And, of course, since the majority of those emissions come from burning carbon-based fuels, that means a big shift from high-carbon fuels to low or no-carbon energy forms.

And our GHG emission inventories, formally assessed by CARB due to statute, but Energy Commission contributed to the methods by which that is developed, revealed that most GHG emissions result from end user energy consumption, there is still substantial energy that’s used in the extracting, transforming, transmitting, and distributing of energy to end users. And so understanding energy demand and

the pattern of change from one energy form to another is critical to assuring that we have reliable supplies for each of the energy forms over the years as we transition more wholly to electricity.

And I also want to make clear, and Anitha will elaborate on this in more detail, that we, in this project, are covering all customer sectors and all fuels. That was also urged by Commissioner Monahan this morning. And we can do both total Btu and GHG projections as part of this project and intend to do so.

Next slide.

So we set out on this endeavor kind of late last year, early this year, partly under the guidance of then Deputy Director Gunda and have been working to make it a reality ever since. So we're going to develop the specifications of demand scenarios.

We're going to first assess them in terms of final energy demand and later sort of, perhaps on a staggered basis, focus on the supply side dimensions and consequences of satisfying these demands, probably starting with electricity, somewhat in the nature of how we did that work

for the AB 3232 legislation.

Clearly, out of this we'll develop some insights, and we want to communicate those to our sister agencies and to stakeholders. And we expect to adapt our methods through time, you know, as we better understand our sister agency needs and desires.

So we're ultimately going to create a product in each biennial IEPR cycle that is sort of parallel to the core demand forecasts. And, perhaps, the Energy Commission will desire to adopt those if that standing is found to be meritorious and useful in their use by other agencies.

Next slide.

Obviously, this effort is more than can be accomplished in a single year and so we set out some particular objectives for this 2021 IEPR. We're going to develop and assess scenarios that are focused on high electrification. And we're not necessarily going to be able to focus on the amount of implications of a high hydrogen future or other sort of lower carbon or more moderate carbon fuel forms.

We are developing modeling capabilities,

partly by adapting existing tools and partly by creating new elements that can assess these scenarios. We're going out on an annual basis out to 2050 so that we can observe things in that mid-century realm that policymakers have announced is out goal. We are generally focusing on annual consumption and results. But for electricity, obviously, we need to convert that annual electric energy into hourly 8760 load impacts that the generation sector needs to do its assessments.

Similarly, we're going to be doing this at a geographic basis that is comparable to the planning areas in major utilities, as is the case with core demand forecast itself. It's also necessary for the kind of electricity generation and transmission intensive analysis that we expect to be following the development of demand projections themselves. We're going to be assessing all the major energy forms, fuel types and, as I said earlier, going to be computing GHG consequences.

So in this initial effort for the 2021 IEPR, we are building off the existing demand forecasting models that will be focused on partly

today for transportation, and more so December 16th for the sort of building and industrial sectors, with the ancillary projection tools that are developed for AAEE and AB 3232 fuel substitution.

But for other elements, we're relying upon E3's PATHWAYS model which has been adopted under a work authorization we have with E3 to, in effect, take the results of certain of our models and tools, export them into PATHWAYS, bypass the internal PATHWAYS computations for those particularsectors and fuels, retain PATHWAYS for the balance of sectors and fuels, and then generate a total anthropogenic projection for all fuels in all sectors.

We anticipate, with resources, that we will shift more towards reliance upon Energy Commission tools, whether they're further adaptations of PATHWAYS or something else. It's a little hazy at this point but there's plenty of room for improvement in our modeling techniques and in our collection of data.

Next slide.

And finally, we're aspiring to develop these scenarios in such a way that we're

explicitly quantifying impacts of programs, standards, policies that impact energy demand and GHG emissions in our customer sectors. And that's a significant difference in our mind from some of the other projections that have been developed as part of GHG plans in CARB's Scoping Plan where there's more sort of basic assumptions about the penetration of technologies and the shift of one fuel form to another without a clear programmatic or standard inducement to define that trajectory through time.

Our analysis is going to try to achieve this by having several scenarios where we sort of look at business-as-usual world, a sort of programmatic policy world, and then a mitigation world where we can make some of those more heroic assumptions.

And, clearly, the effort to understand how programs will operate in the period beyond our traditional forecast is a challenge. And we will need to be working with our other agencies and utilities to better understand exactly how we can improve upon what we're doing in this cycle. But the capability to take the level of programmatic disaggregation that Ingrid showed

this morning and continue that out all the way to 2050 is in place and that will be the basis for our long-term projections.

And so just wrapping up that theme about the importance of understanding what existing or near-term in-development programs will contribute to energy change and GHG reductions, that will then give the basis for understanding by sector/by end use where we need to develop additional programs that will sort of close the gap between what we anticipate, sort of continuation of existing types of policies and programs, and to get down to the level that's required for mitigation.

And with that, I will turn it over to my colleague, Anitha Rednam.

MS. REDNAM: Thank you, Mike. Good afternoon, Commissioners and stakeholders.

Next slide, please.

So my first slide here explains the general difference between a forecast and a scenario. So in simpler terms, a forecast attempts to predict a likely future. The demand forecast has always referred to the next ten years, so this is the forward time horizon that

reasonable levels of demand certainty with the lead time for procuring and constructing supply-side infrastructure occur.

But scenarios, on the other hand, look at the range of long-term possible futures. They help to understand the deviations and divergence between each future.

Next slide, please.

So a quick review of our Demand Scenarios Project here. So the purpose of the demand scenarios is to help examine these fuel shifts that occur on the demand side and the consequences of those changes on the supply side and evaluating crosscutting metrics, such as greenhouse gas emissions and costs.

So we are developing three demand scenarios which will extend out to 2050. We will be including what will be the fuels in the analysis and cover greater range of uncertainties which are typically not covered, which are typically outside the forecast range, for example, technology cost reductions and performance improvements over time, assumptions about consumer behavior, and goals that have not yet been translated to policies.

So the method we will be using is to start with our managed mid demand forecast as a starting point and adjust it with the load modifier tools we have available, such as AAEE, additional achievable energy efficiency, and additional achievable fuel substitution, AAFS, especially for the residential and commercial sectors.

Next slide, please.

So as Mike mentioned in his presentation, our demand scenario process will focus on the high electrification theme. We will develop different demand projections by modifying the baseline. And I will go over this a little bit in deep in the framework process. In addition to producing demand projections, we'll also produce greenhouse gas emissions by sector.

Next slide, please.

So why are these assessments needed?

So demand scenario assessments, they help set or reassess California's energy and greenhouse gas emission reduction goals by providing a clear and objective information to us. Then these assessments can also tell how easy or how difficult it may be to achieve these

goals and provide incentives or insight into where programs need to be developed.

Next slide, please.

So these are the proposed scenario types we are envisioning, a reference scenario, a policy compliance scenario, and a mitigation scenario. So as mentioned, again, these stress electrification as the basic theme, and so the results will show the impacts of a growing combination of regulations, policies, and programs with electrification as the objective.

So the reference scenario is the first scenario. It's the business-as-usual scenario. It uses the same assumptions as the CEC-adopted Mid Demand Forecast through 2035.

Beyond that, this scenario assumes that the standards, programs, and policies that were included in the demand forecast will continue with the same degree of compliance. And it also serves as a reference against which the policy compliance and mitigation scenario can be assessed. So this comparison will tell us how much more needs to be accomplished after the existing processes have been exhausted.

So moving on to the policy compliance

scenario, this is built off the first scenario. So the policy elements that were not fully captured in the reference scenario will be captured in this scenario. The compliance elements of this scenario will quantify standards that have not been brought to full compliance in the reference scenario, so they would be brought up to a higher level of compliance. And so the increment between the reference and the policy would be the impact of fully achieving the intended goal of the policy and the program.

So moving on to the mitigation scenario, this is an aspirational scenario, so more programs and standards can be added onto those that then already -- that are there in the policy compliance scenario. And the gap between the policy compliance and the mitigation scenario will tell us the need for fuller policy development or new program designs or approaches that need to be quantified in the future.

Next slide, please.

So this slide shows a high-level framework of our scenario design. So the first column, you can see the various sectors, followed by the inputs in the second column where we are

assessing, and the fuels being considered.

For the sectors in the fuels, we are assessing as seen in the light green color here and the peach color, electricity and natural gas for the residential and commercial, and all the fuels in the transportation sector. Like Mike mentioned, this process involved extending our existing demand analysis tools to 2050. And these tools are listed below, like our stationary demand forecast models, our AAEE/AAFS programmatic tools, our FSSAT models, and traditional demand forecast transportation tools.

So these tools, and for these sectors, E3 will adapt their PATHWAYS model to replace their data inputs and calculations with inputs from us which quantify energy projections using our 2021 economywide econ demo projections, projected households, and projected commercial floor space out to 2050.

So the other demand-side sectors, like industry, agriculture, as seen in light purple, we will be relying on the E3's PATHWAYS model. The complete PATHWAYS scenario will then be generated covering all these sectors and all the fuels, as seen here on the slide, and the results

will also include greenhouse gas emission projections from all of these sector fuel combinations. So our analysis also relies on the modeling formulations and other assumptions built in the E3 tool.

Next slide, please.

So this slide is a preliminary reference scenario design, so a key emphasis on the word preliminary. It's not finalized yet. So this is how we're approaching it. So we are going to be extending our residential and commercial consumption baseline forecast to 2050. So to generate the 2050 baseline forecast the models are provided with additional years of econ demo driver data that is available to us through Department of Finance and Moody's Analytics.

The baseline projections will then be adjusted for impacts of AAEE and AAFS, reflecting a business-as-usual perspective, as can be seen here in light green. So business-as-usual energy efficiency is best seen by Scenario 3, so this has been a standard choice for a managed demand forecast, and it's used by PUC and ISO for general generation and transmission planning and procurement.

So AAEE will come entirely from the programmatic contributions being developed in our EEFS tool, energy efficiency fuel substitution tool. So there are several elements or data streams that we draw from for AAEE, those are IOU and POU potential and goals projections, codes and standards savings projections, and beyond utility impact workgroups. This year, we're also adding AAFS and will be treating it in a similar way to how we treat AAEE currently. So AAFS will also have scenarios encompassing, limited to extensive shift from natural gas consumption to electricity through time.

But the key point here is that AAFS will have two components, one just like the programmatic contributions from the EEFS tools, so the same elements there from EE will be updated to capture the fuel substitution impacts for these scenarios. And then the speculative fuel substitution contribution will be captured in the exact model for programs that are still in development.

So as you can see here in the reference scenario, we will be selecting an AAFS scenario that contains only a limited set of fuel

substitution programs that exist today or that have already been adopted and will be implemented in the next year. So the other fuels in these sectors, like kerosene, LPG, we will be relying on the PATHWAYS model.

Then moving on to the transportation sector, the baseline forecast energy demand is forecasted, again, using models that incorporate consumer preferences, regulations, economic and demographic projections, and other market factors. Again, for the remaining sectors and all the scenarios, will be using the PATHWAYS model that was last used for the 2020 Carbon Neutrality Report with the inclusion of the residential, commercial, transportation fuel demands from us.

Next slide, please.

So the next few slides have the same structure as the reference scenario, so I will not get into too much detail here. But I just want to point out that the baseline forecast is adjusted here to reflect more aggressive energy efficiency and expansive fuel substitution impacts then that were included in the reference scenario. So the more aggressive AAFS scenarios

take the existing elements that were in the business-as-usual Scenario 3 and increase them beyond reference scenario values for compliance, participation, and funding.

And I want to note here on the transportation sector that we will be starting off with the 2021 IEPR Mid Transportation Forecast as a baseline, and then we will be layering that with the CARB State Implementation Strategy for capturing the incremental impacts beyond the reference scenario. So this is based on CARB's proposed regulations for Advanced Clean Cars II for Light Duty Vehicles and Advanced Clean Fleets for Medium and Heavy-Duty Vehicles.

Next slide, please.

Moving on to the mitigation scenario. The baseline residential and commercial consumption forecast will be the same, just like the reference in the policy compliance scenario. But, again, the energy efficiency and the fuel substitution modifications are more extensive here. So the more aggressive AAFS scenarios take the existing elements from the business-as-usual AAFS Scenario 3 and will increase them from reference scenarios to maximum achievable values

for compliance rate participation and funding.

And moving on to the transportation sector here, we will be using the 2021 IEPR Mid Transportation Forecast as a baseline and then plan to layer it with the CARB Mobile Source Strategy for capturing the incremental impacts beyond the policy compliance scenario. As with the policy compliance scenario, the mitigation scenario will use increasingly more aggressive ZEV attributes and ZEV policies.

Next slide, please.

So a quick review of our demand scenarios project timeline. We had a Demand Analysis Working Group meeting on September 15th. Today we are having an IEPR workshop on the project overview and the framework. And then in March '22, we are planning to have a workshop on the actual inputs, the assumptions and results.

Next slide, please.

With that, I'm done with my presentation. Thank you for the opportunity.

COMMISSIONER GUNDA: Thank you, Anitha and Mike. That is so exciting to see the work moving forward. I recall, you know, a year or so ago when we were kind of just talking about this

as a conceptual thing and kind of seeing how much work you're able to pull together, just want to both thank and commend both of you for helping pull this together.

I think, you know, earlier in my kind of comments, like I mentioned, you know, the -- you know, all the things that you laid out as to why we need to do this work are extremely, you know, valuable and important. And I think, you know, for a lot of policy questions moving forward, and also some of the choices we might have to make on the system planning side, this information will be extremely valuable.

So just a couple of -- oh, and maybe just kind of a question on kind of the thinking on the framework.

So one is just kind of how we landed, where we've landed for '21, and then kind of, then, what's next kind of question on the framework?

So if we go back to slide number 12 on the scenario framework for 2021 IEPR, so I think, you know, what I hard, Anitha, from you is, you know, much of the work is going to be focused on understanding the electricity needs, you know, on

the system. I just want to get an idea on, you know, how we are thinking about the gas side, specifically, you know, how are we going to treat that into the scenario work?

And also, you know, are we thinking about how the fuels, again, like, you know, the RNG elements or hydrogen elements? And you know, sure, it's kind of hard to pull them together into a cohesive framework, but just wanted to get an idea on what -- you know, how we landed, where we landed for now and, you know, where you are planning to take this into the next year?

MR. JASKE: So let me respond to that question. This slide isn't what I think you were referring to, Commissioner.

As you know, the staff forecasting models cover electricity and natural ga and they're not the totality of energy forms used. Certainly, there are some minor fuels but the bulk of the focus is on those two. And, essentially, the gas forecast, the base gas forecast becomes the important predictor of eventual electrification consequences.

So if you can imagine the amount of natural gas energy being used in the residential

sector for space heating, you know, the shift of that to electricity without harming or degrading, you know, the level of comfort in people's homes, you know, will be supplied by electric heat pumps. And as Commissioner McAllister indicated, and I think parallel thinking of Commissioner Monahan, that those are much more efficient.

And so there's a very close nexus between the base natural gas forecast and the consequences of electrification of that and that is built into this methodology, similar in the commercial building sector. And I think Aniss, you know, made that same point in the transportation sector. If you shift from one fuel to another fuel you're going to have a reduction in the former and an increase in the latter.

COMMISSIONER GUNDA: Yeah.

MS. REDNAM: So, Commissioner Gunda, I just wanted to add. Our scenarios do reflect that. I didn't spell that out in my presentation because we are not -- we didn't decide on them 100 percent yet.

COMMISSIONER GUNDA: Great. Thank you. I think, you know, just kind of as we move

forward, absolutely understanding the electricity side and the impacts are essential from the grid planning perspective, but kind of having the other end of it, which is the gas-side implications of all these scenarios, which I presume will be, you know, the outputs will be extremely beneficial in the long run.

I know Commissioner Monahan has to jump off soon, so I just want to give her an opportunity to comment or ask questions.

COMMISSIONER MONAHAN: I do have some questions. I actually was getting a little confused in the beginning. I was like is this for -- was this for, what, the next IEPR cycle? How are we thinking about this? And it sounds like, I'm going to restate just to make sure I understand, so this is what we're planning to roll out in the next IEPR cycle going forward?

And the scenario analysis will include inputs from the Air Resources Board and partner policy agencies, I would call them, to ensure that the scenarios reflect what CARB expects their vehicle regulations to go, and so we'll be more aligned, ultimately, as a result of this kind of cross-agency collaboration and this new

scenario planning; is that fair?

MR. JASKE: We are attempting to do that. But as you particularly heard from Bob talking about the medium and heavy-duty trucks, they're -- the form of regulation that CARB seems to be pursuing, which obviously has benefits to fleet operators in terms of credits and earned and sold to some other entity, you know, create major issues from a forecasting side because it becomes harder to predict who's actually doing what.

And you know, we've already had that problem in the National, you know, EPA Fuel Standards formulation, and for the very same reason, that it allows manufacturers who, for whatever reason, can't/won't produce, you know, compliant vehicles to, in effect, buy credits, which presumably they're rolling into the price of their vehicles if they're going to stay insolvent as an entity, and if they have vehicles that consumers want to pay for that have a price premium because of that, that allows that whole system to persist through time. It's been that way on the vehicle side, the federal vehicle side, for many years.

So that's a -- that is a challenge to forecasting because it says money can blur the actual intended goal of shifting from -- away from dirty fuels to clean fuels.

COMMISSIONER MONAHAN: I totally agree. I can't agree more. Although, I would just say I'm happy that this cross-agency conversation is happening because, I mean, it would really be ideal in the next few years if, when we have these demand forecast workshops, CARB is at the table, too, and they're informing and using these forecasts. In a way, like they use their forecasts, we use ours and never the twain shall meet. And that, to me, is a problem. Like we should actually be talking to each other and having data that complements and is useful to the other agencies. So I think that conversation alone is worthy.

MR. JASKE: It is happening and it needs to happen at a higher level.

COMMISSIONER MONAHAN: Where's the Eight Ball (phonetic)?

COMMISSIONER GUNDA: Yeah, I think we should.

COMMISSIONER MONAHAN: But I just want to

say I think it's a good direction to go.

COMMISSIONER GUNDA: Yeah, Commissioner Monahan, I just wanted to comment on that. I think, you know, at a 30,000-foot level, kind of a key strategy or, you know, key kind of goal that we are kind of trying to put forward is starting 2022 IEPR, you know, we really package all our products into a single statewide planning library of products. And that, you know, inherently means, you know, it has to buy off CPUC, CARB, CAISO, and other agencies. And I think there is the JASC (phonetic) forum, and then there's a supply JASC forum, and so on. There's like different forums where the conversations are happening.

But to Mike's point, I think we're still coalescing as to how best to clear this process. And this very first iteration of the product will help us put something at the table and then kind of have, you know, reactions on the process development around that to, you know, ultimately move to the point that you're talking about where we have both a crosscutting lexicon but, also, crosscutting, you know, analysis that we're all kind of starting off of.

And you know, our kind, at least from my vantage point, you know, it's been, you know, if you have 10, 15 scenarios, right, we ultimately develop in a library of products, you know, CPUC might end up, you know, using a certain variation for a study and a certain variation for planning, and, similarly, CARB. But at the end of the day, by the time we get to the scoping plan and then the blueprint is developing in four years from now, the next one, we're all having a starting point of the CEC's library of energy products.

COMMISSIONER MONAHAN: And I have to go. But thanks Heather, thanks Mike, Anitha, really. A really great day of presentations, actually, so bye everybody.

MS. REDNAM: Thank you.

COMMISSIONER GUNDA: Thank you, Commissioner.

Yeah, I think with that, I do not have any more questions but just general kudos again, Mike, to you and Anitha and the entirety of your team. I know this has been a lot of work pulling this together. And thank you for working with our sister agencies, you know, but also kind of bringing in the elements from E3 that we could

leverage for now on the PATHWAYS and continue to enhance them to better serve the state policy questions.

So I think with that, we're going to go to Heather for any Q&A.

MS. RAITT: I don't see any Q&A, so I think we can actually move on to pub comment.

Dorothy, are you available, Dorothy from the Public Advisor's Ofc? Dorothy Murimi, excuse me, go ahead.

MS. MURIMI: Thank you, Heather.

So just a few instructions for everyone. One person per organization may comment and comments are limited to three minutes per speaker. And if there are several parties interested in commenting, we may reduce the time to one-and-a-half minutes per speaker.

If you're using Zoom, the platform, go ahead and use the raise-hand feature to let us know you'd like to make a comment. It looks like a high-five and should be at the bottom of your screen or device. And we'll call upon you after your hand is raised.

Now if you are on the phone, go ahead and press star nine to raise your hand, and then star

six afterwards to unmute your line, and we'll unmute from our end.

I will list your -- I will speak your name. apologies if I do not state it correctly. Once stated, go ahead and state your name and your affiliation, if any.

And if you're on the phone line, I will list the last three numbers of your phone number, and so I'll give this a moment.

Again, the raise-hand feature looks like a high-five to indicate you'd like to make a comment, or if you're on the phone, star nine to raise your hand. And one last call. Again, if you're on the phone line, star nine to raise your hand, and the raise-hand feature if you're on the Zoom platform.

Seeing no raised hands, I'll hand the mike back to you, Vice Chair Gunda.

COMMISSIONER GUNDA: Thank you, Dorothy.

Just I wanted to say, thank you again to everybody for your attendance today, all the attendees. Thank you to the entirety of the team, the IEPR Team, for putting together kind of a thoughtful and important conversation today. And I'm glad the discussion we had this morning,

and some of the responses for the discussion, without, you know, actually being able to answer, in the last segment, the demand scenarios.

So with that, you know, I don't have any other comments. I'll hand it off to Heather for closing.

MS. RAITT: Great. Thank you, Vice Chair Gunda.

So I'll just remind everybody that written comments are always welcome and they're due on December 16th. And the information is in the notice for how to submit comments.

And then, also, just invite everybody to join us again tomorrow at 10:00 for a workshop on supply-side demand response, and so that will be another good day of information.

And I thank everybody for participating today and I think we're done.

COMMISSIONER GUNDA: Thank you, Heather. Bye-bye.

MS. RAITT: Thank you.

(The workshop concluded at 3:58 p.m.)

CERTIFICATE OF REPORTER

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

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MARTHA L. NELSON, CERT**367

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I certify that the foregoing is a correct transcript, to the best of my ability, from the electronic sound recording of the proceedings in the above-entitled matter.

January 18, 2022

MARTHA L. NELSON, CERT**367