DOCKETED	
Docket Number:	19-AB-2127
Project Title:	Implementation of AB 2127 Electric Vehicle Charging Infrastructure Assessments
TN #:	236972
Document Title:	Transcript 02-05-21 re Commission Workshop AB 2127 Electric Vehicle Charging Infrastructure Assessment
Description:	N/A
Filer:	Patty Paul
Organization:	California Energy Commission
Submitter Role:	Commission Staff
Submission Date:	3/4/2021 9:22:18 AM
Docketed Date:	3/4/2021

CALIFORNIA ENERGY COMMISSION

In the matter of:

Assembly Bill 2127 Electric Vehicle Charging Infrastructure Assessment	)	Docket No. 19-AB-2127

COMMISSIONER WORKSHOP

AB 2127 ELECTRIC VEHICLE CHARGING INFRASTRUCTURE ASSESSMENT

REMOTE VIA ZOOM

FRIDAY, FEBRUARY 5, 2021

1:00 P.M.

Reported by:

Peter Petty

APPEARANCES

COMMISSIONER

Patricia Monahan, Lead Commissioner on Transportation

CEC STAFF

Raja Ramesh, Air Pollution Specialist

Noel Crisostomo, Air Pollution Specialist

Micah Wofford, Associate Energy Specialist

Jeffrey Lu, Air Pollution Specialist

Larry Rillera, Air Pollution Specialist

PUBLIC COMMENT

Dean Taylor

Steve Davis

Ray Pingle, Sierra Club California

Kristian Corby, CalETC

Robert Perry

Erick Karlen, Greenlots

Margarita Parra, Clean Energy Works

Stephanie McGreevy, Open Energy Alliance

Bob Coale, Gladstein, Neandross & Associates

Andrew Larkins, Sygensys

Shiba Bhowmik, Sinewatts, Inc.

INDEX

P R O C E E D I N G S

1:01 P.M.

MR. RAMESH: All right. So once again, welcome to the Assembly Bill 2127 Electric Vehicle Charging Infrastructure Assessment Lead Commissioner Workshop. This meeting is being held on Zoom and will be recorded virtually and by the Court Reporter.

We have a lot of content to share with you all from the latter part of the Assembly Bill 2127 Staff Report. And we're looking forward to hearing your feedback. We'll be monitoring the question and answer box throughout, as well as taking questions at the midpoint and at the end of the workshop orally using the raise-hand function.

With those introductory remarks, I'd like to hand it over to Commissioner Monahan for any opening remarks.

Thanks.

COMMISSIONER MONAHAN: Thanks Raja.

Well, good afternoon everybody. Welcome to the second day of our AB 2127 EV Charging Infrastructure Assessment. And this is, as I said yesterday, really critically important to the State of California, as we embark on

electrifying transportation, we want to make sure that there is enough ZEV infrastructure, zero-emission vehicle infrastructure to meet the needs of all Californians. So that means not just passenger vehicles but, also, medium- and heavy-duty vehicles and off-road.

I would say, in terms of our understanding, of course, passenger vehicle market is ahead. Then we know a little bit less, but still a fair amount, about medium- and heavy-duty charging. And then off-road is the one where we're learning.

And we're going to be doing this assessment every two years, so there's -- I think you'll see an evolution in how the team is thinking about doing this analysis, and also looking forward to what we can do in the future in future reports.

So I feel, you know, really, really proud of the team for all they've done in pulling together the AB 2127 Draft Assessment, really looking to -- forward to feedback. The report itself has data through 2030 and it includes not just the targets that were set under the Brown Administration, 5 million EVs by 2030, but also

the implications of the new ZEV executive order which ARB estimates will lead to about 8 million ZEVs on the road by 2030.

So the team has also looked forward to 2035. That's when the Governor's ZEV E.O. kicks into gear, especially for the passenger vehicle segment when all new passenger vehicles must be electric, according to the targets set for the Governor's executive order.

So this is really a bedrock analysis. And your feedback and your comments just will help us make it better, so the team is listening intently to all the feedback that we're getting, both through these workshops and also through written comments. But I just encourage everyone to participate and to gives us your best input. And we are listening and we'll come out with the best report that we can.

So with that, I'm just going to turn it back over to Raja to kick off the day.

MR. RAMESH: Great. Thanks so much, Commissioner Monahan. Okay. So thanks again for the opening remarks.

First we'll have Micah Wofford giving a presentation on EVSE Deployment and Grid

Evaluation tool, or EDGE. This will be followed by Noel Crisostomo giving a presentation on Vehicle-Grid Integration, also featuring some of the load profiles from the analysis presented yesterday. Then we'll have a presentation from Jeffrey Lu on Connector and Communication Standards. This will be followed by a question and answer session, after which we'll hold a break for five minutes.

When we return I'll speak on Tailoring Charging Solutions to Local Constraints. And then Larry Rillera will speak on Workforce Training and Development. We'll have our final question and answer session. Commissioner Monahan will give some closing remarks. And then we'll adjourn at 3:30. Thanks.

Whenever you're ready, Micah.

MR. WOFFORD: All right. Thank you, Raja. Can you hear me?

MR. RAMESH: Yes.

MR. WOFFORD: Good. Good. Well, happy Friday everybody and thank you for joining us for the second session today. My name is Micah Wofford and I'm an Associate Energy Specialist in the Transportation Planning Analysis Unit at the

CEC. I'm leading the development of the EVSE Deployment and Grid Evaluation tool, otherwise known as EDGE, on which I'll be presenting today.

Next slide please.

So here's a brief overview of the presentation. I'll briefly provide some context in the form of background and purpose, as well as stating the objectives of this work. Then I'll cover the design choices of the model by outlining data sources, EDGE's basic structure, relationships to other analyses, and the allocation methodology. Next, I'll showcase some of the results that have come out of the work done by EDGE, first in the form of statewide analysis, and also done in a case study done in conjunction with the EVI-RoadTrip model. And then, finally, I'll conclude by discussing limitations, future work, and a call for stakeholder engagement.

Next slide please.

As you know, through Assembly Bill 2127, the CEC is tasked with assessing the charging infrastructure needed to support California's goal of having 5 million ZEVs on the road by 2030. In order to properly distribute those

vehicle chargers, it is important to identify geographic locations that can sufficiently and economically host them. Therefore, the EDGE tool is designed to act as an early warning system of sorts by helping users to focus infrastructure deployment and plan associated investments.

In terms of grid planning, this could involve pinpointing areas which may require special attention, such as distribution grid upgrades, in order to host the charging infrastructure that is projected to exist there. This is a highly iterative process which requires ongoing analysis in order to properly support California's transportation electrification targets.

Next slide please.

To illustrate this point the image on the left of the slide is a depiction of an analytical process flow that is needed to generate insight and provide direction to the market so that we can sufficiently -- successfully deploy sufficient infrastructure for everybody. Using data from several sources, EDGE seeks to address four distinct goals: minimize and mitigate the impacts of charging to the electric grid; achieve

air quality improvement targets; meet EV travel demands in California; and ensure that EV charging infrastructure is deployed in an equitable fashion throughout the state.

This initial phase of EDGE development focused primarily on distribution grid analysis. However, future iterations of analysis through EDGE will include a total of four conceptual domains of study, and those are grid impact, air quality, travel demand, and equity considerations.

Next slide please.

The charging infrastructure quantification results that output from both the EVI-Pro 2 and HEVI-LOAD models will be used as a foundational layer upon which other data and analyses will be built. EDGE will provide a basis for users to view progress to infrastructure-related policy goals, strategically target deployment solutions, and focus investment efforts. The domains I mentioned in the last slide are separated here, showing some of the datasets that fit within each.

EDGE currently uses data from the

Investor-Owned Utilities' Integration Capacity Analyses and a Grid Needs Assessment Work to analyze the capability of the electric grid to incorporate increased EV charging load.

We also plan to work with the Energy Assessment Division in the CEC to incorporate their GHG emission factor work into the tool to assess air quality improvement strategies. EAD, or the Energy Assessment Division, also has a great database of zero-emission vehicle and infrastructure statistics which is planned for EDGE integration.

And finally, both the CEC's SB 1000 disproportionality analysis and the Location Affordability Index data will factor into studies within the equity domain.

Next slide please.

This is a visualization of the tool's overall framework. Data are input into EDGE for processing and combination. Resultant outputs are then viewable using EDGE's geospatial domains as filters or lenses. The table on the right lists the relationships between the domains in terms of units of geospatial resolution. EDGE notably targets the traffic analysis zone, or

TAZ, as the smallest unit of resolution for most domains. However, not all data share the same resolution. Units in the same color in this graphic tend to fit nicely into each other. This table provides a glimpse at an important barrier that exists within all of the data in EDGE.

Although some domains have the capability of sharing spatial units, the data are generally not commutable across domains, meaning it isn't easy to convert between sets to view meaningful correlations. Therefore, as a result, statistical analysis of the physical characteristics of each domain is required before invoking EDGE's inherent algorithm.

Now for the rest of this presentation I'll be speaking exclusively to the grid domain.

Next slide please.

This graphic shows relationships between several different EV infrastructure models and forecasting work. Starting from the top left, the California Air Resources Board's work on their Mobile Source Strategy feeds into the HEVI-LOAD model. The CEC's ongoing IEPR work influences both the EVI-Pro 2 and HEVI-LOAD models. IEPR data is also factored into the

Utilities' Distribution Planning Working Groups which finalize the ICA and GNA disaggregation methods and load growth demand forecasting. The infrastructure quantification outputs from EVI-Pro 2 and HEVI-LOAD are input into EDGE, as well as the distribution capacity data from both the ICA and the GNA utility work.

Notably, as this infrastructure assessment is ongoing and iterative, EDGE will provide an important feedback loop into the CEC's infrastructure models and, hopefully, also influence future iterations of planning within the Distribution Working Groups.

Next slide please.

So now we'll talk about the methodology used to determine regional grid hosting capacity.

First, EDGE inserts the charging quantities from EVI-Pro 2 and HEVI-LOAD and layers the utility distribution grid circuit data on top of it. Note that in this example we are not yet using actual CEC analysis results but, instead, I'm just using charger data sourced from the Alternative Fuels Data Center to illustrate this scenario.

Next slide please.

Next, EDGE inputs geospatial boundaries of interest, in this case the shapes representing TAZ boundaries. The circuits are separated or cut along the boundaries of the TAZs, and then pieces that sit inside their respective TAZ then have their capacity summed upon a TAZ-wise basis. The load contribution from the vehicle chargers is also aggregated to the TAZ level.

Next slide please.

Finally, when comparing the aggregate load contribution from EVI-Pro 2 and HEVI-LOAD results to the allocated TAZ grid capacities, EDGE will identify TAZs that don't have sufficient capacity to support those chargers by specifying a net capacity deficit. The goal for this concept is to help users focus infrastructure deployment strategies to areas that can handle expected load from the chargers. At the same time, this information could help utilities by identifying areas that may need improvement in order to support the expected charging.

I'd also like to point out that we haven't yet made any decisions on where to place chargers based on this analysis but we are still

actively developing the tool.

Next slide please.

So these two images show different views of the same data. The left image shows ICA datasets for the three largest IOUs, that's PG&E, SCE, and SDG&E. In this case, the ICA data are still in their rawest form of circuit lines. On the right-hand side, this image shows the same capacity data, just allocated to TAZs throughout California using the methodology explained in the previous few slides. Both images show sections with hashed lines which represent areas where there are gaps in the grid data. We currently lack sufficient data for publicly-owned utilities, as well as other IOUs that aren't shown here. This highlights an important opportunity for improvement and collaboration with more California utilities.

Another item of interest here is how TAZs are situated in relation to the utilities. Since TAZs don't fit cleanly into the shapes of the utility territories, and since we don't have adequate data to span the entirety of California's electric grid, some TAZs may currently have incorrect values associated with

them.

Next slide please.

This is another view of the ICA capacity distribution. The histogram on the right shows a breakdown of the additional load that can be integrated on circuits within each IOU territory. Again, these results are based on the available ICA data. As you can see, based on these data, over 70 percent of circuits for both Edison and San Diego have zero or less capacity to bear additional load. The same is true for 30 percent of PG&E circuits as well.

Based on conversations with the IOUs, these results may not accurately reflect the true state of the grid and that the zero-capacity deficiency should be closer to 25 percent. However, the underlying issue sits within the framework by which the data are validated.

As a step in the right direction the Public Utilities Commission recently established a process to improve the IOU uniform load analysis in order to provide more useful results for customers looking to interconnect more load. Future EDGE analysis will seek to integrate those improved ICA results.

Next slide please.

As part of the EVI-RoadTrip study being conducted by our partners at the National Renewable Energy Laboratory, a case study was done using functionality from EDGE. For those of you who weren't able to attend yesterday's session and hear about it, EVI-RoadTrip is a model focused exclusively on simulating the network of chargers necessary to support long-distance inter-regional electrified road trips. Unlike EVI-Pro 2 which is built upon destination charging, EVI-RoadTrip assess waypoint charging in which vehicles stop to charge on the way to their destination.

On this slide we see a collection of TAZs where at least some portion of them overlap within Edison's territory. These results are based on comparison of Edison's ICA capacity data with overall load contributions from EVI-RoadTrip's simulated charging stations. This case study shows some areas within Edison's territory where insufficient capacity exists. In order to accommodate expected load growth from EVI infrastructure projections, areas with a net-positive capacity deficit may require grid

upgrades. However, the overall results from this study show that current grid capacity should be able to support charging demand from the road trips simulated in the model.

Next slide please.

So there are several places within the capacity map where there just weren't enough data to compose a complete picture. Based on the way that the TAZ geographies are situated and their relationship to the physical presence of the utility circuit lines, there are multiple cases where incorrect inferences are possible.

For example, if a large TAZ contains only a small amount of circuits with available data, then only the capacity values from those circuits will be summed into the TAZ, thus yielding an incomplete output. So by having access to data from more utilities, this analysis can produce a more accurate value, thus improving the overall result.

Second, the utility ICA data provide only a snapshot of the grid conditions at the time that the utility analysis was conducted. Therefore, as this is the first rendition of EDGE analysis, and it only included the ICA data, and

there is no current -- there is currently no time-dependent aspect of the results. The integrity of the available utility data has been an ongoing concern as well. There is currently no way for a user to validate whether the data accurately reflect real-world grid conditions since these are the only accessible sources of that information. The data must be taken at face value at this point.

Confidential information protection standards exist across all utility data layers at the expense of analytical granularity. To protect sensitive information, utilities remove certain grid assets from public view which can create anomalous GIS modeling artifacts that could adversely alter the results of impact analyses, such as EDGE.

So what is next for the tool?

Future iterations of EDGE will strive to include GNA and DDOR datasets into grid impact modeling in order to add a temporal forecasting component. This is a notable change from earlier EDGE development based on our conservations with utilities.

Other conceptual domains of study and

their relational connections will be explored in order to focus on the remaining goals and barriers that EDGE hopes to address. Stemming from those relationships, specific uses cases will be developed to craft unique scenarios and solutions to specific objectives and issues.

Next slide please.

And so to continue the development process of EDGE and recurrently improve upon its design, we welcome stakeholder input on a number of items.

What additional data sources exist that could inform travel volumes between origins and destinations or provide grid capacity estimation and validation?

We also seek feedback on the types of use cases we are planning to incorporate. Among others, these could be smart charging, air quality attainment, carbon emission intensity, and equitable infrastructure deployment.

As this tool will eventually be made publicly available, how can the user interface be designed in such a way that would be most user friendly?

The utility data going into this model is

critical in allowing accurate analysis of regional grid conditions and the ability to host expected new EV charging load. Therefore, how can the CEC work with utilities best to ensure that the proper data are being used for this work? How can we look at these data in a more productive manner? Gaining access to certain data, for example, commercial customer information, can help us identify where there are likely opportunities for charging and allow us to provide a more finely-resolved analysis.

Finally, how can we secure the grid data going into this tool?

This concludes my presentation. Thank you very much for listening. I'm happy to take questions later during the Q&A session.

MR. RAMESH: Thanks Micah.

Next we'll move to Noel's presentation on Vehicle-Grid Integration.

MR. CRISOSTOMO: Hi everyone. My name is Noel Crisostomo and I lead VGI Technology and Policy Analysis for the Fuels and Transportation Division.

VGI represents the vital link between the infrastructure quantification models described

yesterday and the capabilities of the state's electrical systems that Micah just captured with EDGE. Our efforts in this arena have implications that span the Energy Commission's preparations for a clean energy future from encouraging charging away from peak, to reducing resource adequacy costs, to adding storage capacity that supports SB 100's clean energy targets, to helping customers weather public safety power shutoffs.

I think of our current VGI efforts in transportation electrification as being akin to the state's commitment to energy efficiency to meet the demand growth amidst the energy crises of the 1970s. To elaborate, VGI is foundational to achieving our EV charging infrastructure goals timely, cleanly, and cost effectively for everyone.

On the next slide, I'll review how AB 2127 approaches this opportunity. First, I'll profile how charging may manifest its load and its possible impacts to grid operations with examples from EVI-Pro 2, EVI-RoadTrip and HEVI-LOAD, including some new figures generated since publication. Second, given these load profiles,

I'll explain the proactive planning, economic, and technology measures that the state could employ with automaker, charging, and utility partners to optimize where, when -- where and when customers get the electricity they need for mobility.

Next slide.

The first and most detailed load profile comes from EVI-Pro 2. This load profile featured in the report implemented, as a post-processing step, an aggressive adoption of residential time-of-use rates in which commuting load is timed to charge at midnight -- start at midnight, in line with common educational messages to EV drivers. Thanks to a utility data response from last month, we are working on a smart charging analysis that incorporates a variety of off-peak hours, including those that might occur during the midday.

However, today, we highlight the midnight TOU case as an indicator of the effect of a simultaneous class-wide response to a price signal. Commonly referred to as a timer spike, the surge in load may pose an overloading risk to transformers, causing a sag in voltage along the

secondary distribution system, especially if EVs continue to be adopted within neighborhood clusters. With the repeated nightly surges, particularly considering building electrification, it became apparent that a more intelligent management scheme, shown on the next slide, was necessary.

In this new 2035 profile, EVI-Pro 2 implements a two-stage control strategy for residential customers as it solves for the charging supply. First, it includes most investor-owned utility and large publicly-owned utility residential customers participating in TOU rates which, again, are scheduled with lower prices at midnight. Some drivers choose to switch to high-capacity Level 2 chargers to acquire their needed energy within the shorter yet less expensive time period.

However, initiating -- instead of initiating charging at midnight, drivers must complete their charge by their departure time. This allows for a more gradual distribution of the load which offers a sinusoidal shape that dovetails with the other -- with other drivers beginning their day and demanding nonresidential

charging, like at work.

EVI-Pro 2 decreases residential charging access as more drivers use EVs. And these drivers for workplace charging first, then in accordance with surveyed -- drivers surveyed and their desire for speed, public fast charging, then public Level 2 charging.

We were surprised by the relative demand at workplaces. But the national and California surveys upon which the travel demands are based highlight that at noon only about a third of the fleet is parked at work.

Fast charging ramps up beginning at 7:00 a.m. and undulates intra-hourly until 7:00 p.m., although actual demand may not be as spiky as it's illustrated, which is an effect of drivers rounding their itinerary inputs to the survey. To smooth this effect, on the next slide, NREL applied a Sovitsky-Golay filter to smooth these surges.

While DCFC demand is less pronounced, when overlayed with the other charging curves the DC fast charge demand still waivers between 3 and 5 gigawatts between 7:00 a.m. and 7:00 p.m. Reinforcements to the secondary distribution

system will be needed to support these intra-hour surges and demand, especially at the site level, which I'll describe more during the RoadTrip section.

While we continue to analyze and refine these curves overall, the combined effect of smarter residential charging and more public charging results in a better alignment with morning solar energy and a relatively lower peak-time charging, especially compared to other scenarios examined on the next slide.

We examined four alternative futures for 2030 beyond the residential TOU and departure time-based charge schedules that I just featured. Each altered a single behavior, key assumption, or a charging option that Matt described yesterday. These each quantify the various effects of visions for the future that we discussed in detail. I'll focus on the effects of the four scenarios on the grid, instead of the network, starting with the next slide with what could happen without rate signals.

Stakeholders familiar with our work on EVI-Pro 1 in 2018 and preliminary results from August will recognize this profile to result if

commuters plug in and initiate charging upon returning home, unconstrained by price incentives. This residential evening peak, combined with midday and evening work and evening public Level 2 charging and surges of DC fast charging, was dubbed the "dragon curve" in order to encourage efforts to tame the load. Of the alternative futures we analyzed, this unconstrained profile has the largest contribution to peak in 2030 with 3.5 gigawatts at around 7:00 p.m. On the next slide we reinstate TOU rates at midnight.

But the gas station model examines a future where among the 5 million ZEVs by 2030, only 40 percent of drivers have access to charging at home, instead of the 72 percent that Matt described.

In lieu of charging being installed at homes, charging is provided at work and at public chargers which represent a net increase in the network of 14,000 chargers. Charging at home is -- charging at home and fast charging during the day and evening result in a peak loading of about 1 gigawatt less than the uncontrolled scenario and is approximately equal to the BAU

scenarios, the first two that I described. The next slide contrasts with this gas station future.

Enabling Level 1 charging at work and public sites replaces 360,000 Level 2 stations with 620,000 Level 1 stations. We're still examining how charging speed trades off with the size of the network as this would be a net addition of 250,000 chargers, or 35 percent, and implicates the construction of tens of thousands of additional stations.

Similar to the midnight TOU scenario, daytime demand remains relatively flat with 2 gigawatts of peak loading at around 7:00 p.m.

The next slide is our final alternative future for light-duty vehicles. Here, plug-in hybrid electric vehicles are required to charge at all workplace and public Level 2 opportunities. However, despite growing the network by over 100,000 chargers, maximizing electric vehicle miles traveled only serves about five percent more kilowatt hours than the BAU scenarios.

I'll note that this does not represent an "EV happy hour" scenario where load en masse is

shifted from residential locations to nonresidential locations. This EV happy hour scenario is still in progress. Instead, this future demonstrates the limits of the additional watt hours that could be served by nonresidential Level 2 locations after drivers get most of their charge at home. Further analysis will analyze the tradeoffs here. But this scenario has peak load of around 2.5 gigawatts, which is nearly equivalent to the TOU and gas station futures.

The slide features load from EVI-RoadTrip. RoadTrip solves for a subset of DC fast charging for light-duty vehicles traveling more than 100 miles across regions. This load profile is more sinusoidal than the intra-hour travel charging patterns which represents some alignment with solar energy, but this is not exact. We examined the load by varying the state of charge in which the travelers unplug their EV and continued upon their journey. Across both behaviors, charging during the peak time of 7:00 p.m. still represents over half of the maximum daily load.

We also examined the RoadTrip load profiles to understand the possible benefit from

energy storage, acknowledging distribution impacts from high-power charging demand fluctuating within one hour. The behavior where drivers are always topping off, or ATO, to nearly a full state of charge results in almost twice the amount of variance and demand within a given hour. This is shown in the blue series in the lower graph. Most prominently in the 10:00 a.m. hour, demand jumps 50 megawatts, or a quarter of the total network demand. At the individual station level, this suggests that storage is more valuable for demand charge mitigation or voltage stabilization where people take elongated charging breaks.

On the next slide we profile charging from LBNL's HEVI-LOAD model. HEVI-LOAD, as described yesterday, is still in early development. So at this stage, rather than focusing on the peak profile, take note of the shape variations across the trucks, tractor-trailers, and transit applications and their relative growth over the decade. As described yesterday, the introduction of these vehicles across the state, in accordance with the Advanced Clean Trucks Rule and other emissions reduction

rules, will affect where and when grid upgrades are needed. We can estimate a need for several gigawatts of charging load for these vehicles by 2030.

However, developing more realistic profiles below the transmission level requires incorporating additional behavioral and technology insights given the site specificity of these fleet operations. For example, acute upgrades at the substation level may be needed once individual connectors rated for several megawatts are completed. Of interest is the Megawatt Charging System that is undergoing tests at the National Renewable Energy Lab with the support the Clean Transportation Program.

With a wide range of grid conditions that could be posed over the next decade, the state, working with automakers, charging companies, and utilities will need to employ new tools to maintain their reliable, cost efficient, and low-carbon operation of the system. This is where, on the next slide, smart charging becomes essential.

Smart charging will ensure that transportation electrification is operated in a

way that maintains and improves reliability, reduces customers costs, and integrates renewables. There are two key parts to this equation, first, the objectives and associated price signals to motivate action.

Second, the actors and enabling equipment, or hardware and software as it's known in AB 2127. Utilities and the California Independent System Operator will have to manage the challenges of new charging load at the transmission and distribution levels which will, of course, vary geographically throughout California. Fortunately, markets and price signals can encourage charging to shift from the peak system demands to, instead, earlier in the morning or later in the evening.

Shown left, with a tariff from Southern California Edison, Edison employs a two-period TOU rate to shift demand, especially during the summer. In contrast, on the right, during spring, San Diego Gas and Electric has six periods to integrate renewables and to avoid peak loading. Beyond these currently available rates, the location and temporal granularity of prices may continue to become more specific with the

ongoing Load Management Standard rulemaking at the Energy Commission.

Balancing the complexity of grid operations while offering convenience and cost effective electric mobility is where manufacturers and network aggregators come in. Utilities, in theory, may send these price signals to charging systems directly using direct load control.

However, more commonly, and the perhaps more flexible approach, would appear to have EV charging signals be sent to EV service providers or automakers that coordinate responses to, for example, Open Automated Demand Response signals. Here, an aggregator could use equipment management protocols, like Open Charge Point Protocol, to the EVSE or, eventually, distributed energy resource protocols to a local energy management system if one is available at the site. This flexible networking design is scalable for any of the charging implementations that we described today, home, public, for passenger cars, or at depots for medium- and heavy-duty vehicles.

To maximize the foresight of customers'

energy and departure presentation, implementing a common and unique two-way communication between the charger and the vehicle is critical. As Jeffrey will describe, this Vehicle-To-Grid communication interface, which is being implemented by the majority of the automakers as part of the Combined Charging System, will help customers get the electricity that they need in a way that is grid friendly and, therefore, least cost.

You might be asking, why is Vehicle-To-Grid communications important? And isn't that technology always five years away? On the next slide, I illustrate why we must harness the gigawatts of mobile energy storage to increase energy resiliency as soon as possible.

As everyone is well familiar, last August's extreme heatwave across the West posed resource challenges to California's electricity system. By the end of the month, two-thirds of the portable gasoline generators, less than 18 kilowatts, hosted online by Home Depot were sold out. The following week, with skies gray or orange in the Bay Area, with the sun occluded by wildfire smoke, shown on the left, CAISO's

Outlook reported a 37 percent reduction in solar generation.

Like prior years in which Public Safety Power Shutoffs induced stories of customers yearning for electricity, including some who jury rigged their car's 12-volt batteries to refrigerators, not only is there increasing interest but there is an imminent need for zero-emission alternatives that are also extensible for other VGI applications. This demand for storage will only increase as the state commits to 100 percent clean energy, as illustrated by our colleagues' SB 100 Report.

While tapping your car's energy storage has been a niche use case for the past decade, more automakers, and a select few shown on the next slide, are outwardly describing their intent to offer bidirectional charging.

For example, Lucid Motors has described their Air to offer vehicle-to-home during outages, and during daily operations for vehicle-to-building services to offset commercial demand charges, especially when aggregated with other cars. Rivian, in 2019, described capabilities of vehicle-to-vehicle charging. Similarly, Ford is

actively advertising on television the current F-150's capability for vehicle-to-load which ranges up to 7 kilowatts of capacity, enough to power a mobile metal shop, for example.

During last week's Staff workshop, we heard these automakers, and five other manufacturers, highlight the growing potential for bidirectional charging as batteries become more energetic for less cost and more intelligent in order to protect their driver's mobility and the vehicle's warranty. So while OEMs continue to surmount technology challenges, the next slide highlights the need for ongoing assistance by the state to commercialize V2G.

First, the state needs to support bidirectional charging by confirming administrative pathways for inverters designed for mobile energy storage. The CPUC's Rule 21 decision from September identified procedures for interconnect DC V2G chargers and plans to pilot AC V2G while automotive and electrical technology standards harmonize.

First-of-their-kind projects that seek to open this unlocked door have raised to us a potential to leverage the Energy Commission's

Solar Equipment List to validate the grid and safety functions of bidirectional charging and interconnects more quickly. We'd like to understand if that option, or some other mechanism, will be useful to assist developers' efforts as we prepare for future summers.

Second, the state needs to unlock greater value or revenue-generating options for bidirectional charging to assist with the range of reliability services I've outlined earlier. For example, last week, manufacturers echoed the need for longer-term market opportunities to alleviate congestion or, if well orchestrated, even defer upgrades beyond the day-to-day operations that were the main focus of our scope.

And finally, to conclude, we want to acknowledge that AB 2127 serves chiefly as the CEC's charging infrastructure needs assessment and is not the main forum for VGI planning. However, as I began today, since this analysis is so foundational to understanding what's next for electric transportation, we will be coordinating this charging assessment with the ongoing draft of the VGI Roadmap due later this year.

Next, my colleague Jeffrey Lu will

describe our assessment of the equipment hardware and software that is necessary to realize this grid-integrated future.

Thank you for listening.

MR. LU: Hi everyone. This is Jeffrey Lu. I am Staff here at the CEC and one of the coauthors of this report. I am here to discuss our report's findings regarding charging connectors and communications. And I think maybe, first, it's helpful to talk about existing conditions.

Next slide.

Today, EV charging -- the EV charging experience is siloed. There are different connectors for different vehicles. And sometimes there are even different connectors for Level 2 charging and fast charging on the same vehicle. On top of that, there are lots of charging networks, each with their own RFID keycards and their own apps or other authentication equipment.

Since there are currently multiple fast charging standards, drivers who need to find a fast charge not only have to identify a nearby fast charging station, but they also have to make sure that that particular station has a charger

with an available connector that's compatible with their particular vehicle. Now sometimes drivers can use connector adapters. But these often run hundreds of dollars and they're also not available for every connector in the market today.

Often times pulling up to a new charger on a network that you don't usually charge on requires another app download, meaning that a lot of drivers will just not utilize certain stations because they don't want to go through that hassle. These virtual walls which exist today are stifling the potential of the charges which are actually already out there.

Now, to the industry's credit, many EV service providers are entering roaming agreements to reduce this friction for their customers. But overall, when we step back and look at the charging experience today, charging is, at best, not maximally convenient, and it requires a notrivial level of baseline knowledge and investment from drivers. And at worst, it's actively confusing and discouraging, and it's holding back folks from switching to EVs.

I know some folks might be looking at

these rhetorical questions I have the screen and thinking, well, they're pretty basic questions. But these are actually real challenges that people face today.

A while ago I was hiking up at Point Reyes and a group of friends pulls up in a Model-S that they had rented for a road trip across Northern California. They had something like 30 miles of range left, so they had navigated to the charging station at Bear Valley Visitor Center which has a couple of 1772 connectors there. They were surprised and frustrated to find out that the charger plug didn't fit in their vehicle. And when I suggested that they check whether or not their rental came with a 1772-to-Tesla adaptor, they had no idea what I was talking about. They weren't really sure what to do. So eventually I pulled up PlugShare and ended up suggesting that they head to a nearby hotel which had a Tesla destination charger. And I think they would have just like barely made it based on the range that they had.

Now this is just one anecdote but it illustrates how charging is not obvious to many people today. The folks in this anecdote, they

were not backwards people who, you know, refused to change with the times. They had gone out of their way to rent an electric Tesla for the road trip and yet they found charging confusing. And the experience probably left a bad taste in their mouth.

So as we look forward to deploying hundreds of thousands, if not millions, more chargers over the next ten years, it's not enough just to get chargers in the ground. We're working for the larger vision of decarbonizing California. And to get there, charging needs to be easier, smarter, and better than gassing up. This is entirely doable. And we're hoping to work with a lot of the folks who called in today to get there.

Next slide please.

I want to briefly touch on fast charging connectors that I mentioned earlier. There are currently three on the market today and they all do very similar things. Basically, they all deliver power to your battery on the order of 50 to 300 kilowatts. Yesterday, Matt Alexander described our EVI-Pro 2 and EVI-RoadTrip models. And I want to reiterate that our models assume

that any car can charge with any charger. So continue fragmentation of fast charging connectors will necessitate even more chargers than what our models currently project. From a practical standpoint, this means that industry and government will have to pour money and more time into building a larger charging network but for no tangible benefit. We don't get any more electric miles enabled. We don't get any more emissions abated. And we don't get any additional air quality improvements.

Next slide.

Helpfully, however, I think the numbers suggest the market has decided on moving forward with standardization around CCS. An analysis from CARB late last year found that model year 2022, 51 of 59 EV models expected to be available in California will use the CCS inlet for fast charging. Separately, CARB is also moving to introduce requirements under Advanced Clean Cars II to require that vehicles sold in California be equipped with the CCS inlet, or an adapter, starting with model year 2026. So the momentum is very clearly behind CCS.

Given this context the report calls for

the CEC to align technical requirements with both the market's direction and, also, CARB's pending regulatory actions. At the same time, we'll also be keeping an eye on supporting legacy connectors which are still on vehicles rolling around the state.

Next slide.

This is mostly a reiteration of some of the material I introduced yesterday during the off-road section. But a lot of similar challenges exist in the medium-duty and heavy-duty space too. Many early adopters of electric and VHD vehicles have voiced concerns about the lack of interoperability and specifically highlighted the need for greater standardization when it comes to charging. This is especially true in environments where you have multiple equipment types. So, for example, at ports or railyards, you might find yard tractors, forklifts and other cargo handling equipment.

Today there's a pretty large range of connectors that are available for these vehicles. Some are proprietary connectors. And some are even repurposed connectors that were originally designed for the light-duty segment. CCS is

actually a pretty common choice for many of the early on-road medium-duty/heavy-duty vehicles where DC charging with CCS works well for some applications, such as overnight charging or longer duration charging.

Many standards designed specifically for medium-duty and heavy-duty are still being worked on. And the sector overall is also just ramping up electrification now. So by being proactive about charger implementations which conform to standards, we have the opportunity to get this right early on and to avoid the fragmentation that we see in light-duty today. Keeping a focus on charger interoperability will be key to accelerating electrification in this sector which, in turn, is critical to reducing toxic air pollution, especially in communities near trucking corridors or ports or railyards or airports.

That said, we do recognize that there will be many different physical interfaces for charging, given the wide range of use cases in medium-duty/heavy-duty. Some will stick to a conductive plugin/plug out connector, such as the under-development Megawatt Charging System. But

there are other form factors, too, such robotic pantographs or wireless charging.

Regardless of what the appropriate physical interface is, we need industry and government to prioritize chargers which conform to industry standards to maximize interoperability. So, for example, pantographs should be designed to SAE's J3105. And conductive connectors should be designed to CCS or MCS. Technical requirements of CEC programs and funding opportunities will reflect this going forward.

Next slide.

So that's connectors. I want to pivot from that over to communication protocols. Today, basic low-level charger-to-vehicle communication is widely used. And this signalling scheme is sufficient for communicating the desired charge current, but it doesn't have any cyber security provisions, and it's not capable of communicating information such as billing, desired departure time, grid signals, such as pricing, carbon intensity and things and so forth.

So what this means is that any setting

for charging that isn't a charge current has to be done separately from the charger. If you want to pay, you have to take out your credit card, call a number or fire up an app. If you want to communicate departure time information, you have to set it on the charger or set it on the charger's app, if this is even possible at all today. And if you want to align charging to low electricity rates, you have to manually set timers, and you have to manually update those timers if TOU rates change by season and by year.

And by the way, if you visit a charger on a different network or buy a replacement charger for your garage from a new manufacturer, you're probably going to have to go through all of these steps all over again.

So generally speaking, today, it's the responsibility of the driver to figure all of this stuff out and to be the liaison between all the different actors. I know for some folks this is actually probably fun and it's like a technical puzzle. But for most, this is not a delightful experience.

That said, our analysis does suggest that this is changing. A lot of automakers and

charger manufacturers have begun rolling out products or have announced future products which will use ISO 15118 for high-level communication between the vehicle and charger. And this is happening both here in the U.S. and globally. ISO 15118 is basically a language that the car can speak to the charger and the charger can speak to the car, and it supports the exchange of information such as authentication, billing, grid signals, and it also support cyber security provisions.

Using ISO 15118 opens up a whole new world of features which can make charging more convenient, smarter, and more grid responsive. In the near term a lot of automakers, in conjunction with charger networks and manufacturers, are implementing 15118's Plug and Charge feature which enables a driver to initiate and pay for charging sessions simply by plugging in. This means that you can pull up to a fast charger or the shared charger at your apartment building or at the grocery store and all you have to do to start and pay for charging is plug in. There's no need for an app. There's no need for fumbling through for I.D. cards. There's no

credit card swipe. This is actually a huge step in making charging super easy, intuitive, and simpler than a trip to the gas station.

Some products already support plug-and-charge today. For example, the Ford Mach-E, the Porsche Taycan, and also chargers from Electrify America and Greenlots. And there are many more coming down the pipeline.

In addition to Plug and Charge, ISO 15118 also supports the exchange of information for grid-responsive charging and bidirectional charging. In fact, as Noel mentioned, at a CEC workshop just a week ago or two weeks ago, industry panelists indicated that 15118 will be key to enabling features such as vehicle-to-home and vehicle-to-building, which can provide energy residential during wildfires, wind storms, or other grid outages. This means that 15118 in home chargers is going to be critical going forward, as well, not just shared chargers. And 15118 is also the basis for communication for a lot of developing interfaces, such as wireless and pantograph.

So given all of this, and to support this market direction, the CEC will prioritize

deploying chargers which are at least hardware-ready to support ISO 15118. And we'll do this through technical requirements and, also, other avenues. This is in alignment with the CPUC's draft transportation electrification framework.

I should also add that ISO 15118 is backward compatible. And if you have a vehicle that uses the 1772 connector today, you can still charge using a charger which speaks ISO 15118. However, the chargers that we deploy today are going to be in the ground for years. So we need to prepare for the next generation of vehicles coming off the line, and also ones which are already here that can take advantage of ISO 15118. This means prioritizing chargers with the necessary hardware transceivers and security modules to enable features like Plug and Charge. To folks who are on the line and well versed with the implementation of ISO 15118, we'd be curious on your thoughts on how to best define hardware readiness.

Next slide.

In addition to 15118's rule in simplifying the charging experience, the report also identifies widespread use of 15118 as a key

enabler of vehicle-grid integration at scale. As discussed before, 15118 is a common language for chargers and vehicles to exchange information about billing, grid signals, and mobility needs. And an example of a mobility need would be, "I need 50 miles by 3:00 p.m., which is when I leave to go pick up the kids." These are all critical tidbits of information that we need in order to enable grid-integrated charging.

Now here's how smart charging might work today without 15118. If I have a JuiceBox charger at home, I use the JuiceBox -- JuiceNet app to set my target range requirement and maybe enable participation and demand response if my utility supports that. But then if I drive to the library which uses PowerFlex chargers, I have to set all those preferences all over again using the PowerFlex app. And I have to rinse and repeat for any other charger that I might visit. There's a lot of redundancy. And the different actors are siloed and, generally, don't communicate with one another.

Now the way 15118 is designed, charging revolves around the driver via their vehicle. So the driver sets their range requirements,

departure times, price preferences, whatever, on their vehicle or through the vehicle's app. And whenever the car plugs into a charger, the charger passes along any pricing or grid signals to the car. Using all of this, the car can make decisions on how best to optimize charging based on your preset preferences and any of the dynamic information that it gets from chargers.

So what this means is that as long as cars all speak 15118, this dynamic information can be seamlessly exchanged anytime and anywhere a car is plugged in. It doesn't matter what charger network you're on, who the charger manufacturer was, what model car you have. This ability to exchange VGI parameters between any car and any charger, as a result of standardizing around 15118, is precisely why the report identifies 15118 as being so important to vehicle-grid integration at scale, and the key is at scale.

And to make this annoyingly clear, if you have a 15118-capable charger and it's ready to go with all sorts of juicy information for grid-integrated charging, if a car pulls up that doesn't speak 15118 and plugs in, it will start

dumb charging. There's no seamless way of exchanging any pricing or grid signals. Here we just lost an opportunity for VGI, or we're back to that siloed approach where it's, you know, separated by network and by app.

Same thing if you flip it around. If you have a 15118-capable vehicle that pulls up at the legacy charger, since the charger isn't capable of communicating any pricing and grid information we, again, lose an opportunity for VGI, like smart charging or bidirectional, like vehicle-to-home. By maximizing the number of cars and chargers that speak 15118, we at least have the opportunity to achieve grid-integrated charging at scale.

Now given that grid-integrated charging is critical to decarbonizing transportation, we want and, indeed, need to prioritize ISO 15118-ready chargers for all drivers in all communities. We have an opportunity to lead globally here.

As a clarification, preparing for ISO 15118 does not prevent other ways of achieving VGI and can actually compliment other implementations. So if an automaker really wants

to do smart charging over telematics, they can still use Plug and Charge to simplify the customer experience using 15118.

That said, given the market announcements from both automakers and from charger folks, we view ISO 15118 as the most promising common language to enable widespread vehicle integration. And where appropriate, the CEC will update its own technical requirements to support this work.

Next slide.

While 15118 covers communication between the vehicle and the charger, Open Charge Point Protocol, or OCPP, covers communication between the charger and the backend network which is used to monitor and manage those chargers. OCPP is actually already the de facto standard for charger network communication. And the report identifies prioritizing OCPP-compliant chargers as an action which can further expand market choices and appropriate product lock-in.

Generally speaking, and this is broad strokes here, any OCPP-compliant charger can communicate with and be managed by any OCPP-compliant network solution. This is actually

pretty powerful because it gives site hosts a two-way flexibility when it comes to hosting chargers. If a site host likes a particular OCPP-compliant charger management network, they can use that network to manage any variety of chargers so long as all of those chargers also speak OCPP.

You can also flip this around. If the site host already has a mix of OCPP-compliant chargers, they can shop around for network solutions based on features and costs. Maybe that site host wants to implement reservations for their chargers. They can switch to a different network provider which has that feature implemented as long as it also speaks OCPP. This two-way flexibility is important for expanding market choices both in terms of charger hardware and network solutions. So that's the first major benefit of OCPP standardization.

The second benefit, which applies to networked charging more broadly, is that it enables a whole host of management features which are critical to VGI, and also critical to making chargers more easily shared among many drivers. With networked charging, you can manage access to

your chargers, and you can even finely control access by driver groups. So, for example, on weekdays you might set your chargers to only be usable by employees at a particular office building. Or say, if you're an apartment manager, you can set your chargers to grant your tenants preferential pricing and access, but still have those chargers be open to the public overall.

OCPP has provisions for reservations which may be useful for chargers with high utilization or lots of sharing, say at an MUD. And of course, OCPP can pass along grid signals it receives from utilities, aggregators, or other actors to enable grid-integrated charging.

So given these two advantages of product flexibility and also management capabilities that you get with OCPP, the CEC will prioritize OCPP-compliant chargers moving forward and update its technical requirements to reflect that.

As a final note, I want to emphasize that everything we presented here is a reflection of our analysis of where the market is today, but more importantly, the direction it's headed. And when we talk about prioritizing 15118 and OCPP,

it's our view that this mirrors where the market is, but it's also a nudge so that we can move more quickly to enable easier and grid-integrated charging at scale, that means for as many drivers, cars, chargers as possible.

We are putting chargers in the ground now. And we want to make sure that these chargers are ready for the next generation vehicles, and that they're ready to play a larger role in providing energy resiliency, and also decarbonizing California.

We have had conversations with many of the folks who are called in today and recognize that these technological changes are not trivial. We hear you and we're moving forward with funding for a standards testing lab here in California and, also, vehicle interoperability testing symposiums, so that's our ViGIL solicitation, and also our recently proposed testing events, RFP, which we're now calling VOLTS. As always, if you have feedback for how we can better support easier, smarter charging, we're all ears.

That's all I have. Thanks for setting aside time and being here with us today. Let's move into question and answer.

MR. RAMESH: Thanks, Micah, Noel, and Jeffrey.

We'll start with the Q&A box. And then I saw there were some raised hands, so we'll move there as well.

First question from the Q&A box from Karim Farhat at ENGIE, "Thanks for this presentation, very informative. Among the various types of chargers charging, which are assumed to be impacted by utility time-of-use rates and which are not specifically for all considered scenarios? DCFC seems to have significant impact on the grid. Are DC fast charger load profiles assumed to be impacted by utility-imposed time-of-use or private-party imposed private pricing structure that looks like TOUs?"

MR. CRISOSTOMO: I'll take that one.

Karim, as we've described in Matt's presentation and briefly during mine, right now we haven't incorporated the data response from the utilities -- thank you, utilities, for submitting them -- which would impose different hourly price periods. So while we haven't done a smart charging analysis yet we plan to.

That said, prices have not been used as a

constraining factor in the network design. But we were actually just talking about that potential for that type of analysis with HEVI-LOAD this morning. So that's a nice idea. We'll consider it.

MR. RAMESH: Great. I have now allowed Dean Taylor to talk.

Feel free to un-mute. Dean Taylor?

MR. TAYLOR: I apologize. I didn't mean to have my hand up. I think that was a mistake.

MR. RAMESH: Okay. No problem.

Moving on to Steve Davis. I have allowed you to un-mute.

MR. DAVIS: Great. Thank you so much.

Micah, Noel and Jeff, I -- this is less of a question and more of a comment. I think this is just a red-letter day for the State of California. In the last IEPR workshop that I attended I responded with some comments that I -- you know, were deliberately planted in that I was concerned that we were still, you know, languishing without clarity, technical clarity, of what we needed to do for a revolution-scale adoption of electric vehicles. And as a proponent of the -- everybody knows I've been a

proponent of the ISO 15118 standard for many years now, but I've never seen anything quite like this.

So I think that my constant discussion of simple always wins, and the best time to plant a tree is always 20 years ago, we're now really, with today's workshop, discussing with moral and technical clarity. And I really did appreciate Noel's use of satellite images to underscore that, as Jerry Brown used to say, "This is damn serious."

And we're going to need lots and lots of storage to integrate renewables that we're going towards. And we're going to need to have a simplicity for the consumer to tease forward the accelerated adoption of these vehicles. And a plug-and-play world and the homogenous ecosystem of plug-and-play for electric vehicles is absolutely unequivocally the way for us to go. And I think today we just -- I heard the State of California say that that's what we need to do and we need to start investing in that direction.

So, in addition, the plans for a series of testing symposiums and a testing lab in the state of California is going to put a marker to

the automakers that have already made their sounds that the ISO 15118 standards is the way they're going anyway. And the State of California is now saying, okay, we hear you and we're going to embrace that technology so that you can embrace that technology.

And far more than that, what that ecosystem enables is innovation by all sorts of small players that are going to leverage that plug-in-and-charge functionality and capability and simplicity in ways we can't even imagine now.

So this is a really great day. I compliment. Patty, I compliment you. I compliment Noel and Micah and Jeff because this was very clear and really moving the ball down field, so thank you all.

MR. RAMESH: Thanks for that comment, Steve.

Okay, moving on to Ray Pingle. I've allowed you to un-mute.

MR. PINGLE: Thanks. This is Ray Pingle, Sierra Club California. And I'd like to, first, echo Steve's comments. I mean, I think this is a red-letter day and another round of excellent presentations.

And I also appreciate putting forth very clearly that we have to have VGI. It's just not a nice thing to get revenue for school buses, although that's very good, but we've got to have it to get cost-effective infrastructure in place that's fully functional and easy to use.

So this first question/comment I have is for Noel. And you know, I appreciate and learned a lot from all of these various load profiles assuming different charging scenarios, such as the gas station, the timed, and so on. But I think it would be helpful for the final draft of this report to also build a draft hypothetical ideal profile.

For example, if we assume that we went with smart charging, we may want to allow charging to start at 10:00 p.m. and, you know, extend until 7:00 a.m., something like that, but have staggered starts or lower levels so that it's flatter during that period, combined with charging for those vehicles that are parked during the day at employers that could take advantage of that charging.

So, in other words, it's good to see all these problems, but it would be helpful to come

out with a vision of where are we trying to head? And I know that won't be finalized for a while but I wanted to bring that up for one thing.

And then --

MR. CRISOSTOMO: Yeah.

MR. PINGLE: Go ahead, Noel.

MR. CRISOSTOMO: Yeah. If we can take this piece by --

MR. PINGLE: Yes.

MR. CRISOSTOMO: -- since that was a lot? Thank you.

Totally agree with the need for fine granular analysis and building in the flexibility of adaptation in our equipment, as Jeffrey was describing. We don't know how the market will necessarily react, given the high-level analysis, network analysis, for EVI-Pro 2. As we described yesterday, we don't have exact locations for which workplace or which parking lot for light-duty vehicles yet. That's really where our partnerships with third-parties deploying the equipment, sometimes, where are incentives come in.

And so, hopefully, we will be able to, with the right enabled hardware, respond to the

risk of simultaneous of class-wide rate designs. This is where the high-level communication and automation of when people need to go can afford a more smoother and sinusoidal optimal rate design -- or sorry, optimal load profile shown on the By-Departure-Time load profile.

So we don't have all the answers yet. Those load profiles are visions for the future still. But we can't optimize without the enabling equipment. That's the point of our work.

MR. PINGLE: Yeah, and that's fine. And I guess all I would say is, and this may be obvious, but to say the goal is, ideally, we'd like just a flat load curve 7/24. We know we can't get there but we want to do what we can using the optimal combination of all of these technologies to get as close to that as possible. And we won't know that -- how to do that until we get deeper into it.

But the other thing I wanted to bring up is you get a lot of questions from consumers that are all interested -- that are at all interested in this. And they say, first of all, what is it going to do to my battery warranty?

But, also, I think it might be helpful to start developing, again, kind of a draft vision from the lens of the EV owner, you know, that's going to do this, just to get more understanding and buy-in to the overall process, to say, you know, for example, you can decide you don't want to participate at all, that's one level, or another level is you want to participate but only to allow management of when the charging occurs, but you're not going to take anything out of my battery. You can just control when power goes in.

And the third is maybe I would authorize, especially if I can get some revenue, frequency regulation, but I don't want to do wholesale export, something like that. So just some gradation so people can start getting their heads around what might this look like for the driver.

MR. CRISOSTOMO: Yeah. Absolutely. This is where our engagements with industry and the charging service providers working with the automakers will be really important so that the operation of the VGI application is, one, always opt-in or at least acknowledged by the user. VGI isn't VGI for the purpose of the grid only. It's

principally designed to make sure that we meet our needs for transportation, of course.

MR. PINGLE: Right.

MR. CRISOSTOMO: And so the implementations beyond smart charging or V2G will necessarily be an actuated decision by the customer --

MR. PINGLE: Great.

MR. CRISOSTOMO: -- with the help of their enabling technologies.

MR. PINGLE: Great. Thanks. And I just have one more question and it's for Jeff.

Jeff, so as far as the connector standards on medium- and heavy-duty, because many, as you mentioned, many medium- and heavy-duty vehicles right now are using CCS for as high up as the power goes. And the MCS charging standard, hopefully, is going to come pretty soon. But do you think it's likely that the de facto conductive charger standard will, basically, be CCS, just the different power levels, but the physical connector would be the same -- could become the conductive standard; is that fair to say or" --

MR. LU: I think that's certainly a

possibility. I think, based on some of the things we're heard from the manufacturers of medium- and heavy-duty trucks is that CCS is going to be deployed in the first generation of trucks that are going to be rolling out onto the roads. And so, I mean, that might help make CCS become the de facto standard, at least in the short term.

But that said, there are plenty of applications and plenty of manufacturers that are interested in, eventually, migrating to higher-power solutions, especially to catch those corner use cases where 350 or even 500 kilowatt CCS charging just doesn't get you there, so --

MR. PINGLE: So my point, though, is that, I mean, mechanically, the MCS standard will have the same physical plug template, right, as a CCS today, and the only difference is the power level?

MR. LU: I don't believe that's true, no. I believe MCS will be physically different than CCS.

MR. PINGLE: Oh, will it? Okay. All right. Okay. That's my question. Thank you.

MR. RAMESH: Great. Thanks Ray.

MR. PINGLE: Thank you.

MR. RAMESH: I'm now allowing Kristian Corby at CalETC to talk. And this is a good time to remind everyone to please introduce yourself with your name and your affiliation before you begin your question or comment. Thanks.

MR. CORBY: Good afternoon everyone. This is Kristian Corby at the California Electric Transportation Coalition.

And I want to start by really thanking Staff for all their hard work on these presentations, both today and yesterday. It's been very, very informative and, really, a ton of useful information. So, really, thank you very much.

And I wanted to definitely throw support behind the standardization of the connector types. I think, you know, as – like Steve said, like teasing forward EV adoption, that's going to be something that will really help uh streamline for the market. And I've certainly heard from our constituents that that's something we're very interested in.

The um you know, one thing CalETC has had

some issue with is the adoption of ISO, or some concern with is the adoption of ISO 15118. And I think it stems from um two main points, one being that we were kind of hopeful that the market would be able to kind of make this decision and kind of allow for some um more open competition around which standard would end up -- either end up being the best or end up being adopted or end up becoming the most popular.

But then secondly and probably more importantly, is the concern around just low-cost charging and making sure that there aren't additional added soft costs to charging and keeping the prices as low as possible and affordable as possible so we can ensure that not only is -- you know, not only do we have EVs being able to be owned and used by low-income communities and priority communities, but also that the fueling is affordable.

So you know, I think part of this is also a question, which would be, I don't -- you know, I'm not sure if the -- if Staff has looked into how much added cost would come from a mandate of ISO 15118? Or if there is additional soft costs is -- do -- does the Staff have a plan for how to

keep those costs lower or help subsidize those costs? Just kind of wanting to make sure that that was part of the plan with a potential mandate.

So thank you very much.

MR. CRISOSTOMO: Jeff, I'll start and maybe you can complement me.

So the first question about competition in terms of the industry selecting ISO 15118, we believe that the industry has, indeed, selected 15118 as the basis for high-level communication, low level of communication that's, of course, endemic with IEC 61851. And all but one of the manufacturers implementing CCS are planning to use 15118 for their high-level communication. So we do believe that the market has decided on the basis of high-level communication.

And, further, during our prior workshops in 2019, we explained a challenge with parallel implementation of high-level communications protocols. Essentially, multiple implications -- multiple implementations of communication within a single individual interface would create an interoperability problem. Essentially, if you were to implement one communication on the

vehicle, another on the charger, even though they fit together they would literally not be able to communicate.

So the common and unique implementation of a communications protocol between the vehicle and equipment as ubiquitously as possible is essential to enable that plug and charge future at the least cost to both the manufacturers who have stated their intention for their product lines in the next decade and the EVSE manufacturers who are trying to minimize the cost of operating the network.

So, yeah, we believe that competition is resulting in the level of market clarity that we have been examining for the past five years in earnest, or more, and that the low cost potential comes from that robust implementation of the standards that we have called out in a market where multiple providers are competing to offer the best solution for customers as effectively as possible.

Jeffrey, would you add anything to that?

MR. LU: Yeah, just a couple brief points.

Thanks for the comment, Kristian.

Definitely, cost is on our minds always. All else equal, we want costs to be lower.

That said, you know, we have a couple of efforts that we're doing, like the ViGIL solicitation of the VOLTS RFP, where we are trying to help industry get to the technological readiness to get this cost down.

So that -- those are some efforts on our end. Certainly happy to entertain any additional thoughts from industry on how they think we can help alleviate any cost concerns or how serious those cost concerns are.

And then sort of more broadly, you know, yes, I know, you know, implementing new features is going to cost money up front. But we also know this is stuff that people are asking for.

Last June we had Ray Leon, the mayor of Huron here on an IEPR panel. And he was saying, you know, in his community they want easier charging. They don't want to deal with these cards. You know, essentially, he was asking for plug-and-charge, though he didn't call it out by name.

And so we know that folks want this. It's already rolling out to consumers today, so

we want to do our best to support what the market is demanding but, of course, keeping costs down, in line as well.

But thanks for the comment.

MR. CRISOSTOMO: Just to really hit that point home, to quote Ray from our IEPR workshop back in June, he was saying that his communities deserve the best available control technologies, and that his communities don't want secondhand technologies.

We want an equitable and widespread distribution of smart charging such that it's easy and, effectively, as least cost and clean as possible for everyone, including disadvantaged communities.

MR. RAMESH: Okay. I will now allow Robert Perry to talk.

MR. PERRY: Hi. Can you hear me?

MR. RAMESH: Yes.

MR. PERRY: Okay. Great. Just want to echo the comments of my predecessors, great presentations, great tools. This really bodes well for accelerated adoption of VGI and, by extension, EVs.

This is a question for Jeffrey. You

know, your anecdote regarding the people with the, you know, spent battery really kind of switched on a light for me. And with respect to the ISO 15118 standard, is there any consideration concerning vehicle-to-vehicle charging? You know, like in your anecdote, if both of your cars were, you know, compliant with the standard and you had a full charge, you could conceivably give enough charge to give them security to get to the next charging point.

It also opens the door for, you know, incentivizing medium- and heavy-duty road service companies to, you know, to basically be mobile charge centers so that, you know, people, if they're caught in a bad situation, you know, the charging station comes to them. It seems to me that, you know, a big obstacle to EV adoption still is range anxiety. And developing a feature like that, while it's not -- there's not much grid in that scenario, would, it seems to me, really go a long way to ease people's minds and to make them more -- make the possibility of them buying an EV much more probable.

Anyway, I'd like your thoughts on that.

MR. LU: Yeah. Absolutely. I think

that's --

MR. RAMESH: One second.

Before you answer, Jeffrey, would you mind stating your affiliation, Robert?

MR. PERRY: Oh, I'm sorry. Robert Perry. I'm an energy policy consultant, working with the Climate Center and Vote Solar on California policy. And you know, I have a specific interest in how VGI can not only accelerate EV adoption but add significant resource adequacy to our energy system.

MR. RAMESH: Great. Thanks Robert.

MR. LU: Yeah. I think 15118 can be a compliment to that. If I'm not mistaken, 15118 adds provisions under 15118-20, which is currently being worked on the standards organizations, it has provisions for vehicle-to-vehicle charging. And we've also seen announcements, at least on the light-duty side, from Rivian, from Lucid, about vehicle-to-vehicle charging. Elsewhere in the industry, we've also heard about the sort of like charging as a service or emergency out of, you know, out-of-range services where they use vehicle-to-vehicle.

So, certainly, we think this is an

opportunity going forward. And I think supporting 15118 broadly and the charging ecosystem can also help facilitate those features later on.

That said, when it's vehicle-to-vehicle, like it doesn't really involve a charger deployment from our end. So in terms of us aligning technology requirements in our programs and things like that, there's not anything too specific, I don't think, that we can do to target vehicle-to-vehicle, other than specific solicitations. But I think supporting 15118 broadly will help us get there.

MR. RAMESH: Great. Thanks Jeffrey. I'll time check.

MR. CRISOSTOMO: Sorry.

MR. RAMESH: Oh, go ahead.

MR. CRISOSTOMO: For the record, the Megawatt Charging System that Jeffrey mentioned does have bidirectional features and is also based on that same technology.

So -- and, Raja, I believe you'll cover vehicle-to-vehicle charging very briefly during yours, so more to come.

MR. RAMESH: Great. So time check. We

have about seven minutes left for the question and answer session. I see there's one more hand raised but I'm going to go to the Q&A boxes first.

So first from Michael Coates, "What is the current inventory of MD/HD chargers and how was it obtained?"

MR. CRISOSTOMO: Jeffrey, was that a reference to your description of, I guess, a few interviews that we've had in workshops that we've heard?

MR. LU: Oh. Okay.

MR. CRISOSTOMO: -- on MD/HD?

MR. LU: Sure. Yeah. I thought that was sort of more of a counting charges question.

The current -- so we don't have like a database of medium-duty and heavy-duty chargers throughout the state right now. Counting chargers, I think, right now is strictly limited to the light-duty. But a lot of the thoughts that we've heard from medium-duty and heavy-duty have been through interviews and, you know, IEPR workshops where panelists, for example from the Port of Long Beach or from BNSF have indicated problems with interoperability in MD/HD charging.

I hope that helps.

MR. RAMESH: Great. Next question from John Holmes, "In terms of aggregator-managed charging, how are CEC addressing utility responsiveness to Rule 21 implementation which specifies IEEE 2030.5 for distributed energy resource dispatch, this in comparison to OCPP implementation?"

MR. CRISOSTOMO: Yes. Thanks John. If you could chat your affiliation just so we know?

Yes, OCPP is usually vehicle to -- sorry, equipment-to-network communication. We also understand that IEEE 2030.5 will be DER controls.

As I understand, there's a use case similar to OpenADR where the EVSE network operator could be an end node to send those DER controls to the EVSEs. So we believe that it's a compatible and extensible design. Let us know if we need to speak more about that.

MR. RAMESH: Great. And next question from Bjoern Christensen. "What can CEC do to convince the IOUs to fully get behind bidirectional EVs in their grids, including AC bidirectionality?"

MR. LU: I'll take a brief stab at that.

I don't know that we're going to try and convince IOUs of certain things but we're certainly going to work with them. We're engaged with the IOUs and their AC V2G pilots. We're also looking internally on how we can support AC V2G to get that technology more ready and, also, to support standards development and agreement in standards development in that area. So that's some of the work we're doing in that area.

MR. RAMESH: Great. Next question from Andrew Larkins, "Comment: It would be good to show renewable energy generation timing in the report to show the match between zero-carbon supply and electric vehicle demand. This would indicate optimum load profile."

I believe a graphic like this, similar to one presented in the draft AB 2127 report is in the IEPR report which also has the addition of the renewable energy generation window.

Anything else to add from other panelists?

MR. CRISOSTOMO: Yes. The RoadTrip profile is captured in the IEPR. But, yes, we are internally coordinating with the SB 100 Team and have reviewed that report to understand the

extent of storage necessary and the operational considerations for us to consider smart charging implementations.

MR. RAMESH: Okay. It looks like another comment from Andrew Larkins. "A flat load curve is not ideal due to the impact of daylight on solar generation."

Thanks for the comment, Andrew.

Next question from Enrique Rodriguez. "Hi Noel. Do all charger types discussed work with 1.4 kilowatt power?"

MR. CRISOSTOMO: Yes, as Jeffrey described, there is backward compatibility, since these are based on J1772.

MR. RAMESH: Great. Next question from Dean Taylor. "CARB has already regulated payment of public charging and mandated three solutions, plus mandated OCPP, but did not mandate plugin charge ISO 15118. Is CEC planning to regulate on SB 454?"

MR. LU: Thanks for that question, Dean. The short answer is no. We're approaching this from a hardware readiness standpoint in terms of deploying chargers that are capable of supporting ISO 15118. I don't know that there are any plans

to mandate that Plug and Charge be available or anything like that.

MR. RAMESH: Thanks. Next question from Margarita Parra. "Thanks for the report and presentations. A question that emerges, perhaps for further discussion, is how the revenues of the V2X services are going to be factored in on the electricity tariff? How can they really offset the Cap-Ex and Op-Ex of electric vehicles, especially fleets like buses?"

MR. CRISOSTOMO: Yeah. I know the CPUC has not yet established tariffs for V2G yet. They're working on those topics in the DRIVE OIR currently. But just as an example, the anecdote that I described, Lucid is offering demand charge management, don't necessarily need a V2X tariff. They just simply need to be able to interact with the system and safely interconnect. The tariffs that they would be interacting with as a storage device, not necessarily as a vehicle, per se, is just the regular commercial tariffs.

The extent of the demand charge management, the operation at the site and how those are remunerated for individuals, will determine the extent to which Cap-Ex and

additional Cap-Ex on this equipment would be paid off.

MR. RAMESH: Great. A comment for the record. John Holmes's affiliation is Paratelic Systems.

And next, a comment from Jamie Hall. "It's important to note that ISO 15118 is a series of standard business and cyber security processes and not just a single document. It's important to be very specific what aspect of 15118 we are talking about. We've heard comments about automakers already moving towards the standard but you need to go a level deeper. Many companies will take on the cost of implementing 15118 for basic DC charging. Beyond the basic functionality, companies may add to -- may add plug and charge functions, passive or active V1G functions, or even V2G functions. Business cases for the higher functions will drive implementation. There are real costs here, multiple back offices to coordinate, et cetera. And there are ongoing discussions around PKI and cyber security, so we support Kristian's reservations on cost."

MR. LU: Yeah.

MR. RAMESH: Thanks for that comment, Jamie.

MR. LU: I'll just quickly address some of the points there.

Absolutely agree, basic DC charging and moving beyond that will require different approaches and, of course, even more hardware for bidirectional.

We'd actually appreciate feedback on this from folks. We are talking about a charger hardware-readiness approach to 15118 for the short term. We're thinking about -- you know, obviously, that required the power line transceiver for the power line communications but, also, hardware security module for plug and charge. If other folks feel like there are other components we should be looking at or things we should be considering, please let us know.

And, incidentally, regarding PKI, we actually had a discussion with SAE earlier about their effort about PKI. So we are monitoring those efforts as well.

Thanks Jamie.

MR. RAMESH: Great. So we'll delay a few minutes by -- so we can take the remaining hand

from Erick Karlen. I'll just read Andrew Larkins affiliation for the record. Sygensys is Andrew Larkin's affiliation, a European company working on optimizing grid resiliency in the presence of EV charging.

Thanks Andrew.

Now I'll allow Erick Karlen to talk.

MR. KARLEN: Yeah. Thanks everyone, Noel, Jeffrey, Commissioner Monahan, really refreshing to hear what we have heard today. Just this intent, driver focus and grid focus, is exactly what the state needs to be doing at this point. And the pieces of the puzzle that we've heard elaborated on today are what is needed to happen to get to a point where not only is public charging as easy as using a gas station but is, indeed, easier and a better experience, which is what we should be striving for.

But also really importantly, this sort of direction is exactly what the industry needs to be hearing. We've heard the Commission, over the years, kind of contemplate different standards, arguably, not too much to kind of move towards them, so exciting to hear what we're hearing here today.

You know, as Jeffrey indicated, you don't really need to read the tea leaves to see where the industry is moving towards with respect to standardization. But with a little nudge we can avoid another five years of meddling on these issues and, you know, waiting for, perhaps, the industry to, on its own, fully coalesce to whatever standard people expect around a certain technology.

So really excited to see the Commission move here forward with the clarity, the direction, and the focus on these issues at the situation and across those who are out here today in this space.

Thank you.

MR. RAMESH: Thanks Erick. And would you mind stating your affiliation?

MR. KARLEN: Yeah. Sorry. Erick Karlen with Greenlots

MR. RAMESH: Great. Thank you.

Any response from panelists? Otherwise, we can move to the break.

MR. LU: No, but thanks for the comment, Erick. I appreciate it.

MR. RAMESH: So we'll keep the five-

minute break, so now we'll return at 2:40 instead of 2:35. Thanks. And talk to you all in a few minutes.

(Off the record at 2:35 p.m.)

(On the record at 2:40 p.m.)

MR. CRISOSTOMO: All right, everyone, we're going to get back started. And I'll turn it over to my colleague, Raja Ramesh, for the next presentation.

MR. RAMESH: Great. Thanks Noel.

So good afternoon. My name is Raja Ramesh. I'll present today on tailoring charging solutions to local constraints, which is covered in Chapter 6 of the Draft Staff Report.

So the central question here is how do we ensure charger deployment is equitable and effective? So building on Micah's discussion of distribution and grid capacity, Noel's discussion on EV charging demand analysis, and Jeffrey's discussion on standards, this is charging infrastructure that is accessible to and easy to use for, as well as meets the needs of, all Californians, meaning that it will be cost effective and effectively utilized by the community it lies in.

But how do we achieve this vision?

We'll move to the next slide.

California has a diverse built environment. Areas vary by local distribution grid capacity, land use, for example, multi-unit dwellings or retail, et cetera, space constraints, some parking may be in garages, on narrow streets, et cetera, and other characteristics.

Electric vehicle drivers and the communities they are part of also have a diverse set of needs, the time of day they expect to travel, their ability and willingness to share vehicles, as well as the different types of housing situations they may reside in. These communities know their needs best.

As a result, there is no one-size-fits-all approach to designing electric vehicle charging solutions. Instead, the report identifies the need for a BESTFIT approach which leads to solutions that fit the needs of a community in a cost effective way and produce multiple economies of scale.

In this, there are several form factors. On the left, ChargePoint's pedestal-mounted

charger which may be suitable for a parking area curb. In the middle, FreeWire's mobile battery integrated charger which may be suitable for tight parking garages or quick charges. And on the right, BEAM's transportable solar canopy integrated charger which may provide a cheaper charging option for spaces with high space and sunlight but low distribution grid capacity. These are illustrative examples. And other companies may make similar products.

Next slide.

Historically, transportation planning and projects have often insufficiently considered the needs of local communities, particular low-income and disadvantaged communities suffering disproportionate health impacts. To ensure the benefits of electrification are equitably distributed, policymakers must directly involve communities in identifying and planning high-quality charging solutions that meet local needs and yield direct community benefits. Here are three examples of ways to implement planning in a more community and equity-centric way.

First, the Greenlining Institute recommends planners involve communities by

including them in the budgeting for the event in their mobility equity framework.

Second, California Air Resources Board's STEP, or Sustainable Transportation Equity Project, guidance on community outreach recommends compensating community members for participating in outreach events to determine needs.

And last, the Energy Commission has awarded $2 million in grant funding throughout the state, as you can see in the map on the right, to develop electric vehicle-ready community blueprints which would bring together stakeholders, such as local governments, port authorities, workforce development interests, businesses, community-based organizations, and more to understand community needs and prepare for transportation electrification.

Innovative ideas, like multimodal transportation hubs that provide EV charging, have emerged from efforts like these. The Energy Commission recently awarded $7.5 million in grant funding for some of these communities to implement their blueprints.

To take one example of a community

blueprint, Ventura County solicited input from more than 100 major employers and property managers, as well as more than 1,000 employees. In addition, they reached hundreds of additional residents through holding focus groups, two out of three which were delivered in Spanish, listening sessions, lunch and learns, and tabling at community events. They used it to understand and develop from these efforts to set 11 electric vehicle and electric vehicle infrastructure-related targets, including to deploy chargers at or near the 100 largest workplaces in Ventura County by 2025 and to deploy at least two electric vehicle charges at or near the 100 largest multi-unit dwellings and the 50 largest multi-unit dwellings in disadvantaged communities by 2025. This is a great example of how planning can be used to achieve the ideas outlined in the previous slide.

Moving to the next slide, local jurisdictions across the state have modeled how several policy tools can be used to implement the vision of a BESTFIT approach to charging infrastructure that meets community needs in an equitable and effective manner.

First, they've shown building codes can be used to increase access to charging to encouraging charger installations, make adding charging later cheaper and easier through encouraging distribution-level grid upgrades, or even reduce the impact of charging on the grid through encouraging load management systems to allow multiple charger plugs to share one electrical connection. Building standards at a state level can build off of these local practices as well.

Second, streamlining permitting can make it faster and cheaper to install chargers. When permitting processes are straightforward and consistent across the state, charging infrastructure deployment can scale quickly. The Governor's Office of Business and Economic Development has launched a permitting Olympics effort, progress towards which is captured in a screenshot from their website at the bottom of the slide.

Finally, solicitations, like the Energy Commission's BESTFIT approach -- Best Fit Innovative Charging Solutions, can encourage electric vehicle service providers to build

innovative charging solutions tied closely to local needs.

As you'll see on the next slide, which shows the number of applications received in each category for Phase 1 of this solicitation, there are dozens of companies with innovative ready-to-deploy solutions in order to achieve the vision of a BESTFIT approach to charging infrastructure. In particularly, space-based approaches to minimizing grid cost, developing more advanced and convenient interfaces, and increasing utilization of chargers have drawn broad and technically-ready proposals.

Thank you. And this concludes this portion of the workshop.

MR. CRISOSTOMO: Next, I'd like to introduce a colleague, Larry Rillera, Air Pollution Specialist, who will talk about workforce training and development.

Larry, please take it away.

MR. RILLERA: Yes. Great. Thank you, Noel. I appreciate that introduction.

Next slide please.

Aloha Friday everybody. My name is Larry Rillera. I am Staff in the Clean Transportation

Program. I lead our teams and activities with respect to ZEV manufacturing, workforce training and development, and our equity and outreach engagement.

The next portion of this workshop will highlight a small section of the report on workforce. A purpose in addressing EV charging workforce is to make transparent the critical need for job quantity, job quality, and ensuring key occupations and scales required to plan, construct, install, service, and replace chargers. To one set of stakeholders, the numbers -- the number of chargers identified here convey clarity with respect to infrastructure support needed for ZEV goals.

For this presentation, these numbers also represent potential for business growth, job growth, and expose the need to future-proof the workforce sector tied to EV chargers. The state also needs to ensure workforce participation and growth in all communities.

For purposes of my presentation, in the next few slides we are going to shift away from deep analytics and technology. I want you to think about who. Who is going to do this? Who

are they? Who is going to bid on the work? Who is going to put this stuff in the ground? Who is going to dig? Who is going to connect the wires? Who is going to maintain it? Who is going to replace it?

Next slide please.

As context to workforce training and development of electric vehicle charges, I want to highlight a few areas of the Clean Transportation Program's investments in this area. Approximately $35 million has been invested to date for over 20,000 trainees. State workforce entities have been partners since the inception of the program, such as the California Workforce Development Board, the California Employment Training Panel, the Employment Development Department, and the California Community Colleges.

The second workforce area I want to highlight is centered on the ZEV supply chain and, specifically, the manufacturing segment. Approximately $55 million has been invested since program inception. The manufacturing portfolio also includes EV charging companies, such as ChargePoint and FreeWire. The EVSE manufacturing

workforce is a critical component in increasing the value of California's ZEV supply chain, expanding ZEV-related workforce opportunities, creating jobs and serving as local economic engines, and then continuing California's ZEV-related innovation leadership. The total workforce portfolio is growing. And we'll continue to embed equity principles and actions.

Next slide.

And shifting toward the specific discussion in this report, I have highlighted a few statements in the report that cause us to reflect on the workforce elements associated with EV charging.

Fundamentally, the report highlights the importance of developing a workforce to support charging infrastructure deployment. And the report recognizes the importance of aligning EV charging to other energy areas, such as renewable generation. It also acknowledges growth in the electrification of the medium- and heavy-duty vehicle sector. To underscores the importance and role of local planning entities. It rightly identifies training needs. And it articulates and values equity.

Next slide please.

California's EV's Charger Incentive Programs use funding to accelerate charger deployment. These funding programs have relied, in part, on the availability of a workforce with key occupations and skill sets, as identified here.

The figure noted here depicts a general sequencing of electric vehicle charging infrastructure with respect to project milestone activities. It is used to illuminate and capture the range of workforce elements that are fundamental to EV charging projects. In understanding the range of key occupations, it is important to also understand workload, workforce capacity, training and certification, job quality, regional employment differences, and contractor capacity and experience as well.

The other and dual purpose of this figure is to shed some light, not only on the workforce associated with EV charging, but how this workforce is also affected by other business opportunities?

CARB is in the process of approving a suite a clean transportation regulations. These

clean transportation technologies require electrified infrastructure to power vehicles and equipment. To date, we have seen implementation of the Innovative Clean Transit Rule, the Advanced Clean Trucks Rule, and current work for zero-emission transportation refrigeration units, or TRUs, zero-emission forklifts, and technologies in the marine sector. It becomes readily apparently that the state needs to monitor the EV charging workforce, especially given these other market and business opportunities.

In short, we must also future-proof our supply chains and our workforce.

Next slide.

There are other important considerations for this workforce that advance equity goals, implement new regulations for charger installations, scale charger infrastructure to new regulations and markets, implement recommendations of the state's workforce goals, and continue with training that advances markets and the technologies discussed over the last two days.

This concludes my comments. And we'll

now open up for comments and questions. Thank you.

MR. CRISOSTOMO: Just a reminder, if you have any questions, please raise your hand, we will un-mute you, or please feel free to chat them in the box. And this will cover both Larry's presentation and Raja's presentation. And I guess, also, the presentations from earlier today, if anything has come to you, or even yesterday. I know there was a question by Bob Coale that I wasn't sure how to respond to specifically.

But if you'd like to raise your hand, Bob, I'm happy to respond.

Here's a question from John Holmes from Paratelic Systems. "How can standards development organizations support workforce development, for example, UL?"

Larry, would you like to take that one on?

MR. RILLERA: Yeah. I think, John, thank you for your question. This intersection is important, not only to the EV charger discussion, but certainly I spend much more time on the vehicle side. And so there's a lot of

development on the technician training, regardless of the platform or the vehicle classification.

And I think that to the extent that you have some ideas that you might want to submit to where we can work on this integration would be helpful. Certainly on the manufacturing side, the other half or the other area of the Clean Transportation Program, there is some integration work going on there. But we'd certainly love to hear some specific feedback in areas where you think that it should be integrated.

MR. CRISOSTOMO: Let's move on. Next is from Bill Boyce. "I want to thank Larry for putting all those job types on the page. Very little of that has been organized on what I've seen before. This is a good list."

Thanks for your support, Bill.

MR. RILLERA: Yeah. Thanks Bill. I think, you know, this is a start. Part of the message in the report and the presentation is to recognize these key occupations and, certainly, the skill sets for not just the EV charging sector but looking at the other ZEV sectors where -- and markets where this will be really

apparent. And this workforce will be shifting around to accommodate deployments.

Thank you.

MR. CRISOSTOMO: Next is from Bob Coale. "There are some similarities between EV work and that previously employed in the CNG/LNG vehicle arena that might be worthwhile exploring."

MR. RILLERA: Yes. Thank you, Bob. I appreciate your comment.

There is a really great graphic inside CARB's Mobile Source Strategy that was released. And when you look at it, it shows the decline, if you will, in fossil- fueled and some of these old technologies and the vehicle populations for all the vehicle classes. But then you see, of course, which is the focus is in the increase in the ZEV market, the ZEV technologies, fuel cell hydrogen. And from my perspective and the workforce perspective, we are and will be in the transition between the natural gas, the fossil-fuel, while we're continuing to invest in the ZEV training and workforce development.

So this is the issue and the dilemma and the opportunity to transition off the existing workforce into a new area. And so LNG/CNG, as

you've mentioned here, especially for the heavier-duty vehicle classifications, will be important to address what is happening in the heavier-duty applications from ZEV. And that includes focus on the infrastructure part of the equation as well, which will intensify with respect to the knowledge and the skills that must be developed by the vehicle technicians.

Thank you.

MR. CRISOSTOMO: Again, if folks have any questions for not only Raja and Larry, we'll entertain questions from earlier in the presentations, so Micah, myself, Jeffrey, or even yesterday from Thanh, Tiffany, Matt, myself or Jeffrey, if anything else has some up.

Great. The next one is from Deborah Gay-Rigiaud. "I am simply a U.S. citizen who is a California resident."

MR. RILLERA: I can take this one, Noel.

MR. CRISOSTOMO: Sure, Larry.

MR. RILLERA: Deborah says, "Thanks for the list of key occupations. Specifically to the scales needed for EV charger installation and manufacturer, and installation and maintenance, in what way are current curriculums at the

secondary community colleges and universities being developed to train such a workforce?"

Thank you for the question. I will note, the California's -- excuse me, the Clean Transportation Program's investments are specifically in this area. The Energy Commission has invested in career pathway development, starting with the institution of the development of ZEV curriculum at our high schools. And this started a couple years ago where they would learn the technologies, they would get the introduction to careers that are available in this sector, and then they could migrate, if they have an interest, to the community college system. And we've also invested in the community college ZEV curriculum development for both degrees, certificates and the like that have led to jobs, to good-paying jobs.

And then beyond that, we also have investments in partnerships with the colleges and the universities, both on the innovation, so the design and the architecture of these technologies for the further prototyping and commercialization of some of these technologies, but we've also seen some focus on design engineering on the

hydrogen side as well.

So I wanted to throw it out that the investments, the partnerships all across the board for EV charging, is in development and will continue in development, especially to the technologies, to the analytics that have been discussed over the last two days. This is very cutting edge. And California's educational system is ripe to pick this up and to turn it into a curriculum where we can train tomorrow's engineers and tomorrow's technicians.

Thank you.

MR. CRISOSTOMO: Next is from Andrew Larkin -- Andrew Larkins. Excuse me. "What do you see as the greatest challenge to the rapid adoption of EVs? Will charger availability limit growth rates?"

This might be a broad question that few of us have thoughts on.

Commissioner Monahan, do you want to start, if you'd like? I know you presented recently on the ACEEE electrification webinar and had some thoughts about three Cs.

COMMISSIONER MONAHAN: I do have some

thoughts about the three Cs. You can say them, Noel. So --

MR. CRISOSTOMO: Please. After you.

COMMISSIONER MONAHAN: -- well, I like to keep it simple. So, I mean, I think we have three major barriers, the three Cs, cost, convenience, consumer awareness. You know, the cost one is pretty simple, new vehicles cost more. And but we're seeing cost curves come down, so I'm actually pretty confident that the way the global market is moving on battery-electric vehicles that we'll see, in the next two to five years, these vehicles will be cost competitive.

The convenience factor, though, we still have some work to do. And I would put convenience into two categories. One is the convenience of refueling, so we need to make sure this is ubiquitous and -- you know, ZEV infrastructure is ubiquitous and easy to use. And no matter where you live, or whether you live in an apartment building or you live on a farm of you live in downtown, that you can conveniently refuel your vehicle.

But I would also say the convenience

factor means we need more vehicles that meet the needs of the diverse set of drivers and we don't have those. So we have -- I mean, we do have a growing number of battery-electric vehicles coming to market. Over the next, again, three to five years we'll see a lot more. And Noel referred to the Ford F-150 being electric, we'll see the Rivian trucks, we'll just see more variety out there in terms of the utility of the vehicle. And that will, I think, build the market.

I would say that the consumer awareness piece is actually quite challenging, more challenging than I thought it would be. But again, as we build the market, as we have more chargers available in places that people see, as people, you know, sit in electric vehicles and get comfortable with the technology, then I think we'll see, also, a broader set of consumers just being aware of these vehicles.

I'm very heartened by GM's recent statement that they are planning to meet California's goal of having all new passenger vehicles be electric by 2035. And you know, so we're seeing now that the automakers are seeing

the writing on the wall, that the future is electric and they need to invest in these technologies.

So you know, the combination, and I think we'll, over the next three to, you know, well, maybe five to ten years, I think we're going to knock off all those barriers and we will reach full commercialization of electric vehicles. But we've got to work hard, especially on building out that ZEV infrastructure, to be able to overcome the barriers.

I hope that responds to your question.

MR. CRISOSTOMO: And, Andrew, if you'd like to be un-muted and opine yourself? This is very much not just a we-have-all-the answers session. We'd like to hear from folks. So let me un-mute you. You should be un-muted.

MR. LARKINS: Yes. Hi. I'm Andrew Larkins from Sygensys. And I'm over here listening to you from the U.K. One of the key factors in the adoption of EVs is learning from other markets because there are differences between markets. And one of the key factors is no one can predict the future. So the more different markets you look at the greater the

chance that you come across how the market in your country or your region will develop in the future, which is the main reason I've been listening so attentively today.

So I would congratulate the presenters. It's been a fascinating session. And the speed of adoption and the balance between standardization, and therefore being able to provide broader access to infrastructure and market forces at the same time and providing space for innovation is absolutely key.

I think one of the key aspects is trying to avoid installed infrastructure which becomes orphaned in the future. That's technology which is no longer applicable. And the challenge is in providing that compatibility.

So I would really congratulate the group today on the proposed route forward. It sounds very well thought through in terms of the choice of the hardware.

I think as a bit of feedback, we all have a great deal more to do in terms of load profiles and exactly how it will work out. We're all trying to predict something that no one can know. And, therefore, having a broad range of

projections is really helpful.

So thanks for today.

MR. CRISOSTOMO: Thank you for calling in, in the evening. I definitely have worked with some of your -- or our counterparts at BEIS over there and seeing some of the same challenges with the U.K.'s proposed work on charging standardization, so definitely trying to leverage economies of scale and lessons from there too. So thank you --

MR. LARKINS: Yeah.

MR. CRISOSTOMO: -- for attending.

MR. LARKINS: And the path alongside that that we, particularly as a business, are looking at is resiliency of the system in terms of trying to ensure, under unusual circumstances, be it that role in blackouts, be it about storm events, that the system remains resilient and reliable as far as possible. And the one aspect I would say is do think about the interlinkage between communication and power system. With smart charging you are dependent on communication systems, as well as power, and you need to find mechanisms which are resilient in difficult conditions.

MR. CRISOSTOMO: Great. Thank you for raising that point. We know our Broadband Plan still requires us to make sure that everyone has access to high-speed communication.

Again, any questions that you'd like to further dig into, we're happy to. Staff from yesterday are active, as well as our colleagues from Berkeley Lab, NREL. So this is definitely an opportunity just to continue the discussion.

A question from Deborah. "This was a great informative session on both parts. I really appreciate the information outlined with the corresponding acronyms. Thank you so much for this."

Thank you for attending.

A question from Shrayas Jatkar. "For Larry, could you discuss priorities and/or differences between the key occupations listed, for example, highest labor demand and most challenging to recruit or hire?"

MR. RILLERA: Great. Thank you, Shrayas. I appreciate you attending and weighing on.

If we could back, Ray? Thank you.

I think the question around highest is going to be around what is in most -- in the

highest demand, and so probably looking at maybe some of the engineering positions. I know that at the local level now, planner positions are -- have, you know, a tremendous bandwidth in priorities because it's not just chargers. There's a whole complex of projects they must review.

And certainly in the construction space as well. That is another area where it's very intensive during the project-development continuum where that will be key.

I want to make sure I'm capturing all your -- and responding to your questions here, Shrayas. Let me scroll down here.

And the challenging, in terms of recruitment, I think from my perspective, I'm not a business although I listen to the businesses talk about their hiring. In this space, some for the jobs in the private sector can be difficult to attract, to retain.

But I think one of the key lessons and points with respect to your question and integrated into the report is the identification, not just generally but specifically with respect to regions, I think we need to understand those

questions, the application of this sort of framework with respect to charger deployment throughout the state. It makes it look like there's just one lens in which to look through. But we need to understand, those questions, Shrayas, that you post with respect to communities in El Centro and Calexico, versus those that are in L.A. or urban areas like the Bay Area, and certainly the northern portions of this state, so those will all be the regional issues we deal with just within the charger markets and space.

Part of the report and part of the presentation also teases out these other markets and other opportunities with respect to oncoming clean transportation regulations that we also need to be aware of.

So thank you.

MR. CRISOSTOMO: Next question is from Margarita Parra from Clean Energy Works. "Thanks again for the discussion. It will be great to have intergovernmental discussions, CEC and PUC, in issues that relate to the consumers, like cost, since the lack of awareness, the last C, is related to the lack of practical information, not

just of the up-front cost but the operational costs in the long term. For heavy-duty the up-front cost is so high still that the operational costs and services, like V2X, will be key for affordability."

Thank you, Margarita. Would you like to raise your hand and I can un-mute you to further elaborate upon this operational cost challenge? I know your colleague, Holmes, presented recently at a PUC workshop. And I believe some of our PUC colleagues on the TE Team are in attendance. And, also, ALJ Sisto, who held that workshop last week. I will un-mute you.

MS. PARRA: Thank you, Noel. I hope you can hear me. And thanks for --

MR. CRISOSTOMO: Yes.

MS. PARRA: -- the opportunity to listen to this very technical workshop and really trying to provide all the information to the public. This is amazing that we can actually do this.

I do believe that all the tools and all the regulations and the standardizations that you guys are discussing will be very important to really overcome these barriers that Commissioner Monahan, a friend of mine in the past, outlined,

which is the cost, the convenience and the consumer awareness. I do think that for segments, like heavy-duty, the cost is still much higher. And I think that cost priority is still further away from happening. So we have to work harder on issues like -- or factors like V2G or V2B so that maybe they can help offset that cost.

We've been doing some analysis that my colleague, Holmes, presented for school buses where the upfront cost is still three or five times more than the equivalent over diesel bus. And we really want to see more information. And maybe the pilots that California is pursuing will help to quantify those revenue streams for V2B or V2G so that they can be factored in on that operational cost and make it more affordable.

And when I asked the question about who set those rates and what the impact on those costs will be, and you mentioned PUC, then my suggestion is maybe to hold workshops together with them to ensure that we get more information, up-to-date information, with the two different proceedings that you guys are doing.

Thank you.

MR. CRISOSTOMO: Yes. Agreed. We work

closely with -- across Commissions. And while we didn't have a presentation on it, we do have a chapter on financing that raises these important points around improving business models and, yes, driving down the cost of electricity.

COMMISSIONER MONAHAN: And I just wanted to comment quickly.

Margarita, thanks for the question. Good to hear your voice again. And totally agree that, on the heavy-duty side, we need to look for ways to drive down cost. And it will be important over the long run to price VGI appropriately so that we set the right incentives that the charging happens at the right time of day, the owners are compensated for providing some kind of grid benefit back to us. And it gets even more interesting when we're talking about giving money -- I mean, giving money? -- giving energy back to the grid, like through school buses and other applications.

So you know, Noel and the team are working hard and in collaboration with the CPUC on vehicle-grid integration. And we definitely agree with your recommendation that we need a partnership here.

MR. CRISOSTOMO: A comment from Shrayas Jatkar. "And thanks for addressing the importance of job quality."

Larry, would you like to add anything to that?

MR. RILLERA: Thank you, Noel.

Thank you, Shrayas. That is certainly an important dimension that we need to consider and will be considering with the release and focus on some just transition reports and others that will be coming out this year.

MR. CRISOSTOMO: We have a raised hand from Shiba Bhowmik.

Shiba, you should be able to un-mute yourself.

MR. BHOWMIK: Hi Noel. Can you hear me?

MR. CRISOSTOMO: Yes, we can.

MR. BHOWMIK: Give me a second. Sorry about that.

Yeah, I wanted to thank you and the team and Commissioner Monahan for taking the leadership or showing us the leadership with respect to V2G and VGI and everything that is related to vehicle adoption or electric vehicle adoption and making it more equitable.

This was fascinating over the last two days. And my apologies, I probably jumped the gun yesterday with respect to asking some questions. But it's always a learning experience whenever we listen to CEC and the process of the various different modeling that you have gone through and taking us to the next level.

Talking about the next level, with respect to convenience, we have heard from multiple -- the broader audience, and also some of the stakeholders, that V2G AC could have very meaningful impact, both in terms of EV adoption, utility load mitigation, and many other aspects of it far beyond V2G DC.

So my question would be with respect to that, I mean, if you could kindly give us a little broader perspective? And again, I apologize because I may not be fully up to date on all the standards that CEC already has in place and all the planning.

What are the overarching goals with respect to homogenizing VGI with respect to the V1G, V2G, V2X? I mean, you have so many different categories of vehicle integration with respect to the grid or without the grid, islanded

operation, non-islanded operation. If you could give a little broader perspective of where you're coming from? Number one.

Number two, along those lines, there are standards getting implemented for all the right reasons, possibly. But those doesn't necessarily encounter or take into consideration innovations that are already happening.

One particular case that came up is with respect to the gap analysis between some standards, between the UL standard and the AC standard, and you probably are aware of that, which mandated, essentially, like a splitting order of standard that is getting implemented in the two standards. It will only make it more complicated with the implementation. (Indiscernible) would have to match up with the EVSE and other aspects of it.

So can you guide us into your vision with CEC and how you're going to implement V2G AC with respect to both the convenience piece and all the various different aspects? They're two different questions that I had.

MR. CRISOSTOMO: I'll start taking a stab.

But, Jeffrey, feel free to jump in, given our work on the workshop from last week.

Or even, Matt, if you want to describe some of the ideas in BESTFIT.

So our vision, broadly, is to make sure that charging is available for everyone to meet their mobility needs as easily and cost effectively as possible using a wide range of solutions that we're seeing in the market. We think that the need for basic smart charging is essential and that, based on our observations of the manufacturers, that V2G is coming. And preparing for that optionality will be important to improve the resilience of our system. And the V2X examples that we provided offer a kind of inkling of what could come at a smaller scale for interconnected systems and interactive systems with the grid. And so I believe you attended that workshop on the 25th describing the V2B potential here.

MR. BHOWMIK: Yeah.

MR. CRISOSTOMO: And so we're very much interested in a widespread bidirectional future from building the capacity for storage necessary to integrate more vehicles. So that's high-level

perspective of where we're trying to go with smart charging.

In terms of a standards question and harmonization across SAE and UL, we understand that those AC questions are still in the standards development organization working groups where, from our workshop last week, we heard that those invertor zones need to still be addressed. And right now there isn't an answer. So that's really why the V2G AC proposal in the Rule 21 decision from last September set forth the need for pilots to understand how we can move forward in a test case before the harmonization across UL and, say, SAE J3772 is complete.

So we're not taking any options off of the table. And as described in this bullet, we want to really clarify technical pathways but also, more importantly, the administrative pathways for as much charging to be well integrated with the system as possible.

MR. LU: Yeah. Briefly, Shiba, thanks for your question and comment.

To address your sort of split inverter question, like Noel said, our long-term vision is grid integrated, grid responsiveness, grid

interactive bidirectional charging, right, for all vehicles. How to actually get there, we don't have the path laid out entirely. When we presented earlier today about certain standards, such as ISO 15118, that mirrors a market readiness for us to say, okay, we want this to be the standard going forward.

In terms of split invertor or a single invertor system, a lot of those like UL/SAE standards are still being developed. We haven't seen market consensus on how to achieve that invertor topology. And so we don't have a good answer for what is our vision there. We can tell you the long-term vision. But in terms of the intermediate technical implementation, we still have to wait to see what folks, like yourself or other people in the market, actually come up with.

MR. BHOWMIK: Thank you so much.

MR. CRISOSTOMO: I believe we are a little bit over time. I'm just going to do one last call for comments or hands before we close. Oops. There we go.

All right, hearing none, just to close, the Staff Report and Staff Assessment is now open

for public comments to our dockets and electronic filing systems. I'd like to offer these both through the link. These presentations are online. And it's possible to receive comments via the docket. They will be due in about two weeks on the 26th. Please let us know if you have any specific questions.

With that, I'd like to offer some time for Commissioner Monahan to close the day and offer final thoughts and remarks.

COMMISSIONER MONAHAN: Thanks Noel.

Well, I just want to thank everybody for joining us today, and maybe for the folks that joined yesterday, as well, to give a special shoutout of thanks to them, and to the team. I mean, as you can tell, the whole team is really working hard to make sure that this is the best report and listening carefully to the feedback that we're getting.

And, you know, the goal is, really, to be able to use this as a starting point for helping to build out necessary ZEV infrastructure. And to do it in a way that is going to be best for the market in the long term, so, you know, open standards. Making sure that we have the right

set of standards in place to support the growing market, that is really going to be key to helping drive down costs and helping us as the lead agency responsible for helping built out the infrastructure do it in a way that makes the most sense.

So I just really appreciate this comment -- this workshop and encourage folks to -- if you haven to given your feedback verbally at this workshop, please do send us your comments in writing.

So I think that closes out our set of workshops. So thanks everybody. Hope you all have a good weekend and enjoy the sun.

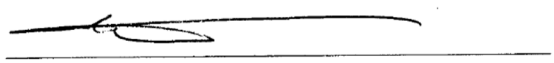
(Off the record at 3:32 p.m.)

REPORTER'S CERTIFICATE

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

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

IN WITNESS WHEREOF, I have hereunto set my hand this 1st day of March, 2021.



PETER PETTY
CER**D-493
Notary Public

CERTIFICATE OF TRANSCRIBER

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

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

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.

MARTHA L. NELSON, CERT**367

March 1, 2021