BEFORE THE

CALIFORNIA ENERGY COMMISSION

In the Matter of	)	Docket No. 14-IEP-1B
	)	
2014 Integrated Energy Policy	)	Workshop re: Transportation
Report Update (2014 IEPR Update)	)	Electricity, and Natural Gas

ELECTRIC AND NATURAL GAS VEHICLES
IN CALIFORNIA

CALIFORNIA ENERGY COMMISSION
HEARING ROOM A, 1516 NINTH STREET
SACRAMENTO, CALIFORNIA

MONDAY, JUNE 23, 2014
9:30 A.M.

Reported by:
Peter Petty

APPEARANCES

Commissioners Present (*Via WebEx)

Janea A. Scott, Lead Commissioner for the 2014 IEPR Update
Lead Commissioner on Transportation
Robert Weisenmiller, Chair
Karen Douglas

Also Present at Dais

Carla Peterman, Commissioner, California Public Utilities Commission (CPUC)
Steven Berberich, California Independent System Operator (CAISO)

CEC Staff Present

Heather Raitt, IEPR Lead
Mike Gravely
Silas Bauer
Jim McKinney
Rey Gonzalez

Presenters

Heather Sanders, CAISO
Mark Higgins, CESA

Panelists (* Via WebEx)

Adam Langton, CPUC
*Camron Gorguinpour, Department of Defense
Paul Stith, EV Grid, Inc.
Steve Davis, KnGrid
Greg Haddow, San Diego Gas & Electric (SDG&E)
Felix Oduyemi, Southern California Edison (SCE)
Amy Myers Jaffe, UC Davis ITS
Rosa Dominguez-Faus, UC Davis ITS
Tim O’Connor, Environmental Defense Fund
Simon Mui, Natural Resources Defense Council (NRDC)
John Shears, Center for Energy Efficiency and Renewable Technologies (CEERT)
George Minter, Sempra Energy
Todd Campbell, Clean Energy
Julia Levin, Bioenergy Association of California (BAC)
Karen Hamberg, Westport Innovations
Henry Hogo, South Coast AQMD

APPEARANCES (Continued)

Panelists

Erik Neandross, Gladstein, Neandross & Associates
Chris Shimoda, California Trucking Association (CTA)

Also Present

Public Comment

Stacey Reineccius, Powertree Services
Valerie Wynn, Pacific Gas and Electric Company (PG&E)

I N D E X

I N D E X

I N D E X

P R O C E E D I N G S

JUNE 23, 2014 9:36 a.m.

MS. RAITT: Welcome to Electric and Natural Gas Vehicles in California. This workshop is part of the 2014 IEPR Update.

I’m Heather Raitt, I manage the IEPR Unit. I’ll begin by going over the usual housekeeping items. First off, if you’re missing a pair of sunglasses, let me know. The restrooms are in the atrium, and please be aware that the glass exit doors near the restrooms are for staff only and an alarm will sound if you try to go through them. The snack room is on the second floor at the top of the atrium. If there is an emergency and we need to evacuate the building, please follow the staff to Roosevelt Park which is across the street, diagonal to the building.

Today’s workshop is being broadcast through our WebEx Conferencing System and parties should be aware that you’re being recorded. We’ll post the audio recording on the Energy Commission’s website in about a week and the written transcript in about three weeks.

I’ll briefly go over our agenda. This morning we have opening comments from the

Commissioners and executives on the dais, followed by two presentations on Electricity, and then a panel on the role of Battery Electric Vehicles and Smart Charging on the Grid.

Before breaking for lunch, there will be an opportunity for public comments and questions on the morning presentations only. We'll return after the one-hour lunch break for presentations and a series of panels discussing topics related to the use of natural gas as a transportation fuel. At the end of the day, there will be another opportunity for public questions and comments.

Since the agenda is very full, we request that presenters please limit your comments to the allotted time to ensure that all have an opportunity and the time needed for their presentations.

Also, we are asking parties to limit their comments to three minutes during the public comment period. We'll take comments first from those in the room, followed by people participating on WebEx, and finally from those who are phone-in only.

For those in the room who would like to

make comments, please fill out blue card and give it to me. When it is your turn to speak, please come to the center podium and speak into the microphone. It’s also helpful to give the Court Reporter your business card.

For WebEx participants, you can use the chat function to tell our WebEx Coordinator that you’d like to ask a question or make a comment during the public comment period, and we’ll either relay your question or open your line at the appropriate time. For phone-in only participants, we’ll open your lines after we’ve taken the other comments from folks in person and on WebEx.

Materials for this meeting are available on our website and hard copies are on the table at the entrance to the hearing room. We encourage parties to submit written comments on today’s topics and the comments are due at the close of business on July 14th.

The public notice that is the hard copy on the table and posted on the website provides instructions for how to submit public comments. And I’ll turn it over to Commissioners for opening remarks.

COMMISSIONER SCOTT: Great. Thank you, Heather. Good morning and welcome, everybody, to the 2014 IEPR Update Workshop on Transportation, Electricity and Natural Gas.

I am pleased to be joined by my fellow Commissioners Douglas and Weisenmiller, and also by today's guest, President of the California Independent System Operator, Steve Berberich, and California Public Utilities Commissioner Carla Peterman.

I think we have another interesting and informative day lined up to discuss the intersection of electricity, natural gas, and cleaner transportation. And we have a great set of vehicles out front for you to see and to drive, so please be sure to spend a little bit of time checking them out.

I look forward to today's presentations, I'm going to keep my remarks short because we've got a lot of great presentations, and I will turn to Commissioner Douglas for any welcoming remarks that she might like to make.

COMMISSIONER DOUGLAS: Well, I'll just join Commissioner Scott in welcoming everyone here. I'm looking forward to the workshop.

CHAIRMAN WEISENMILLER: Again, I'd like to welcome everyone here and thank them for their participation today. Obviously, one of the things that is really important to deal with in the climate change context is greenhouse gas emissions, transportation is about 40 percent of our greenhouse gas emissions, so it's very important that we look at cleaner or Zero Emission Vehicles there. Our transportation is also a key part of our air emissions. I remember a chart I saw last week from Barry Wallerstein which basically was looking at sources of pollution in the South Coast and sort of at the top of the list was heavy-duty vehicles. So again, I think moving forward in this way is dealing with both our air quality challenges and our greenhouse gas challenges, and certainly building off of our electric system. Thanks.

COMMISSIONER SCOTT: Mr. Berberich?

MR. BERBERICH: Thank you, Commissioner Scott and thank you for having me here today. I will keep my comments brief because our Heather Sanders has a lot to say and I don't want to steal her thunder, but let me just say this: Electric Vehicles have tremendous promise for

Grid operators and the ability to provide ancillary services, as well as to soak up generation that may otherwise have to just be disposed of, that we would get from clean generators, solar, and wind. So if we do this, though, Electric Vehicles can be a great boon to the Grid, but they could also be quite detrimental to the Grid if the policies are not closely aligned. And so today I think the critical thing we can do is think about those policies and the alignment of them so that Electric Vehicles can truly be unleashed for their full promise.

COMMISSIONER SCOTT: Thank you. Commissioner Peterman.

COMMISSIONER PETERMAN: Thank you. Good morning, everyone. Thank you, Commissioner Scott, for including me in your IEPR Workshop. I was delighted to see the IEPR this year focus on transportation because we’re recognizing, of course, the increasing intersection between transportation and our Electric and Natural Gas markets and supply.

At the California Public Utilities Commission, we have an open proceeding that’s looking at a lot of issues related to alternative transportation, and really not only how to mitigate the impacts of electric and Natural Gas Vehicles to the Grid, but to have our utilities play an active role in facilitating their roll out. So I think it's a real testament to the coordination that needs to happen across agencies that you have three present here today on the dais, and particularly we're doing some vehicle to grid integration work with the ISO, and so looking forward to the presentation today. And I encourage all of you to take what you learn here and feed it back into our proceeding. Thanks.

COMMISSIONER SCOTT: Great. Let us turn to our first set of presenters. We will start with Heather Sanders.

Heather Sanders has worked in the wholesale side of electricity for over 15 years in consulting and software. Formerly the Director of Smart Grid Technology Strategies, she was responsible for demonstration, research and promotion of Smart Grid and other technologies supporting ISO reliability, market efficiency and transmission utilization objectives. Her focus now is on advancing policy that enables the incorporation of distributed energy resources that include distributed generation, demand response, energy storage, Electric Vehicles, and microgrids. She also leads an internal ISO corporate initiative entitled “Grid Evolution Readiness” that studies the impact of renewable integration, evolving operational needs and resource requirements, smart grid technology integration and pilots, and renewable forecasting. She holds a B.S. in Electrical Engineering from South Dakota School of Mines and Technology and an MBA from the University of Utah. Welcome, Heather.

MS. SANDERS: Thank you, Commissioner Scott. And thank you for having me here. Mike Gravely contacted me and asked me to really set the stage for what it will be like in operating the green grid of the future.

And so while a lot of you are familiar with a Duck Curve and what we’re going to need for the future operation, I wanted to take the opportunity to frame it up for you before we go into how Electric Vehicles can best contribute to helping manage the green grid.

All right, so to talk about this, let’s

think about the resource mix needed to maintain a reliable grid, needs specific capabilities in the right place, at the right time. So what, when and where.

Focusing on what first, the Duck Curve, the infamous Duck Curve shows us what? Historically, we focused on meeting peak and we went about procuring resources that helped us meet peak because the rest of the time of year, if we could meet peak we would be fine. So we just needed to have enough generation there to meet peak.

Times are changing. We now have a resource mix that includes variable generation, as well as controllable generation. So what we do at the ISO is we exactly match supply and demand every second to make sure we keep the grid reliable.

So what the Duck Curve has changed is not looking at the load curve on its own as the only source of variability, but now it’s looking at the net load curve because that’s now your variability. So you have load, variable load, we want to make sure we can meet what consumers need at the time, subtracting the generation sources that help contribute to meet that need that are now variable, wind and solar. So we come up with this net load curve. This shows us now what the ISO must have, what the grid operator must have in terms of resource mix, to manage this green grid.

So a few years ago, the ISO said, well, okay, we're getting these renewables on, we need to start helping people understand how things have changed from an operating mix. What the Duck Curve specifically brings out, now these are net load, you have megawatts on the Y axis and hours of the day on the X axis, what it shows us is the load shape. Now, in the middle of the day as you go through time, adding more and more renewables, specifically solar, you see less need for resources in the middle of the day. You also see on the two ends in the morning, with that significant down ramp, and then in the afternoon the significant up ramp, a need for what we call "ramping capability" which is the ability to decrease generation on line, or increase generation on line, as the sun rises and sets. So ramping capability is the first thing the Duck Curve shows us.

The second thing you see down there in the belly of the Duck is this over-generation risk. Now, this is coming just as a result of the fleet we built to meet our needs for peak. Now, those resources have minimum operating conditions. So when they come on, they have a minimum level that they need to operate at. You know, they come on, they have to heat up, it's just a characteristic of how the existing fleet operates.

So what happens is we bring all those resources on in the middle of the day, or when we need to, so that they are ready for when the sun sets and they can ramp up. So what happens now is we have those, and there's about 12,000 to 14,000 megawatts of those base load resources currently on the system, and then if you have significant solar coming on, now you have more supply than you have a need for it. And that will result in negative prices, and that will also result in curtailment of renewables at a last resort to manage that over-generation.

So the two things from "what" that the Duck Curve tells us, we move to net load, we need ramping, and we need to be able to mitigate the over-generation risk.

Where? Nothing has changed about where. Historically we needed to focus on where the resources were located and we continue to need to focus on where the resources are located. This is because we don’t build transmission to serve every piece of load from a centralized generator. We trade off the ability to transport energy into the local need areas using our transmission from central generators with the need to build local generation. So “where” has always mattered and it continues to matter.

With the retirement of the San Onofre Generating Stations, SONGS, a bright light was shone on the “where.” We got people much more interested in understanding what local effectiveness factors are, local capacity requirements and capabilities. So we will continue to focus on “where.”

Okay, “when”? Back to the Duck Curve. This is a spring Duck, so the when you need energy has changed significantly. In the spring, peak is not from noon to six, it’s pretty evident you get to 2020, peak is not from noon to six. But let’s look at the flock of Ducks. This is

January. In January, you see a double hump, so the peaks are pretty much the same, which requires you to meet an upward ramp, a downward ramp, another upward ramp, and another downward ramp. In February, you see similar curves, the Duck starts to emerge toward the end of the month, spring Duck, as you see you get a lot of generation in the middle of the day, loads are still low. Moving into April, you start to see that belly rising, and into May and June and July and August, the summer months, the belly is gone. What you see about these is this maximum continuous ramp that you need. So you still need that generation that continues to provide energy through the day to meet the summer months.

Okay, so now September, also a peaking month in California, very similar. In October, you begin to see the Duck reemerge as loads go lower, November same thing, and in December you see the double hump again. Now, the double hump in December is much more significantly steep than in January because we have a lot of Christmas lights and we’re very festive here. So here we need to again emphasize that the fleet needs this ramping capability.

So we've talked about the "what" and we need flexibility. I want to hit on what flexibility means. So flexibility is the ability to start and stop quickly. It's the ability to operate at zero or minimum load, it is the ability to continuously provide output, so you will hear us talk about what in the terms of availability, duration, and speed. So flexibility is a need to be available when it's needed, a need to be as fast as the need is, and a need to be able to last as long as that ramp is. So we'll have a lot of different resources that are able to contribute. And then we have the "where" and we've covered that, and then the "when." And for resources to have with intra-day ability to be flexible in when they operate, that will help contribute to the reliable management of the green grid. So that's all I'm going to cover now, just to set the stage, and then as we move into the panel about how Electric Vehicles contribute, we'll talk more specifically about how Electric Vehicles provide each of these capabilities. So thank you.

COMMISSIONER SCOTT: Great. Thank you for that terrific setting of the stage.

We have one more setting of the stage presentation before we go into our panel, and that is Mark Higgins. Mark brings a deep wholesale energy market experience to Strategen. Mark's career in the energy industry has focused on renewables, project development, and utility regulatory strategy. Mark most recently served as Pacific, Gas and Electric Company's lead on electric transmission policy work at the California ISO where he worked on formulating PG&E policy on energy storage, demand response, generator interconnection, and transmission planning issues. Prior to PG&E, Mark was Director of Utility West at Sun Edison. His responsibilities there included management of California utility-scale project development strategy and execution.

Mark also has a strong private equity venture capital and investment banking background, including placing over $125 million in equity for publicly traded companies while at Roth Capital Partners. Mark holds a Master of Pacific International Affairs from the University of California San Diego and a Bachelor of Arts in Government from the University of Notre Dame.

Welcome, Mark.

MR. HIGGINS: Thank you very much for having me. I really appreciate the opportunity to come speak with you today.

So I'm Mark Higgins from Strategen Consulting and California Energy Storage Alliance (CESA). California Energy Storage Alliance represents over 80 companies that are operating in the range of energy storage technologies from bulk resources, pumped hydro on the large side, down to EV charging infrastructure companies on the behind-the-meter side, so a very very wide spectrum of companies.

So Heather did a fantastic job of framing out what are some of the issues we're facing and of course the issues are really driven by California's State's greenhouse gas reduction targets, which are 80 percent reduction of our 1990 emissions by 2050.

Now, what's interesting about this is that about half of our GHG reduction targets need to come from grid De-carbonization and transportation electrification. And what's really interesting about those two sectors is that, when you look at them, if you put in place the right policies, transportation and electrification can actually be quite complementary to cost effectively solving our Grid De-carbonization system challenges that we're facing.

And actually EVs are already starting to make quite an impact on the state's load situation. This, I think, is probably overstating the case if we put in place the right policies you're going to get a lot more kilowatt hours that you have available, but you're not necessarily going to have to contribute a lot to the peak kilowatt system needs that you're going to have from EVs.

So Heather talked about the Duck and, of course, we know that it's not a Duck, it's a flock of Ducks, as she's fond of saying now, I think. And I think what's interesting about storage and EVs in the context of this is that they're really flexible resources and they can be really responsive to what market signals they're getting. And in fact, this chart right here is actually an aggregation of publicly available data on public charging stations from ChargePoint and Ecotality. And what you see here is that actually even just the way that they're operated today, they're quite complementary to raising the belly of the duck, and helping reduce some of the ramping needs by sopping up that energy. And this is just workplace charging, public stations. So that's without any major policy change, and I think that's really interesting because it shows that they're already contributing.

Now this chart right here is actually – this is actually a snapshot of my own personal house on a random day last week. I have a *Nissan Leaf* at home and I have it set to charge at 11:00 p.m. because that's when the time of use rates drop. So, snap, at 11:00 p.m., my load shoots way up. Now, if you get into a neighborhood where you've got a high penetration rate of EVs, you know, this could be a problem, but vehicle to grid integration could be a great solution for this. You help smooth out overnight, raise up the load during the middle of the night, and that's without any fixed storage you can put in place a really great solution for that. So Smart Charging at home really makes a lot of sense. Of course, nobody is going to do that unless there's economic incentives for them to do so. Nobody wants to pay more for equipment at home that has all these capabilities if they don’t have the right rate structure, if there’s not market incentives to enable them to actually recoup some of those costs or even make some money off of Smart Charging.

So just a little bit more on vehicle to grid integration benefits. So Heather talked about the what, where, and the when. There’s another way to look at what a resource can offer and what its value is in the market, so benefits are basically reflected in market products, and how much value a resource has depends on its duration, its speed, and its availability. And some of the benefits it can solve is managing the Duck Curve, providing ancillary services, that’s on a bulk system. And actually on a local system it can also provide a lot of benefits in terms of voltage regulation and phase balancing, peak shifting.

And then one of the things that I like to think about is it actually provides a lot of benefits from the rates standpoint, as well, because if you can better utilize the resources that we have out there, you’re going to be able to lower consumer costs. Not only are you using more kilowatt hours for the fixed cost infrastructure that you have out there, but you're helping better utilize existing generation that you have out there, fossil generation, in particular where you've got minimum loads, and you want to get that utilization up so that you can lower the capital costs per kilowatt hour that's generated; as well, when you're using your fossil resources effectively, you're actually lowering the emissions per kilowatt hour, as well, that are coming out of fossil generation. So there's great benefits from a rate standpoint, there's great benefits from a consumer cost standpoint if you're increasing the utilization in a smart way of the electric grid that we have.

So just back to those characteristics, so on the duration side if you're able to sop up some of that energy at the bottom of the Duck, the belly of the Duck, you're lowering the need for minimum dispatch and ramping of fossil generation, and you're reducing the need to curtail renewables, and you are basically creating a more cost-effective system. On the upside, you can lower consumer costs by reducing the need for peakers, you know, if you're able to discharge at the top of the head of the duck, I guess it would be.

Storage resources can really address system needs also through their speed. A lot of storage resources that are out there can be very very fast responding and so you can deal with a lot of the ancillary services, frequency regulation, a lot of the things that we need to deal with, and particularly EVs and EV linked storage can help address that.

And then availability. When you're looking at VGI-enabled EV charging stations, obviously EVs are only being driven a very small fraction of the time, there's a lot of time that they're either connected to the system, or they're parked somewhere, or they're charging, that a VGI-enabled system could actually help contribute to the system needs.

Now in some of the use cases, it actually may be complementary to add in some fixed storage as well because you can solve some problems without having to create consumer behavioral changes, as well as increasing the availability of the resources that are there.

So we do see stationary storage in some use cases as being quite helpful when you're looking at VGI-enabled systems because it can really help deal with the availability issue. And it actually solves a lot of other problems, too. Consumers, we all know they don't really want to change their behavior. When you're looking at this type of a scenario, you don't really need storage because you can smooth things out through a VGI-enabled system. All I really care about is that my car is charged in the morning to go to work.

But when you're dealing with this type of a situation when you have a lot of HVDC chargers all installed together, you've got the higher kilowatt capacity Level 2 chargers, you could end up actually triggering a lot of localized system issues. You've got a higher load impact that could trigger a lot of network upgrades, so if you add in storage, you could reduce that. And then you also, in certain use cases when you add in fixed storage you don't have to change consumer behavior because if there are use cases where you're getting a lot of consumers coming in, they want to charge quickly and then get out, having fixed storage there to help address the demand impacts there can be really helpful and smooth that out so you don't create a lot of peaks that then end up creating a lot of local issues, even if they're solving bulk system issues.

And actually rate redesign alone can't keep up with EV adoption unless you create a more dynamic schedule, kind of what the SDG&E pilot is looking to do where you have dynamic pricing and that would help address a lot of those types of system problems, because you don't just have everyone turning on at 11:00 p.m. And of course, as you saw from Heather, the Ducks change every year and are changing quite quickly as we move forward, so if you have a static rate structure that can't be adapted very quickly, you know, what may be good two years from now is not necessarily going to be good four years from now or six years from now.

So what are some of the roadblocks to VGI policies? That boulder, yes, is one of those roadblocks. We think the first thing is, in creating the right market incentives you have to have some form of rate reform, you need wholesale rates for wholesale market participation application. If there's a system out there that's charging, in order to enable providing services into the wholesale market, that charging has to happen at a wholesale rate. Retail rate treatment is for end uses, not power resale.

And then, of course, on the interconnection side, this is really challenging right now because there are so many different tariffs out there that could apply, oftentimes you're seeing multiple tariffs being applied, you have load interconnection tariffs, you have Rule 21, you have the wholesale distribution tariffs, and it's been very confusing for developers to identify the right tariffs to apply under and that actually qualify them for the right types of treatment that they're looking for. And also, a lot of times developers are finding that the interconnection costs that are under the existing tariffs don't really reflect the unique characteristics of their systems to be able to manage the load impacts that they're actually having. They're very, I'll say 20th Century, where you're having hardware fixes for things that can actually be solved through software today. You know, we live in the 21st Century and the ISO has an amazing software dispatch tool that solves a lot of the wholesale market conditions. There is software out there that can solve a lot of the localized impacts, as well, in managing the demand of EV charging stations on the Grid. We shouldn’t have to solve everything through expensive hardware fixes for new EV charging facilities out there when it can be solved through software.

So retail rate design for the end use is also I think a very important thing, particularly for V1G applications. You want to create the right dynamic kind of pricing to incent smoothing out the load and not creating the demand impacts on a localized basis. You want to be able to get a way to ultimately reflect localized system conditions in whatever incentives you’re creating out there. Market participation is also a continuing challenge and there’s a lot of reform that needs to happen in order to enable cost-effective metering telemetry for the ability of these systems to participate in wholesale markets.

And then I think the last point is

really, you know, this area of our Grid is changing so rapidly, it's great that there are utilities out there that are doing pilot programs, but we have to get past those pilots as quickly as possible because, if we don't, all these technologies are going to be left in the dust. And you're going to have a massive roll-out of EVs and the charging equipment that is out there is going to be -- I don't want to say this –- but it could be dumb equipment that doesn't really have the ability to change its usage based on the market signals that it's getting. So you don't want to go from a situation where we have a one, one and a half percent of vehicles that are sold today that are getting charging equipment installed, and that's not smart equipment, to maybe 10 percent five years from now or 10 years from now, and those consumers are still installing those timer-based systems that don't really have the ability to respond to market signals. But we're never going to get to that point unless we roll out programs throughout the Grid, and not just for pilots, that enable those kind of responsiveness to market signals. So we really encourage the utilities -- pilots are great, but we’ve got to get past them quickly. So the good news is that the Grid is not going to break, EVs are going to contribute -- EVs are already in certain circumstances contributing to solving some of the Grid problems. But through the right policies, we can really really make EV charging and vehicle to grid integration quite complementary to meeting our statewide GHG reduction goals, as well as through some of the system challenges that we’re seeing on the Grid. So thank you very much. I appreciate, once again, the opportunity to come speak with you today. And if you have any questions, here’s how you can get in touch with me. Looking forward to the panel.

COMMISSIONER SCOTT: Great. Thank you very much, Mark. These are two terrific stage setting presentations for us. Do we have any questions from the dais on the first two presentations? Nope? All right, before I turn it over to Mike Gravely to get going with our first panel, I just want to remind folks that there is an open proceeding before the Public Utilities Commission, so it’s just a gentle reminder to all of our participants not to go into any specifics of cases you may have pending before them, but to stay general as you make your comments. And I will turn to Mike to kick off the panel.

Mr. GRAVELY: Thank you, Commissioner Scott. So the panel we have before us today is going to kind of go forward with what we have just heard from both the need and the opportunity, and since Electric Vehicles provide a challenge, there’s a goal in California to have a minimum of 1.5 million vehicles on the road by 2025, that’s a large projection of growth so that becomes a charging challenge for the customers and also an opportunity.

So today we’re going to hear from different speakers on projects that are out there, from the utilities on what they’re doing, and we’re going to look specifically at where are we today in Electric Vehicle charging, both what they call V1G, or Smart Charging, as well as V2G where you’re using the vehicle for vehicle integration, and also just addressing the issues associated with that.

Our first speaker today is from the Public Utilities Commission, Adam Langton is actually managing -- we’ve heard before about this Alternative Fuel Vehicle proceeding, so he’s the staff lead for that proceeding, and he’s also been very active with the Governor’s Office in the Zero Emission Vehicle Initiative in the ISO led projects, and also the cap-and-trade for the electric sector. So he is a regulatory voice and is going to give us a little idea of where the PUC is going and the issues, they think. Adam?

MR. LANGTON: Thank you, Mike. And thank you, Commissioner Scott, for inviting me to be here today.

I’d like to just give a little kind of regulatory perspective here and talk a little bit about the opportunity and some of the challenges that we see in making vehicles a grid resource.

We saw this slide in Mark’s presentation. This is just a simple calculation of what the load from Electric Vehicles could look like, taking the CEC IEPR Forecast and projecting out what Electric Vehicle load could look like, and we have a mix of hybrids and BEVs on the Grid. And this shows by 2025 us reaching the Governor’s target of getting 1.5 million Electric Vehicles on the road in California by 2025, and if that happens we have about almost 8,000 megawatts of load from Electric Vehicles. If they were all charging at the same time, and was all happening on peak, it would represent a 15 percent increase in peak energy usage. That’s probably an unlikely scenario for reasons that I’ll talk about in a minute, but it is something to be mindful of.

As we saw in Heather’s presentation, the peak seems to be moving later into the evening around 6:00, 7:00, 8:00, and that’s when people are returning home from work, so you have the potential to have a lot of these vehicles charging at that time and contributing to peak. Well, there’s an opportunity here to make sure that that doesn’t happen and to charge in such a way that it’s actually providing Grid benefits.

Another note on this is that the state has a number of initiatives that are aimed at reducing emissions, GHG emissions, in the State of California by 2020, and also by 2050, are some of the target dates. Electric Vehicles are one of the few initiative elements that are actually going to result in an increase in electricity, so that’s why this challenge is so important because there’s an opportunity both to reduce the emissions, but also do it in such a way that we get benefits to the Grid.

This chart shows the -- and we already saw this also in Mark’s presentation -- and it looks like my titles are missing, but I can kind of fill you in. That top wedge there, that black wedge, is the amount of time that people spend driving, about four percent of the day is when a car is driving. And that green wedge is the charging time for if you take that average car and you’re charging it with a Level 2 charging station, you’re spending about 10 percent of your time charging. So the other 86 percent of the time your car is waiting. So that presents two opportunities for us, one is that we can charge that vehicle in such a way that it’s not contributing to peak and that it’s helping us to meet other Grid balancing needs, that’s one opportunity, and the second opportunity is that you could potentially discharge the battery to the Grid to provide energy storage, and then have enough time to recharge it in time to meet all your driving needs.

A couple of limitations to this, so the

fact that your driving doesn't -- as you are probably aware -- it doesn't happen in one wedge in your day that happens at the same time, it's spread throughout your day. And because the vehicle is driving, it's moving to different parts of the Grid which makes it more difficult to interconnect it than a traditional stationary resource which is always at the same spot on the Grid. And also a vehicle is pretty small relative to the overall need that Heather talked about that the Grid has for balancing, when we're talking about at the thousands of megawatts; an Electric Vehicle is a few kilowatts, maybe 10 kilowatts, perhaps higher than that, which looks really small relative to the overall Grid, which presents a challenge for integrating them into the wholesale market.

But then, from the local perspective, when you're looking at the local grid in a residential neighborhood, an Electric Vehicle is actually very big. That load can be equal to what a house load is. So when you buy an Electric Vehicle, you're potentially increasing your neighborhood load by an additional house, so that can constrain the transformer in the local distribution system. So that presents kind of opposite challenges that we see.

Just a little more context on driving behavior. This is a breakdown of where cars are throughout the day, hour by hour, based on the National Household Transportation Survey, and what's interesting here, and then I wanted to point out is that cars spend a lot of time at home at night, that's kind of obvious, and the other interesting component here, though, is that the cars spend a lot of time at work, as you can imagine. They are, just by looking at this graph, you're seeing a big increase in cars arriving at work, that's that middle section, that dark blue area there, around 8:00 a.m. or so, and then that starts to taper off and it kind of dramatically tapers off maybe around 5:00. And what's interesting about this is that it kind of aligns with what we see the Duck Curve need in the spring and fall, as Heather talked about, that we have this net load dropping around 9:00 a.m. and then increasing around 5:00 p.m. So it's during that whole time that we see a lot of vehicles at work. And they've already driven to work, so they probably have a need to charge up.

So there’s a particularly interesting opportunity there where we could use workplace charging to kind of help fill the belly of the Duck and, as Heather talked about, help levelize this curve and reduce some of the integration costs.

Other opportunities are meeting that evening ramp when the solar is coming off, we have vehicles, then, at that time that are traveling from work, going home, and they have the potential to help us meet that ramp in the evening. We want to avoid the peak hours that we see after that ramp. And then at night there’s potential opportunities to integrate wind resources at night when we occasionally get wind spikes, so having that nighttime charging available could be scheduled to address those.

And then the other opportunity at night is to avoid overloading the local distribution system by potentially staggering the charging that vehicles are doing on a given transformer, doing some kind of scheduled charging, opportunities like that are worth exploring because they can help reduce utility costs.

I want to talk about the two primary types of VGI that we see. And I actually want to introduce a third type that kind of blends between these two types and helps us understand some of the complexities to integrating this resources. So this is just a graph showing this middle line is a vehicle that is not charging, and what this shows is the potential charging range for the load up to a max charging level here shown as 6.6 kilowatts, but vehicles can go higher than that.

If a vehicle was receiving a signal, its charging behavior could look something like this, this is just meant to be kind of representative of what a vehicle could look like when it's charging. That blue area is the charging level, you can see that it increases, stays steady, and then drops off, drops off for a while, there's a couple spikes, drops of again, there's another spike, and then it's done. And this is over some period of time. This time period, I didn't specify the scale on this because it could be many different scales, we could be talking about a scale of one day, so this could represent one day of charging where it's getting a signal not to charge during certain points of maybe the morning or the afternoon to avoid certain congestion periods, it could be spiking up and down in response to Grid signals that are happening throughout the day. This could also represent charging in just one minute, so this whole length of that black line could represent 60 seconds. And so this vehicle could be getting signals every few seconds which happens for frequency regulation, and it could respond to those signals by increasing its charging rate, or decreasing its charging rate. Vehicles can do that pretty quickly and we think that charging like this, making these kind of changes in charging, it isn’t damaging to the battery and doesn’t necessarily affect the cycle life of the battery.

The other primary category that we see is bidirectional power flow, or what I’m calling here “battery discharge.” So this is the same signal, but now because the vehicle is capable of discharging, when it gets that signal to stop charging, in this particular example the battery is actually discharging, and it is providing power onto the Grid. And it’s responding to a signal for a need to have additional power on the Grid. It can go down as low as -6.6 kilowatts or essentially a supply of 6.6 kilowatts. And by doing this there's a couple of advantages, 1) you can provide services for a much longer period of time because now you're charging and discharging the battery; in the other example, when you're just doing charging, eventually your battery is going to get full and you're going to be done providing services. You can go up and down, you can respond to Grid signals that are asking you to increase and decrease your charging level, but eventually you will be full. But when you're talking about bidirectional power flow, you're less likely to have your battery fill up and you can essentially look like any other storage device.

The challenge here, though, is that when you're discharging the battery, you are impacting the battery life. You are reducing the number of cycles that you can get from the battery and, as a result, you're reducing the life of the battery which is potentially creating a cost for users. And it's not clear that the value for a user discharging this battery for Grid services is worth more than using those cycles to drive, it's not known yet, we'd have to know more about what the value of the Grid services are, we'd also have to know more about the cycle life and how it impacts the battery life.

But the third example that I wanted to talk about using this particular battery discharge example, so this is a graph of the vehicle and the vehicle's charging and discharging. If this charging were to take place at a facility that had a very high load, let's say that facility had a load that was constant at, say, one megawatt throughout the day, if that was the case, when this battery is discharging, the meter is never running backwards, so what the facility load sees is the facility load is increasing and decreasing, but it's never actually running backwards.

So from the vehicle standpoint, this is a bidirectional resource. But from the meter standpoint in this particular example that I'm describing where you have a one megawatt load all the time, the meter is never running backwards. So from the utilities' perspective, it doesn't necessarily look like a bidirectional resource, it looks more like a load modifying resource.

So in that particular example, is this a

V1G resource? Or is it a V2G resource? From the perspective of the meter, it looks like a demand modifying resource. But from the perspective of the vehicle, it looks like a bidirectional storage resource. So this is just an example of some of the complexity that we start to see when we start to break down some of the use cases, is that there are some mixing of the two examples, and it really depends on what your perspective is; the perspective becomes very important.

So just like a car has a frame and that frame helps to organize the vehicle and where you have passengers, where you have the drivetrain components, and it provides support for the vehicle, the regulatory framework provides a similar function when we're talking about VGI. And in the staff white paper we identified four key questions that we thought were important to addressing in order to create the right framework.

The first question is define the VGI resource, is the resource the actual vehicle? Is the resource the charging station? Or is the resource the facility? And this is important because it determines where you want to communicate, who you are communicating with, where you're measuring the resource, so it can drive a lot of how we regulate this kind of resource. Who aggregates? So I mentioned that the vehicles from the wholesale market perspective are very small, so you probably need to aggregate these vehicles to get them to participate in the wholesale market. Who should do that? Should the utilities do it? Should third party entities aggregate? Or should we have some kind of hybrid where the third parties are aggregating to the utilities, and then the utilities are aggregating to the wholesale market. Or you could have other iterations along those lines. And that gets to what the utility role is in how we aggregate. There are advantages to having the utility play a role in this, but there are also advantages to having third parties play a role.

And then how do we capture the distribution benefits? So I mentioned one of the benefits is at the local level where you're avoiding distribution costs, how do we actually capture those benefits? What are those benefits? And then how do we make sure that they're flowing back to somebody, to a driver, a facility, or a charging station that's actually providing those benefits?

And then the fourth question we identified was ranking the primacy among VGI activities. So there are benefits at the local level, there are benefits at the wholesale level. At times those benefits could be -- you could be getting conflicting signals, so you could imagine that a local circuit is looking for you to decrease your load because it doesn't want to overload a transformer at a particular time, but you could also imagine at the same time that the wholesale market is asking you to increase your load because there is wind spikes on the Grid. So if you have situations like that, how do you rank different VGI activities so that we make sure that we're maximizing the total benefit to the Grid?

Having answered those four questions, staff identified kind of additional implementation questions that should be answered once we've answered those primary questions. So these questions that we see here kind of all flow out of whatever the answers to the primary regulatory framework questions are. So how does a VGI resource interconnect? That will depend on where the resource is located. What utility tariffs do we need? That kind of speaks to what the utility role is, are they an aggregator or are they not? How are they capturing the local distribution benefits? What kind of metering do we need? So where does that metering need to be? Who is it talking to? Communication requirements would seem to very much flow out of where the resource is located.

And then how do we make sure it's safe? So one potential safety issue here, so I mentioned this example where you have a battery or a vehicle that is providing bidirectional power flow, but the meter never sees that because the meter is seeing this up and down in the load, but it's never running backwards. You could argue that the utility maybe then shouldn't necessarily need to have a role in that because it's just load modifying, it's not necessarily reflecting the distribution system, it's not flowing backwards onto the Grid. But it does introduce a safety issue because if the utility can't see where a resource is back feeding onto the Grid, when the utility goes out to a particular circuit, wants to do work on that, they usually want to depower that part of the Grid. And if they can't see that there's a bidirectional resource on there that's potentially sending electrons up from a facility, that creates a potential safety hazard for the utility. In addition, there's other safety issues which are important for us to look at.

So what are some of the things that are happening next? We have a few things going on that I think are relevant to this process that CEC and other stakeholders should be aware of. We have an ongoing storage proceeding, and one of the questions at the storage proceeding we're looking at right now is looking at what the definition of "storage" is. And this affects a number of different resources and staff has identified kind of a narrow definition of storage and a broad definition of storage. And different resources fall in as storage depending on whether you're looking at the narrow or broad definition. And the controlled charging is one of those resources where it falls in under a broad definition, it doesn't fall in under a narrow definition. So right now staff is exploring this, there have been workshops and comments on this, so that's happening right now.

We also have an Alternative Fuel Vehicle proceeding that was started in November, we had a workshop in December, and since that time we've been kind of evaluating the feedback that we've gotten from parties in trying to identify the specific next steps that we are going to use to move that proceeding forward. And we should be releasing a scoping memo soon that will have those detailed steps and mention the specific issues that we want to address, what the order of those issues is, and the workshops that we will be having.

So I would suggest keeping an eye out for that and for anyone who is interested in this issue, I think that would be a good chance for you to learn more, but particularly valuable for us to get your feedback on how we move forward on those next steps.

And finally, there's a few pilots that are underway that the Commission is working on to help us better understand this. The DOD pilot that is doing bidirectional power flow at a couple different bases in California is one example, and those pilots are really helpful for us because it helps us understand what the challenges are. It also has been helpful to bring together the different stakeholders in that process, so in the DOD project CPUC staff and CAISO and the utility have worked closely together to start to understand these challenges. And I think that's going to be an important component to moving forward on this.

I know that we've had conversations at the staff level with CEC and CAISO to figure out -- to make sure our efforts are all aligned on this and to share information so that we can make sure we're contributing to this process of moving forward. So I appreciate that CEC invited us here so that we could talk about this and have our input and help collaborate on this.

A final thing I want to mention is that CAISO has a road mapping process, they did one on vehicle/grid integration, and they're doing another one on energy storage, and that's another example where we can bring not only stakeholders together, but these agencies together to kind of collaborate and make sure that our strategies are aligned. That’s all. I think we’ll wait on questions? Is that correct, Mike?

MR. GRAVELY: That’s correct. We’ll have questions at the end of the panel here, so thank you very much, Adam.

So our next speaker is Heather again from us, and one of the things we work together with is on this vehicle to grid integration roadmap for the Governor’s initiative, and Heather will talk about some of the issues that have come out of that, a little bit about the roadmap, and I will remind our speakers, we have quite a few speakers today, so do your best to stay within the five to six minutes so we can get all the speakers in. Thank you so much.

MS. SANDERS: Okay, great. Thank you very much. I wanted to start first by building on some of the things that Adam talked about. As Steve laid out, it’s really important to have the policies aligned so that we do not further burden the Grid by the Electric Vehicles and have the opportunity to benefit from them.

And what I wanted to start out with is just very practically describing what it takes to do these different forms of Vehicle/Grid integration. The first thing is I want to thank all of you for participating in our partnering Roadmap on Vehicle Integration as part of the Governor’s ZEV Action Plan last year. It really helped us bring this common language of what did we mean by “vehicle to grid,” what do we mean by V1G-V1G?” And so that roadmap has proven to be a very valuable resource as we go through to enable Electric Vehicles to provide Grid service. So I want to thank the CEC and the PUC for your partnership, as well as all of you for developing that roadmap.

V1G. V1G is charge discharge, it’s one way power flow, one way signaling. It can be accomplished in a couple different ways, it can be accomplished through rate structures that help people understand what they need to do, when. And they will respond based on how it benefits them.

The other way to manage V1G is to have essential aggregator be establishing a program or some other way that helps send the signals at the right time. V1G can also be accomplished in the wholesale market. Again, what we come to is, what is the benefit for that vehicle, or for that vehicle aggregation, to provide that service?

So in the wholesale market you can aggregate a number of vehicles and come in as a demand response resource, react to dynamic signals from the market, and charge and reduce charging, or stop charging as dispatched from the market. Each of these require different infrastructure, different metering and telemetry, and different participation levels by the end user, really the aggregator in the case of a wholesale market participation. So at the simplest level, V1G from a rate structure is just helping people know, the end users as you mentioned at your house, when does your off-peak rate start? How am I benefiting from that? How does it reduce my bill? That's one way.

The second way, through a utility program and aligning the signals, the most important thing is to align what is actually happening on the grid at that time. So we talked about we can get time of use rates seasonally positioned to help with that, but the more we're able to connect with what is actually going to be going on in the system, whether it's locally on a distribution system, or at a wholesale level from a supply/demand balance, the better we're able to leverage the capabilities that Electric Vehicles have to manage the grid. Utility program, aggregating that resource, providing some value to the end-use customer to provide that. Connecting the signals from the wholesale market, what's going on, are prices high? Are prices low? Are we in a contingency event?

The third way, into the wholesale market, now this from a grid operator perspective is the most valuable way because we have dispatch capability for different resources, but it's not the only way. Each of these require different things. Pretty simply from a time of use, if we individually are going to have Electric Vehicles at our home and we're going to have time of use rates, all we need is to know, we need to know how to set up our vehicle timers to react, and we should benefit from that rate structure.

The second way is for a centralized entity, whether it's San Diego Gas & Electric's pilot that they set forth, or another way to be able to connect those, and I assume you're going to talk about that pilot. Okay. We're very supportive of that pilot because they took the wholesale conditions and linked that with the schedule for the charging and gave people a choice to do that, so that's the second way. And he can talk about what the requirements are for someone to participate in something like that.

Now, when you get to a wholesale market, and the reason participating in the wholesale market is attractive is because it's another revenue stream. It also provides the ability for these resources to potentially provide some type of capacity value, as well, RA, as we know it. But what is required is much more because, as the Grid Operator, you need to be able to handle these resources to know when and where and how much. So you get into the ability to I need to know you're available, I need to be able to dispatch you to react at the amount of response we need, and I need you to react for as long as that. So what you'll hear people say is, "Okay, I've got a first interconnect." So if we have our private vehicles, we can call up the utility and say, hey, you know, I don't even have to call you, I can just plug it into the wall, but if you're going to provide Grid services, you need to interconnect, and if you're going to provide wholesale market services, you need to interconnect under a Wholesale Distribution Access Tariff -- we think. That's one of our open policy items. In order to do that, you're providing a service, a sale for resale, you interconnect. There are studies because if you are modifying the power flow on the system, you've got to make sure that it's going to work. So there's interconnection, there's interconnection processes you need to go through, there are metering and telemetry requirements. Telemetry is a real time measurement of what that resource is doing, it's real time. And then the measurement, the metering, is the revenue side of it, so you can ensure that the resource did what it was supposed to do at the time it was supposed to do it.

So I wanted to lay that out for you because it's really important. When we start talking about these things, there are a number of ways to accomplish what we need to do, there are different values to the customer, the aggregator, and others providing these services, depending on what you do. Most of this has been covered already, but just to show why the ISO is really emphasizing this policy alignment is there's enough capacity out there today to serve the Electric Vehicles, this is from 2012. This is a Summer Load Profile. There is 8,000 megawatts of capacity available to serve that charging if it was at this time.

Here is what a typical winter load looked like in 2012, again, you see there is capacity available for charging through the day. Finally, you get to our study period of 2020 and you see even more capacity available during the day because we brought the peaks up higher and the dips are lower. So again, getting these policies right and understanding what it takes and what the value is to the end user will be key as we go forward in developing what's needed.

So again, I emphasize this, if you're participating as a Grid resource, a wholesale resource, this is what is important. You know, as participating as an aggregate in another configuration it's important to ensure we meet the needs of the customer, at the same time understanding what benefits it can provide the Grid.

So with that, I will turn it over to my

other panelists and look forward to your questions later.

MR. GRAVELY: Thank you, Heather. I’m sure we’ll hear some questions at the end of the panel here.

So as technology is, we’re having a little challenge, we have one person speaking, Camron Gorguinpour from Department of Defense in the Pentagon, he’s on the phone, but I don’t think he has WebEx. He said he wasn’t able to WebEx, so see if we can bring him up.

Camron, can you hear us?

MR. GORGUINPOUR: I can hear you. Can you hear me?

MR. GRAVELY: Yes. Thank you very much. Okay, for those in the room and those online, Camron Gorguinpour is the Executive Director for the Department of Defense Plug-In Electric Vehicle Program and they’re looking at transferring their non-tactical fleet from Fuel Vehicles to Electric Vehicles, and it is one of the biggest, if not the biggest, Electric Vehicle demonstration programs in the world. Camron also is a California-trained, his Masters and PhD is from University of California Berkeley, and he’s got a long distinguished career working with the Government and working with industry. With that, Camron, I'll let you go ahead. Now, we can flip through the charts for you, just tell us which one you want us to change.

MR. GORGUINPOUR: Sure, that's great. Thanks. And that's an overly gracious introduction, thanks. So I'm sure that Adam and Heather's slides were beautiful, unfortunately I couldn't see them, but they were very descriptive, so I feel like I'm there. Anyhow, as Mike mentioned, I am the Executive Director for DOD's Plug-In Electric Vehicle Programs, so broadly my role is to try and figure out strategies to expand the use of EVs within DOD's non-tactical fleet of vehicles. But I'll spend this period of time really talking about our biggest project, which is the Vehicle to Grid Pilot Program. So if we can go to the next slide, the second slide.

Really, we are trying to operationalize the use of VG technologies in our fleet. And so we want to demonstrate and validate the technology on both the vehicles and on charging stations. We are developing now with Lawrence

Berkeley Lab a full control software system that's being implemented and we're actually trying to participate in ancillary service markets and other demand response activities.

So ultimately what we're trying to do is determine on a broad scale implementation is V2G, something that we can use to mitigate the extra cost of using EVs, can we add operational capabilities to our installations, and frankly, just logistically, can we make it work with all of our requirements to participate in the market.

So if you go on the next slide, slide 3, we are now opening up on five bases around the country, two in California, and then in Texas, Maryland, and New Jersey. The idea here was that we wanted to look at different ISO markets to see how the processes might be different and to gain experience across a range of different markets.

In California, the Mountain View Army Reserve Center activity was just recently launched, we're grateful to the California Energy Commission for providing financial support to Berkeley and to PG&E to launch that effort. I think the key difference with Mountain View and the other bases is that at Mountain View we won't be participating in the frequency regulation market, it will be more demand response activities being coordinated by Pepco. The other four locations will specifically be in ancillary service and in frequency regulation markets.

Obviously, other than just the market participation, we were looking for demonstrating the technologies in a variety of different operational settings, climates, terrains, and so forth. And L.A. Air Force Base is probably going to be the first to come on line. And I think as many of you know, it will be the first federal facility to replace its entire fleet of vehicles with Plug-In Electric Vehicles, and the vast majority of those will be V2G-capable. So we have already started delivering vehicles and things are going through testing right now with the associated charging stations, so again hopefully by the fall we'll be live in CAISO's market. And the other bases are likely to come on line just shortly after that, maybe trailing by a month or two, just based on delivery schedules for vehicle and charging station vendors.

So if you go to slide 4, along the lines of vehicle vendors, this is the mix of vehicles that we are expecting for all of the bases really, though LA is the only base that's going to use all five of these vehicle types, so just starting from the top there, EVAOS is a California-based company, they do a retrofit on F series pick-up trucks where they convert it into a Plug-In Hybrid, and so that vehicle will be used on at least four of the bases.

Moving on to the right, another California-based company -- actually, now that I think about it, most of these are California-based companies –- EVI based out of Stockton again, actually with California Energy Commission support, they are developing a Plug-In Hybrid Heavy-Duty Truck, so we are getting four of those delivered to LA Air Force Base. At the bottom right is Phoenix based in Ontario. And there is one small shuttle bus requirement at LA; because we're replacing all the vehicles, we had to go out and get a bus, so Phoenix is producing that for us. That will be a fully electric bus. Of course, we have the Nissan *Leaf*, which will be at all five locations, and then on the left VIA which is a Utah-based company will be providing passenger and cargo vans. So again, all of these vehicles will be V2G-capable, and when you consider other work the Army has done at one of their bases in Colorado, you can add Smith Electric Vehicle and Boulder Electric Vehicle onto the list of DOD supported EV companies who have developed V2G capability.

So we're pretty excited to have by the end of this a healthy supply base, and I'm not going to commit to any or all of these companies to commercializing V2G technologies, but at least we can say that they'll have the experience and they will have done it. And so we think that's a pretty exciting thing.

And on slide 5 here, the corresponding charging stations, now some of these are non-V2G charging stations because at LA we're replacing all of the vehicles with EVs, there was a need for some non-V2G-capable charging stations, so the two in the center there, the AeroVironment and the Eaton are non-V2G-capable. But if you look the others, the Princeton Power unit and the Coritech units, we now have two charging station vendors with three different models, the Princeton Power System is specific to the *Leaf*, it uses the CHAdeMO connector, and that's a DC charging station, so all the power electronics are onboard the charging station. And then with Coritech, those are the SAE charging stations and we have an AC unit for some of the vehicles that have the power electronics onboard the vehicle, and then we have a 50 kilowatt DC unit for some of the larger vehicles. So that one, the DC Coritech unit, will be used only at LA Air Force Base to support the EVI Trucks and the Phoenix Bus. I should also mention the Princeton Power System actually has the 30 kilowatt inverter onboard, but would cap that to 15 kilowatts because that is what Nissan would allow us to do with the *Leaf*, is to max out at 15 KW. And then the AC unit on Coritech has the capability up to, I believe, 19 kilowatts, roughly.

So a lot of different models, a lot of different capabilities and, again, all of these are going to be going through testing at Southern California Edison's EV Testing Center. We have already begun and I think almost completed at this point testing of the Nissan *Leafs* with the Princeton Power Units, and next month I believe we'll begin testing with the Coritech units.

On slide 6, this is really the brains of the project. This is the software system being developed by Lawrence Berkeley Lab, and there are five key modules here that allow it to operate, the most critical is -- well, I shouldn't say the most critical, but the one that has the closest connection to actual user interface is on the left-hand side, the bottom left there, the EV Fleet Management System. So the goal is to have that module be the sole interface with people on each of our bases and essentially it's a Zip Car-style fleet reservation system, so people can go in, they tell the system what time they need a vehicle, what type of vehicle they need, where they're going, and based on that it recommends a vehicle capable of meeting the requirement. And then it feeds back into these other modules to plan a charging schedule, so on the bottom center, that Grid Scheduling Module, that is Berkeley's DER/CAM which is an optimization tool that takes into account the tariffs and rate structures for each of the bases, and then will optimize the charging schedule to minimize the cost, and I believe that's also the piece that will structure the bids into the ISO markets.

And that communicates with sort of the central control module, the EV Asset Coordination Module, and in the bottom right is the Charge Control Module, so taking the information on charging schedules and bids, that bottom right segment is actually the signal being sent from our server to the charging stations, so again it's reading in the charging schedule, it is reading in the signal from the ISO, and then dispatching a charge/discharge signal to each of the available vehicles.

And then everything above the EV Asset Coordination Module is Grid Interface, so we talk to our Scheduling Coordinator through that top module and then we also receive and transmit that information to the ISO about how the vehicles are actually being used.

So that's sort of a quick snapshot of how the system is set up. I think it seems more complicated than it is when you lay it out like that, but we're pretty well into the software development here. I think, again, probably by July-August, we will have a fully functioning system ready to be tested and then certified for use in the ISO. So we're looking forward to that.

We have had some challenges, this is all very new stuff, very challenging stuff. So if you go on slide 7, I think many of you know that the CPUC passed a resolution, I guess it was last year, enabling us to participate in the ISO markets under a pilot tariff with Southern California Edison, so we are definitely grateful for them to have moved that along. But even still, the process of interconnection, as many of you realize, is particularly challenging. And Southern California Edison has been a very good partner, especially given sort of the novelty of what we're trying to do, and a lot of this stuff is right on the cutting edge in trying to work through some of their bureaucratic hurdles and frankly just figuring out what conceptually we should be doing is a challenge. But we did note particularly for LA Air Force Base and for a Navy Installation which we are pausing right now in terms of its implementation, but may very well pick up later, that there were some common challenges in the interconnection process. So we conveyed those to SCE and they are developing a plan to actually be able to address that more proactively. So we're looking forward to seeing how that all shakes out. But just to give you a feel for the types of things that we experienced, just going through those sub-bullets here on the first major bullet point, internal coordination between the different utility offices, what we were trying to do engaged so many different offices with within Edison that oftentimes I think things were missed and we ended up having to go back and redo things later; like an example being telemetry where we had SCE approve all the electrical infrastructure and we installed it, and then a year later as we were going through the interconnection process, it came out that we needed to install telemetry on top of that, and so there's a whole process that we have to do that would have been cheaper and easier if we'd just known upfront. And again, these are the types of things that just sort of shake out with any sort of new project.

We had a hard time on those next two bullet points really understanding what the interconnection process is and what the requirements are, so there were many data requests from us largely around our inverters, but without knowing really what the process was going to be, or what folks were really looking at on the SCE side, it was difficult to provide the correct data. And so we ended up spending a lot of time just going back and forth with data requests and, you know, DOD is kind of a big bureaucracy also, so every time we get a data request back, there's a whole churn that has to happen and, you know, several months later finally we got all the data to them that they needed, but it was definitely difficult and it's something to keep an eye out for, that we really do need to have a much clearer description of how to make it through the process and if there are going to be requirements like data requirements, or physical requirements like telemetry, that those are better conveyed.

Defaulting to negative conclusions, I think that's -- I guess what we're trying to say is that there are, in a project like this, many decision points and many things that don't necessarily fit cleanly into normal buckets for different regulatory requirements. And as with I'm sure any utility, there's a default towards the most conservative assumptions possible and that can be limiting. And so we've been, again, working with Edison and they have been very helpful in working through some of these issues. But again, it is a challenge. It's a challenge trying to convey what we're trying to do and why certain things that we're trying to accomplish aren't necessarily going to devastate the entire grid, for example. But anyhow, that's another thing.

And one other point, and that's the last point here, the lack of cohesion between the utility and the CAISO requirements. So CAISO has, in fairness to them, a very well defined process, and they give you a nice spreadsheet that you can sort of work through, but we found that there were several duplicative requirements, telemetry being one of them, metering, and then the review process is duplicative. So we've had to submit one-line diagrams for a system on probably four different occasions between CAISO and Edison, so the different folks can look at the exact same thing, so we just felt there was some room for improvement there to better coordinate the different sets of activities so that resource developers don't have to run around in circles and repeat the same things over and over again.

So those are basically the gist of the interconnection challenges that we faced. We have a great support network now with CEC, the PUC, Edison, and some of our instate folks for DOD, and so we're meeting roughly every month to go through these issues on top of our weekly calls with the PUC and CAISO, and SCE. So there's no shortage of conversation in getting this done, but that's really what it's taken to really move this stuff forward and finally now I think we're just about at the point where just the last few wickets on telemetry and then I've got to have our lawyers look at the interconnection agreement and get that signed, but that's all imminent, so within the next month or two I think we will have finally gotten through at least the interconnect process.

So anyhow, that's a general description. I think I probably went a little bit over the five or six minutes, sorry, Mike. But I will shut up now and wait for questions later.

MR. GRAVELY: Okay, so you're able to hang on for about 30 minutes or so for a question and answer period?

MR. GORGUINPOUR: Oh, Yeah. Yeah, of course.

MR. GRAVELY: Okay, so we'll get back to you at the end. Thank you very much.

Our next speaker is Paul Stith from --

COMMISSIONER SCOTT: Mike, we've got one question up here.

MR. BERBERICH: If I might. Steve Berberich. Camron, Steve Berberich, the CEO of the California ISO. I'm interested, and maybe this is a question for Felix and Heather, as well, but obviously this has been a groundbreaking project and we're delighted to be able to work through this process, but it's also disconcerting that it's been so difficult. The question is, have we resolved these issues? Have we documented these issues? Do we have a process now that is much more seamless? That's my question.

MR. GORGUINPOUR: Yeah, I mean, I think that we are definitely documenting the challenges and certainly, you know, as I mentioned we have many many meetings to resolve, so again, I've got to highlight that, of course, doing something like we’re doing is -- challenges are going to come up, you know, and that’s something that we’ve accounted for, and if we can take lessons learned and apply them more broadly, I think that’s the best we can expect. So I’m very comfortable that we have a path to resolve these issues. I think probably the next step is going to be to take these lessons learned and resolve them obviously for the existing bases, but then generalize that information and help improve the process for everyone else I think is a big part of our interest. I mean, we don’t really think it’s going to be -- we want to demonstrate V2G and how it works great for DOD, but from our perspective it’s not entirely successful if other people can’t do it. So I think we’re on that track, to answer your question. But obviously still more work to do.

MS. SANDERS: So, Steve, let me respond directly to make sure you’re comfortable with our understanding of these issues and what we’re doing. Electric Vehicle providing V2G as in the DOD is another form of energy storage, and with the recent decision around the energy storage targets, we recognize energy storage is going to have many of these same challenges. So what we've done is partnered with the CEC and the PUC to do an energy storage road mapping effort that gets to what are these issues that are being faced, lessons learned from what we got from the DOD experience, and then really identify what is the forum where we go address those issues, in what priority. So we've taken in what we've learned from Camron, we have in some cases specific stakeholder efforts to address those. But overall, we're embarking on this partnership for an energy storage roadmap to ensure that we are clearing the path for not just the one use case of the V2G, but many more use cases of energy storage to provide grid services and capabilities.

MR. GRAVELY: Thank you, Camron, and we'll bring you back on for the open discussion period.

MR. GORGUINPOUR: Okay, thanks.

MR. GRAVELY: So our next speaker is Paul Stith from EV Grid. And he's been with EV Grid since 2013. He has a long distinguished background in Electric Vehicles, distributed energy storage, and renewable integration. And I believe you also have a display unit for us out in front of the building, if I'm not mistaken. So Paul, go ahead.

MR. STITH: Very good. And I wanted to thank you very much for the invitation to speak. This is a rare opportunity to express our vision for where we'd like to see the grid go with EVs helping them in a dramatic way.

I want to first off start off to something simple, is we couldn't ask for a better Ambassador for Vehicle to Grid than the BMW Mini E that's parked out in front. EV Grid was entrusted with a large quantity of BMW Mini Es after the field trials finished of the first round in 2008 and 2009, and that culminated ultimately with the i3 that's just now launched so in their resume the Mini E's have a long set of research that's been done for user preferences with UC Davis, and now we're using them with University of Delaware in other projects. So a lot of credit to BMW and to that fun car.

So my thing is first off also to thank Camron because he went before me, if he stole in line, of course, and he highlighted all the things that I don't have time to highlight in my presentation, which are about interconnection and all of the things and the challenges that we want to take these great vehicles and plug them into the Grid, and we don't want it to take a year and a half in order to be able to do that after you come home from the dealership or the fleet sales company, if it's a large vehicle asset, this needs to get easy, it needs to be as easy as home solar, or easier. You can't skip any of the steps because we are talking about energy flowing back to the Grid. So thank you, Camron, for all the work you're doing, we look to leverage that.

So a little bit about EV Grid and some perspective is that we're uniquely qualified and we understand batteries. We also understand the process and how long it's been taking to get vehicles on the roads, and particularly moving to the next stage where we're using them as storage assets.

EV Grid actually, the heritage is that we built battery systems, including the one that's in the Mini E and other boxes that are on the roads today. We had a lot of projects that unfortunately I don't get to talk about, but we get advanced access to cells and we're able to learn and understand a lot about battery economics before the general population is ever going to understand it. Based on that, I want you to understand that we see where cells are going and we know that the battery degradation, the costs associated with that, is truly a non-issue, and so I do want to make sure you understand from our technical point of view, and the access that we have, where we see the market going. So I did want to throw that out there.

We are doing second life battery projects, some of them supported by the CEC, and working with our partners; when we go live with those, we'll be able to talk a lot more about which ones and where they are.

So it's a great opportunity and let's talk a little bit about a couple of projects after I show you the long road it took to get here. So through the years, there's been a lot of talk, and more talk, and a few demonstrations talking about effectively 16 years from when the concept came up through all of these various steps and it started getting accelerated if you look in, say, 2010 where you actually have a J1772 connector that's going to start coming on a number of the vehicles that are coming on the road if something that is standardized. The team at University of Delaware that we work with took that connector and actually developed a communications protocol that is compliant with that coupler, and I'm happy to say that that ability to use the pilot wire that's in every coupler, actually was developed in 2010, is now part of the J1772 standards so that there is an open access to using communication architecture over the existing plugs, and that's a pretty key point that happened. In 2011, NRG teamed up with the University of Delaware and began the Grid on Wheels project. I'm going to be giving a couple of updates on the Grid on Wheels project and also a bus project that is actually using the same technologies.

For all of the words of wisdom that Camron was sharing, and what it's taken to get on line, understand that last February we actually had vehicles in on the East Coast providing grid services and receiving compensation, so that started in February and that project I'll give you an update on, it's in a PJM territory, I'll state that it's a little bit easier in PJM to bring on small distributed resources, but they have been on ever since, and we're expanding it.

So with that, I will talk about the Grid on Wheels project. There's a lot of logos, it takes a lot of hands, a lot of participation. At this stage, the vehicle logos that stand out, of course you have the Mini Es, and also Honda joined this in December. They have a plug-in Accord that is actually utilizing the exact same coupler and the same protocols and same hardware capabilities to link in. And again, a lot of folks there to make this move forward.

The goal of it was really to show that you can actually provide revenue to the owners, and we look at that a lot and we want to make sure that you return the value to the owners of the fleet assets. They're fast responding batteries. They come with the vehicles, you just need a control architecture and, as Camron showed you, again thanking him, there's a lot of parts to that architecture, it's already up and running in this pilot in the University of Delaware with the driver preferences, with the grid scheduling, with the asset workloads, and so forth. So being able to support renewables is a key thing. And at the bottom there was about whether or not we're studying battery degradation and it is part of that project plan.

Today there are two locations, up to nearly 20 vehicles came on line last year. Over the summer months there are going to be 10 additional locations. Those will include actual consumer residences and employees of the university and other stakeholders that are taking part of this, and taking these vehicles out on the road using them in their daily lives. There's another thing that's coming up using the same technology to be aware of, using the NYSERDA grant award, that will take this technology and apply it toward vehicle-to-building, and so that's something coming up.

So we really want to focus on it's live, it's not the technology, it's more about the policies we'd like to drive home on making it easier to connect these resources.

The consumers that are participating actually received an app that they run on their phone that they schedule their actual interaction with their energy storage platform, which happens to also be transportation.

Something also to note is if you're doing frequency regulation, the variations in state-of-charge are really not that great and they're short bursts, and they typically zero out with the requests, and a workload can certainly be scheduled that way across multiple vehicles. Sixty-five to 85 percent of the batteries is the typical state-of-charge that's being worked in that's friendly to the batteries, it also leaves you in a position to be able to schedule a charge full trajectory with very little effort. And be aware, these vehicles do have faster AC charging, they're typically charging at 15 KW. That is important for grid services, that's important and you've seen it in Tesla and others, 10 KW for example allows you to recover energy faster, it also delivers more value when you're providing grid services, so look at that trend as it continues to go up. Adam had 6.6 kilowatts on his chart which is typical today, we'll see those going up, especially in larger trucks, Camron.

So five dollars a day is the mark that has been set in the work with the fleet, you know, this is a learning process. Just through changes in the optimization in how you dispatch, we are actually able to change the revenue by 20 percent -- not changing the vehicles, not changing the actual state-of-charge -- but actually just optimizing the vehicle dispatches. So I wanted to make sure that everybody understands this is something that is a learning process and we’re certainly learning every day. For example, who would have thought that if you have a Nor’easter roll in that your vehicle-to-grid project is going to be a little bit on ice? And that’s literally that you want to consider these things, that weather could affect battery charges, for example, or extreme heat is another one.

These are the vehicles that are in our project. We don’t have as big of trucks as Camron. These each have capable onboard, through the standards-based coupler, are able to control the vehicles every four seconds in responding to the requests from the grid operator.

The other area I want to talk about is our work with the Clinton Global Initiative. Today, in fact, in Denver one of our colleagues on a project is giving a presentation at the National Conference where the industry, government and many hands come together and make commitments. Ours is with National Strategies, Ernst & Young, PJM, and NRG, to bring about the viability of zero emission school buses that are assisted by the financial boost of vehicle-to-grid. That's a project that actually is national in scope. There are five states that are part of it, there's funding established in California, South Coast Air Quality District, Massachusetts has funding, and there are others that are coming together in Illinois, Texas, and New York.

This project actually utilizes the larger buses for a number of reasons that you're actually having a chassis that is built to handle more weight, it's also a bus platform that lasts longer and may very well encounter drive train replacement in its regular life, certainly the maintenance costs go up, so there is some economic tipping points that make these particular sized vehicles. Certainly it can carry a lot more weight. The bidirectional chargers you can see, and in this one we're looking at 60 kilowatt-type capabilities. So a lot of energy being able to move in and out of these for the purposes of recovery of the energy and being able to go back to transportation, as well as the value that you can provide.

One thing, safety is extremely important and you’ll see a crazy amount of effort going into the safety initiatives as part of the project, but the other bullet item here is that we are working in a transparent environment where the data that’s being collected from the parties that are participating are able to actually share that. Ernst and Young, for example, is creating a financial modeling that will come out as a result of this. There are many hands, but I just wanted to share that having a great goal to rally around creates huge opportunities, opens doors, school districts very much have many many interests which I’ll get to that make a lot of sense for them.

If you hadn’t already figured out, school buses are an ideal platform for a lot of different reasons. I’ve got lots of texts that I’m going to just let folks read at their leisure, but by and large they are very predictable routes and, extremely important, is that the owner of the asset, the location it’s parked, and the mission of the vehicle are all in alignment so that you can get through some of the early questions that Adam talked about; for example, where is the resource? Is it the site? Is it the EVSE? Is it the vehicle? When those are all aligned, you can actually make progress toward the market.

If you think about it, with 20 buses, literally that is a megawatt of energy capability. So think of how many school districts might welcome the opportunity to have that revenue towards their transportation and other initiatives.

These projections are based on a PJM market, so we're talking $5.00 a day and extrapolating it from the smaller vehicles to larger size. Picture-wise, the spectrum going from the small to the larger, the bus platform uniquely transfers over into short haul trucking, so all of the engineering that is being done is actually available for other applications in the Port Districts and other short 100-mile and less short haul. If you think about everything that goes from the coast to the Central Valley, for example, in terms of distribution centers, perfect application, the vehicle is going to be parked again at its…. V2G is something that is a reality, it’s just a matter of taking these technologies and matching them up with policies that work.

Some economics. A greater larger vision for what we hope to accomplish with regard to the V2G bus project. You’re doing clean air, you’re going GHG reductions, you’re helping schools with budgets, and you’re proving a technology path towards the market access. There’s also certainly the local value streams that I also want to make sure we cover, emphasize. Nothing about this is easy, Camron already described. This particular project is a place to gather around, it’s fantastic, the fact that we’re doing it in multiple states it makes it go across ISOs, across states, and certainly gives it a different appeal for partners to participate.

So I want to thank you. In this particular picture, you can see this Mini E outside, it just happened to park next to a bidirectional looking sign, so I want to leave you with that, that electrons flow both ways, and it’s a yellow sign, it’s kind of a caution: bidirectional is ahead, but I don’t think there’s that much caution, it's just a little hard work. Thank you.

MR. GRAVELY: Thank you, Paul. Our next speaker is Steve Davis.

COMMISSIONER SCOTT: Hey, Mike, just before you introduce the next speaker, we've got about 20 minutes or so for the last three speakers, so I'm sorry that you got crunched a little bit, I just want to make sure that my fellow Commissioners and folks have a chance to ask a few questions at the end of the presentation.

MR. GRAVELY: So we'd actually like to try and get done in the next 15 minutes, if possible, but 20 minutes is the deadline. So if those of you who are speaking would keep yourselves to five minutes.

Steve Davis is from KnGrid. He'll talk to us a little bit about the work they've been doing. He has extensive experience in this and also in the Standards setting community. Steve.

MR. DAVIS: Well, thank you for the introduction, Mike, and thank you, Commissioner Scott, for the introduction, good to see you again.

Well, I'm going to depart a little bit from the ground-laying work that the previous speakers have done for me. I appreciate that very much. I'm very interested today to talk to you all about Smart Charging Interoperability Standards and what they mean to the State of California and to the folks on the dais as policymakers. So with that….

Okay, so I want to start by giving you guys what I'm going to tell you, first of all, I want to back up a little bit and talk about California's VGI vision, then I want, at the risk of putting you to sleep, talk about what a Smart Charging Standard looks like, and then from there I want to talk quickly about what the CEC can do to support acceleration and mass market uptake of this kind of technology.

So if you would indulge me, let's channel Steve Jobs for the next 60 seconds if you would. And let's imagine a future where we're 10 years ahead and we're thinking of California's charging ecosystem. So that charging ecosystem, what does it look like? Well, I look at it from, taken from no mean sources, the CAISO Strategic Plan, statements by the Governor's Office, the CPUC

Energy Division, it kind of looks like this: any PV owner can safely plug in AC Level 2 anytime and anywhere and be dispatchable as a certified resource. That certified resource can help System Operators, whether it's Distribution or Transmission System Operators, maintain reliable service while we're achieving our State RPS and Greenhouse Gas Reduction Goals -- if this sounds pretty aggressive, well, it's going to get even more so -- seamlessly, without confusing the consumer or impacting their transportation needs, and in a way that lowers their total cost of ownership of the vehicle. So we're trying to create a killer application here. And while you're keeping those bullet points of what we want in mind, that's simplicity. But at the core of the network, we know there's quite a bit of complexity. Right? So we have in that system, we are going to want to impute into the charging activities of those vehicles the conditions of the distribution grid, which is going to be Greg's primary concern. But we're also going to have system-wide conditions as we go towards more and more utility-scale renewables, and more and more distributed renewables. So all this has to be taken into account, and then at the heart of that, in that blue circle, we need a distributed energy resource that is certifiable as a certified resource, no matter who we're talking about dispatching it. So if that starts to make you feel like you're playing 3D chess against Dr. Spock, I get it.

So what does a Smart Charging Standard look like? Okay, and I'll ask you to try not to doze off here, but here we go: the good news is one exists already, it is actually complete, it was created by the ISO, through the ISO and IEC, through a joint effort led by RWE in Germany and Mercedes Benz. So that effort basically sought to create everything that we're talking about in that future vision. It creates a certifiable resource by creating a power line, hardwired carrier between vehicles running off the production lines in series production, right, there's no modification to any of these vehicles, we're not talking prototypes at all; so that vehicle knows how to communicate with the charging station. And that charging station is standard and now can communicate back to the vehicle and find out what the consumer needs.

You'll notice there is an electric energy meter -- I could take 10 minutes on this slide, but since I'm running out of time as Mike warned me, I've got to keep going -- but you'll see also on the right-hand side, there are secondary actors and in that blue circle you'll see a demand clearinghouse which creates a channel between any one of them and the distributed energy resource. So we might have a fleet operator trying to communicate in staggered charging schedules based on prioritized departure time and needed kilowatt hours. The Distribution System Operator is going to need to collect all the local distribution constraints and impute it into a forward energy profile, again, without undermining the value of the vehicle which most buyers tend to rank at the very top its ability to get them from Point A to Point B. Most buyers tend to, you know, rank at the very top its ability to get them from Point A to Point B.

So what happens when the vehicle connects to the grid? Okay, steps one and two are pretty basic, you have a Cable Safety Test and how much power the charging station can deliver, and then three and four is an Automated Authentication, which is really cool, which means you just plug in, the vehicle notifies the back end, it has a valid account and the owner is paying their bills, and then you get to five and six, and this is the interesting part, and this is probably the most important: the vehicle automatically tells the charging station how many kilowatt hours it needs. And through an input from the consumer, they enter their departure time. Out of that, that gets rendered back into the Demand Clearinghouse, and the Distribution System Operator -- in most cases -- it could be the Transmission System Operator or an Aggregator, will then impute all the grid conditions, and getting to Adam's point about primacy of various grid considerations, will suggest a forward energy profile. So, "I need 12 kilowatt hours by 9:00 a.m. tomorrow." The Demand Clearinghouse, once all this forecast data and local grid conditions data gets input, comes back with a forward energy profile suggestion, "Here are some power levels and prices over time and a special rate for wind power between 3:00 a.m. and 6:00 a.m. at three cents per kilowatt hour." So, based on the consumer's preset preferences, okay, "I'll adjust my plans, I'll wait until 3:00 to 5:00 a.m. and I'll take six kilowatts of power for that two hours and get the energy I need." That's important data for the System Operators, particularly the Transmission System Operator who is managing a market. You are not going to pay that vehicle owner to curtail at 5:00 a.m. Why? Because you already know their load is departing.

So this gives you system wide visibility and intelligence about what the conditions are for these distributed energy resources. And it gives you the ability to know where you can bury surplus over-generation, how deep that sink is, and when it will fill up.

And then there's an ongoing process where the System Operator can update about new conditions, but the forward energy profile that the customer agrees to at the beginning, it's optional for them to move off of it. So I'll underscore that.

Okay, so what we're talking about, and through the good graces of the CEC, we're demonstrating at UC San Diego, is smart cars that you can buy today, so you see two of them here in this picture, the Smart ED3 which we have on display outside, the BMW i3, and we have literally 20 more models coming into the United States very soon that will be arriving on showroom floors, rolling off the production lines with this communication stack for bidirectional communications with the grid standard. So you have simplicity, automated and seamless consumer experience, lower total ownership costs through market participation, or DR Programs, killer app transformation, which is what I think we're really looking for as we try to get consumers into mass market uptake, where everything just works -- again, channeling that Steve Jobs, you know, iPhone experience -- any car, any charging station, plug-and-play, grid friendliness, the collection of complete grid picture through standards, dispatchability as a certified resource, and then the flexibility to adapt to regulatory climates as they change. The System Operator, the control room at the CAISO has confidence in this resource because they understand it and they know when they pull the lever it will actually respond. And Mike is giving me the high sign here.

Okay, so what can the CEC do to support

acceleration? This is ticklish, but I'm going to say it, I think we need to provide -- much in support of what Mark said earlier -- we don't want to go too much farther investing every day in charging stations, whether it's consumers or public money, in charging stations that can't get us where we want to go. This can play a very important role in greenhouse gas reduction and firming a renewable grid, but in order to do it we have to be Standards-based. So I would encourage the CEC and the CPUC to move as quickly as possible to say, okay, we're going to send the market a signal, the automakers in particular, because we can't afford to be dispatching by brand. And right now, there's no clarity about which direction they should go in terms of Smart Charging Standards, and they're actively working on it.

If we go down that road, we have, you know, with the 15118 Standard, this is an example of something that RWE has up and running today where they're able to take forecast energy output profiles from either granular small resources out in the distribution grid, or rolled up with charging clusters that could involve an entire utility or entire balancing authority area. So I think I've probably done the best I can in the amount of time Mike gave me, so thank you very much. By the way, real quickly, oh, well, that picture didn't show up, but T Boone Pickens likes to ask the question this way, "When is the best time to plant a tree?" And his funny answer that tickles us is, "Well, 20 years ago." The second best time is right now.

So with CEC funding, we put up 26 of these charging stations on the U.C. San Diego Campus, they're up and running right now, and any 15118 vehicle can plug in and be communicating bi-directionally with that charging station. So, thank you very much.

MR. GRAVELY: Thanks, Steve. Our last two speakers are from San Diego Gas and Electric and from Southern California Edison, so, Greg, we would like you to try to keep it as short as possible so we can finish up in the next 10 minutes, if you would, yourself, and then Felix, you get the chance to wrap it up, but fortunately you have no charts, so I guess it's going to be a little easier for you.

So Greg (Haddow) has got over 30 years of experience in this industry and he's a Clean Transportation Manager for San Diego Gas and Electric and he's going to talk a little bit about some of their plans with Electric Vehicles.

MR. HADDOW: Thank you very much. And, Mike, thank you for the invitation, I really appreciate it. And I do commend the CEC for creating a forum for the exploration of alternative fuel vehicles and, of course, the CPUC for continuing to be in the front for developing policy for alternative fuel vehicles now and in the future.

Already, Mark and Heather have referred to a proposal that we have before the CPUC, so today I'm going to briefly describe what's in the proposal and its benefits. But first let me set the stage.

Obviously we're here today because we believe transportation and electrification is a long term greenhouse gas reduction strategy. As Adam referred to it, and it's been referred to several times, you know, the watch words are Vehicle Grid Integration, it's viable, you've already seen some examples, and it is an enabling solution and we need to explore it.

The VGI pilots need to take place and I know that, yes, let's get on and past the pilots and get on to some programming, but we do need scale and we do need exploration. We've already heard about dynamic pricing and the need for it, but it needs dynamic load management to complement that.

We do believe utility leadership is necessary at this critical point and mainly because the utility itself has the grid visibility, the ISO does not. We know about our distribution system and we know and understand how to use Smart Grid technology to get the most out of it.

We believe, and again, it's outlined in the paper that was part of the alternative fuel vehicle proceeding most recently launched, and Adam was one of the authors, there are some long term net societal and ratepayer benefits that we believe can be rendered, but we need to explore it, we need to test it and see whether or not that's possible, and so investments are needed at this time to make that happen.

This is my obligatory -- here are the stats on our region, and this proposal is customized to our region and our region's needs. As you saw in one of Heather's slides, there are critical interests that we have in SDG&E's service territory that might be different from the rest of the state.

I'm going to skip through this, but the watch words here are Efficient Integration of Electric Vehicle Loads. This is something that we have been sponsoring since the dawn of the first alternative fuel vehicle OIR back in 2009. It takes technology and, as you've heard several times, it takes price and innovation and education. But the wild card here is the customer. You can give them technology, you can give them pricing, but now we need to test and see whether or not that pricing is attractive enough for them to then participate in a VGI-type framework.

I have two more slides. So this is the content of our proposal, and I'll walk through it very quickly. The proposal right now is proposing a day ahead hourly rate that reflects the changing energy and system, as well as circuit level conditions, so changing prices in energy throughout the day, as well as circuit conditions and system conditions. This is giving the customer choice and out of that choice they can select and get the best price possible for their vehicle charging needs. But it requires enabling technology that's currently available on the market today.

So the proposal also is asking the CPUC to allow SDG&E to install the VGI enabling charging infrastructure in two areas where we have a long duration of parking time, multi-family communities, as well as places of work. And we've seen Adam had a chart that showed the density of those duration parking in those various locations; 50 percent of our residential service territory is occupied by multi-family residents, so that's a very unique characteristic of our service territory, and it's an area that really does need a solution for providing charging for the residential customer.

This is a very important part, this next bullet. We are dependent on third parties to build, install, operate and maintain this charging equipment to SDG&E's VGI standards. So you've heard a lot of examples about the technology that is in place today, we believe that it’s possible to turn to the third parties to create this enabling technology that will allow this VGI rate to work to benefit our customers.

We’ve currently experimented with this with our own employees on our SDG&E campus and it’s working quite well, but the technology that we’re using is about three years old, so we know there can be some additional innovations realized through this pilot.

So we’re looking at 550 facilities in total, it’s actually going to be 550 installations because there could be more than one at a facility, with 10 chargers each to create scale economies at that particular location, and the installation would take place over a period of five years.

One of the features that we think customers would enjoy, because we’ve gotten some feedback on this, is that we’d have the EV charging billed to the customer’s SDG&E bill, so to limit the scope of the pilot, it’s just focusing on SDG&E customers, and this will allow whatever charging they experience during the day or at home at multi-family, it will go to their

SDG&E bill. Multi-family, keep in mind, many times is coming off a commercial rate. These would be independent installations, each usage is individually metered, and it would go directly to the customer's home bill. That's an important feature. The benefits are, you've heard all of them today, again, reducing harmful air emissions.

The second bullet is really important, just imagine that future that we've been talking about all day, where all of this usage and load can come into the system without any upward pressure on system capacity build out, at the distribution, transmission, and energy capacity level. Imagine that future, it's quite possible, but with Vehicle Integrated Charging, it becomes a reality. All customers benefit from that. The best part about this, as you heard earlier about the availability of renewable energy, this is a load sync, these Electric Vehicles in large numbers have the ability to be dispatched, that is the load dispatched, to take that energy.

We do think we're at a critical point in the market itself where we're concerned that the market will stall, and we believe a pilot like this would help stimulate the market and keep that momentum going.

The other feature that you heard talked about today is Plug-In Hybrids. Some of them have a limited battery capacity and, so, during let’s say a commute to work, one leg of that journey is electric, the other leg is gasoline. So we need to be able to double those Electric Vehicle miles if we can. Again, because of the third party context that we’re creating, it’s going to create jobs. And you heard earlier references from Mark about the need for dynamic pricing, well, this is a precursor to, we believe, a long term dynamic pricing model that will work for our customers’ benefit.

We do believe this will help guide Electric Vehicle policy in the future and we do believe it’s a stepping stone for the Vehicle to Grid technologies that you heard talked about today. And of course, it increases U.S. energy independence. Thank you for your time.

MR. GRAVELY: Thank you. So our last speaker from SCE will be Felix Oduyemi and he’s going to talk a little bit about the SCE’s transportation. He comes out of the

Transportation and Electrification Policy and Strategy Section of SCE.

MR. ODUYEMI: I do promise I'll get you out of here soon. I have no slides and I've heard a lot of good recommendations today. At SCE, many of you here have worked with me for about 20-30 years, I see Tim Carmichael, who used to drive an Electric Vehicle before he decided to drive a natural gas vehicle. I see Todd Campbell. These are folks who have been working on this for a while. So I really don't have any slides. I've heard everything I need to hear. But the only thing that I want to remind you is that at Edison we've been operating an Electric Vehicle Technical Center since 1982, so we've done a lot of work in this area. We have learned a lot over the last 20 years and we've been sharing experiences with all the folks in the industry, so there's really nothing that I've heard today that we've really not gone through. We've worked with OEM's, we've worked with battery manufacturers, we've worked with control systems, Advanced Technology Lab in Westminster, we've tested everything from transformers to whatever communication or control devices, or automatic load control systems that you would need to actually make Vehicle Grid Integration a reality.

Our concern, though, is this: we want to make sure that whatever we do from a utility point of view, because I have permission of Peterman here, we have to justify our cost. There will be a cost associated, for example, with control technologies and communication technologies that we've been talking about to make all these things possible. Those costs need to be factored into the equation before we proceed with VGI, at least on the utility side. All that talk that batteries may do whatever the business models allow them to do, but from a utility side we want to make sure that because we invest in systems, whether it's in direct systems, whether the front office or the back office, we have to be able to ensure two things: it cannot do any additional damage to the grid, and it must be cost-effective for our ratepayers. So no damage to the grid, and it has to be cost-effective to our ratepayers.

I have 15 pages of talking points that I prepared, but since I have three minutes I'm not going to go through them, I know that I will have the opportunity to cover most of these points during questions. But I want you to know that everything that we're talking about here today, we did some math trying to actually deal with Vehicle Grid Integration. We have 26,000 vehicles in our service territory right now, the average driver drives about 40 miles round trip, *Volts* constitute most of these vehicles, and from my calculation they have a 35-mile range. Now, it does mean that when that person gets to work, they see they have 15 miles left, so if they do plug in, they need to plug in for five miles to make it back to work to drive all electric miles. So the point I'm trying to make here is that the amount of money you're going to be thinking about is a penny to five cents from the customer side, and for that penny to five cents per day, we're going to build communication control systems that will cost maybe $5.00 to $50.00, it may not make economic sense and it may not be cost-effective. We are looking forward to making these things work, we have all the pilots, we've been working with not just the DOD pilot, before DOD we were working with the Advancement Grid Demonstration

Project, we also have other pilots that we have been operating since 2004, and so we have some experience and we look forward to working with you all.

MR. GRAVELY: Thank you very much. Before we turn it over to questions from the dais, I just want to remind everybody, if you weren't able to cover anything today during your panel presentation piece, feel free to send us written comments into the IEPR (docket), the schedule will be posted here. We encourage any additional information you want to provide the IEPR Committee that you provide that in written form for anybody on the panel.

And with that, I'll turn it over to the dais for questions.

COMMISSIONER SCOTT: Great. Well, thank you very much. This was just, I think, a fascinating and really interesting panel of experts. I thank all of you for coming to talk with us. I will -- let me turn it over to our guests and see if they've got some questions.

COMMISSIONER PETERMAN: Thank you. Yeah, I'd like to start with a question and, first of all, a disclaimer: I'm going to ask my question and then I'm going to leave because SDG&E has presented on an active application and the facts are finally here, but I don't want to hear any discussion about the merits so that I'm not unduly influenced.

So my question relates to the interaction with the automakers. A couple of the panelists raised the need to provide market signals and particularly some standardization direction to the automakers in terms of having the vehicles be suitable for V2G. Can you provide some more specifics about what are the highest priority standards that you think are missing and that if we don't get them out there the automakers are going to be, you know, not implementing these changes soon enough into the automobile engineering?

MR. DAVIS: Well, since you're looking at me, I guess I'll answer. Yeah, this is Steve Davis with KnGrid. When you talk about the types of things and, again, getting back to that vision where these are dispatchable resources, we've got to have meter association and we have to have a standard methodology for the vehicle to render the data that's necessary for intelligent dispatch and intelligent forward energy profiles. So that Standards work is done, but the OEMs -- and I'm not going to speak for them here today, I do know that there is one or two in the audience and they are not all of one mind at this point. That's why there is a need for a market signal because if we're going to try and dispatch brand by brand, we're going to miss the opportunity, and Mr. Berberich is going to miss in his control room, the opportunity to have real clarity about a single virtual resource that would be the bigger it gets, the better it gets. And I'm not just talking about dispatch by the ISO, I'm also talking about dispatch by Greg and his colleagues in the distribution level handling instability with…so, again, the automakers need to know -- I think California has enough economic and market clout with the automakers, as we've proven in the past, that we can help them become clear about where this is going. In Europe there is no issue. All automakers in Europe, as well as auto parts manufacturers in Europe, have signed on with the European Commission to go with one direction towards one common unique standard that they're going to use. And that's 15118.

MR. STITH: Paul Stith with EV Grid. I want to skip over the communications portion of it and talk about a fundamental thing in the signal that the OEMs do need to understand, and that actually is the difference between bi-directional and uni-directional charge/discharge. The Vehicle Development Programs are five, six years and more in the making and the fundamental changes to vehicles that optimize by cost the ability for a vehicle to discharge need to be made very early on in vehicle development programs. So that is a signal that we're looking for from the policy process that will help us in our conversations with each of the OEMs that retain us for our expert guidance, they want to know how the market will develop. I agree with Steven that there's certainly going to be opportunities and a need to pick and to encourage interoperability among them. I don't know how that's going to play out, but the fundamental difference about bi-directional needs some really early signals to go for the most value available.

MR. HIGGINS: This is Mark Higgins. So I just wanted to actually comment on the economics of providing those market signals again because I think it’s relevant here. As Felix just mentioned, you know, it’s a five cent decision point and there’s a lot of infrastructure that you may have to build to get there. Well, really that’s just the constraint, you’re just trying to get to that charge point. And I found this statistic really interesting, but NRG actually told me, and this is something they told me I could share, is that they’re finding that their systems that are operating, and these are systems participating in the PJM market that are V2G enabled systems, that they’re actually generating roughly five dollars per car, per day today, in just participating in the ancillary services markets. So obviously you have to get to that charge point, but there are so many other things that these vehicles can do and services that they can provide to the grid that actually do make the economics make a lot more sense, and I just thought that that was a very compelling point that I heard. And that’s happening today. Thank you.

MR. DAVIS: Can I just jump in for one more second before Carla leaves us? Yeah, the incremental investment to add the last five miles is one thing, but let’s all keep in mind, 70 percent of the action in charging is going to take place at home or in a detached residence. So that’s actually where the biggest opportunity for intelligent charging is, it’s not in the workplace or in public charging. It is in the residential charging.

So Steve’s investment in multi-unit dwellings and as proposed there, I’m 100 percent behind because that is where we’re going to have the biggest -- over time it’s going to build as market uptick becomes mass market uptick, but in the early stages we need to invest in residential charging, I believe.

MR. ODUYEMI: Yeah. The question specific to OEMs, from about ’94 to 2002, we worked with almost all the OEM’s at Pomona EV Tech Center. And there was expressed a common concern, one, they had proprietary requirements that come along with their products, they are not just going to open up everything just like that. In the olden days, they were very very protective of their technology, as well as they need their communication devices on schemes that will actually enable V2G of any type of Vehicle Grid

Integration. That's different now. They are becoming a little bit easier to work with, they actually are cooperating more with each other -- I see that Tesla is working with Toyota, and GM is working with some other parties. In the olden days, that was not the case. But what's needed is a standard, like you mentioned. We need a common standard, a Smart Grid Interoperability Standard that they can all develop towards. All utilities can get together and force the industry to at least adopt one set of standards whether they are for control technologies, or to meet load control systems, cyber security systems, and everything I've heard today where you're introducing all the digital nodes into the system, where they're actually not looking at the cyber security implications of what we're talking about, that's an additional cost. So, yes, most of the charging will take place at home and they still need to come up with technologies that will actually operationalize all these benefits that can be derived. But until the market becomes robust enough, all that we're talking about is not going to happen. The market is too new, it's too nascent, we're talking about less than -- it would not even be a decimal point in the number of vehicles on the market. And so I will hope that we focus our attention on building the market first before we start to look at all these benefits that may or may not actually come to pass.

COMMISSIONER SCOTT: Great. Let me see if I've got other questions here on the dais.

MR. BERBERICH: I have a follow-up to Commissioner Peterman's question and then, Mr. Davis, it's probably the best for you. Obviously the automobile industry is a global industry. I'm curious why we wouldn't just adopt that EU standard here in the U.S., as well. Are there holes in it? What would stop us from doing that?

MR. DAVIS: That is a very very good question and it vexes me every day. But I will say this, there is another standard that, while 15118 was rolling to completion, we have the Smart Energy Profile, or SEP 2 Standard, that is basically a residential domain standard and the folks at Edison have been deeply involved in it, and there is that potential that some of the OEMs are leaning towards it, but nobody is -- it's not there yet, number one, and number two, I think when you’ve got automakers that have got global scope, it would be really really nice for them to have a global standard to look at. So this is happening up, it’s not growing up, so some of this, I guess, you know, when you’re dealing with multi-cultural get togethers, and I’m on the Infrastructure Working Council with EPRI and we meet every few months, and also participate in some of the SAE Committees, there is a lot of sacred cows, of course, and as you can imagine. So that’s why I feel like California has got a unique position because everybody is watching us, everybody knows that this is where it’s at as far as the auto market is concerned and renewable integration is concerned. So we have almost a responsibility at some level to take some methodical time, convene people, get it right, but then say “this is where we’re going.” And once we do, I think it will be a very helpful thing to all the automakers. And one quick thing I would say, if I may. I take issue with the idea that it’s not ready for primetime, or that it’s too early. The automakers, I mean, BMW is sending vehicles off the production lines into our market now with this standard in place, there’s several thousand across 18 countries in Europe of these charging stations with this standard in place. So this is not too early. The security standards, the SAE J2931 is very robust, so I’ll just leave it at that.

COMMISSIONER SCOTT: I’ll turn to the Chair. Any questions?

CHAIRMAN WEISENMILLER: Yeah, a couple questions. I mean, when I was in Germany it was pretty notable there was not a lot of Electric Vehicles on the highway compared to California. So having said that, you know, and looking at all of our problems trying to get standardization around chargers, what chance do we really have to get standardization in this area? There’s obviously a lot of competitive advantage that is associated with these unique chargers, so, again, how are we going to do that? What is the price point? And how much operational experience do we have at this stage in terms of batteries and cars doing this over the life of a battery?

MR> DAVIS: Well, again, you’re starting to get into the Dr. Spock piece, right, so we’re a multi-level chess and we’re trying to figure this out. Part of what you say is about the batteries, and I think you’re hitting on something that is very important, so the OEMs are a long way from comfort about enabling V2G technology. I almost kind of hate to talk about it right now because what we’re talking about is modulated charging for several years to come. On the other hand, if you recall the second to last diagram, I said we want to map towards it and we want to build up towards it. Every day that goes by, we’re putting in more charging stations that can’t get us there regardless of which bi-directional standard you want, and I’m talking bi-directional data now. So every day that goes by, we’re losing ground and the cost of rip and replace, or double investments gets bigger and bigger. We want to avoid that. And I guess the good news is that, as I mentioned, 70 percent of the charging activity again is going to take place in the residents where most people are still trickle charging. So we have a real opportunity to go after the heart of the real opportunity and without too much double investment. And as far as Germany and the small number of cars, yes, they’re earlier so they got out ahead. We were a little bit later.

MR. ODUYEMI: Edison doesn't own any charging system and we don't -- we have not stuck to any charging technology. I have to say that. However, I believe, yes, we will be stranding a lot of investments if we do not come up with standards that will inform the technology that we deploy. And stranding investments is not going to be acceptable, I'm sure, to the Commissioners here on the dais, as well as the CPUC because we have to justify those investments on behalf of our customers. And so there lies our challenge, which is why we are very very aggressively involved in the development of communication standards for EV. Some of these standards have yet to be finalized, we still have a lot of angst with many of the stakeholders and when NIST was running the program, it was actually going a little bit well, but now you have SGIP which is a voluntary organization, so the whole process has kind of deviated not in a very positive direction as far as we're concerned, and Edison has taken a step back from participating in the standard development efforts. So hopefully we will get back engaged and the utilities should be more engaged in that process because, until that's done, we're just going to be building different things that may not necessarily be sustained in the future.

MR. LANGTON: Just one more thing on that. From my perspective, it's not clear where we need the standards, like exactly where those need to be yet because -- I understand Steve is talking about like having the vehicle have a standardized way to talk to the charging station, but you could under certain models -- the charging station could be the resource and it could talk to the user through some kind of -- the driver through an app or something like that on their phone, and there may not be a need to talk to the vehicle. So from my perspective it's just not clear where the standards exactly need to be and it partially depends on where the resource gets defined.

CHAIRMAN WEISENMILLER: Well, certainly part of the global vision would be also the utility grid, or distribution, or transmission talking. So, again, that's another set of complexity which at this point, you know, as we're just dealing with the grid we have, trying to keep it solid, so how do we build it out to enable.

MR. LANGTON: Yeah, so it’s kind of like we have all these different communication pathways and I think we need to figure out exactly where the standards need to be. In some areas we may say, well, we don’t need a standard here. I just -- I don’t know the answer to that, but I think more probing on that might be valuable for all of us.

CHAIRMAN WEISENMILLER: Certainly in folks’ written comments, I encourage conversation on that.

COMMISSIONER SCOTT: I will say thank you again to our fantastic panelists. This was a really interesting discussion and we probably could have spent all day on it, but we just have the morning session. I will underscore what the Chair said and also what Mike Gravely asked, if you have studies or surveys, you mentioned the roadmap, please make sure you send that to us. Felix, you mentioned you have 15 pages of great thoughts you want to share, please make sure you get all of that information to us.

We did say that we would do a little bit of public comment this morning, so if anyone has urgent public comment that they would like to make right now, they won't be here in the afternoon and they won't be submitting something in writing, please make sure you've got the blue cards to our terrific IEPR team who is right over here, and we will take a couple comments before I encourage you all to go and visit and drive the vehicles that are out front. We've got a great set.

MS. RAITT: We don't have any blue cards yet and we don't have anybody raising their hands on the WebEx at this point.

COMMISSIONER SCOTT: Any other pressing questions here on the dais? Okay -- oh, we've got one here.

MR. REINECCIUS: My name is Stacey Reineccius. I'm CEO of Powertree Services. I do want to say that I thought the presentations today were very informative. There are a couple of points from the point of view of a company that is actually deploying now three megawatts of distributed storage with Integrated EV, thankfully with some support from the CEC through two separate grants that we've received so far. One is interconnection is absolutely the choke point right now. We have been negotiating our interconnections for two years and that has been a constant restart process with the different utility personnel involved, and as an area that absolutely is a roadblock and needs to be clarified.

The second and related to the interconnect is that the accounting for energy used when taken at the retail level, but then released back whether it’s from an EV, or whether it’s from a stationary storage device at that location, is the primary sticking point within the interconnection process, it’s the counting for that energy that is taken and then released within five minutes. And that can be a real make or break. So that level of detail has to be understood.

The other point I want to disagree respectfully with SCE, this is not a five cent question, this is an electrification of transportation question. Cars are getting faster and faster in their charging and the vehicles are getting larger and larger in their batteries. Tesla has really set forth some great examples of the change in operating characteristics and behaviors when you go to large batteries that can charge faster. The closer and closer you get to the gasoline experience, being able to get a week’s worth of fuel or several days’ worth of fuel in one session, the more rapidly vehicles are going to be adopted. And that is the model that we are building out against and that I encourage you to think about. It’s not a five cent transaction, this is a full tank of fuel transaction that goes on. Thank you.

COMMISSIONER SCOTT: Thank you.

CHAIRMAN WEISENMILLER: I guess we should get on the record while we have Camron on the line, how long have you been in the interconnection process for the L.A. Air Force Base?

MR. GORGUINPOUR: Well, I mean, how long have we been in the extension process, kind of a vague question, we have been working this project since maybe 2011, really, middle of 2011. We actually formally submitted our W (indiscernible) application about a year ago, keeping in mind that when we submitted it, it was under the Fast Track process (laughing). Then, about a year later we are close to getting this all sorted out.

MS. RAITT: Commissioner, did you want to check the phone lines?

COMMISSIONER SCOTT: Let me take one comment from Paul, and then I think what we will probably do, because we've got to have a hard stop with the vehicles and their availability, that we will break for lunch after Paul, and then we can pick up with the rest of the comments in the afternoon public comment session.

MR. STITH: I just wanted to say with regard to interconnection, it's all going fine until you state that there's a battery involved. As soon as there's a battery involved, all bets are off in terms of the timing. We're in the middle of helping some of our clients through interconnections, you have solar, some who don't, I'm in the middle of processing and starting my interconnection for my Electric Vehicle that I want to do V2G, and even though it falls under the 30 kilowatt limit and it qualifies for the fast track interconnection, the moment that the vehicle has an opportunity to dispatch power, all bets are off and it becomes an advanced zoo project whereby it needs to get investigated from all angles, even if it’s a 10 kilowatt or a 20 kilowatt, or as we have coming up a 60 kilowatt vehicles. So you take a vehicle purchase and you’re trying to extract value from its interaction with the grid, and you could buy a vehicle and spend two years working through that process, we’ll need something better that approaches the fast track for solar residential, five, ten days, otherwise it will be extremely difficult to see the value from the vehicles that can dispatch power.

COMMISSIONER SCOTT: Well, let me just say thank you again to our excellent panelists and to Mike for his great moderation. And please go out and check out the vehicles, there are a bunch of them and will be neat to look at, and we will resume in an hour.

(Recess)

(Reconvene)

COMMISSIONER SCOTT: Welcome back, everybody to the afternoon. Let’s turn to Silas Bauer and to Jim McKinney who are going to kick us off this afternoon.

MR. BAUER: Good afternoon. My name is Silas Bauer. I am the project manager for the AB

1257 Report. I work in the Natural Gas Unit in the Electricity Supply and Analysis Group here at the Commission.

The purpose today is for us to gather feedback from our panelists and from you on the challenges and opportunities to natural gas as a transportation fuel here in California, both for the AB 1257 report and obviously for the IEPR, the 2014 IEPR Update.

I’m going to give you a little background on the bill and how we’re approaching this report. The bill itself, Chapter 749 of the 2013 Statutes, asks the Commission to identify strategies to maximize the benefits obtained from natural gas, including biomethane, as an energy source. It identifies 10 topics that we need to cover and that a number of other agencies need to coordinate with in this process. And it’s due to the Legislature by November 1, 2015.

The 10 areas of focus, obviously natural gas is a transportation fuel; it also points out natural gas in the resource portfolio; natural gas is a low emissions resource in biogas; natural gas is an end use efficiency energy source; natural gas infrastructure, storage and pipeline and system reliability; and natural gas in Zero Net Energy homes. There are also a number of crosscutting topics, specifically electric and natural gas industry implementation.

So one point on this. We want to get feedback today from panelists and stakeholders about what you think the challenges and opportunities may be for the industry in making Natural Gas Vehicles more accessible in California or helping the market along.

The bill also looks at jobs development and then how state and federal policy can facilitate any of the proposed strategies. And this last one, evaluating the economic and environmental costs and benefits of proposed strategies, including lifecycle greenhouse gas emissions based on -- and obviously this is the important part -- authoritative peer reviewed and science-based analysis or in consultation with the State Air Resources Board.

So what we're asking of stakeholders is, if you think that you know of any research on the environmental or economic costs and benefits of natural gas, please docket it for us and then we can go through it and use that information in our report.

So the Report Work Plan, obviously what we're working on now is this transportation section, partially why we're here today. And we're using any information that we get today, any feedback, as part of our report process.

After today's workshop, there is another workshop on July 14th that is focused on CHP, Combined Heat and Power, that is outside of the IEPR process but is coordinated through the Electricity Analysis Office; in fall or winter of 2014, we're planning on having a workshop on fugitive methane emissions and lifecycle greenhouse gas emissions. We're targeting that date so we can try to get as much feedback from ongoing studies as possible, and there are, I believe -- and I can be corrected on this by Tim O'Connor -- but 16 studies the EDF is in the process of working on, and then a number of studies both funded by the Energy Commission and through the ARB. And so we're trying to get as much information back as possible before we have that workshop. And obviously Fugitive Methane Emissions will be touched on today, we're having a few presentations on that; ZNE Buildings and

Efficiency, early 2015; Natural Gas Infrastructure Storage and Pipeline Safety; and in the summer of 2015, about one year from now, we're going to have the workshop on the Draft Report for AB 1257. And I want to note that we're having one workshop for most topics in the report. That workshop on the Draft Report will be a chance to add any additional information on transportation or any of the other topics, so we encourage you to come to that workshop, as well.

So after that early summer first draft, we're looking at the workshop in mid-summer, early fall, revisions, and then obviously get the report to the Legislature by November 1, 2015.

As you already know, the transportation section of this report is coordinated with the 2014 IEPR Update. All the other sections will also be coordinated with the 2015 IEPR, and there will be descriptions of what's going on with the report in that IEPR, and then our final report will be separate from the IEPR.

So prior to this workshop we had a number of conference calls with utilities and NGOs to discuss what they would like to see in the AB 1257 report, specifically in the Transportation section. They were all very helpful discussions and in the process we got a lot of feedback that helped to form our panelists today and the topics they'll be talking on.

So some of the feedback we got: heavy-duty vehicle and freight sectors are where the biggest opportunities seem to be for Natural Gas Vehicles. Obviously we'll have a panel on fugitive methane emissions and this is an area of concern for a lot of people, and so we're looking at all these studies trying to figure out what is a viable number for the amount of methane that is leaking out of the system.

Biogas, you'll hear a bit about biogas today. And obviously emissions targets in the South Coast Air Quality Management District and the San Joaquin Valley Air Pollution Control District, these are two areas that were noted again and again as areas where Natural Gas Vehicles could make a difference with the emission targets.

So stakeholders, we strongly encourage you to log comments on the public record today, or file comments in the docket. And this goes throughout the process for all other aspects of the report, as well. So we'll be looking for as much feedback as possible as we go along. And my contact information is at the bottom. We're not taking questions right now, so this slide is slightly misguided, but please take down my email and my number, and if you have any questions about this report feel free to contact me. And now I'm turning it over to Jim McKinney.

MR. MCKINNEY: Good afternoon, everybody. I'm Jim McKinney. I'm Program Manager for the Alternative and Renewable Fuel and Vehicle Technology Program in the Transportation Division of the California Energy Commission. Welcome. Let me add my thanks to our panel; I'm really excited about the panel today, so excited I'm banging the microphone. And I just really want to acknowledge the policy leadership of Commissioner Janea Scott for pulling together the IEPR focus on transportation policy issues and alternative fuels and vehicles this summer. So I think we're just generating a tremendous amount of information, good input from our stakeholders. I also wanted to say welcome back, Commissioner Peterman, and then Steve from CAISO, it was good to meet you earlier, as well.

So what I want to do is just kind of set the context for how natural gas figures in our transportation system here in California today. I think a lot of you have seen this slide before, it's what I call the Nation-State Statistics for the California Transportation Sector. So we are currently I think the eighth largest economy in the world, we have one of the largest fuel markets, one of the largest vehicle fleets in the world, and they generate a lot of greenhouse gas emissions, as our Chairman said this morning.

About 40 percent of all GHG emissions in California come from the transportation sector. So for on-road transportation, that's about 168 million metric tons of CO_2 equivalent.

On the vehicle side, so over 26 million cars, about one million trucks, and kind of the interesting factoid on the trucks is that it's about three, three and a half percent of our total vehicle fleet and it consumes most of the diesel figure you see there, so they are consuming about over three billion gallons of diesel fuel per year, so that's about 16 percent of the fuel that we use.

But in terms of criteria emissions,

greenhouse gas emissions, and particulate, it's up to 25 percent of the total, depending on which of the criteria emissions or emissions factors you're looking at. So trucking is a critical part of our economy for goods movement out of the ports, getting things to markets both here and in the inland areas, but we think it's something we can really tackle in terms of pushing out petroleum, bringing in alternative fuels would make a lot of sense.

There are a lot of niche markets in the trucking industry, so it's really important to match the fuel type with the technology, with the drive train technology, and really match the duty cycle. And I talked about fuel, you can see the stats here on alternative fuels, so corn-based ethanol is still by far the predominant alternative fuel in California, so over a billion gallons of that.

But I look at the stats for natural gas on the LCFS Compliant Report from U.C. Davis, so we're running just over 100 million gallons a year in diesel gallon equivalents for natural gas fuel in the truck sector and that's about comparable with biodiesel and renewable diesel, so again about 100 million gallons.

So it's a good start, we're moving the meter away from zero, but it's a long way to go to make some meaningful dents in the sector here.

Also, another good fact, so on the station side, we've got over 650 CNG, LNG, or RNG, so that's Renewable Natural Gas stations here in California. About 400 or so, maybe 450 of those are private and the balance are publicly available stations. And with that, I want to ask my colleague from the Research Division, Ray Gonzalez to come up and say a few words about what they are doing in the research sector. And then I'll pick it back up again.

MR. GONZALEZ: Thanks, Jim. My name is Ray Gonzalez, I'm with the Research and Development Division's Transportation Research area; I'm the Technical Lead for the Transportation Research area.

Jim asked me to present a couple slides that kind of highlight our major initiatives and also describe some projects that support those initiatives.

Our transportation research area focuses around supporting electric drive and Natural Gas

Vehicles and I'll be presenting obviously the natural gas vehicle slide. The major topics for our research include vehicle technologies and includes engine development, onboard storage, and we also cover fueling infrastructure and the production of Renewable Natural Gas as a transportation fuel.

The first initiative on this slide is the Development and Demonstration of Ultra Low Emissions, High Performance Spark-Ignited Natural Gas Engines. We have a $1 million project with the Gas Technology Institute who is partnered with Cummins Westport to develop a 6.7 liter natural gas engine. This engine leverages the successful Spark-Ignited Sociometric Engine technology that is currently available for the 8.9 liter and the 11.9 liter Cummins Westport engines. This project should be completed in 2015 and we will look to further advancements of this engine as it gets into the beta and pre-commercialization phase with opportunities to do integration and demonstration efforts.

One of the items that we had gotten feedback from, from the Engine OEMs, is that natural gas engines, the current natural gas engines available were meeting the 2010 standards quite easily and what that led to was an initiative for us to look at advancements that target NO_x reductions that get down to 90 percent. And so we funded a project that is coordinated with South Coast Air Quality Management District and Southern California Gas Company to look at projects to reduce NO_x levels under 90 percent while keeping performance at par and the other emissions also at par. And this was again a $2 million effort from the Research and Development side, but as well we have some AB 118 funds that were also applied to the same project, and that funding is to support the demonstration efforts.

Now we've done other engine development work and so I've included a note here that shows that we've done active engine development work from 12 liter on up to 15 liter. And one of our strategies is to look at the portfolio of products that are available and basically plug the holes and look for engine development work where there isn't any in the market and in order to drive a good market availability.

Natural Gas vehicle Onboard Storage: we

have a project, in fact, we took a project to the June 2014 Business Meeting just last week, and we're targeting the absorption technologies for activated carbon, and the idea or the strategy is to get to a conformable storage tank design and this, in particular, would fit well with our light-duty vehicles and this is the biggest challenge for passenger cars. And this technology that is successful would also enable better home refueling because they would be refueling at a much lower compression rate.

The next initiative is Natural Gas Vehicle Hybridization. This is another initiative that had projects that were presented in the June 2014 Business Meeting. This was a total of $2.7 million for three projects and this is a very interesting and exciting area for our Natural Gas Vehicle research and development work. This is the first time we've attempted to integrate battery electric into the natural gas platform. One of the objectives of these projects is to target the lower efficiency modes of, in particular, Sociometric Natural Gas Engines, and that being part-load, as well as looking at opportunities to reduce idle.

Natural Gas Fueling Infrastructure Improvements: this is an initiative that we hope to have a solicitation released in mid-2014, and this is going to target improvements in the economics of compressed natural gas fueling infrastructure, as well as looking for opportunities for the performance of the station and also addressing any fugitive emissions.

Advanced Ignition Research is an initiative that will have a solicitation that will release in mid-2014. And this was an initiative that was basically provided by feedback in one of our workshops where, recognizing that there is a barrier to the ignition of methane, we are targeting innovative opportunities to improve combustion. And this is going to lead to better performance and higher efficiency of natural gas engines. And again, the two solicitations should release mid-2014.

The next initiative is an initiative for Renewable Natural Gas production and we are currently supporting four projects that are developing Renewable Natural Gas with co-products or co-benefits, and the idea is to use the co-products or co-benefits to offset the cost of

Renewable Natural Gas so that it could better compete with conventional natural gas.

That’s a list of our initiatives. We currently fund at approximately $4 million per year and this has been an ongoing effort over the last six to seven years. Thank you.

MR. MCKINNEY: Thank you very much, Ray, for walking us through the investments from our Research Division and different pieces of the natural gas supply chain for transportation.

What I want to do here, I’ll go through these slides quickly, is just situate the way we pay for natural gas in an ARFVTP or AB 8. So as you can see from this slide, we’re at about half a billion dollars in total investments to our program since ’09 and ’10, over 312 projects, so natural gas and propane is about $82 million, 16 percent of our total funding, and our biogas investments are in the biofuels section, and I’ve got more information on that.

Here is another way to slice it. So the purple part of the histogram is natural gas, so you can see on fueling infrastructure under $20 million in investments; on the vehicle side about –- I think we’re coming up on $50 million there.

And so typically the way we work with AB 8 or ARFVTP is that we do a lot of focus on the pre-commercial phases, and it's our colleagues at the Air Resources Board that take over, say, when electric drive or fuel cell technologies get to commercialization. That's not the case with natural gas, so actually a lot of our money goes into vouchers for commercially available natural gas trucks here in California.

So in the truck sector, this is about a third of our total funding for the reasons I stated earlier, so you can see now we're at nearly $50 million in investments in our natural gas trucks, so that's about $2,300 total that we'll be able to put on the road, and then another 600 trucks from the earlier investments we did with propane.

On the infrastructure side, again, it's a modest number, about $17 million for about 62 stations, and there's a handful of LNG and RNG stations mixed in there, as well.

On the demonstration side, we've got four projects, so not a lot out of the 36 total, but there's some good ones. Ray already mentioned our co-funding the low-NO_x engine development project that Henry Hogo will tell us more about since South Coast is on point for that. And we've done some work with Cummins Westport for the ISX 11.9 liter Class 8 Engine, which we feel is an important market niche. Then GTI is doing a plug-in LNG tractor for drayage applications down on the ports in Southern California, which I think is also really interesting.

On the Fuel side, so here you can see our biogas investments, we've got 12 projects just under $40 million and I think everybody knows here biogas has got just about the lowest carbon footprint for commercially available alternative fuels coming in between 10 and 12 grams per megajoule, so again about 85-90 percent below the carbon baseline.

I just want to show a few slides from the benefits report that Dr. Melaina presented at our last IEPR workshop. So what this does is he and his team at NREL looked at over 200 projects, a good chunk of our portfolio, so $426 million there. What you can see here, these are what we call Expected Benefits, so assuming everything in our portfolio, sort of the half billion dollars there, is built out and run through its design life at its design capacity, these are the expected benefits through 2025; this chart shows carbon emission reductions. So the green bar there is vehicles and commercial gas trucks, or the darker wedge there, so you can see kind of a modest contribution, about 11 percent of the total GHG emissions through 2025 in the truck sector, and it’s actually ZEV trucks or Electric Trucks; and in the medium-duty sector that kind of come on strong later, that’s where you get the continuing uptick in the bar there.

On the Infrastructure side, this is really where CNG/RNG really shines. You can see over two-thirds of the benefit there is from natural gas, again, that’s the blue bar. And remember, this is only $17 million out of our portfolio, out of $500 million. So a pretty good return on investment on that.

And down on the bottom you can see our biofuels investments, so biomethane is the light colored wedge, up there between twelve and one o’clock, so about 10 percent of the total GHG benefit from that.

This chart shows it a little differently, you can see how it plays out, so I’ve highlighted the natural and renewable gas. So again, the way this works, the way it works in these projections is that we're assuming the demand for trucks will continue to grow, that market will grow, and the throughput will continue to grow in 2020 and 2025. On the truck side, trucks have a relatively short half-life in terms of their optimum efficiency when they're going to fleets, so we see the big part of the benefit there in the early years between 2015 and 2020 on the vehicle side. And then for biomethane you can see as those facilities come on line in 2020 and contribute a nice amount.

So I again am just very excited about the panel that we have today. We've got this broken into three basic groups, so we're going to talk first about kind of very general market supply issues, kind of supply/demand balance, so Amy Myers Jaffe from UC Davis will handle that part of kind of the kick-off presentation. And then we'll have a series of speakers talking about methane escapage, so Rosa (Dominguez-Faus) and then the representatives from the three environmental NGOs that are here with us today. And then we're going to switch to kind of the mid-part of the supply chain, so station development, and we'll also have a speaker talking about biogas there. And at the end of the day we'll talk about end use, so how do the fleets work, what do they need, what engine designs do we need to really make this market continue to accelerate.

Silas and I have put together six key questions for the panelists and we don't expect all of you to answer all of them, but clearly these tie to your specialties.

So first and foremost, kind of what are the market opportunities for natural gas as a transportation fuel and, second, and I think this really kind of gets to the heart of the policy discussion about natural gas and it's pluses and minuses, shall we consider it as a near term low cost bridging fuel with moderate environmental benefits? And I would propose that that's really kind of the classic interpretation for natural gas in the transportation sector. And I think, as we're going to hear from Sempra and some others, there's a very different business model and policy model out there, what they call "greening up the supply chain."

So the second option is, what is its potential as a ZEV caliber truck fueling option with the potential to meet the same environmental performance standards as electricity and hydrogen? And I know that’s a little provocative for some folks, but if you look hard at the numbers and you look at the supply mixes for biogas and green hydrogen getting into the pipeline, the potential is there in my view.

How should policymakers and regulators consider the long term potential for natural gas as a transportation fuel, given the risk and uncertainty associated with methane leakage and potentially higher carbon intensity values? This is the other part of the key question in this policy discussion.

Number four, what are the opportunities and constraints for using biogas Renewable Natural Gas at a commercial fueling scale in California? We’ve got some serious issues with AB 1900 in opening up the pipelines to biogas in California, we need that to open the market. We’ve also got some feedstock constraints, there’s a finite amount of organic feedstocks available in California. The current information from UC Davis, they’re estimating about 660 million diesel gallon equivalents for biogas if we can optimize the resources we have now.

Turning to the fleet side, what changes a natural gas engine design and sizing options are needed to make natural gas trucks competitive in California and the West? And when can we expect sizeable numbers of vehicle products?

And lastly, what do the fleet operators need from OEMs and government policymakers and regulators to make natural gas trucks a competitive alternative to diesel fuel trucks?

So again, I am very very pleased with the panelists we have today and, with that, I want to queue up Amy Myers Jaffe’s presentation. Do you want to come up here, Amy, and speak?

So Amy Myers Jaffe is currently the Executive Director for Energy and Sustainability at the University of California at Davis Institute for Transportation Studies. She is one of our leading experts on global energy policy, geopolitical risk, and energy and sustainability. Along with her appointment at ITS, she also has a joint appointment with the Graduate School of Management in the ITS. She is Associate Editor for the *Journal of Energy Strategy Reviews* and serves on the Editorial Board of the *Journal on Economics of Energy & Environmental Policy*, and prior to coming here to California she headed up the Energy Forum at the Baker Institute at Rice University in Texas. So welcome, Amy.

MS. MYERS JAFFE: Thank you. It's a pleasure to be here. Thank you for this opportunity to talk to the Commission and to stakeholders. Natural gas is sort of an interesting emerging topic, I think, and biogas even more so. And one of the things I'm going to talk about today I think is going to surprise people a little bit because I'm going to talk about the commercial context, which everybody thought was very favorable; and then I'm going to talk about why, even with the commercial context seeming very favorable the market is not developing at the pace that maybe some people thought it would, and talk a little bit about why.

So I think the first step just in sort of giving a general overview, I would say over the last year, and especially here in California, and I would be happy to take some questions on that, there’s been some question about whether the so-called shale revolution was real or not and whether or not we would have just a temporary boost in natural gas supplies, or whether it was going to be a lasting trend line.

I brought the U.S. Government Department of Energy Map, and for those of you who may have seen this map in the past, I just want to sort of call your attention to something interesting because, had I presented this map a year ago, some of this would have been here, and a lot of this, and this would have been here, and you would have had a little bit here on the Marcellus, but the build out of all this resource here, these new resources, the size of the Marcellus, a lot of this Niobrara play which is just starting out, and the movement all the way up into Canada and down into Mexico was not indicated on this map a year ago, and it’s not theoretical, these are plays that are being drilled and are being developed.

And of course, the Monterey is here on the map and we’ve had a lot of controversy in California over the past few weeks about whether the Monterey is or isn’t producible and whether the U.S. DOE's estimates are too high or too low, and I think what I would tell you is that in California there is some question about how much of the oil has migrated away from the source rock in California and how much hasn't, so that's part of the controversy that makes people have different opinions. And then of course there's a wide range of opinion as to how producible it's going to be.

So what I would say to you on California, and I'll show you some slides in a minute, is that when I talk about the supplies that are going to come from Texas and people are looking at the Eagle Ford play and also now this Permian Basin play is going to be a giant play, and just to give you an idea of the scale, when the Eagle Ford first started being drilled on the oil side, people thought that it might be able to produce 350,000 barrels a day of oil and now it's getting to be close to a million barrels a day of oil, and on the Permian Basin, the new theory is that it might be able to get up to as high as three million barrels a day. So we're talking about giant basins with giant production. Same with the Marcellus out of Pennsylvania.

So we’re now seeing that there’s a tremendous amount of potential, but it’s a technology play. And in California the companies are experimenting with different technologies and so far not that many people have been successful, and so you’re getting this sort of downsizing of what the potential is based on the sort of commercial lack of success. But what I would tell you is in the Barnett, which was the first play, there were analysts that said that the natural gas there could never be produced and there would be no liquids production whatsoever, and we now all know the end of the story which is that it turned in to be a very big and successful play. So I just think it’s very dangerous to base what you think might happen in 10 years, five or 10 years, on the basis of what companies have accomplished or not accomplished in their first couple years of drilling because there’s probably not enough information.

So I brought this chart, this is the chart from the Energy Information Administration about what the outlook has been and where the expansion has come from, so you can see that these areas like the Permian, the Bonespring, and the Wolfcamp, which are just starting to grow now and are expected to grow much more in the future, how much the Eagle Ford has grown, and then also for natural gas just how much expansion in production we've seen since 2008 until current on natural gas from the Marcellus. When you see something like the Haynesville, one of the reasons that the Haynesville is not growing as much is not because the resource isn't there, it's that it is a dry gas and the companies don't want to seek dry gas because it's so much more profitable to have gas that is combined with natural gas liquids and crude oil, so you're just seeing investment dollars shifting from one place to another.

When we look at California, the target is definitely going to be oil and so I don't expect us to see a giant increase in the amount of natural gas that's going to be available by the development of the Monterey, the Kreyenhagen, and some of these other plays. The thinking is that a lot of the material that will be produced in California is going to be liquids.

So given that, we have done some projections working together with the Center for

Energy Studies at Rice and our expectation is that California will be bringing in its gas from other areas. A lot of new supply is probably going to come from Canada and then also continuing supplies coming from the U.S. Mid-Continent and Texas, and we don't see a big increase coming from California maybe in the near term, but over the long run we don't see the shale as playing out as becoming a major supplier for indigenous fossil gas.

Demand by sector, again, using that same modeling we don't see a large increase in demand coming from transportation, there's *some* increase. But we do see an increase in industrial use and also to some extent, and maybe it's just a leveling off of power generation, not a big expansion there as well.

So what's the theory, then, behind why people are so excited about natural gas and transportation? And part of that comes from what I talked about, which is we have a giant resource base for natural gas, not necessarily here in the state, but definitely across the United States and Canada, and people are basically projecting that natural gas could be sort of like diesel fuel was for the Class 8 trucks; in other words, it started out very slow for diesel, and we had this sort of S curve formation where, you know, the more parties that shifted to diesel, the more it gained momentum until we got to the point now where the entire industry in the trucking industry has switched to diesel. And so the question is could that happen in natural gas and would that be desirable? And if that is desirable, what would it take to get out a lean part of the curve and get yourself up to the higher penetration?

So we've looked at that using an Optimization Model with GIS mapping capabilities and we're using that model to not only determine how the build out would look and what role California would play in sort of a national market, but also to look at what some of the commercial barriers are to the development of a network.

So first and foremost, the parties that would switch to natural gas from diesel fuel have to believe that the current gap in prices is going to be lasting; and with all the turmoil in the Middle East, maybe that's looking a little bit more realistic than it might have if I'd given the talk three months ago because there is a lot of oil coming out in the United States, so always a little difficult to make forecast predictions. I think it's probably a safe bet to assume that the price of natural gas will stay low, with the exception of seasonal outbursts in New England if we have a very cold winter, but I think we can expect that the supply is there to meet whatever demand growth there is going to be because it is so abundant. And then the oil price, it's very hard to talk about that uncertainty. I would say that certainly this year the price of oil is likely to remain high given the turmoil in other parts of the world and the problems between Russia and the Ukraine.

But as you can see, even looking at these sort of average projections and forecasts that come from the DOE, and these are very typical, there's a lot of uncertainty and even for the next year, you know, the uncertainty for oil supply is that the Intranet global market might see an extra two million barrels a day from OPEC, or turmoil in the Middle East might curb to have a three million barrel a day loss. And when you’re talking about a five million barrel a day swing in oil supply, there’s no amount of extra drilling in the United States that’s going to be able to close that gap. And if it turns out that a lot of oil comes out of the Middle East because the turmoil passes easily, then we could have the price of oil collapse, and the flipside could be true if we get a lot more disruption coming out of the Middle East and we could see a much higher oil price.

And so we’ve tried to construct a model that would be able to capture those uncertainties and do sort of a boundary analysis letting you know under certain conditions what would the market development look like. So the first step is to do work, which we did, which is to look at how many years it would take, or how many months it takes given the cost of the vehicle and the amount of vehicle miles traveled for Class 8 Trucks to break even by switching to fuel. And we used a $4.00 diesel gallon price assumption for doing this particular exercise, and it really basically shows that for the very long haul Class 8 trucks, the breakeven is under three years and that makes it fairly commercial for a venture for a fleet and shippers.

So one of the things that made everybody excited about the Class 8 vehicles shifting to some kind of natural gas fuel, or some kind of alternative fuel, is that putting in the fueling infrastructure is easy because there's like, if you look at those red lines here on this map, it's limited, there's a limited network, you aren't having to do – it's not the same thing as trying to propel passenger vehicles where you have to be on every corner in every major city. You have these clear routes, we know how many miles the trucks have to go before they stop, we know what the average distance is for travels on each of these routes, and so for a commercial enterprise there's a very predictable market to develop. And California plays a very key role in the distribution of goods, as does Texas and the Great Lakes Area. So, again, a company that wanted to have a strategy to work on the infrastructure and the marketing of natural gas into heavy commercial transportation, commercial transportation, seems to have a high potential because it's really a finite number of routes, concentrated markets in key states, and it leaves a lot of potential to getting something off the ground.

So we built an optimization model to identify how the build out for LNG and CNG supply chains, whether that can be a sustainably commercially profitable venture and, if so, what would be the most cost-effective supply chain configuration. And so the model gives two choices, one is to go through what we call Small Scale LNG Manufacturing, which then is transported on by truck to about a 350-mile radius through LNG refueling conventional stations; the other option is transport by natural gas pipeline, and that could also be for biogas, and then coming out to new technology like the GE LNG In A Box, or CNG In A Box where you're having these modular stations that could be attached to an existing truck stop and you're bringing the station technology remotely. That's a more expensive option than doing Mini LNG, but it has two advantages, one is it takes two years to build a scale-up mini LNG plant, so you can address immediate demand and not have to try to get a customer to agree to a chicken and an egg plan to meet you with demand in two years, and then also it could be used as sort of a fill-in technology: if it’s commercial, to put the plant in a certain place, in another place, but if there’s some holes in your roof then you have this GE or some other vendors are also making that same technology. You have this option to put these slightly more expensive stations sort of in the middle.

So to figure out -- because that’s a very complicated set of choices for the market –- so to figure that out takes a computer, memory, and we use the network analysis to look at what were the most profitable routes, what would be the highest concentration of build outs, and where would be the most profitable places to start the network? And the interesting thing about our early findings is that, surprisingly, even natural gas fuels, we start with LNG that have between $1.00 and $1.50 per diesel gallon equivalent price advantage, it needs some kind of assistance for us to get the computer to build out the network. So that was, I think, a little bit surprising and maybe even depressing when you think about the more beneficial alternative fuels such as how hard it is even with a fuel cost advantage to get past the chicken/egg problem.

What we found was that the success of these networks was that it was highly sensitive to where we started the initial penetration rate. So if we just pretended that we were Walt Disney and we instead of starting at one percent of the market existing, we could change that and say, okay, let's say we woke up in the morning and magically it was 10 percent penetration in the market, or 50 percent penetration, then the impetus for the market to build out itself and to have more and more commercial players join into these networks becomes very rapid. And I think that that's going back to the S curve for diesel fuel, you know, that's borne out by the historical experience with diesel.

The second thing that, when we go back and do the analysis about why the computer didn't choose to build in different places, or how could it didn't just build all these stations across America because the computer doesn't have to worry about a fleet thinking that they're not sure what the price of oil is going to do, because the computer is more confident. What we found was that basically the infrastructure costs for the stations and for many LNG are still a little bit too high to make it very compelling. And of course that problem is not unique to natural gas; it's going to be a problem in hydrogen, going to be a problem in some of the other fuels, which is just the higher cost to put in this infrastructure. And, you know, who is going to bear that cost? Is it going to be the station developer who is going to put that cost onto the fuel purchaser? You know, who is going to bear that cost?

So I want to show you a few graphics of some of these results just so you can get a visualization on it, and then I can talk just briefly to leave time for Rosa Dominguez-Faus to talk about the methane leakage issue, just talk very briefly about what might be the commercial path forward if the path forward is not going to be government intervention.

So we did some what I call static runs which is instead of having a dynamic solution where the computer programs out every possible station, we picked particular penetration rates as a starting point, and then like imagine us just taking a photograph instead of running the computer to the end conclusion. And you can see the difference between what is built out under the existing stations and liquefaction plants under one percent penetration where really truly it’s a pretty thin network and maybe not attractive to shippers to have to worry about whether the fuel will be available. But you can see at 16 percent you still to get important corridors like in California, around the Great Lakes, up and around Pennsylvania and New England, and even a bit around the sort of Houston Port. So that’s interesting and, of course, at 31 percent penetration, you see a fairly substantial build out and a substantial build out in the Mini LNG, both in California, again around the Great Lakes, around Houston, and in New England. So it shows you that if you got past the chicken/egg problem, it becomes a very commercial venture to build out the rest of the network.

So putting that in a different way, where this has to do with what stations are profitable or not profitable, and at different penetration rates, assuming there would be no subsidy for the stations, and again you can see a lot of red dots versus at the higher penetration rates you start to see sort of the network develop out more fully with less unprofitable stations. When we run the same scenario and start with a 50 percent subsidy on the station costs, again you see that under the current situation where the market is under one percent penetration that's not all that helpful, but as you move to the higher penetration rates, you know, it's kind of hard to see it, I'll flip it, you can see that it's a little bit more thickly populated than without the subsidy and many more less unprofitable stations which shows you that ultimately it's very cost sensitive if GE or one of the manufacturers would have a big breakthrough in the cost of the technology, that would make a big difference.

And in thinking about what do these results mean, I think another issue that one has to look at is, what is the business model under which the suppliers are going to try to sell the fuel under this system? So right now the way suppliers have been going about it, natural gas producers and other parties like GE and so forth, the risk has all been on the fleets, right?

"We'd like you to buy this truck for a certain amount of money, and we're going to provide the fuel for you, and you will take on the risk, and the gap between your current diesel fuel price and the natural gas price is going to work in your favor. And you should take on this risk. And then after we're sure you've taken on this risk, then we're going to build these networks to supply you." Or, if you're a station developer like Clean Energy, you're taking on the whole risk yourself and you're just hoping that, you know, build and then it will emerge. Right?

So the interesting thing to think about from thinking about the oil industry's history, not in this area, but in other parts of the industry, you know, the question is maybe the pricing model is not the way people have thought about it. In other sectors in the oil industry, one of the things that people have done is people have brought in what I call a "risk party," so you might bring in a financial player, or a bank, or some kind of a trading company and they put together a derivative swap where the fleet purchaser is not taking on the price risk, nor is the station and natural gas developer, but the price risk is taken by a third party that makes profit on trading that risk at the upside, right, of the price if it over-performs. We've seen that done in the oil industry and Gulf of Mexico when people who were afraid to do these very expensive projects they would bring in a financial firm to take the price risk. So we may see over time different kinds of pricing packages if it turns out that price subsidies are not going to be an option and if there's a desire to move to this program apace of all parties and government. It may be that there needs to be sort of a different business model for thinking about how the costs are going to be hedged away and incentivized.

So just a moment, just a little bit on our initial assessments on Renewable Natural Gas. So this comes from the California Biomass Collaborative and they've looked at the existing potential in the state to develop Renewable Natural Gas and we've made an Infographic that makes itself explanatory in terms of there being sufficient supply to meet the current level of natural gas consumption in the state, so it gives you sort of an idea of the relative supply versus the current demand, anyway.

Okay, Rosa?

MR. MCKINNEY: Okay. Thanks very much, Amy. Our next speaker is Rosa Dominguez-Faus, who is a Post-doctoral Fellow at the UC Davis Institute for Transportation Studies. Rosa obtained her PhD in Environmental Engineering from Rice University with a dissertation on Biofuels, Water and Climate, and her current research is around sustainable energy production.

And if I could just do a time check with Commissioner Scott because I understand some of our guests will need to leave?

COMMISSIONER SCOTT: I think we’re okay.

MR. MCKINNEY: Okay, great. Rosa?

MS. DOMINGUEZ-FAUS: Yes. So today I’ll talk about methane leaks and I would like to start with a video from the EPA that is showing with infrared cameras where these methane leaks are occurring.

So in here you can see with the naked eye that we don’t really see any gas leaking, but then if we apply -- and those are like they are trying to measure -- this is EPA trying to measure, but if you apply the infrared cameras, then you can see the gas. We have many examples throughout the supply chain. This is probably a processing facility, and then you can see this black smoke which is just the methane as seen by the infrared camera.

We can also see if we apply -- so that's another example and those are the measurements, the CO_2, sort of bottom up measurements that they take, some more methane examples, and I want to show -- next would be a distribution infrastructure measurement, let me just bring it up a little bit, and then you could see they're trying to take measurements off a manhole and you couldn't see anything, but now with the infrared camera, you can see that there are some interesting leaks, and once they open that, it looks really bad.

Some pipelines that must have been burst. And also they're using these cameras to monitor storage tanks in production areas, so that would be an uncontrolled leak, an oil well that's also leaking some natural gas, and there will be also some natural seeps. Basically this technology can allow us to detect where these leaks are, so that will be the challenging data that some people think the authorities or the agencies don't know where these leaks are occurring, but I just want to show that it's happening.

So anyway, methane leaks. Is natural gas good or bad? Natural gas burns a little cleaner than coal or petroleum, it has less Mercury particulates, etc., but it also has less CO_2 emissions when burned. But then these methane leaks might negate any climate benefit that you can have by burning natural gas.

So what we do is a lifecycle analysis to compare. We basically translate methane emissions to carbon dioxide equivalents by basically attributing a global warming weight that's very dependent upon the time horizon you use; for example, the IPCC recommends that you use like a 100-year time horizon and in that time horizon methane is between 20 or 30 times more potent than CO_2. So many people have done this lifecycle analysis and they have concluded, you know, natural gas is better or worse than coal when you take into account both CO_2 and methane. And there's been a lot of differences in the results. And what I'm going to show here that I think the differences depend more on the assumptions that people have used in their method than in the actual values. For example, many might have heard of Howard from Cornell who criticized gas development, particularly shale development, and he showed that natural gas is so much worse than coal, and for the most part it is due to the fact that he is using a 20-year global warming potential, so it's giving methane a higher weight. Why? Because methane is more potent than CO_2, but it's shorter lived, so it does more warming at the beginning and it's better in the long run because it has less CO_2, all the methane disappears and then you're left with less CO_2 than with other alternatives. So when you take his analysis and then use the 100-year revolving potential and to standardize it with the other studies, you see that the difference is not as big.

Other parameters that affect the results are the efficiencies in converting the energy you assume. If you are comparing sort of an old natural gas turbine with the best coal powered generation technology, then you're also penalizing natural gas, but that's not an apples to apples sort of comparison, right? Like you have to compare either best case natural gas to best case coal, or worst case to worst case, or average to average, and that’s not what’s happening, right?

And so what this is showing is basically all these studies put together, and for the first part we have shale gas used to produce electricity, conventional gas to produce electricity, or coal, and those are over all lifecycle emissions, right, all converted to CO_2 equivalents. Two things to look at here: basically gas, either shale or conventional, is better than coal across the different studies, and the other thing is that CO_2, which is the blue part of the bar, is still the significant part. So CO_2 that comes from burning the fuel, it is still the biggest contributor to the emissions, not so much leakage, which of course there is some and it would be the green part and should be minimized.

So what is the leakage rate that puts natural gas at parity with coal? How much methane has to leak for it to be as bad as coal, right? So again, different studies using different methodologies have come up with different leakage rates. Richard Muller from Berkeley estimates using a somewhat different approach, a Muller Approach, that I think needs a little scrutiny, it hasn't been peer reviewed, but he says that as high as eight to 14 percent methane leakage still makes natural gas at parity with coal, so anything below that would make natural gas more favorable. The more standard approach using the 100-year global revolving potential that last one uses estimates that this breakeven leakage rate is six percent, and the thing that we're using, this 100-year global revolving potential, is like the benefit is going to happen really didn't, we might have more warming now. And another study that is not using this 100-year global revolving potential, but using global revolving potential right now, so that would be the leakage to have a benefit starting now and even better in the future is by Alvarez, and he estimates that a 3.2 percent leakage rate is still acceptable. Above that, then it is bad, but 3.2 or below we should be switching to natural gas.

And that was for power generation. For transportation, it's a different picture for two things: first, because the difference in exhaust emissions between natural gas and petroleum fuels is not as big as the difference is between coal and natural gas, so there’s less to make up for, and then because the results will change, right? So about the same immediate benefit methodology for transportation, what Alvarez finds is the leakage rate for light-duty vehicles is 1.6 percent and for heavy-duty vehicles is 1.0 percent.

Now the heavy-duty vehicles is really basically just using a bus, it’s not for heavy-duty trucks and other applications of natural gas and transportation, or off-road uses, it would be a different one that would require a different lifecycle analysis.

So which one is the actual leakage rate? According to official estimates, EPA, basically it’s around 1.5, it could be 1.7, depending on how you do the calculation because EPA gives you how much methane is being leaked, and then you have to divide that by how much natural gas is produced, and then you have to assume how much methane is in the natural gas, so this 1.5 could be 1.7, for example. But anyway, this is like a number to keep in mind.

But EPA has been very criticized by using emission factors that are outdated and that are not taking into account all the emissions that there are. So there's been lots of studies that are trying to make their own estimates with different methodologies, down versus bottom up, and it's really hard to have an idea. There is a wide variability across the different studies because they apply to different basins, some of them include natural gas and oil, some of them just attribute to natural gas, and there's differences in operators, etc. But there's been this scientific literature review published in the *Journal of Science* and by Brandt from Stanford and other collaborators including Bob Harris at the EDF, that have done this analysis based on a compilation of all these studies, and their best estimate is that the actual leakage might be 25-75 percent higher than what EPA thinks, so that would put the actual leakage rate in 1.85 to 2.63 percent, right?

So what if we apply this leakage rate, let's say like EPA 1.5 corrected is something between 2.0 to 299, and let's use 2.5 to see what would be the benefit of switching gasoline or diesel to natural gas.

So what this is showing is that there would not be an immediate benefit by switching a light-duty vehicle right now, but there would be one in 40 years because of this reason, right, like natural gas leaks more methane, which is bad at the beginning, but eventually you will have less CO_2. That is, I think, a relevant point.

For heavy-duty diesel vehicles, the benefit will come so much later, but again I think we need to understand that this is just a bus that was running on diesel, that it’s been converted to a CNG bus, and there are other sort of assumptions in these analyses that I think might be more relevant than the actual methane leakage, which is for example a 20 percent penalty in fuel economy by switching from a diesel compression engine bus to a CNG spark ignition bus. So it’s really not the fuel, it’s the technology, right?

And to illustrate that, I have run the Grid Model which is the standard LCA model, Life Cycle Analysis Model for Emissions, and what I’ve done is gasoline compared to CNG in the first row, these are compared to LNG, second row, so first column will be incumbents, and second and third columns will be natural gas, both at the 2.6 leakage, so the high sort of leakage estimate, and the only difference between the second and the third column is that the third column has no fuel economy penalty and the second column has the 20 percent fuel economy penalty. So what you see, if you compare first and third column, there is an advantage to both using CNG and LNG, substituting gasoline and diesel, respectively, given the best estimate of our leakage rate right now. But if you give it a 20 percent fuel penalty, of course it looks worse, right? So that's one thing.

And the other thing, you have to look in all of these graphs I'm showing, the emissions come from the different segments in the Life Cycle Analysis. The first column will be Feedstock Emissions that will be natural gas and crude oil production, the next column will be fuel emissions converting these commodities to the final transportation fuel, and the third column will be vehicle operations and those are exhaust emissions. The fourth column is the total. So you want to compare the total column, right, which is what I just did, compared total for gasoline to total from CNG with and without the fuel penalty. But what I want you to see is that, again, a majority of the emissions come from the operation of the vehicle, so that's why the fuel economy has such an important role, maybe even a bigger role than methane leaks. And of course, even if you convert everything to CO_2 equivalents, you still have this difference between methane and CO_2; one has a higher warming at the beginning and CO_2 will accumulate over time so you will have more warming in the end.

So this is a debated strategy, whether you should focus in mitigating one type of emissions or the other, right? So what I'm showing here, it's an IPPC graph that shows you estimates of temperature change based on different types of emissions. So the blue line is the reference scenario, the emissions as they are today. The green line would mitigate CO_2 emissions, so that would be equivalent to favoring natural gas right now because it has less CO_2 emissions, even though it might have more methane. The orange line will be mitigating methane type pollutants, so you will have less methane at the beginning, but maybe more emissions at the end. That would happen if you use coal, you have less methane emissions now, but then you will have more CO_2 accommodation. And the purple line is basically mitigating all sorts of emissions, which is what of course everybody recommends.

But what I wanted here to show you is the green and the orange. Again, the green is mitigating CO_2, so that will be favoring natural gas, and the orange is not favoring natural gas. So you see that the two lines cross, right? At the beginning the green line has more warming because there's more methane, and then around 2008, it crosses the line where you would be emitting more CO_2, right? But then after that there is a shift, so you will have more warming now if you use natural gas, therefore more methane, but you will have less warming in the future even though you have more methane now. So, I mean, that's still debated, so that's a decision that I guess policymakers need to make where, you know, natural gas is better or worse.

MR. MCKINNEY: And Rosa, if I can ask you to move to completion here?

MS. DOMINGUEZ-FAUS: Okay. So the final thing I want to show and speak about is what we are doing in terms of controlling these methane leaks. So not many people are aware that the EPA has different programs, they're called STAR Programs as for natural gas, for coal, for intake methane, and basically it is a guidance program where companies voluntarily adhered to the program, and then the EPA tells them where the majority of the leaks are, what the technologies are, what the costs, etc. So as we can see, the big pie chart is showing that the majority of methane leaks come from the oil and gas sector, and then the other pie charts show you in the different segments in the supply chain where the majority of the leaks come. So we see that in production, as well in venting and flaring, and pneumatic devices, and in the other part of the system is mostly compressors.

So the EPA also shows you a list of technologies, costs, potential benefits, and therefore you can calculate a payback period. Most of the technologies have a relatively low payback periods, a few months to a few years.

And this is a voluntary program that has achieved reasonable levels of reduction so far, but it's just voluntarily. But Obama is trying to make one of the technologies in that list compulsory after January 2015, maybe 2016, they're still debating when to start it. And that's the green completion, which is basically controlled emissions at the drilling and fracking sort of time. But this is only sort of pre-production and production states, there are many others.

So what I want to show you is the accomplishments so far with the natural gas STAR program. Over the years it's been capturing around 1,100 Bcfs of natural gas. Last year, or in 2012, which is the last date I have, it was 66. That's still pretty low, it's just about 10 percent of what is actually being emitted, but you have to realize this is sort of a voluntary program that, you know, if we are capable of regulating these, then everybody controls the emissions, then we should be able to achieve better reductions. The majority of reductions have been at the production, what is shown in blue in the pie chart, and transmission sort of segments. And there's two examples here that showed the incentive that these companies have in applying these technologies to capture energy. Basically Devon Energy at the production level and Northern Natural Gas at the transmission level. Both achieved significant levels of recovery, which translated to millions of dollars in profits, and in case of Devon, that was equivalent to three percent of your annual earnings in 2010. So that's a strong incentive for companies.

MR. MCKINNEY: Great. Thank you very much, Rosa, and Amy too. So that's kind of the academic contribution to our panel today. Thanks to both of you for kicking it off and I think really setting the stage both for supply and market issues and methane leakage.

Were there any questions from the dais before we go to the next phase?

We now have three speakers from different parts of the Environmental community, so first up is Tim O'Connor from Environmental Defense Fund. Tim is the Director of Environmental Defense Fund's California Climate Initiative in San Francisco. Since joining EDF in '06, Tim has been engaged with state regulatory agencies and

Legislature on implementation of AB 32, with particular focus on heavy industry alt fuels and vehicles and compliance. And Tim's education includes a Master in Environmental Management from Duke and a law degree from Golden Gate University. So, Tim?

MR. O'CONNOR: Thanks, Jim. And Commissioners, thanks for the opportunity to speak today. You'll see in my presentation there's a lot of information, there's about 30 slides of which about 15 of them are really just for information so that they could be submitted sort of into the record, a lot of it is about the studies that EDF is doing, so I won't go through each of them word for word, but for reference back. And also, Rosa and Amy, thank you so much for your presentations, a lot of great information back to refer to.

So EDF has been engaged in natural gas work for the last several years and as the science has emerged around the contribution that methane emissions has to global climate change, and looking at what is both a 20-year time horizon at possibly 84 times of CO2 and really in the first year over 120 times that in terms of the contribution of CO_2, methane really has emerged as a very significant contributor to global climate change.

And when you look at really what that means, looking at the IPCC data, you can actually tell that upwards of one-third of the current warming that the planet is experiencing is from methane, from emissions of methane into the atmosphere. And if you also were to look at what control of methane can do in terms of bringing down the leakage of natural gas, if we were to actually implement all the cost-effective and low cost strategies that are available in the oil and gas sector across the U.S., that would actually surpass all of the pollution reductions for global warming pollution that you would get from full implementation of the EPA 111D program between now and 2030. And so this is not an insignificant amount of emissions we're talking about.

Rosa did talk about a paper that Ramon Alvarez, a scientist at EDF did and had in PNAS back in 2012; we updated the data from that paper using the most recent IPCC estimates and, actually, because of the global warming potential now finding to be much higher, you can actually see that the leakage that can occur in order for natural gas to serve as a climate benefit starting in year one has been reduced. So if you look at it as natural gas being used to replace coal, based on those AR5 estimates, you can only have 2.7 percent of the natural gas leaking into the atmosphere from the full lifecycle for it to have an immediate climate benefit. And this is not mean that if you have 2.7 percent or greater leaking that it isn't a benefit to replacing coal, it just means that in the first year as we move out further and further down the time horizon, it takes just a little bit longer for natural gas to become a climate benefit and really we should sort of pay attention here to that bottom number for the heavy-duty diesel as we saw pretty significant penetration rates being planned possibly for the sector.

You can tell that a very low leakage rate, you start to question whether in year one you have climate benefit. And so this really just means we need to be reducing natural gas as much as possible in order to ensure that climate benefit.

So who really knows, though, how much is leaking? I think we heard that there's a fair amount of information out there that shows that some estimates are possibly lower than the actual emissions rates, some are higher.

And so to try to really evaluate the science around natural gas and methane, we embarked on a partnership with over 90 academic institutions and with 16 studies with several business collaborators to evaluate really the science around leakage. We broke this out into five different portions of the lifecycle and have tried to evaluate the emissions on the value chain from each of the individual components there. And there's a couple folks in the room that we've been working with, whether it's in the distribution side, or whether it's in the truck side, or whether it's in the upstream production side. And so I have not been the lead collaborator from EDF, that has really been the responsibility of a gentleman named Drew Nelson and Ramone Alvarez, and they wanted me to extend their thanks and gratitude for all the industry partners that have been working with us, and all the academic institutions that are really giving this a lot of credibility.

They're all planning to be published or submitted for publishing by the end of 2014, and it involves a pretty significant effort, both it has fly overs, also has vehicles that are outfitted with various equipment and technology, and really does involved academic institutions at really ever part of the chain.

And when you look at the various studies, what are we really looking at here? What does natural gas leakage equate to? And if you just look at a 1.2 percent leak rate from across the U.S., you can really tell we're talking about significant emissions, and we use so much natural gas throughout our economy, we are really talking about billions and billions of dollars of money, of revenue that has otherwise leaked into the air, or on a greenhouse gas basis equivalent emissions equal to 112 million cars just from 1.2 percent worth of leakage.

Some might say, "Oh, 1.2 percent leakage, that means we've kept 98.1 percent in the pipes, that's pretty good." Well, no, this actually means that we need to be driving further and further down those emissions in order to make sure that we're both keeping the economic benefit and the climate benefit of natural gas as a fuel source.

And just to take a quick step back, you know, EDF has always tried to focus on where the science lies and so this presentation is not meant to say, you know, natural gas leakage is too high, therefore we should not be using it as an energy source, or that it means that once we get to a certain threshold, then it's good. This is all just saying we need to be driving emissions lower and lower, as low as possible, in seeking reductions and leak tightness throughout the value chain, and not pre-judging various technologies until the science really comes out, but really trying to make sure we understand the science and reduce the emissions wherever possible.

So the next 16 slides are actually about the methane studies. The first two are ones that we have already published, the UT Study and the Colorado Study really are sort of in the oil and gas space looking at what are the emissions, and both of them have sort of found that emissions can be significant in the fields and comparing the traditional inventories, finding that emissions are probably somewhat higher than in past.

Now these are not ordered in the order with which they'll come out, most of them will be submitted for publication by the end of this summer, hopefully in time for this to be fully into the docket. And again, I'm not going to read through these, but just so folks have the information. For this particular purpose, we're looking for the vehicle side of the equation really to highlight the ones where I think it's most relevant and, indeed, this one, the Washington State Study looking at the distribution system and where along and throughout the distribution system leaks are occurring and what are the emissions I think is going to be rather relevant for what we're looking at here as natural gas, is fed further and further into the economy for filling up vehicles.

The Boston Local Distribution Study really sort of looks at a different type of system, one that has a lot more cast iron and older pipes, and I think what we'll see and people have been seeing from Boston, is just a lot higher emissions throughout the system than you would in, say, a much new system that is maybe built more on plastic and piping.

Jumping forward, I think we'll go to number seven, this is looking at again mapping across urban areas throughout the U.S., really to identify how utilities map their systems and where the leaks are in those systems, and really how we develop a good rapid response network for being able to identify and fix the infrastructure. Probably the most relevant one here is the West Virginia study on pumped wheels and looking at sort of what are the emissions both on the vehicle and in the refueling station. And again, the folks from EDF decided, when I was talking about this, they said I can't actually present any data for these studies since they're all under review right now, all the data has been collected, is being evaluated and prepared for submission, and I'll be submitting them into the record once we're done.

And finally, probably the most important ones as we get into transmission and storage is obviously relevant and Indianapolis is going to provide us another one, but slide 15 is really putting all the data together, you know, what does the full lifecycle emissions from various usages tell us from these studies? And I think as we look at not just the EDF 16 studies, but also studies we've already seen starting to get developed in the Central Valley Region of California, the stuff that the Energy Commission and ARB are coming out with, we hope to really sort of put a finer point on where are the emissions inventories in relation to actual emissions. And as we try to sort of move away just from the science of what are the emissions, similar to the NRDC Study I think you'll hear in just a second, we hired an ICF consultant to do an evaluation of what are some of the emission reductions opportunities in the natural gas sector, and we created sort of a McKinsey style cost curve looking at the costs, as well as the reduction potential at various points along the value chain. And from this, we developed really kind of a cost-effectiveness infographic, if you will, showing that -- and if you look on this chart on the right-hand column, everything that is in green where it has a little green dollar sign, that's everything that's actually cost negative, the cost savings immediate per million standard cubic feet reduced. And everything that is also in the gray, the less gray bubbles, the cheaper it becomes. And so you can see that actually based on the ICF work, which looked at the whole value chain both from the upstream production and from the midstream and the downstream, that although emissions are likely to grow over the next five to 10 years, and a lot of that is going to be coming from infrastructure today, we can actually cut methane emissions at a very low cost in a very high percentage through technology that exists right now. And when you look at what this is in terms of cost savings, at less than a penny per thousand standard cubic feet produced, you can have significant reductions and really from day one many of these pay for themselves.

And so we have a webpage which is devoted to our methane studies, that's identified here in the presentation. And really this is just meant to be a backgrounder on the kind of work that we're doing. But also if you look at sort of what ICF is finding, what others in the industry are finding, what the industry partners themselves are finding, is that even though methane of course is and natural gas is quite cheap compared to where it was in the past, and maybe folks want to be producing liquids as opposed to dry gas, there is both an economic benefit in savings, as well as a huge climate benefit for being responsible for this. And even though in California if we may not be doing much dry gas development and fracking for that gas, you know, it's coming here. We are the beneficiaries of oil and gas production across the U.S., and in order to be good stewards for that energy that comes to California, we really need to be responsible in how we use it and in our system as we move forward. Thank you very much.

MR. MCKINNEY: Thank you very much, Tim.

COMMISSIONER SCOTT: A quick clarifying question before you step away. Thank you, Tim, that was a fantastic overview and it's music to my ears to hear that we'll get all of this into our docket when it's ready. On your slide 8, I think it was, where you were showing the 1.2 percent leak rate, is that across that entire supply, so that's an average across the supply chain?

MR. O'CONNOR: Yes, that's correct.

COMMISSIONER SCOTT: Okay. I just wanted to check. Thanks.

MR. MCKINNEY: Great. So our next speaker is Dr. Simon Mui with the Natural Resources Defense Council. So Simon is a Senior Scientist and Director of NRDC's Advocacy and Research on Vehicles and Fuels in California. And over the past six years, he has engaged in various state and regional efforts to cut climate pollution from the transportation sector. Simon is a native of California and has an undergraduate degree from U.C. Berkeley and received both a Masters and a Doctorate from MIT. So welcome, Simon.

DR. MUI: Hi. Thank you, Commissioners and thank you for organizing this workshop, CEC staff. Great to see the IEPR workshops really delve into some of the issues that are actually challenging to understand, some of the controversy with some of the natural gas leakage issues. You know, we've had some great presentations already, so I'm going to try to skip over some of the areas that may be duplicative or covered already. We've got a great background in terms of what Amy and Rosa presented in terms of the overall inventories, as well as the market assessments and lifecycle.

So one thing to remember with the natural gas production is that we're talking about oil and gas production really in terms of leakage, in terms of methane emissions, with the majority being actually from the gas production, but oil production being a major part as well. Most of the emissions occurs upstream at the production site overall, so for gas production, about two-thirds, based on EPA's inventory as in for oil production basically the majority happens at the crude oil production site.

You know, just on oil production, I thought it would be helpful to show an image of the significance of some of the methane leakage. Here we have the Bakken shale compared and I think this is probably for energy wonks, you know, sort of been circulating quite a bit, but it does show that flaring is quite a major issue with some of the oil production, as well. And here, Bakken North Dakota, I think Amy showed some of the geographic locations compared to Chicago and Minneapolis during the nighttime, but what you see is the flaring essentially lighting up the state, enough so that you can actually view it from satellite imagery; this one is from NASA and NOAA. This image is down in Texas, Eagle Ford Shale, showing in the red lines the kind of corridor of shale production compared to Houston and Dallas Lights.

You know, there's a lot of knowns and unknowns right now and what we do know is that methane is a powerful global warming pollutant. We know that the emissions are growing. And what we did in 2012 was start looking at the technologies to address the methane leakage, and what we do know is that this is eminently controllable. The leak in profits studies which I'll talk about showed that 10 cost-effective technologies alone could address really most of these emissions. Where we need a better assessment on better information is really the inventory which Adam Brandt, Stanford, and a variety of other researchers at Harvard and elsewhere conducted a study recently that published in February, showing that the EPA inventory may be underestimated by 25 to 75 percent.

In terms of leakage assessment, we have to know just how much, and from where, and studies from EDF will be really vital to providing more information for scientists and policymakers to evaluate really the things like fuel cycle assessment, what is the GHG emissions in Natural Gas Vehicles versus diesel vehicles?

And what I show here is basically just some slides from the default assumptions from the recent GREET -- this is Argon's model -- between GREET 2012 and GREET 2013. And the real difference is really the EPA inventory assessments of leakage, and basically I think Rosa commented that the earlier study had a higher emissions leakage and the latest study had lower. We expect those numbers to go up potentially given some recent studies, including grant studies. But the short study is that vehicles fueled with fossil base, and I clarify fossil-based natural gas may have higher or lower emissions basically. This is over a 100-year timeframe and the one caveat is this is for -- GREET evaluates passenger vehicles, so this is not for the truck side, but basically you’ll see similar results from heavy-duty because it really comes down to the fuel economy differences.

In the red you see here is basically the methane from the upstream emissions, and they can be higher, in this case we’ve got about I believe three percent in the bars on the left-hand side, and then basically the reassessed EPA numbers, which is one and a half percent.

And I think we talked a little about it, but basically their sensitivity, of course, to things like timeframe to which global warming potential utilized as you evaluate these emissions, these fuels, and obviously if you’re concerned about near term impacts in terms of global warming, like Tim has talked about from EDF, you’d be looking more at the right-hand side, and if you’re concerned more about the longer term 2,100 type scenarios, you’d be looking more at the left-hand side.

What’s important, though, and this was not included in the packet, so I’ll send an updated slide for the website, but basically one of the important stories, I think, is that regardless of where methane leakage is, fuel efficiency, the type of source for the gas, whether it’s fossil biogas, is very important regardless of where the methane leakage is. And the reason is because if you are in a scenario where you’re trying to get deep reductions, you know, frankly fossil natural gas might not get you there, that you really do start needing to go towards high efficiency vehicles, as well as bringing in your carbon intensity significantly down. And so I don’t think most studies I’ve seen haven’t really necessarily disagreed with that, but here you see the potential for things like biogas from animal waste, biogas from wastewater, landfill gas, being pretty 90 percent and even negative in some cases, and mainly because that is methane that would have been released anyhow into the atmosphere, so utilizing that, capturing that has significant benefits climate-wise. I think one of the questions which Amy addressed is potential volumes and limitations in terms of blending them into the pipelines, blending them over time, what is the timeframe of that?

As I said before, our study in 2012 really identified just 10 technologies and just looking at 10 profitable technologies, what we found was that, versus a no control case, versus a no standard case, it resulted in over 80 percent reductions in the methane leakage from these technologies if they were deployed. This does not look at feasibility, this is not a technical feasibility study, but it did look at the potential reductions. And what it found was similar to other results, the discussion around green completion, so basically having closed loop systems for the liquids and gasses that come out during a completion of a well, really critical. This is now being what we would say partly regulated under EPA's New Source Performance Standards, which actually regulates volatile organic compounds, which is not a direct control, but actually has co-pollutant benefits for methane.

So what the next slide shows here is that many of these technologies are in fact -- the pay-off period in many cases is two years or less for these 10 technologies. And so there's a very short payback period. So one of the things that I'll mention is that critical in all this is cleaning up existing fuels production. So the

EPA Regulations going forward right now are very critical, making sure that existing sources, as well as new sources get covered, that methane is directly regulated, and that facilities are actually given a list of technologies that are essentially identified and needed. We see all of those things as being very necessary to controlling methane emissions.

And one of the major reasons why a lot of these technologies haven't been deployed goes back to, while the companies do have very high capital internal rates of return, so they are not willing to even in some of these cases fund projects if the capital is more profitable in other areas, and this is a very challenging area, but in terms of environmental benefits there are tremendous benefits to regulating these types of emissions. We really shouldn't be wasting methane like this.

Finally, I think Rosa commented that vehicle efficiency is critical. And so regardless of the fuel type that you utilize, regardless whether it's fossil-based diesel, whether it's natural gas, even electricity, you really want to have policies that drive vehicle efficiency to improve because that's where you'll get a big bang for your buck. Fuels switching to lower carbon intensity fuels where you can is critical, as well, to the long term climate goals.

And, you know, backing up a little bit, even in the heavy-duty space, thinking more about transport modes, about efficient transport modes, the balance between trains and barges is very critical, as well. So that is my presentation and if you have any questions, I'd be happy to follow-up.

MR. MCKINNEY: Thank you very much, Simon. Our next speaker is going to be John Shears. John is CEERT's Project Team Leader for Clean Transportation Issues including vehicle technologies and alternative fuels. He is well known to us here at the Energy Commission for his work on our Advisory Committee for AB 118, and he is also on the Boards of the California Fuel Cell Partnership and California Plug-In Vehicle Collaborative. So, welcome John.

MR. SHEARS: Good afternoon, everyone. Good afternoon, Chair Weisenmiller and Commissioner Scott. And thank you for the opportunity to speak to you today on the issues, the challenges facing us in developing natural gas opportunities in the future.

I just want to take a slightly higher level approach to start, put this more in sort of the broader climate context in looking at what's going on with methane globally. In the southern latitudes, it's dominated by biogenic sources and in the northern latitudes, where population dominates, the emission sources are dominated by anthropogenic sources, and especially the natural gas and oil industries are an important emission source in the northern latitudes.

I just wanted to show what's going on with methane in terms of global average concentrations as of late. During 1999 through 2007, it seemed like methane emissions had plateaued and some type of equilibrium had been arrived at within the global bio geosphere, and then in 2007, methane emissions started to climb again. The climate researchers that work on methane and its role in climate have posited that not only due to feedbacks that they can assess indicating that there are greater emissions coming from the tropics, largely from wetlands, they've also posited that the northern latitude oil and gas industries' recent uptick in activity is responsible for this resurgence again in the increasing emissions trend for methane.

So if we look at the global inventories for emissions, just highlighted here coal, oil and gas essentially are an important signal here in the northern latitudes, especially agriculture is also an important source of emissions if we look at the most recent EPA inventory, it also confirms for the United States that the oil and gas industry and the coal industry are important sources of methane emissions.

And I wanted to touch on the fact that, yes – actually, not touch on, but stress in my talk that, yes, while there are indeed practical ways of monitoring the natural gas infrastructure and the oil and gas infrastructure systems, and there may be cost-effective ways of dealing with emission sources, that we're talking about a scaling problem here. When we look at the total scope of the infrastructure, and here what I'm highlighted are facts in terms of the number of facilities, miles of pipelines, number of storage facilities, compressor stations along pipeline systems, etc., from the EIA website, it still is a significant task to be able to monitor and police everything that is going on nationally and also within the state. So I just included one of the maps from the EIA website to sort of give you a visual on the extent of infrastructure and the associated compressor station system, and this in fact is really data the EIA hasn't updated since 2007-2008.

Now we're dealing with the oil and gas boom and, as these projections from the EIA Annual Energy Outlook suggests, we're going to have massive increases in production, and also we're going to have to have matching increase in infrastructure to keep pace with that production. I've included some numbers on well drilling rates from a recent paper that technically is not in print yet from researchers in the UK doing an assessment of oil and gas industries around the world as part of an analysis for oil and gas industry prospects in the UK. Clearly, the U.S. has the dominant activity globally in terms of drilling activity. When we look at the number of oil and gas wells, according to this same study with the UK-based research using EIA data, there are over 2.5 million wells that have to be dealt with and tracked, and for Alberta, I've taken some of their data and updated it from other sources in Canada, just in Alberta alone they're just shy of 360,000 wells in Alberta alone, that does not include British Columbia, Saskatchewan and Manitoba that also has some activity, and any offshore activity in Eastern Canada. So all of these wells also have to be policed and monitored. And then the gas pipeline system is also expanding rapidly to keep pace with increased production.

In California we have nearly 80,000 oil and gas wells that have to be policed, most of the straight up natural gas wells are in Northern California, those are the blue dots, leaded and natural gas production in Southern California is what is called associated gas that is collected as part of oil drilling.

So I want to focus on Adam Brandt's and his co-author's paper from earlier this year, which has been highlighted by Rosa and I think both Tim and Simon also mentioned Adam's paper. In his paper, he and his co-authors reviewed 200 other studies that were in print, that had already been published, whether peer reviewed academic journals, but also technical publications that had been published by reputable consultants and the like, and they had calculated this 25-75 percent higher emissions rate over what the EPA inventory would indicate. At the same time, they offered cautions in that -- and I highlight in red -- current inventory methods rely on key assumptions that are not generally satisfied. And if you go to read their article, the articles actually pointed at policy people and regulators, and they want to stress to folks that there are a lot of problems right now with the literature that's out there and there need to be improvements in the way both researchers and regulatory agencies need to work with industry to get a better handle on what's going on. The EDF efforts are certainly going to be very helpful, but probably there will have to be much more work done even beyond that. I think the EDF work basically kicks off and hopefully addresses a lot of the concerns that I have listed here, I won't read them off because everyone else can read, there are a few pages, but the one thing I would like to highlight, too, is that they did note that the problem seems to be a problem of super emitters. But even with that, that still requires that you are vigilant and are monitoring the systems thoroughly and on a regular basis so that you can actually detect or develop some way of predicting where you should be able to locate breakdowns in the system so that you can locate those super emitters. I didn't get into the issues around the debate in the research and industry literature about failure rates at capped and active wells, there's quite an extensive debate going on there, so that's an example of where you might be able to develop a way to predict where you should go to revisit wells, to make sure that they don't fail and start having emissions problems.

I've included the changes and the emissions factors from the IPCC, so right now U.S. EPA and CARB traditionally have been using the global warming potential from the 1995 second assessment report, whereas in the current assessment report, if we look at the updated significantly higher global warming potential, at some point industry and regulators are going to have to address, you know, how that adjusts, you know, how we all work together. Both Simon and Rosa included some of these adjustments in their work, so that was helpful.

And then I want to touch also on the issue that methane is an important air pollutant, not just a greenhouse gas pollutant, but it has different roles depending on whether you're talking if it's located in the stratosphere, in which case it's a problem for maintaining ozone, whereas in the troposphere, or down at ground level, it actually is involved in the cascade of reactions that can increase ground level ozone.

So when we're looking at drilling projects, and this is taken actually from the -- I took the graphic from InsideClimate News the list of sources at the developing well pad from a report just released by the Alamo Area Council of Governments, and I'll provide an updated slide deck with that reference for the Energy Commission and for posting to the website, but they highlight all of these issue areas as being problematic for local air pollution. You know, granted, here in California we tend to regulate air pollution emissions a little better, but still any increased activity around Monterey shale will be of concern to the local communities and Southern California.

So with that, I'll just finish again with the Ramone Alvarez, et al. notation about again using the technology warming potential as opposed to global warming potential, but that the old calculation, whether we're talking 2.7 percent, as Tim updated us, or the 3.2 percent that Rosa mentioned, roughly a 3.0 percent leakage rate could negate the benefits of natural gas relative to a clean coal power generation facility. So we need to get a better handle on this and work together to make sure that we don't just provide fleeting attention, but that we maintain vigilance on this going forward. Thanks.

MR. MCKINNEY: Great. Thank you very much, John. Commissioner Scott, that concludes both kind of the academic and environmental part of our program. Did you have any questions from the dais or the Chairman?

COMMISSIONER SCOTT: I do. I have a clarifying question, John, from you on your slide about the IPCC assessment of the global warming potential of methane. And it's just up here on the top with the global warming potential in 100 years, and it says “with CCFB and without CCFB” and I just didn’t know --

MR. SHEARS: Oh, sorry, with Climate Change Feedback, Without Climate Change Feedback.

COMMISSIONER SCOTT: Thanks a lot. Thank you for that. And I also wanted to invite Valerie Winn from PG&E to come and just give us a word or two on the early detection program that PG&E has going on, and then I’ll turn to the Chair to see if he has any questions.

MS. WINN: Good afternoon, Commissioners. Thank you for letting me speak on these important issues because methane leakage is an issue that we’ve been looking at, and while we don’t have really hard numbers yet on the methane leakage from our system, we are looking for ways now that we can begin to reduce those emissions. And really reducing those emissions goes hand in hand with our enhanced safety program because, as we are looking at how to safety operate and maintain our system, part of that is improved leak detection. And we have been one of the industry leaders in new survey techniques. We have a Picarro System that is one thousand times more sensitive than earlier technologies at detecting leaks. And so we've been really pushing that technology out there and getting really good results from it.

One of the things that we are concerned about, though, is that as we're looking to reduce methane, it's getting the regulatory support that we need to really advance these programs. For example, in our recent General Rate case, we had proposed to do leak surveys once every three years and the Proposed Decision that we just received last week would have us doing the surveys once every five years. And so we really think that there are benefits to doing these leak surveys more frequently. And we're hopeful that we could identify and repair those leaks more quickly than what we may get in the General Rate case.

We also think that there are certainly areas for increased research and development in this area, and we look forward to working with the CEC and with other partners on research in that area. Thank you.

COMMISSIONER SCOTT: Thank you. Any questions from the Chair?

CHAIRMAN WEISENMILLER: All right, I

wanted to thank everyone for their presentations and certainly encourage everyone as reports are ready to file those with the Commission in the docket, and I'd also encourage your participation in our ongoing research in these areas to, again, make sure that we're developing a strong database for California on these issues.

I would note, yeah, when PG&E did the leak detection tour for me, and I don't know how many others have seen that, it's pretty impressive technology, and my question was how fast we could do it. And particularly moving on from the neighborhoods to areas where there's potentially high consequence, you know, of trying to do those surveys. So it was sort of shocking the PUC went from once every three years, I would probably be happier if it was like two, to five. So, anyway, that's something for those of us concerned about not methane as a greenhouse gas issue, but also safety, that you may want to weigh in on that.

MR. O'CONNOR: Thank you, Chair Weisenmiller. This is Tim O'Connor from Environmental Defense Fund. And indeed we've been really evaluating what are the best practices for leak detection and how are various utilities across the U.S. doing, and I think what we've seen is, depending on the age of the utility, depending on how rigorous they are and the regularity with which they perform detection, you actually do have a demonstrable change in the amount of leaks in the system. And so the more you check them, the more you are able to find those and reduce those.

We've been working on a bill actually in the State Legislature that's aimed specifically at leak detection and repair, and we think it has an opportunity for making it through the Legislature this term, SB 1371, and as that progresses we'll be alerting the Commission where it's going and so that it's in the docket, as well.

CHAIRMAN WEISENMILLER: That's great, and obviously one of our other common issues is to make sure the cast iron pipe is out of San Francisco, and I think PG&E has made good progress on that, but that is certainly one of the more significant issues is the type of pipe.

MR. O'CONNOR: Yeah, and in that vein, I do know that recently Con Ed up in the service territory in the Northeast actually just received funding to replace, I believe, all of its cast iron pipes, or very significant portions of it. So across the U.S., there’s a real focus on cast iron piping and the need to upgrade and remove it.

COMMISSIONER SCOTT: Great. Well, that was a terrific panel. Again, we just have so many experts and just a lot of great interesting information and a lot to take in, so please do be sure, as the Chair has said, to send us all of your studies and data and information so that we can take in all the underlying work, as well.

I’m going to turn it back over to Jim for Panel 3, but I’m just going to note that I appreciate everyone’s indulgence today with a very ambitious agenda that we have, lots of speakers, lots of great information, and so to make sure that we get through it all Jim is going to be a task master and start waving at you when you get close to one or two minutes left in your presentation, just to make sure that we get to hear from everyone as we continue through the day. So that’s for that. I’ll turn it back over to Jim.

MR. MCKINNEY: Yeah, and actually Commissioner, I'm actually going to lunge off the table when we get past the 12-15 minute mark.

So Silas and I are sharing moderator duties this afternoon, so Silas is going to moderate panel 3.

MR. BAUER: All right, so Panel 3 is going to look at Natural Gas Supply and Sales. We have three presenters, panelists, George Minter from Southern California Gas Company, Todd Campbell from Clean Energy, and Julia Levin from Bioenergy Association of California. Just to follow-up on Commissioner Scott's point, please as much as you can try to keep your presentations to 10 minutes just for the timing overall.

So starting off with George Minter, George is currently the Senior Director of Policy and Environment at Southern California Gas Company. He is a Public Policy professional with 35 years' experience in energy and environmental affairs, policy development, communications strategy, and political advocacy. George is the father of two grown children, married, and lives in Pasadena, California. He is a Phi Beta Kappa and Honors Graduate of the University of

California at Berkeley. So, George?

MR. MINTER: Thank, you. One of my kids is an environmentalist and keeps me on the straight and narrow, so…. I guess that's why you must have put that in there. He's following in his dad's footsteps, actually.

Mr. Chair, Commissioner, thank you. I think I'm here to kind of provide a broad overview where we think the gas industry is going, needs to go, and where the gas company, Southern California Gas Company, is headed. And I think that Todd will be providing a lot more detail with respect to the transportation market opportunities and growth, and then Julia of the Biogas/Biomethane potential and opportunity.

We start from the perspective that we're an energy company providing natural gas, and we've got to address energy use, we've got to reduce our emissions, and that means we've got to work on technology and we've got to drive emissions down on technology, but we also have to look at our fuel and we have to drive the carbon content down on our fuel. We see many of the state's planning documents really focused on electrification of energy end use, it's focused on de-carbonizing the electric generation sector. Our focus is to develop near-zero zero equivalent technologies, technologies that are power plant equivalent, or electric generation equivalent. To do that, we've got to reduce emissions, we've got to also address our fuel.

Decarbonizing the pipeline is the future direction. We need to go from geologic supply to biologic supply and ultimately to hydrogen, hydrogen blends, and synthetic methane. Now, that's a long term future, but I think it's important that we direct ourselves to that long term future. But there's also a short and a mid-term, and it's really important, particularly for Southern California Gas Company, which has 80 percent of its marketplace in the two extreme non-attainment regions in the United States, the only two in the United States, and that's the San Joaquin Valley and the South Coast. And the problem is ozone. And the problem with ozone is NO_x. And here you have a chart that looks at South Coast NO_x emissions and you've got almost 90 percent coming from the transportation sector. We already saw the pie chart where 38, almost 40 percent of GHGs are coming from the transportation sector.

So we have a dual problem and I think it’s really important for energy and environmental policy and planners and commissioners to realize that it’s a dual problem. We have a short and mid-term NO_x problem, criteria pollutant, it’s governed by federal law, and we have a longer term GHG problem in California governed by state requirements for 2020, AB 32, and the Governor’s Executive Order for 2050, but it’s a much longer timeframe on the GHG front.

I think many people would say that living in the South Coast in the L.A. area, particularly in poor communities, would say driving down ozone is a priority. Certainly it is with short and mid-term, these are federal requirements. We have a 2023 requirement and a 2034 requirement, and both of those are long before the 2050 requirement for GHGs.

Where is it at? It’s at trucking, it’s at transportation sources. Transportation is the problem, it’s the NO_x problem. And if you look at the top 10 emitters in the South Coast, heavy duty diesel truck far and away exceeds any other source of emissions. That's where the problem is, but that's also where the opportunity is. And the opportunity is great, and we've heard some of that discussion today, we'll hear much more of it tomorrow.

But it isn't just trucking, it's all of the transportation sources. And if you think about goods movement, it isn't just trucking but it's rails, it's locomotives. It's also marine, it's shipping. It's also the other areas of goods movement which would include a lot of the equipment movement, the power requirements for equipment movement.

If you look at just the goods movement sector, we're looking at about 40 percent of all the emissions in the South Coast. What's exciting -- and I'll get to methane emissions and what I think is the positive story behind the story we just heard on methane emissions, which very briefly is everything is headed in the right direction, which means emission rates will go down because of all this concern and attention -- but what's exciting is that the marine sector and the rail sector are making inquiries today and quickly want to move to LNG fuels.

When you look at the volumes, rail is a very significant volume, but marine just eclipses in terms of volume and in terms of emission reduction potential, eclipses the amount of LNG that would go into long haul trucking. When you complete displace your bunker fuel which is very very dirty, much dirtier than diesel, with LNG, you have tremendous emission benefits, not just obviously NO_x but GHGs as well.

And we just had an interesting meeting a month ago with the Port of Los Angeles, they're meeting with us, and I'm trying to understand our supply capability, our delivery capability, high pressure transmission lines to deliver into the port, they are asking us where are we going to be building our liquefaction facility to refuel the marine demand and to utilize that to provide refueling for the locomotives originating out of L.A., as well as to have in the harbor area liquefaction to supply LNG for trucking. And that's happening now. We actually are working on that and looking at how you do liquefaction, and they actually have a vision. Their vision was we want a small scale low head liquefaction facility on every pier, and we want that to provide LNG refueling at every pier for every ship, as well as to provide the natural gas for fuel cell and micro turbine that will provide 100 percent shore power. That was kind of their vision. That's a pretty exciting vision.

What's driving NGV growth? And I think that, Todd, you'll get into this a lot more, there is a continuing price differential, the NO_x emission requirements in the South Coast and San Joaquin Valley would really drive the use of natural gas in the truck market, and I think over time the pressure to reduce GHG will also move us toward natural gas.

This is very simply sort of what comprises the price differential, it's important to note here that the commodity price for natural gas is a smaller component in the overall price of delivered natural gas as a transportation fuel than diesel. We think even if the commodity price would double, that we would only see about a 50-cent per diesel gallon equivalent price differential. So we anticipate, and other speakers have said, that over the long term there will always be a price differential. And clearly the truckers and the rail companies and the marine companies are seeing this. In Europe the shippers are already moving to LNG, we're seeing inquiries now in the United States, it will continue.

And this actually is work that was done by GNA, Gladstein Neandross and Associates, on our behalf looking out over time on the price differential, looking at sensitivities, and basically documents for us that the price differential will continue to remain a driver. Natural gas pathways aren't just for the short term, and I think again it's important to emphasize we need to move in this direction to get the NO_x emissions we need to get to meet federal requirements in Southern California. And that's short and mid-term. But over the long term, we need to de-carbonize the pipeline to address the GHG reductions. Well, how do we do that? Well, I indicated we move from geologic to biologic. We've got to build our biomethane opportunity. We've got to develop green pathways for hydrogen. And we've got to look at hydrogen blends and Methanation. When you look at renewable gas, and I think one of the earlier speakers had a similar chart, this is based on the carbon content value under the LCFS program and ICF did some work for us, and basically renewable natural gas has a very low, lower than average electric generation carbon intensity, and even a negative carbon intensity, depending on the type of renewable natural gas.

The view here is that we've got to move renewable natural gas into the pipeline, it can be a hydrogen stream for hydrogen use, it can be a methane stream for pipeline use, it can go to transportation, it can also go to other uses, electric generation, it can go to normal household natural gas heat-oriented, water heating, space heating, clothes drying, even cooking. That's sort of the biologic fuel.

Now people ask, and I don't know, Julia, if you're going to get into this, but people said, "Well, what's the volumes?" And the DOE and the National Petroleum Council have done studies and it looks like it's 17-20 percent of the throughput could be displaced by existing biologic resources, landfills, wastewater treatment, dairy, Ag, Woodland waste, urban waste, we're looking at what's the next 20 percent and the pathway for biodiesel and biofuels that the ARB has kind of laid out is also a biomethane pathway, I mean, biomethane is the pre-stage to biodiesel, to liquid biofuels. And our view is if the transportation market moves to gaseous fuels, as we see it will move, that biomethane will be the choice for transportation use, not liquid biofuels. So we see the potential of going from 20 to 40 percent de-carbonization just from biologic resources.

But the real mid to long term challenge is how do we produce hydrogen and how do we methanate hydrogen and put it into the pipeline. And I think that we're coming into a situation that Germany and the European Unions came into several years ago. They had an over-supply of electricity, it was challenging the transmission system, they were offloading some to Sweden, the federal government stepped in and said, "Look, we need to opportunistically identify where there are constraints in the system, instead of shutting down -- this was a wind resource -- instead of shutting down turbines, let's continue to run those turbines at night, direct that electricity to power electrolysis of water which produces hydrogen, and then we have green hydrogen pathways, and you can have hydrogen for direct use, but you can also then opportunistically take CO_2 pathways, captured CO_2 from power plants, from industrial operations, and methanate that hydrogen and direct it right into the natural gas delivery system.

We think that, just to come to a close, there are things that regulators can do. Let's not do technology mandates, let's set performance standards, and let's move us to meet those standards. We're developing, as was indicated earlier, a 90 percent lower NOx engine, that engine is going to be commercialized and I think we have a representative talking about that engine. What we need now is deployment. How do we increase the adoption rate of that engine? We need deployment dollars, not R&D, not commercialization, but we need a funding for deployment to reduce the capital cost, to bring the adoption rate up, and to give us the shorter term NO_x benefits.

I think that what I've laid out in short version is a view that natural gas, methane, the natural gas distribution system will be here to stay for long term, that it's a foundational fuel that we need to think of natural gas not just as fossil gas, but as both biological as well as hydrogen blended, as well as methalated gas.

We have a study that E3 has put together for us, it's not yet ready for primetime, but it will be in about a month, we'll submit it for the record, which basically looks at de-carbonizing the pipeline mixed with electrification, a balanced approach which gets us to the 2050 GHG reduction goal faster and cheaper than an electrification approach. So I think it's something that the Commission will be interested in, particularly in the 1257 report.

A second study that will be completed in a few months with Environ and with GNA looks at adoption rates, at what kinds of incentives for deployment will increase adoption rates, and what time frame to get us closer to the NO_x goals for 2023 and 2034. And we hope to be able to present that, as well, as part of the record, not just for the IEPR, but also for AB 1257.

I'd like to just comment on the methane slides. I think I began by saying, look, the good news is we have a focus on the problem, and we're going to fix the problem, meaning we're going to drive emission rates down. You know, we were one of the first utilities, actually we were the original signer of the natural gas STAR Program with EPA in the mid-‘90s. Mary Nichols actually headed the Air and Radiation Office of EPA, Ann Smith, former CEO, was the signer of that document. We’ve been focused on methane emission reductions, and I think now the rest of the industry is focused, and I think that regulatory focus, better science, better information, and better technology will drive those emission rates down. And I think the science that’s being developed through all of these studies will get us a better answer. And the science is complicated. Ground level measurements that establish factors for material and equipment may not actually factor in problems. Surface level and air level, or top down kind of emissions monitoring may not distinguish adequately between biogenic and petrogenic sources, or amongst the different types of petrogenic sources. For example, the mapping study with EDF, we’re talking with a professor from Colorado State and, you know, he was very clear on how they were going to differentiate between biogenic and petrogenic sources, but was not aware that, for example, there’s ways that you can differentiate from petrogenic sources. He says, well, all the petrogenic source is either oil or gas, or natural gas distribution, and in Los Angeles that’s simply not the case, there’s tremendous amounts of ground level methane that is seeping from methane deposits; we were in an oil and gas producing region long before we were a city, and it’s not the oil industry, and it’s not the gas distribution system; in fact, when we identified a methane leak in the last several years using the Picarro and other technology, we go out to that leak and about 50 percent of the time that’s not our pipeline gas, that’s other petrogenic sources of methane -- in the L.A. area. So there’s a lot of science that still needs to be perfected. But I think what’s really important is to take a step back. Tim talked about and wrote in the Sacramento Bee the other day that 30 percent of shoreline pollutants, including methane, is our GHG problem. But when you really look at greenhouse gas emissions and you look at the gas system and what its share is, the overall greenhouse gas emissions, it’s about two percent of all GHG emissions nationwide, and this is based on the EPA inventories. And if you break that down by the EPA inventories and, granted, there’s some concern with those EPA inventories that the factors are faulty and that they maybe are higher, but if you break it down the distribution company is about four-tenths of one percent of the problem. So it’s really a very very small part of the problem, and yet we’re doing a lot of work to try to capture all those methane emissions.

Another way to look at it is let’s just look at all the methane emissions, natural gas systems, separate it out from the oil systems, it’s only about 25 percent of the problem, so agriculture is the single largest, coal mining, landfills, very significant sources, so it isn’t just the natural gas system.

We’re participating in all the studies with EPA, with GTI, with several California universities, with EDF, we’re part of the distribution study, we’re part of the transportation Wellhead to Wheel Study. One thing that we know from reading the production study and from looking at the preliminary results on the distribution study, there's wide regional differences. On the production side, there's differences based on age of system and region; East Coast have higher rates because they're newer production systems, they don't have closed loop systems, they're still in the production mode. West Coast supply basins are more mature, have recovered more gas. We saw that in some of the pictures where you see a lot of the methane emissions are coming from Bakken or Marcellus, the newer producing regions. That's important when we look in 1257 and we do our natural gas report and we look at full cycle emissions that we should look at California emissions. We should be looking at western supply basins, western transmission systems, and western distribution systems. On the distribution side, I think you heard Tim say it, big regional difference, big difference is age of system and in this case, the older the system the leakier; East Coast systems versus West Coast systems, higher leakage rates from the east, much lower leakage rates in the west. The preliminary results from the EDF study have SoCal Gas at about .3 percent of throughput, very low leakage rate, pretty consistent actually with what we report both to ARB under the AB 32 requirements, as well as to EPA under federal requirements. So in this case, the EDF study has corroborated our emission factors.

Now part of the reason is we have no cast iron pipe, period, there is no cast iron pipe in our system. Now, San Francisco does, they're working to eliminate it, but we have none. And all of our steel is being replaced over time as we replace it with plastic pipe, which has a very very low emissions factor, a very low leakage rate. I think if you look at more plastic, more protected steel, the less cast iron pipe the lower your emissions rate. So in 1257, we really ought to factor that in. We shouldn't be looking at national emissions rates, we should be looking at western supply basin transmission systems and also distribution systems. And also, the breakdown of the data is there in the study, so that's kind of good news. That's it.

CHAIRMAN WEISENMILLER: Thanks. George, one thing for the record is, what percentage of economic activity in the South Coast is goods movement? I keep thinking 18 percent.

MR. MINTER: I can't answer that figure, I can get back to you.

CHAIRMAN WEISENMILLER: If you could get back to us that would be good. Also --

MR. MINTER: I did hear one representative of goods movement say, well, it's the only industry we've got left in Southern California.

CHAIRMAN WEISENMILLER: That may be the other part of the story. The other part is I think you alluded to the South Coast SIP 2023 deadline?

MR. MINTER: Yes.

CHAIRMAN WEISENMILLER: Again, just to get it on record. Thanks.

MR. MINTER: Thank you.

MR. BAUER: Thank you, George. Next we have Todd Campbell from Clean Energy. He is the Vice President of Public Policy and Regulatory Affairs. Previously, he has been the Policy Director of the Coalition for Clean Air, and Mayor of the City of Burbank. At Clean Energy, he is a key architect in promoting federal, state and local transportation strategies that help reduce overall operational costs while meeting tightening federal and state regulatory criteria for air and greenhouse gas emission standards. Mr. Campbell is a Director of the Coalition for Clean Air, the Energy Coalition, and the California League of Conservation Voters. He has a B.A. in Government from Georgetown, a Masters in Environmental Management from Yale, and a Masters in Public Policy from the University of Southern California. Thank you, Todd.

MR. CAMPBELL: Thank you. And I have two boys and a wonderful wife whose birthday is tomorrow.

Good afternoon. Thank you, Commissioners for holding this very informative forum. I think it's really important that we talk about these issues and update you and others, our friends in the environmental community and other colleagues in the industry. Really, what the natural gas industry is doing, clean energy of course is a fueling transportation provider for natural gas, we do both compressed natural gas and liquefied natural gas, and we augment our fuel also with a product we call Redeem, we spent a lot of money on that name, which is essentially our way of saying Renewable Natural Gas, and I'll get into that, as well. We have about 1,100 employees, we're California-based, 550 stations and growing nationwide. We fuel almost 35,000 vehicles per day and we're very proud of that fact.

Some of the benefits with natural gas use in the transportation sector under the Low Carbon Fuel Standard, we're slated to almost get a 30 percent reduction in light-duty applications, about up to 23 percent reduction in terms of heavy-duty applications, and a few. Apply Redeem, your numbers really go down, and it could go down as far as 90 percent was one of the estimates from landfill-based natural gas, or renewable natural gas, and we see that as a really prime fuel because, unlike other biofuels, biomethane can be blended 100 percent, 90 percent, 60 percent, 10 percent. There's no SAE restriction on the engines and, in fact, all the ports in Los Angeles and Long Beach right now are running 100 percent on biomethane. So those trucks that were funded out of the Clean Trucks program are achieving California's 2050 goals today and I think that's something that's not only significant, but something that the South

Coast Air Quality Management District and the Ports of L.A. and Long Beach should be very proud of with their Clean Trucks Program down there, which in my former life as an Environmentalist, I'm still an Environmentalist, but a formal environmental member of the community, we used to refer with Gail Rubin Furrer at NRDC to this area as the Diesel Death Zone.

We're really looking forward to the South Coast AQMD finalizing their in use study for trucks. I think what's really important about this slide is it shows averages of in use emissions from clean diesel, which you can see are the red bar and the yellow bar on the far, that would be your right, and then the natural gas technology which is the four bars from green to that mustard color yellow. The key here also is you see that .2 is the standard. The exceedance level is .3 grams per brake horsepower for nitrogen oxide emissions, which is a precursor to smog. But I'm very proud to say that, in the in use emissions analysis, natural gas never exceeds even the .2 standard, in fact in some of the outcomes for refuse you can see it's well below the standard.

Another important measurement here, and I apologize for the small font, but I didn’t want to touch the AQMD slide, I wanted to leave it exactly the way they did it, so you could see for Near-Dock emissions using clean diesel, the Selective Catalytic Reduction (SCR) is not working very well and you see a tremendous increase in in use emissions for Nitrogen Oxides. For the natural gas product, again, very very low in terms of comparison. And so I think this is really an important testament to what the Energy Commission is doing through AB 118 and potentially what can be done through Cap-and-Trade monies in terms of deployment of natural gas, or an alternative fuel technology that is reducing both greenhouse gases and criteria pollutants today in communities that need it most.

There was a lot of discussion on this topic, you know, how much natural gas do we have, and it looks like we have about 200 years of proved reserves based on 2009 energy use levels. You know, I think what’s really important, and I think George kind of highlighted it, but I’ll re-highlight it, is that industry knows that it must act with regulators, it must act with the community, it must be able to reduce upstream emissions. And I think you will see, you know, I love the slide that George had with all the studies that Sempra and SoCal Gas are participating in, we are also participating with the Environmental Defense Fund. We have several colleagues here that are also participating in that. The statement from our CEO Andrew Littlefair was, “If I’m losing product, I want to know about it because I’m not in the business of throwing away money.” So we have a keen interest in being able to help recover some of the monies that Tim estimated, $1.3 to $5 billion, we’re interesting in recouping that. We cannot move forward without that kind of effort, so we are cooperating.

And I also think, you know, the way this country is moving the EPA and the Air Resources Board, you know, working with local governments, we’re going to solve this and we’re going to work on it together.

I also think methane leakage is important not just for Natural Gas Vehicles. I had a very interesting experience with a fuel cell advocate, an electric advocate, and I was asked about fracking, I was asked about upstream methane emissions, and I said the irony here is that we're all in this together because the most cost-effective way to create hydrogen is through methane reformation. And 60 percent of California's production comes from natural gas, so it's not just about Natural Gas Vehicles, it's about Electric Vehicles, it's also about Fuel Cell Vehicles. And I think that's really why I think we have a common interest in addressing this issue.

Cost? Very very compelling. I looked on GasBuddy and there's a Chevron station down the street at Northridge, or Northgate Blvd. selling gasoline at $4.29. Now, George sort of talked about this, but there's eight gallons per MMBtu with natural gas, so that means at a price, I think it was about $4.53 on Friday per MMBtu, that equates to about $.56 of commodity. In order for me to get to a price at the retail to sell what's being sold in a gallon of gasoline down the street at $4.29, natural gas has to get to about $26.24. We're at $4.51 or $4.53. So that gives you kind of an idea of how far we need to go before we would even get to today's level. I think the struggles in Iraq, you know, I think we're going to see more geopolitical strife in that region, you know, pushing a barrel of oil to $107.00, as Boone would say -- and Boone is one of the founders of our company and I was very happy to hear a Booneism this morning, you know, "I'm for all things American," and I think that's really important for us to be able to bring our energy resources to home.

Growth in the industry has been a little slow. You know, we have about $142,000 Natural Gas Vehicles in the U.S., but we're actually seeing a tremendous uptick as we move forward, especially in the heavy and medium-duty applications. In fact, a national study chaired by former Secretary Chu projects that NGV trucks will make up about 43 percent of the trucking market by 2050.

Natural Gas got its start through Clean Air Regulation. A lot of this has to do with the strong work of Henry Hogo and Barry Wallerstein and Jack Broadbent, and all my other heroes when I was an environmentalist, but what is the real difference here is that, now that we're seeing an economic proposition, you're starting to see more engine manufacturers get involved, more competition in the market, and specifically for these sectors: airports, transit, refuse trucks, rail, and ships. Of course, refuse, you know, Chuck White, Waste Management's leadership, are committing to pretty high numbers, I think it's almost 100 percent in terms of new purchases. The industry -- 60 percent is the number right now of all new purchasers of natural gas refuse trucks.

But here is an interesting statistic I want to point out, the Big Nanu, I call it, is heavy-duty trucks, and if you converted just three percent of the heavy-duty trucks, it would equate to the same amount as the refuse truck market.

The network is growing, and this is Clean Energy's network, we called it the American Natural Gas Highway, and when it's done it will be 150 stations coast to coast, border to border, and our competition is going to fill in the dots a little bit even more, there will be a more robust network for sure. But we're partnering with Pilot Flying J and other major truck stop operators to be able to get an immediate access to real estate, but also to kind of go where the truckers are going, so it's a strategic move to try to build this out.

And to Amy's point about station growth, I would argue part of the slow start was that the 12-liter engine that a lot of folks were expecting to come out was delayed a little bit, so, you know, with delay of product for the heavy-duty sector, you're going to have a delay of adoption and that's just the way it turned out.

This slide is again highlighting the opportunity, 25 billion gallons for the trucking industry annually, and you could see that's clearly our focus. I think the statistics were something like four percent of the vehicles on the road makes up a significant portion of NO_x, around 25 percent NO_x, I think it's 27 percent in the South Coast. And the engine manufacturers clearly see the opportunity, you see every manufacturer in the trucking industry involved, and you're starting to see light-duty manufacturers getting to fleet services, you know, vans, taxi-cab applications, and other services.

And then Clean Energy is no longer alone, we have over 80 competitors nationwide, some pretty significant companies out there that are also building out the industry, so I would say that the most important way to advance the growth of Natural Gas Vehicles is providing incentives to customers because, if you're going to build a sustainable station, you need customers to do that. And that's really -- if you can even cut the incremental cost of a natural gas vehicle by 50 percent, that's significant because it reduces their return on investment that much quicker.

Moving along, I just want to quickly go through what we thought was a very important move for us creating Clean Energy Renewable Fuels, which is our Renewables Division. We have a significant investment in this industry. McCommas Bluff was our first project and is producing about 60,000 gallons per day. We have another facility in Sauk Trail Hills in Michigan and another one coming on line, North Shelby, this is an old picture, so I apologize, it's actually up and running and producing about 14,000 gasoline gallons per day. That investment has a lot, about 14 million gasoline gallon equivalents of Renewable Natural Gas in the market last year, and we hope to get to about 150 million gallons of biomethane production in five years, where the industry should be roughly about 550 million gallons nationwide.

More advertising. This slide, I just wanted to kind of point out to you where renewable natural gas in terms of production costs, it’s about $8.00 to a little bit below $6.00 to produce. And that’s important because if you look at the price of natural gas, you’re saying, well, how can you move this forward? How can you produce something that’s more expensive than fossil-based gas? Well, the key is Standards like the Low Carbon Fuel Standard and the Renewable Fuel Standard. Being able to get that green premium makes all the difference in the world for us to move forward. And what’s really impressive about this is that if we expand from landfills and start going into using anaerobic digestion, as Simon pointed out, we can get to negative carbon levels which I think is pretty phenomenal.

Part of the problem is the price, it’s

not always predictable, makes it very challenging for a producer to get investors to get excited about something that you just don't know where the price is, and so there's some very critical strategies that we think we'll need to do to make sure that the Low Carbon Fuel Standard remains effective.

One unfortunate situation that happened was about, I think, Muratsuchi's Bill, AB 2390, that was opposed by WSPA, ironically, it was a really good bill to help us be able to create a green credit reserve and was championed by Waste Management and other colleagues, and what that would have done, it would have helped us create more production facilities for biomethane by providing some certainty for the investment community. Also, price floors, price caps for political annals for being able to do more production facilities in this space, as George Minter pointed out, we need to do it. It would be very helpful. And also I think trying to ensure that the 2020 ten percent reduction goal is held, that the smoothing out of the compliance curve does not mean that we're going to extend out that goal because every time you extend it out, every day that you extend it, it really hurts.

So to conclude, I just want to show you all the companies that are also adopting sustainability programs, pretty exciting, that's also helping drive the cost. But to conclude, I just want to say the following: Natural Gas Vehicles provide near-zero emission potential, CEC and Air Resources Board, as well as the AQMD are investing in engines that could reduce NO_x emissions by another 50 to 90 percent, that's really important. But also, I think that the near-zero goals puts NGVs on par with ZEV strategies because, remember, it's zero-emission tailpipe, not Zero Emission Vehicle; you still need to get that generation from somewhere and of course renewables would be a part of that solution, but just for renewables that would be in the Electric Grid, biomethane will supplement the natural gas side, as well. And I truly believe upstream emissions will be addressed and cost-effective solutions have been identified. But more importantly, I think it's important that natural gas vehicles and zero-emission vehicle strategies complement each another, and I think that's one of the shames about having oil and gas because sometimes I think it would be really helpful to kind of cut the gas part in between the oil because the gas companies and the gas producers have been very supportive and very much want to work with the community and also the regulators to solve the problem and ensure that our climate future is one that we could be proud of for our children. Thank you.

MR. BAUER: Thank you, Todd.

COMMISSIONER SCOTT: A quick question before you step away, which is you mentioned that you have Renewable Fuels in Texas and Michigan and there was one other state on the list. Do you have anything developed in California?

MR. CAMPBELL: Well, we're working through AB 1900 with -- and thank you for the support the Energy Commission has provided with the Air Resources Board and working with the Public Utilities Commission, and I believe once we get that product process through, and George and I have met several times and we both are championing this through and we're going to have projects. And as soon as we can get to yes, it's going to be significant.

COMMISSIONER SCOTT: Thanks.

MR. BAUER: Next up we have Julia Levin. She is the Executive Director of the Bioenergy Association of California, an association of companies, agencies and local governments working to promote sustainable bioenergy development. Prior to BAC, Julia served as the Deputy Secretary of Climate Change and Energy at the California Resources Agency where she chaired the Governor's Interagency Bioenergy Working Group and led development of California's 2012 Bioenergy Action Plan. Previous to that, Julia worked with the Attorney General, Jerry Brown, to defend California's Feed-in tariff and other clean energy policies. And she has served as a Commissioner at the California Energy Commission, where she was the Presiding Commissioner on Renewable Energy and Associate Commissioner on Energy Efficiency. Julia received her B.A. from Brown University and her law degree from Hastings College of the Law.

MS. LEVIN: Thank you. You didn't mention my kids. I just spent a couple days at Disneyland with them -- on way too many rollercoasters.

So good afternoon, everyone. I feel like I always end up on the last or nearly the last afternoon panel and I'm sorry. I wish I had coffee or chocolate or something to offer everyone.

So as Silas mentioned, the Bioenergy Association of California represents more than 50 private companies, public agencies and local governments working to convert organic waste to energy. We work primarily on policy development, but also on communications, industry best practices, getting the word out about bioenergy, advancing the research and understanding of the science and the benefits and the challenges.

So I'm going to focus on three things today and try to be brief because I know it's late in the day: what the potential is for bioenergy in California, what we're already doing about it statewide, and what else needs to be done.

So I think that you all know, I hope you all know by this point in the day, that bioenergy has enormous benefits for California. Above all, greenhouse gas reductions, you heard about how low carbon and sometimes carbon negative transportation fuels are from bioenergy, from biofuels, from organic waste. On the electricity side, bioenergy can help smooth the duck curve that you heard about earlier, it can provide base load or load following, or even energy storage to complement intermittent renewables. It can also help address California's goals to reduce landfilling of waste, very significant goals, and now have a 75 percent diversion goal. Most of how we get from 50 to 75 percent is going to have to be organic waste diversion. And bioenergy is a very beneficial use of that organic waste.

Bioenergy is also an in-state energy supply. I agree with all the comments about the benefits of fossil fuel natural gas, but California is importing 90 percent of our natural gas right now. If you look at bioenergy, if you look at biomethane, it is coming from in-state, thanks in part to AB 2196, but also because organic waste is heavy, it's not very easy to transport cow poop or food waste or other things, we're certainly not going to be transporting across state lines. Sorry for the technical term of "cow poop," but…. This is an in-state energy supply and it's an important one to develop for a lot of environmental benefits, also for economic benefits. If we have an in-state energy supply, we're not going to be exporting all those dollars to Texas, Canada, and North Dakota, we will keep the fuel and the dollars and the jobs in-state.

So what's the potential for bioenergy? It's not going to overtake natural gas, it's not going to overtake other fossil fuels, but it is a significant potential in California. We produce a lot of waste in this state. We have more wastewater treatment facilities, more landfills, more cows, more dairies than any other state in the country. Altogether, we're landfilling about 16 million tons a year of organic waste, that's just what we put in the landfills, that doesn't include the animal manure, the agricultural waste, forest waste. Altogether that could generate 5,000 to 6,000 megawatts of renewable clean electricity, that's 10 percent of California's electricity supply, or 2.1 billion gallons of transportation fuels, well over 10 percent of California's fuel supply, 2.1 billion gallons. That's according to recent calculations from Rob Williams and Steve Kafka at U.C. Davis. And if you think about it, there was a presentation earlier about how much diesel we use in California, 3.3 billion gallons a year. Biomethane could replace two-thirds of all the diesel that we consume in California. And for Henry from South Coast Air District, when you think about not just the greenhouse gas benefits of that, the NO_x benefits of that, but toxic air contaminants, think about what one of the biggest sources of environmental justice issues is in California, it's diesel pollution, particularly in certain urbanized areas, or areas with large truck concentrations. We could replace two-thirds of all the diesel consumption in California with biomethane. This is enormous, the potential cannot be overstated.

So sector by sector, and I'll go through these quickly, the key number is the one that is bolded, so just diverted organic waste, the organic waste that we're currently putting in landfills, could produce half a billion gallons a year of transportation fuels, or 450 megawatts of electricity, the equivalent of a large power plant.

Landfill biomethane, even if we stop putting organic waste into our landfills tomorrow, and we're not, it's going to be a while until we phase it all out, our landfills are going to be producing biomethane for decades to come. We need to capture, and not just do what a number of landfills are doing now, which is flaring it, so it's converted to carbon dioxide, it's definitely less potent as a greenhouse gas, but it's still a waste, a valuable clean fuel that we could be using. So landfill gas could produce another half a billion gasoline gallon equivalents of transportation fuels, or 330 megawatts of electricity.

And by the way, the slide on the upper right is the Altamont Pass Landfill, it's operated by Waste Management and Chuck White is here in the room. The CEC provided a grant to Waste Management about six years ago, which built the facility you can see in the picture in the upper right, which is converting landfill gas to 13,000 gallons a day of compressed natural gas, compressed or liquefied? Liquefied, sorry, natural gas, 13,000 gallons a day, and in the remainder of the landfill gas is being used to generate about five or six megawatts of electricity. I'm getting the numbers slightly off, Chuck, you can correct me later. It's a very significant source of energy.

The facility on the left is the new Clean World Partners facility at U.C. Davis, it's both taking diverted organic waste and landfill gas, it's combining the two to produce electricity and transportation fuels, and I believe the Energy Commission also provided a grant for that -- so thank you.

Livestock waste, well aside from the fuels potential which is significant, dairy waste and poultry waste is not currently regulated under AB 32, so this is methane that is just going straight up into the atmosphere as methane, it's not even being flared like at a landfill or a wastewater treatment facility. And if you look at the picture on the lower right, you can also imagine all the other benefits of capturing that waste and converting it to energy. You're reducing not just greenhouse gas emissions, but other pollutants, odors, and a terrible nuisance. So there are a lot of environmental benefits of capturing this waste and converting it to energy.

And finally, wastewater treatment facilities. California has over 500 wastewater treatment facilities, about three-quarters of them already have anaerobic digestion onsite as part of their wastewater process. But only about half are actually using the gas beneficially as in for energy, mostly for onsite use. There's a lot of potential still at wastewater treatment facilities, especially if they do co-digestion, meaning they take in some food and other organic waste.

And Agricultural Forestry Waste, another huge potential in California, we're the biggest agricultural state in the country by far, one of the biggest agricultural regions in the world, we produce a lot of waste. Some of that waste is still piled and burned in open field burning in San Joaquin Valley, you know one of the worst air pollution regions in the country, and yet we're doing open pile burning in the fields. Same with our forest waste. The utilities actually have to trim trees around power lines in the Sierras, and we do a lot of forest thinning defensible space measures that produces a lot of forest waste. I'm not talking about tree farms for biomass, I'm talking about trees that have to be thinned or forests that have to be thinned for safety and other purposes, most of that forest biomass is piled and burned. We could put it into a small power plant instead and be producing electricity or fuels with it.

So what are we doing in California to develop more bioenergy? The short answer is not enough. I agree with a lot of what George said earlier about we're on the right pathway, but we're not going to get far enough fast enough with the current policies in place. I think you've already heard a lot about AB 118 today. I would just say, and Commissioner Scott has heard me say this before, out of $100 million, $6 million for waste-based fuels is not enough when you think about the fact that this is the lowest carbon transportation on earth.

The EPIC Program, this is on the electricity side, right now it is allocating about $27 million a year to clean energy projects, but again that's a drop in the bucket when you think about the fact that we're going to need billions of dollars of infrastructure and investments to really convert organic waste to energy in California.

Cap-and-Trade Revenues. In the budget

that was just approved last week, there are a number of pots of money that can be used for bioenergy development, $25 million at CalRecycle, $20 million at the Department of Food and Agriculture, $200 million for Clean Vehicle Infrastructure at the Airport, $22 million for Forestry, it won't all go to bioenergy, but some of it can. But again, this is not enough and actually I totally agree with George, that I think the state is going to have to help fund this because right now biomethane just can't compete with fossil fuel natural gas.

SB 1122 requires 250 megawatts of bioenergy from small scale projects, that's another driver for bioenergy. And then finally, new pipelines standards. I'm sorry that Commissioner Peterman is no longer here, the PUC just adopted the most stringent pipeline biomethane standards in the world, and again back to George's comment at needing state support, if we don't apply either ratepayer funding or public funding or Cap-and-Trade funding to help defray some of the costs of those new standards, we are not going to see new pipeline biomethane projects, which would be a terrible shame in this state. But the costs of the testing and interconnection and monitoring will be too high without some support. So I would say a huge opportunity right now and ask for the Energy Commission and Air Board, and the South Coast Air District's help is to convince the Public Utilities Commission to use some of the gas utilities' cap-and-trade revenues to help reduce the cost of pipeline biomethane projects. It's a very obvious source, there is no alternative to fossil fuel natural gas except renewable natural gas, but we won't be able to exploit that alternative if we don't apply cap-and-trade or other funding to bring down costs.

So the last thing that I want to leave you with is, if you add up all these things, is it enough? And I think the very clear answer is, given how big these opportunities are to reduce greenhouse gas emissions and other environmental benefits, the policies and the funding programs that we have currently available are not commensurate with the benefit and the opportunity, and I would just challenge the Energy Commission in the next IEPR to think about the possibility, or think about energy in

California as a three-legged stool: on the electricity side we have a Renewable Portfolio Standard, it has been phenomenally successful at driving renewable electricity development over the last 10 years; on the fuel side, we have the Low Carbon Fuel Standard, which I think if the oil companies would put their money into development instead of their lawyers, and we actually really implement the Low Carbon Fuel Standard, that will move the fuels market forward. We don’t have anything like this on the gas side. That is the third leg of California’s energy stool, there is no requirement for lower carbon gas or renewable gas in California and we need to address that third leg of California’s energy stool to really reduce greenhouse gas emissions and obtain other environmental benefits from the gas sector. So I think I will end with that, and I’m happy to take questions before -- now or afterwards. Thank you.

MR. MCKINNEY: Great. Thanks very much, Julia. So, Commissioners, that concludes our second panel for the afternoon. Did you, the Chairman, have any questions before we go to the last panel?

CHAIRMAN WEISENMILLER: I don’t think so. No, we’re running late, so we need to move on, I’m afraid.

MR. MCKINNEY: Okay. With that, why don’t we just move right into the last panel? And Karen, before you go to the ISO, so I know, Erik, you have a flight at 5:00, or you need to leave her at 5:00? Okay, I think you’re okay.

So moving to the final panel for the afternoon, we’re going to be talking about Natural Gas Engines, Trucks and Fleet Use. Our first speaker is Ms. Karen Hamberg from Westport Innovations up in Vancouver, so I think you get the prize for the longest journey today to present with us. And Karen heads up Corporate Strategy, Competitive Market Intelligence, Sustainability, Regulatory Affairs and Policy, and I apologize to the last panel I’m not going to read through all the bios, but Karen, thank you very much for coming. We look forward to your presentation.

MS. HAMBERG: Great, thank you. And thank you for the opportunity to speak to the Energy Commission today. I did plan to stick to my 10 minutes, I’ll do my very best to do so.

A quick word about Westport first, we are an engine and vehicle technology company developing the world's most advanced natural gas engines and vehicles, headquartered in Vancouver British Columbia. We're about 1,000 employees globally now, about half of those are in B.C. and we work with some of the largest automotive and truck and off-road OEMs in the world, including Volvo, Cummins, Caterpillar, Volvo Car, Volvo Truck, Tatum Motors, GM, Ford, we seem to have something going on with all of them.

So I did want to tell you a bit about some of the work we're doing right now as part of our Strategic Planning cycle. This is some analysis that my team has been putting together as we're really trying to understand this criticism that the shift to natural gas is not happening fast enough. If you read our Analyst Reports, if you read media, if you read, you know, seeking Alpha articles, there's all of these criticisms that this transition is not happening fast enough. And so the question, then, obviously for us is, well, who is saying that, and how fast do we think it could be happening?

So as you know, in 2012, there were a number of macro studies about the potential for natural gas. Todd mentioned one of them with National Petroleum Council, we also saw a big piece of work from Frost & Sullivan, and another significant piece of work from ACT Research. And so what we did was we plotted all of these market curves out to try to understand what the potential market adoption rate could be. Now, lots of these did go out 2035 to 2050, I capped our chart at 2020, so we can really understand the near term market transition that we are in.

And so then we said, all right, well then how many actual vehicles are on the road now, or heavy-duty truck, or bus, or refuse engines? So if we look at 2012, there were less than 1,700 units. So this is sort of where Frost & Sullivan had us, if we look at their different curves, we're a little less than ACT Research, we're a little higher than the NPC reference case. So this market transition is indeed happening.

Now one of the next bits of work that we did, then, all of these studies have so many assumptions baked into them that really do require some work to understand all the thinking that’s gone into it. And so we said, well, let’s look at rather than plotting just market share over time, let’s plot market share by fuel price differential. So what we did then is we looked at where all of these studies, all of the data points said the fuel price Delta needed to be to be to these Class 7 and 8 market shares, and we’re in this world right now, we’re in this world of advantages of, say, between a dollar and two dollars per diesel gallon equivalent. So we have the potential to increase market share as long as we have these fuel price differentials. But we also need other considerations around infrastructure, vehicle cost and performance, and customer confidence. So these are other bits of work that we’re starting to do as part of our Strategic Plan.

But I wanted to share with you, for those of you who may not be familiar with the Cummins Westport product line, we have the ISLG which has been in production since June of 2007, it’s a 9-liter engine sold primarily in refuse transit, vocational, but some regional haul applications as well; the ISX12G was launched last year, and this was the engine that Todd spoke to about really building out the infrastructure, particularly the liquefied natural gas infrastructure, so a larger engine, attractive to more particularly heavy-duty truck users, and this is the engine that really is driving some of the significant adoption right now. And in 2016, we will have a 6.7-liter engine that is going to primarily target bus and school bus markets.

We also did have a compression ignition engine, the Westport 15-liter that ran on liquefied natural gas. It was suspended last year primarily due to the fact that we have another engine coming out with Volvo in late 2015, which is their 13-liter product, so I think on the Volvo website if you look there, they’ve announced that they’re taking orders for that engine, Q4 of 2015. So you see we have more product, different product, we’re starting to see more engine choice for the different types of fleets that may be looking to switch to natural gas.

So because we were asked to speak to opportunities, challenges, and threats, I think I’ll probably spend more time on the threats or the challenges, and I actually did a much better list when I was on the plane on the way down. But let's go through these threats quickly here, or these barriers. The erosion of the fuel price differential, I think we've seen some quite sophisticated analysis here this afternoon that, given how much gas is available in the U.S. in North America, and the cost of producing that, that we do expect some stability in fuel pricing. Another big threat is the slower than expected market adoption. I think if we look at energy, any energy transition, these things do take time, they're difficult. We're in these early messy days of it where we are learning many more things that we need to know. There could be change in regulations, or uncertainty around incentives and availability, all of the discussion about the Nat Gas Act in 2012 did introduce some uncertainty to the market about whether or not these large federal incentives would be available, so anything that can introduce certainty around that for fleets is important. Concerns about hydraulic fracturing and GHG emissions, we've talked about that, that's something that even comes up in the discussions that we do with an industry or to stakeholders, even as an engine and vehicle manufacturer, it’s critical that these issues are well understood. And as Todd said, the industry is working on that, both clean Energy and Westport are part of the EDF Pump to Wheels Methane Leakage Study.

The other barriers that I have wrote out here on my table tray on the way down was that we’re still not quite sure of the number of early adopters or the innovators that we’re going to have. For every waste management, UPS, Lowes, Kroger, that are showing some real leadership, there’s probably a great number of other companies that are very much waiting and seeing, perhaps they’re not the technology enthusiasts or the early adopters, to use chasm theory, but they are sitting and waiting and thinking, okay, what’s the experience been? How can this be replicated in my fleet?

Most of the customer interest is still highly dependent on incentives. We had some very good exposure to this through sales of our 15-liter product, I have less sort of real numbers to give you with regards to the Cummins Westport product line because we don’t manage that sales channel, but I do expect that it’s high, that it is still a significant driver for customers and they’re able to find creative ways to get incentives for vehicles.

One other thing, too, that came up in our planning cycle last year was that inexpensive fuel does not seem to be enough. You’d think the cheap fuel is going to be enough to drive the sales, but because there are still upfront capital and operating costs that need to be taken care of, this is still a barrier to sales in some degree.

And then this is also perceived, the transition to natural gas is also perceived to be complicated, so again you take the fleets that are well-staffed, well-resourced, ambitious, innovative, like Waste Management or UPS, that really do want to transition, but there are still things that we need to learn and understand about upgrades to facilities, for maintenance, or employee training, or even questions around just CNG versus LNG, which is the right one for my fleet.

The stability of the fuel price differential, of course, still remains critical to this, as well, as is the build-out of public access infrastructure.

So this was a slide actually that was taken from a presentation that one of my colleagues gave to GTI last year, is how to just generally accelerate market penetration. And of course we touched on some of these things and in the interest of time I won’t go through each one again, but there needs to be some work done to try to enhance the economic value to end users. This is a very compelling economic story, the ability switch to natural gas, but again, giving the incremental costs of the vehicle, the likelihood that we need a sustained fuel price differential, fleets are still looking for a way to make the economics and the payback work for them.

Also things that could be done to enhance engine or vehicle performance are important, so we’re going to have more products available, so we’re having the seven liter spark ignition engine offered through Cummins Westport, most likely in 2016, and then we have the Volvo D13 HPDI engine operating on LNG available in late 2015, so we’re having more product become available.

And then also the work that CEC and others can do to accelerate investment in technology development, mainly around the potential for natural gas to achieve these near zero emissions, will be very important. Thank you.

MR. MCKINNEY: Great. Thank you very much, Karen.

Our next speaker is Mr. Henry Hogo from the South Coast Air Quality Management District, and Henry is currently the Assistant Deputy Executive Officer in the Mobile Sources Division. His career there has spanned 38 years, he is a graduate of UC Berkeley. Welcome, Henry. Thanks for coming up.

MR. HOGO: Thank you. And thank you, Commissioners, for having us here to talk about some of the drivers actually for the development of next generation natural gas engines. Actually George and Todd and others have spoken a lot about some of the things that I wanted to speak about, but I just want to give you a little bit more detail of the issues that we face, and it's more of a criteria pollutant in the ozone and particulate matter exposure and air quality standards that we need to meet.

This is a chart that George mentioned earlier about the deadlines for meeting air quality standards and the greenhouse gas goals. You'll see that in 2023, 2025 timeframe, we have an ozone standard to meet. We actually have a newer ozone standard to meet in 2032 timeframe, and we believe that EPA will come out with a new Ozone standard that will probably be in the 2040 timeframe at this time. So as we see the standards tightening up, we really have to reduce emissions even faster in order to meet these shorter near term air quality standards.

This chart shows what the top 10 nitrogen oxide emissions are today. As you can see, heavy-duty trucks are the largest with about 129 tons per day of NO_x emissions, followed by light- and medium-duty vehicles and marine vessels, and locomotives are in the fourth and eighth place here. But what it points out is that mobile sources are the primary contributor to our air quality problem.

Despite the existing regulations that are in place, by 2023 heavy-duty trucks will still be the most significant level of emissions at 51 tons per day, followed by off-road vehicles and marine vessels. So we see that we do need to move forward and bring about cleaner emission vehicles on the road as soon as possible.

To meet the air quality standards, we have to reduce those emissions that I've shown previously by another 65 percent by 2023 in order to achieve the eight-hour standard at that time, and another 10 percent, or 75 percent in total, to reach the 2032 deadline.

In 2012, we worked with the California Air Resources Board in the San Joaquin Valley and produced a document called "Vision for Clean Air" where we looked at a framework for air quality and climate planning. We looked at how short, mid, and long term visioning could be integrated together in a multi-pollutant and multi-deadline timeframe, and this serves as a resource document for future air quality planned developments, as well as the AB 32 Scoping Plan, and the upcoming ARB Freight Sustainability Strategy. But also, we want to make sure that we reduce air toxics exposures as early as possible.

Seven key concepts that came out of this, there was need for technology transformation, early action, and the third one which is most important is cleaner combustion engines. We believe that -- I'm going to skip to this slide -- which came out of vision document, which shows that despite the fact that we like to see zero emission technologies and near-zero emission technologies come on line, they won't come on line until the 2040 timeframe in any significant number. That's our vision at this time. And what you see here is that conventional combustion engines are still going to be the predominant engines on the road, even in the 2020-2035 timeframe. It was mentioned earlier there is about .92 million heavy-duty trucks on the road in California today; of that .92, about 600,000 are actually out-of-state trucks, so you can imagine that in order to reduce emissions from out-of-state trucks, these are really the ones that are the conventional trucks that we have to look at.

We worked with the California Air Resources Board recently to develop what we call optional NO_x and SO_x emission standards. These are optional exhaust emission standards that set early emission targets for development of advanced engine control technologies, and the use of these standards actually have a lot of benefit for the engine manufacturers because it gives an opportunity to evaluate engine performance early before a mandatory standard is established, and provides an in use experience with the new technology. It also helps enable funding incentives for these cleaner engines.

This is a slide that shows historically what the mandatory standard levels are in black, and the optional standards in the dotted blue line, and between the late 1990’s and the mid-2000, the optional standards was actually about 50 percent lower than the mandatory standard. And the only engines that met those standards were actually natural gas powered engines because they were inherently cleaner to begin with, and it didn’t take much more effort in order to reach that standard. But as time went on and the standard was reduced, the optional NO_x standard dropped to about 30 percent of the mandatory standard, and today we do not have any optional NO_x standard until the recent action from the Air Resources Board.

Given an idea what the optional NO_x

standards are today, the current standard for NOx is .2 grams per break horsepower hour and the first level optional NO_x standard is .1 grams and it drops to 0.5 and .02 grams, and we have a very good indication that actually the .02 grams standard could be reached; in fact, one of the projects that the CEC is funding for a micro turbine hybrid system, the project proponent indicated that they're around the .05 gram level today. So we're seeing even today that these standards could be reached.

I want to mention a couple of the demonstration projects that we're working on with the CEC, one is with the CEC, and Southern California Gas Company, and it was mentioned by Rey earlier, it's the commercialization of .02 gram NOx natural gas engines. This is a $7 million project between the co-funding partners to Cummins and Cummins Westport to develop a 9-liter, 8.9-liter, and a 15-liter natural gas engine. So these two projects are on a timeline to have a prototype within the next couple of years or so, and we identified project partners with fleets and truck manufacturers to deploy these engines and test their performance over the next three to four years.

The Air Resources Board is also funding a .02 gram NO_x engine development, and this is for diesel and natural gas heavy-duty engine. This is more of a laboratory bench work and is being done with South West Research Institute this time, and that project is slated to be completed by the end of next year.

So we believe that the demonstration projects and R&D work that's being done today could lead to this next generation of cleaner engines in the next four to five years.

I just want to summarize that early commercialization of cleaner engines really do provide projects that help meet near term air quality goals, and it really helps develop an end user confidence in product performance. And it also enables the transition to longer term advanced control technologies. We strongly support the use of alternative fuels with hybrid systems, and we think in the long run that that is the way to go, and to move away from the use of diesel fuel overall. With that, I'm going to conclude the formal presentation.

I did want to comment, though, earlier

that John Shears mentioned that methane has the potential to produce ozone. It is true that methane does produce ozone, but in our earlier analysis about 15 years ago, it would take a high concentration of methane in order to produce ozone on a level that would cause a health problem. So we consider methane as a non-reactive hydrocarbon when it comes to ozone production. I just wanted to put that on the record. And thank you.

MR. MCKINNEY: Great. Thank you very much, Henry, and thanks again for coming up. And I just want to acknowledge the partnership between the Energy Commission and South Coast AQMD, we've done a lot of good work together.

Our next speaker is Erik Neandross. Erik is the CEO of Gladstein, Neandross & Associates, which is a national consulting firm specializing in market development of alternative fuel technologies for on-road transportation and off-road high horsepower sectors. And Erik oversees GNA's day to day business operations, client work, and strategic growth initiatives. So welcome, Erik.

MR. NEANDROSS: All right. Well, thanks

for having me, given that I have a flight and I'm one of the last speakers, I can just say "what they said." Thank you very much.

I'll try to move through it because there is some redundancy in here, but given that we hadn't all planned this together, I think that's a good thing.

So as Jim mentioned, GNA, we're a large consulting firm and we specialize in natural gas project development. We have been working in the heavy-duty on-road transportation field for the last 20 plus years, starting with one of the very first commercial deployment projects, you see Harris Ranch there in the middle with 20 LNG trucks in 1999. Now we're working on a lot of large scale strategic project planning and implementation programs with companies like Frito Lay, Waste Management, Rider, and others, and the exciting part here is what we see as what is often the case, what started in California with maybe 10, 12, 15 trucks, is now moving on a national scale and is now 100 percent of an annual fleet buy for Frito Lay, or as close to 100 percent for Waste Management because they're really seeing the benefits and they're proliferating that beyond California's borders.

We've done a lot of work looking strategically at corridor development projects here in California and throughout the U.S. and trying to figure out how do we get these markets moving, and in the last couple years we've been increasingly focused on off-road what we call high horsepower projects, very very exciting stuff and I'll talk a little bit more about it, but marine, locomotive, mine haul trucks, gas rigs, frack pumps, those kinds of things, just huge consumers of fuel.

So we were asked to take a look at six questions, so I've just broken my presentation down to try to answer those. And the first one is, what's the opportunity for natural gas as a transportation fuel? In the heavy-duty space, we think there's tremendous opportunity, there's significant near term growth that we expect to see happen where I think we're now at the part of an early ramp in that market. It is, as Karen mentioned, it's some of the early market leaders; we hear a lot about the one percent and the 99 percent these days, that this is the one percent. I think the focus now needs to be the other 99 percent. And the competitors to these market leaders, as we've already seen, as I'm sure Chuck would tell you, you know, Waste Management was a clear leader, well, Republic Waste is now stepped up to keep pace, and we need to see those sort of competitive dynamics, and I think we'll start to see those in the on-highway market.

One thing that we see with the fleets that we work with is there is a fundamental belief that that fuel price delta will be maintained into the future, thus the reason that they're going down this path. You've got to believe that when Frito Lay says we're going to go 100 percent natural gas in our on-highway fleet, somebody along the way says, "What's the risk of that delta collapsing or crossing?" And there's a lot of confidence in the market in that price spread continuing.

The other opportunity is in the off-road, this high horsepower sector. This, I think, is a huge opportunity for California. Virtually every segment of the goods movement sector can run on natural gas instead of diesel, and there's a huge amount of potential criteria pollutant benefit that can be realized in moving to a cleaner natural gas, huge diesel displacement natural gas fuel demand growth, greenhouse gas, diesel PM, Black Carbon, that’s sort of the grand slam opportunity here, although I think Todd’s slide did a nice job of putting this in perspective as far as total fuel use. One of the things that we see with the high horsepower segment is just concentration of fuel demand.

The other thing that we really get excited about is the folks that make the engines here, Caterpillar, GE, Cummins, they’re all moving down this path to offer natural gas engines for this segment. Caterpillar has said we believe that if you’re running a high horsepower product, you will be running natural gas in the future, it’s not a question of if, it’s when; it’s not today, it’s not tomorrow, but it will be into the future, and they are working on locomotives, they’re working on the top three largest mine haul trucks, drill engines, frack engines, power generation, they’re all in. And they see this as a global phenomenon, this isn’t just North America, although the shale gas revolution has started here, we’re now seeing export of that technology to Asia, to Europe, all over the world. And Caterpillar obviously is a global company, they don’t make these decisions on a whim, they believe that long term this is where it’s going. So that’s pretty exciting. Having been doing this for 20 years, struggling to get meetings with truck fleets to say, “Please, natural gas,” to now see Caterpillar sort of leading the charge and their competitors is pretty cool stuff.

So I mentioned the huge fuel demand that we see in this sector, and if you look at it on a per unit basis, any one of these applications is just massive. And what this means is that this provides a terrific opportunity for infrastructure development, to developing LNG plants. In just one project, you can have enough fuel demand to justify building a $50, or $100, or we’ve done some analysis of $500 million LNG plants to support these kinds of operations. That’s huge economic investment that can happen right here in California to build this infrastructure, an infrastructure that once it’s built can then be supplied with Biogas in the future when that day comes.

To just give one example, we’re working

on a small container ship project, they have four ships, they'll build two liquefiers, one in the southeast, one in the Pacific Northwest. Those two liquefiers will make about the equivalent of today's LNG market demand in all of North America -- one project, four ships.

So you can get a sense that if this market really starts to move what that infrastructure scaling would look like. And we see this all happening here in the next five years, all these off-road high horsepower markets starting to ramp up and drive fuel production, supply chain, infrastructure, the whole thing, which will obviously then support the on-highway market as well. So it's a bit of a reversal of what we've seen to date, which is everything has been on-road, it's now switching to sort of more the off-road.

I have here a report that we just authored for the State of Wyoming that looks at what can the state do to get their high horsepower segments working on natural gas versus diesel. They see this as an economic development opportunity, they've got a lot of natural gas, they'd like to use it versus buying oil from out of state, as someone mentioned that earlier, I think the State of California probably could do very much the same thing.

So I'll leave that here. George had half this slide, Henry had a similar slide. You know, the opportunity here for California is emission reductions, almost every single major source of NO_x emissions in South Coast and San Joaquin Valley shown in this slide can run on natural gas, can get us criteria pollutant emission reductions. And that's something that I think we need to pay close attention to.

The second question is longer term, is they there with natural gas? Or is this a bridge fuel? We think the answer to the two questions that were posed is yes, assuming that the short term is about five years and the longer term is everything beyond that. We don't think natural gas is a bridge fuel, we think it's definitely a foundational fuel that we can continue to refine and improve the technology. I think the one thing that we really really need to pay attention to today is we have buyers, we have customers that are wanting to buy this product and put it in their fleet at 100 percent of their annual purchase. That is amazingly powerful and something that we always have to remind ourselves, and we hear a lot of conversations about electrification and fuel cells, and that's all well and good, and there's going to be elements of that technology that we'll be able to take advantage of, but I would just caution that we just not get too distracted by the shiny new truck with no tailpipe, given all the benefits that we can offer with natural gas.

We looked at these five pathways and George mentioned some of the work that was done with the gas company, I'll leave this here for the record, as well, this is a report we did called "Pathways to Near-Zero Emission Natural Gas Heavy-Duty Vehicles." And we've looked at how can natural gas, building upon the foundation that we have today, get to effectively the equivalent of an electric truck, or fuel cell truck. And there's five pathways that we think that you need to look at to get there. I do think that funding going forward, R&D funding, should be focused in these directions. Again, we've got buyers, we've got the ability to very easily cost effectively transition this market to near-zero emission.

We've looked at this also on the GHG perspective and we think you can get to the 2050 goals again building on the foundation of natural gas.

The third question, the policymakers, what can policy do looking at natural gas long term? And the question of methane, which there has been great discussion today, I really liked Tim's presentation; to me, that was very reassuring, there's a lot of focus on this and there are solutions. We fundamentally think that this methane issue, it's an engineering issue. We can identify the leaks, we can fix them, and off we go, and we'll move on. So we don't think that you should get -- there should be no pause in the development of this market in any way, shape or form. We need all options all the time here in California. The methane leak issue will continue to play out, we think that there's a good end to that story, there's been mentioned, you know, California is not the East Coast, the Grid and utility infrastructure here, we do think that these issues are solvable. One thing that we haven't heard talked about today is carbon intensity of diesel is also going up as we see more unconventional oil sources coming into the market, so we do have to keep that in mind, as well. And long term, it’s renewable gas, that’s a big part of the long term solution. We don’t have those same leakage issues when we talk about renewable resources being developed in the state, being transported in in-state pipelines, and used here in the state. So the message is continue to push and leverage the growth that we’re seeing, build that infrastructure, build the fleets longer term, build the biomethane, the renewable fuels, I think Julia’s presentation did a great job of highlighting the tremendous opportunity for California to lead, to take these what are otherwise environmental liabilities, turn them into assets, create jobs, create economic investment, to us this is the proverbial no brainer, and a lot of resources should be focused in this direction going forward. It is expensive, unfortunately natural gas is stinkin’ cheap these days, and it makes these projects really hard to compete. But that’s where policy and incentives, I think, can come in to help make sure that we don’t lose momentum in growing that market.

Going forward into the future, one of the things I wanted to just emphasize is, I think the question should be how do we make these trucks more competitive, I think they are competitive now, but we can make them more competitive. We do have basically one engine for Class 7 and 8 trucks today, it's the 11.9 Cummins Westport, that engine can meet a huge huge segment of today's trucking needs. We are going to have more engines, that's going to be good, it's going to help, but we are seeing this ramp up of activity just with the one engine today, so more is going to be better for sure.

I think Karen's slide did a great job of showing the different studies and the different cases. Generally, we see the heavy-duty OEMs talking about we can get to 20 percent market penetration by 2020, and that's national, that's amazing, if we could really see that that would be amazing. We are seeing lower emission engines. Henry, you mentioned the funding program with Cummins Westport to make available this .02 gram NO_x engine in 2016, and commercialization would be shortly thereafter.

One important note there, Cummins Westport has said we'll do it, it's got to be the 8.9, which is a refuse and a transit engine, it's not for heavy-duty truck engine, so why not the heavy-duty truck engine? And they said, "Well, why? Why should we? What's the demand? What's the market?" So as policymakers, we should keep in mind why should they, it's good for the environment, but will it be bought? Will someone pay more for that? And I think in the refuse and transit where there's much more of a sort of public policy element, public dollars being spent, there's justification. But in the heavy-duty on-road truck, they're not quite seeing that yet.

NGVs, they will definitely continue to evolve, and this is heavily detailed in our Pathways report, improved aerodynamics, engine efficiency, electrification, those kinds of things. But I think the thing for the state is just to make sure that there is a clear signal to the OEMs and to the fleets, the buyers, that the state is going to continue to push the natural gas path. This is a critical time and, again, I want to make sure that we don't get distracted by the shiny truck with no tailpipe. We need to keep focus on this growing market and really make sure that we do get there.

Lastly, the question was what do fleet operators need form the OEMs and from Government? The number one answer you get from the fleets, well, how do we help you buy more trucks, they say more infrastructure. We need more stations to fuel. The more stations, the more trucks you'll see. The other thing I think they need is they need more buyers, they need other fleets to jump into this. As the volume goes up, price comes down, it all becomes more self-sustaining. And I think that the state should be first in line. California has a laundry list of policy goals to meet, but I don't see the state necessarily buying these vehicles themselves. I think the state should be much more aggressive in leading the charge because, at the end of the day, orders drive priorities for OEMs and the more trucks we get, the more cars we get, the more options will be made available.

When we look at incentives, one of the things that probably can be done is just, you know, clear and consistent policies and laws so we don't penalize natural gas, and on the grant side, you know, there's probably some things we can do to move beyond criteria pollutants to fund co-benefits, GHG reductions, petroleum displacement, in-state energy use, those kinds of things as we look at the future.

A couple of last slides in summary, just a quick look back to help look forward, when we look at the refuse market I submit that this is a market that was largely driven by the AQMD's 1190 rule starting in 2000, which was a bit of the stick, but also with the carrots, the incentives to go along with it, we saw that that refuse market was a little bit slow to get up and running, but ultimately seven or eight years we started to see that curve take off. And what happened was the fleet started to say, "Hmm, my fuel bill is like 30 percent less than it was last year, maybe I can do this. And what do you know? When I go to the City Council in Pittsburg, Pennsylvania, and say I'll collect your trash with shiny new natural gas trucks, they say let's do that." And we saw that market grow to 65 percent, probably more than that, percent of the trucks being purchased today in the refuse market are natural gas. Can we see the same thing in the on-highway market? We hope so. As volumes go up, prices come down. We've seen that in the refuse market, too. It's all about volume.

Probably for us in the on-highway market, one of the most exciting things that's happening today is the shippers, the folks that are buying transportation services, they do not own the trucks, are going out to bid and saying, "I want you, my carrier, my trucker, that I'm hiring to be driving a natural gas truck when you show up to my door." They realize that with an inherently lower cost of fuel and a competitive marketplace, they can drive cost out of their supply chain. They're also getting a nice environmental benefit. We've seen Lowes, 100 percent of their fleet operations, again, not their trucks, contractors, they want to be running on natural gas be 2020, 100 percent. That's amazing when you think about the risk that they're taking. The product doesn't get to the shelf if it doesn't work. They're very confident that this is going to work. Proctor and Gamble, 20 percent by 2020. Owens Corning, 50 percent by

2018. And the list goes on and on. So this to us is very very compelling because this is the refuse franchise model in the private sector. And once you get Corporate American lowering their cost of the supply chain and getting environmental benefit, we think that that’s the wildfire that you can’t put out. But they need infrastructure, they need product, they need engines, they need support to really make this work, and I think that that should be a big focus.

So our crystal ball says keep after this, this is a good market and we think that this is one of the ways that we’re going to see this on-highway market really start to ramp up in the future. So in summary, stay the course, there’s some really exciting things happening in the market today. You know, don’t take your foot off the gas. Continue to build. Push the infrastructure, push the OEM products, you know, Rome wasn’t built in a day, neither is this market. There’s some huge potential benefits in the short term with continued deployment, continued replacement of old diesels with new natural gas that are much much cleaner today, and as we’ve seen in the next five years they’re going to get even cleaner on criteria pollutants, on GHGs. There’s a really good story here. So it’s an exciting time for the market and I appreciate the opportunity to speak here before you.

MR. MCKINNEY: Thank you very much, Erik. Our next speaker and final speaker for the day is Chris Shimoda and he’s Director of Public Policy for the California Trucking Association and he’s been responsible for their public policy development and implementation since 2007.

I also want to thank Chris for his patience. CTA has joined the Advisory Committee for ARFVTP I think two years ago, and you really bring kind of a real politic perspective to the work that we’re doing. So I really appreciate everything I’ve learned from you about what California fleets need to really start to really undergo this transition. So, Chris?

MR. SHIMODA: Thanks, Jim. And thanks to the Chair and the Commissioner for the invitation to speak today. And I hope I have something original to say about natural gas at this point.

I’ll just jump right into it. You know,

if you hit the convention circuit at all in trucking, you've probably heard a lot said about natural gas and trucking over the last couple years. At CTA, you know, staff got very curious to find out now exactly what does our membership think about natural gas and trucking. So we did a survey, very informal, but illuminating nonetheless last year, 91 fleets in our membership, various sizes, the majority of the responses came in between around 20 to 1,000 trucks, fleet size, which is I wouldn't say your mega fleet, it's not one of your micro fleets, it's really your medium to large trucking fleet that is going to be not necessarily on the bleeding edge of technology, but definitely leading in certain spaces with technology.

So one of the things that we asked was for the fleets to say now give us your opinion on factors that either help or hurt the adoption of natural gas and trucking. Not surprisingly, in the helps category, obviously the price differential between natural gas and diesel came in by far number one as far as the results on that came in. This was very surprising to me. The second factor that our fleet said helped the adoption of natural gas is actually the public perception of tailpipe emissions from natural gas trucks versus diesel. You know, our industry has gotten beat up quite a bit over the past couple of years, past couple of decades, really, due to the air toxic issues with diesel emissions, and so this was actually surprisingly a very large motivating factor for fleets. And then finally the availability of grants and incentives was another motivating factor.

So on the hurts adoption in natural gas category, this actually came as a surprise to me that the number one issue holding back natural gas in the perception of the people we surveyed was still the availability of fueling infrastructure near home terminals and freight lanes, and we'll get back to this in a second as far as why that may still be the case, despite the fact that natural gas is the most well built out of any all fuel infrastructure today.

Number two, hurting natural gas was this issue of insufficient horsepower and torque with the 8.9-liter engine, which was really the only engine that anyone had experience with at the time we did the survey. That may change with the introduction of the 11.9-liter engine. You start getting into the heavier applications up to 80,000 pounds GVWR, which is actually the legal limit that you can carry in the State of California, but there are some heavy haul applications within the trucking industry that are going to need a larger engine.

And then associated costs, not just the cost of the engines, but also the training and maintenance, bay retrofits, and some of the other tangential costs was also something they said hurt adoption.

So this question of the fueling infrastructure, I wanted to bring up the fact that there seems to be an expectation on at least our membership's side as far as what adequate fueling infrastructure is that may be a little bit different from what you've heard today from other speakers. The majority of our members, their expectation is that if they transition to natural gas, they're going to be fueling onsite, fueling in retail, some are looking to use these built out municipal facilities, but not a majority by any means. And then this bottom bar chart is the illuminating part to me, where as far as the proximity where they expect a fueling facility to be in comparison to their home terminal, the vast majority expect fueling to be within 10 miles of their home terminal, and so this is a pretty high hurdle for anyone building out fueling infrastructure to meet. I think that one of the things that I know that we've had some discussions with, with various policymakers, is incentivizing onsite fueling may be something that we want to look at in the near future for for-hire fleets, similar to the mode that has done in the past with the municipal fleets.

And then incentives obviously are going to play a key role and we'll talk about this again in just a second here. But the lion's share of fleets, it's about 82 percent, say that they would not purchase natural gas trucks in the absence of an incentive, or that they would purchase more and deploy more, more quickly if they had incentives, rather than if they're unavailable, and a full 55 percent of those surveyed said, "We will not purchase natural gas trucks without public incentives." So that is a pretty significant number saying that Delta and fuel cost simply just is not enough due to the incremental cost of the vehicle.

So I wanted to concentrate very specifically on this question, I think it's the one that is most closely tied to the in use side of the question of how we get these trucks competitive. So, 1) I just have to stress because this is something I'm actively living today in the policy realm is that incentives are key. The incremental cost of the vehicles, I think I agree with some of the numbers that were in earlier presentations, it's around $30,000 to $40,000 on the retail side, you then incur an additional tax penalty. This incremental cost is still a major hurdle for fleets. Return on investment has to be very quick in the for hire trucking category because, especially in higher mileage applications, you're burning through those trucks fairly quickly, so you may not realize some of the financial benefits if that ROI doesn't happen very fast.

Current purchase incentives in the State are extremely limited with the exception of the CEC's buy-down program. There are no natural gas specific trucking incentives in the state aside from what CEC is doing. So I don't know if the perception is that we're already doing a lot of incentives for natural gas trucking, that's really not the case, it's only about $9 to $10 million each year.

The tax issue. There's a roughly four percent higher tax burden for natural gas trucks than diesels, both bought new. It's something that I know has been attacked in previous legislation, it's probably something that policymakers might want to look at again.

This question of certainty, I think this is very important for the adoption and future accelerated adoption of natural gas trucks, is that there has been somewhat of a mixed signal from California regulators on natural gas trucks. Earlier, I think it was fall of last year, there were some signals saying that, look, one of the major air regulators in the state said we may want natural gas trucking to go away completely by 2050. And when you're talking about building out a market, trying to use syrup, you know, the paradigm of going from diesel and natural gas, those kind of signals really are not helpful for installing confidence in people making massive investments in turning over their fleet. So I know that some of the earlier panelists talked about some of the outstanding issues. I would say from the fleet perspective, the sooner some of this stuff can get worked out and there can be some type of certainty about what kind of technologies are going to move forward into the future, it would help instill that confidence to really make these massive changes in people’s fleets.

And then finally, just something that is definitely a key need for policymakers and regulators is to understand the heavy-duty trucking market. It is an interstate, international type of business. We are competing in 48 states. People run outside of California as a regular course of their business. Fueling infrastructure has to be national. I know there’s been a lot of talk about doing technologies that would just service a single corridor or a single subset of the industry. Really, you’re talking about engine manufacturers that want to build for worldwide markets, truck purchasers who are in multiple states. You really want to understand that, when you’re talking about heavy-duty trucking, it’s not something that is done in small subsectors, but really you're looking for -- and this kind of goes to the next point -- a wide range of applications. You want a technology that's going to be flexible enough to do a lot of different kinds of work. Heavy-duty trucks do everything from 48 state long haul over the road, they do heavy haul of heavy equipment to construction sites, they support agricultural harvest in fields, they do dredge trucking in Oakland and L.A. and Long Beach, you may not know this, but are completely different duty cycles. So we need the kind of technology that can do what diesel does today, diesel services all these markets, with the kind of performance that's necessary to get them done. Natural gas does have the potential to get to those wide range of applications.

And then finally, just when we're talking about moving from applications like refuse and transit over to heavy-duty trucking, especially as you get outside of private carriers and into the for hire space, just remember that this is a very very competitive industry. We are what's called rate takers, we don't set rates, we get them from our customers, and so any alternative fuel that you're talking about, if it's going to have any chance of usurping diesel, it has to be cost competitive or better on cost than diesel in order for people in the for hire truck space to really consider it as an alternative. If a for hire trucker decides that he wants to take on a new technology that, you know, you're increasing your cost, that trucking company is not going to be long for the world. So that's just the nature of the market that we play in. So that's it. Thank you for the time and I'd be happy to answer any questions.

MR. MCKINNEY: Thank you very much, Chris. So Commissioner Scott, that concludes the panel presentations today and I just found it incredibly informative, it's been a long day, but I think highly valuable. So we'll turn it over to you.

COMMISSIONER SCOTT: Indeed. Well, thank you very much. I just want to remind folks, if you would like to make some comments, please be sure that you fill out the blue card and hand it up to the IEPR Team so they can get it to me, so that I know you would like to say something.

Jim, I would echo what you said, I just feel incredibly lucky that I got to spend my day learning from such a high caliber set of experts. Thank you all so much for coming, for your thoughtful and informative presentations. For me, this was just a terrific way to start off the week.

We're going to transition into public comments, and you are welcome to stay. I know folks have flights and things to go to, as well, so if you need to dash out, that is okay as well. And I have my first public comment here is from Valerie Wynn from PG&E.

MS. WYNN: Thank you. Actually, I made my comments earlier on the methane leak surveys, but thank you.

COMMISSIONER SCOTT: Great. No worries. Okay, I have a blue card from Quentin Foster from Cal ETC.

MS. RAITT: Oh, Commissioner, he actually said he'd go ahead and file written comments.

COMMISSIONER SCOTT: Oh, okay. Those are the only two I have. Do I have other blue cards, other public comment from within the room?

MS. RAITT: I don't have anymore.

COMMISSIONER SCOTT: Okay. Do we have folks on the WebEx or on the phone?

MS. RAITT: We don’t have anybody asking questions from WebEx, but we’ll go ahead and open the phone lines. So if anyone is on the phone and wanted to make a comment or ask a question, now is the time, the phone lines are open. Okay, it doesn’t sound like we have any.

COMMISSIONER SCOTT: All right, well, let me then just say, again reiterate my hearty thanks to our excellent panelists. I really did, I had a great day. I feel like I learned a lot. I’m looking forward to looking at all the additional data and studies and information that you send us. This has just been incredibly interested.

I wanted to send a hearty thanks out to Commissioner Peterman and to CEO Berberich for joining us for a large portion of their day today, I really look forward to continuing the partnership that we have in working with them. I wanted to send out also a shout out, a huge thanks to Lezlie Kimura-Zito and Lauren Greenwood for putting together such a terrific set of vehicles for folks to see and to ride and drive over the lunch hour. I thought that was great. And also to say thank you so much to all the OEMs who brought those cars and vehicles to showcase for us today.

I want to thank our terrific staff. We had Mike Gravely, Silas Bauer, Jim McKinney, Rey Gonzalez, my Advisor, Jim Bartridge, Heather (Raitt), Lynette and Stephanie, as always, from the IEPR Team who did a terrific job today. And I just wanted to make a couple of wrap-up remarks which will in no way capture all of the terrific information that we heard today.

But to me what stood out is how electrifying the transportation sector can help us with the integration of renewables. We're going to need much bigger numbers to really make that work. I thought the flock of ducks that Heather presented to us was a really good way to look at it because it's more challenging than you might think because it depends on the day, it depends on the month, it depends on the weather. And also, I think an interesting point is that, when there is over-gen, can we make hydrogen or other renewable fuels that can then go into the pipeline? And that's something that a few folks touched on and I thought was also very interesting.

We learned that it is important to keep our eyes on methane, otherwise it may have the potential to dwarf any benefits that we get from a fuel switch. We talked a lot about how to detect leaks, how to fix the leaks, and if we don't do that, otherwise people are wasting a lot of money.

Then a couple things about Natural Gas and Zero-Emission Vehicle strategies need to complement one another. We heard about the different options that we have with Renewable Natural Gas, and learned really that what is started in California has the potential to move beyond our borders and across the nation, and also across the world. And this is really important because we're trying to achieve climate goals, we're trying to achieve clean air goals, and that's why we're talking about this transformation of the transportation sector.

So those are my remarks. My sincere thanks to all of the experts who brought this hot off the press great information to us, and I'll turn to the Chair to see if he has any closing remarks.

CHAIRMAN WEISENMILLER: Yeah. Again, I'd like to thank everyone for their participation today, and encourage them to file written comments. And, yeah, I think again the transportation sector is really important, but as you look at the pieces, it's going to be hard. I think it's taken us a couple years to move one of the Vehicle to Grid demos which is like 14 vehicles, so as we're looking at thousands of megawatts of swing, it's like, okay gang, it's really important to speed those things up a lot. So anyway, but at this point obviously it's not like you could say we've done a demo that's gone the life of a battery, you know. So anyway, there's a lot to do and a lot to do fast. Certainly, again, thanks for your help today.

COMMISSIONER SCOTT: Great. Have a terrific evening.

(Whereupon, at 4:59 p.m., the workshop was adjourned.)

--oOo--

REPORTER'S CERTIFICATE

I do hereby certify that the testimony in the foregoing hearing was taken at the time and place therein stated; that the testimony of said witnesses were reported by me, a 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 12th day of August, 2014.

PETER PETTY
CER**D-493
Notary Public

TRANSCRIBER'S CERTIFICATE

I do hereby certify that the testimony in the foregoing hearing was taken at the time and place therein stated; that the testimony of said witnesses were transcribed by me, a certified transcriber and 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 12th day of August, 2014.

Karen Cutler
Certified Transcriber
AAERT No. CET**D-723