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BEFORE THE

CALIFORNIA ENERGY COMMISSION

In the Matter of: )
) Docket No. _____
AB 118 2010-2011 )
Investment Plan___ _____)

# Staff Workshop on Hydrogen Technology

## For Transportation

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

TUESDAY, SEPTEMBER 29, 2009

Reported by:
Peter Petty
Contract Number:

Staff Present:

Leslie Baroody
Peter Ward
Tim Olson
Tobias Muench
Charles Smith
Pilar Magana

**Also Present**

Presenters

Gerhard Achtelik, California Air Resources Board (CARB)
John Mough, California Department of Food and Agriculture
Division of Measurement Standards (CDFA DMS)
Bill Elrick, California Fuel Cell Partnership

Panelists

Alex Keros, General Motors
Robert Bienenfield, Honda
Justin Ward, Toyota
Todd Suckow, Hyundai/Kia
Rosario Barretta, Daimler
Dr. Arnold Miller, Vehicle Projects
Paul Scott, ISE
Lawrence Weisdorn, Vision Industries Corp.
John Maddox, BAE Systems
Tom Apalenek, BAE Systems
David Pfeil, Plug Power
Jaimie Levin, AC Transit
Dr. Tim Brown, UC Irvine
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(Via WebEx)

I N D E X

I N D E X (Continued)

P R O C E E D I N G S

SEPTEMBER 29, 2009 9:03 a.m.

MS. BARODY: I think we are going to actually start on time today. Welcome to Sacramento and to the California Energy Commission's fourth in a series of workshops for the 2010-2011 Alternative and Renewable Fuel and Vehicle Technology Investment Plan. We really appreciate you taking the time to be here with us today. And also, welcome, those of you who are listening online. We have had some very successful and informative workshops these past few weeks, and I expect today will be productive, as well.

I would like to introduce our team from the Emerging Fuels and Technologies Office of the Fuels and Transportation Division. I am Leslie Baroody. I am Project Manager for the 2010-2011 Investment Plan. With me is Charles Smith, Assistant Project Manager. Peter Ward and Tim Olsen, they authored last year's Investment Plan and are experts on alternative transportation fuels and technologies. Tobias Muench is our hydrogen specialist and he will be helping to moderate the panels today with Peter and Tim and Bill Elrick. Pilar Magana, who you have already met, will be assisting us today with the WebEx and the PowerPoint presentations. This meeting is being publicly broadcast via WebEx and the transcript and audio will be

posted on our website.

Well, I have a few housekeeping items I need to go over with you. For those of you not familiar with this building, the closest restrooms are out this back door to your left, there is a snack bar on the second floor under the white awning, and lastly, in the event of an emergency or a fire drill, the building will be evacuated, just follow staff to the appropriate exits and we will reconvene at Roosevelt Park which is located diagonally across the street from this building. So that should do it for that.

Well, the main purpose of today's workshop is for the Energy Commission staff to acquire information needed to provide the basis for allocating $100 million in AB 118 funds. We need updated information on vehicle deployment and cost, fueling infrastructure, fuel production, and barriers to commercialization. This workshop is a beginning of a data collection process. We will continue with a review of the docketed materials and subsequent dialogue.

Well, we certainly have a full agenda today and we want to have time for public comments for those in the audience and those on WebEx. Our introductory speakers will be Peter Ward, who will provide an overview of the AB 118 Investment Plan process. Gerhard Achtelik of the California Air Resources Board, he will speak on the zero emissions vehicle mandate, SB 1505 requirements and credits for clean

outlets trigger; John Mough of the Department of Food and Agriculture will speak on fuel standardization; the light duty vehicle panel will be in the latter half of the morning; and we will break for lunch at 11:45. At 1:00, we will begin the heavy duty vehicle and off-road applications panel, followed by the fuel production and distribution panel at 2:30; at 4:00, we will have the public comment session with closing remarks at 4:30. And if all goes according to plan, we should be adjourning by about 4:45.

As I mentioned before, this is the fourth in a series of workshops that we have had in September. We have one more workshop scheduled for the electric drive infrastructure on October 12th, and that will be held at the CPUC in San Francisco. Just please check our website for further details.

Well, the next step in this Investment Plan process is for staff to analyze and incorporate all the information that we have gathered at these workshops. We plan to produce a draft of the Investment Plan in time for our first Advisory Committee meeting on November 19th of 2009. We will then have two more public workshops for the Draft Investment Plan, followed by another Advisory Committee Meeting in January. We hope to have a final draft some time in January of 2010. So if you are not already on our list serve, I encourage you to sign up on our website

under AB 118, it is in the lower right-hand corner, it is very simple, you just put your name and e-mail in there and you will be on our list serve. So, thank you so much for your attention and I will hand over the mic to Peter Ward.

MR. WARD: Good morning, everybody. Thank you all for coming and thank you all for those that are listening in on the WebEx; we really appreciate it. This is going to be an interesting day today, it always is when we are talking about our Investment Plan, and particularly in view of the fact that we are talking about hydrogen technology and commercialization today. We have a good showing here.

I would like to go over kind of where we have been, how we got to this point, and where we are going to be going in the future. And we have a very good give and take today; I am looking forward to that myself.

California is a big state and it could be a nation state, a population of nearly 37 million people, possibly the eighth largest economy, and one of the largest contributors to GHG emissions in the country. We have 26 million light duty and medium duty vehicles and nearly a million trucks. The annual fuel consumption is about 20 billion gallons a year, and that is well over a billion and a half gallons a month. In and of itself, we are one of the largest consumers behind China and the U.S. as a whole, 16 billion gallons of gasoline, and 4 billion gallons of diesel

annually. That is a very big market, it seems appropriate that a lot of the hydrogen development that is going on occurs in this state, as we are going to be needing all the alternative fuels to move forward and to reduce our petroleum consumption over time, reduce our GHG emissions over time, criteria emissions, as well, and improve our economy, many of the public benefits we hope that this program will provide.

The California Alternative Fuels Plan was adopted in December of 2007, jointly adopted by the Air Resources Board and the California Energy Commission. It was preceded by a jointly crafted report from the Air Resources Board and the Energy Commission, jointly adopted, as well, setting goals for California to establish alternative fuels at 20 percent level by 2020, thereby being able to reduce our petroleum consumption by 15 percent in that same time frame, also to set a goal for 30 percent alternative fuels in 2030. In the Alternative Fuels Plan, we have with us the principal author of that, Tim Olsen is up on the dais there, he can answer any questions specifically about that plan, as he was intimately involved in that over many months in creation. We set a little bit finer goals within that plan, getting to the Alternative Fuels Use, and those goals were set at 9 percent in 2012, 11 percent in 2017, and 26 percent in 2022. And we found in that report that these are goals that are

attainable under a moderate development scenario. One major thing that the Alternative Fuels Plan was one of its firsts was the Full Fuel Cycle Analysis of all the fuels that were being looked at. This is pretty much unprecedented at that time, and was very conveniently timed for the initiation of the Low Carbon Fuel Standard. We had already begun work of the Full Fuel Cycle Analysis with a modified GREET model developed and cooperatively extended with Michael Wang at Argon National Lab. That work continues for our program, and it is a governing principal for our program as we want to make sure that we have a sustainable program going forward, and set sustainable goals going forward for the development of these alternative fuels. We feel that we can displace 4 billion gasoline gallon equivalents by the year 2020; that would achieve the 20 percent goal, and, as I mentioned earlier, all the fuels in the portfolio will be necessary to achieve that goal. Hydrogen fuels and technologies can make an important contribution to this goal with corresponding reductions in GHG and air pollution, as well.

Now, to the Alternative Fuels Plan -- I mean, actually, the program that will help implement that plan -- this is the Renewable Fuel and Vehicle Technology Program. It was established by legislation, statutes of 2007, former Speaker Fabian Nuñez, Assembly Bill 118, created the

program, and was subsequently amended by AB 109, also by Speaker Nuñez. It is important to note that the emphasis of this program is to develop and deploy innovative technologies that transform California's fuels and vehicle types to attain the state's climate change policies. And, of course, we are talking about the Global Climate Solutions Act, signed by the Legislature and signed by the Governor in September of 2006, and the early actions and other policies that stem from that AB 32 climate change program. We feel that this program can be a leader in that sense, we think it can lead not only other states, but our nation and other nations, as we move forward to develop those fuels in the most sustainable way possible, with the clear thought to what implications we have for the development of these fuels in California and how that basic amount of knowledge that we will be gaining will be transferrable, as I say, to other states, our nation, and other nations around the world.

The funding and objectives for the program, up to $200 million per year, was authorized for a period of 7.5 years, and this gives an ample long term approach to the development of these alternative fuels, and never before have we had such a robust funding picture over many years, enabling us to send a very strong signal to the market in California, and that signal has been heard outside of our borders, as well. The funding is to develop, produce,

manufacture, deploy alternative and renewable fuels, advanced vehicles, vehicle efficiency improvements for on and non-road applications, and we will be emphasizing workforce training and job creation. It will foster the education, promotion and technology centers of excellence, and we will be preparing environmental market and technology assessments all the way along this program. That last element, I think, is particularly important for us as we want to establish a sustainability moniker for this program; I think it is important that we stay up to date and we plan to stay up to date with all the emerging information on these topics, particularly those that affect the Low Carbon Fuel Standard, the Renewable Fuel Standard across the United States, and as we try to develop the resources that California has to produce alternative fuels in the state, mostly from the renewable sources, and emphasizing our available waste stream whenever possible.

You may know that we adopted our first Investment Plan on April 22nd, Earth Day, of this year, and now we are about the business of preparing this second Investment Plan, and this workshop is a portion of that. We have had previous workshops and we will have one more workshop after this, as Leslie mentioned. But it just seems like yesterday that we adopted this plan. We basically turned on a dime and, in a strategic move which we had high hopes for, many

of those hopes were not realized, but we thought it might be best to see if we could leverage the amounts that we had in our Investment Plan to encourage Federal dollars to come to California, for all those projects that were going to be proposed under the American Recovery and Reinvestment Act, the Federal Stimulus. Many, but not all of those solicitations have been completed, evaluated, and awards announced, not all though, we are still awaiting results from the Advanced Bio-Refinery and I believe ARPA-E Programs. But for the most part, we -- how is the best way to put this -- we were under-inspired by the selection, or the known selection of California projects, which we had many good projects in California. We led the weight of our Investment Plan to that and a lot of the public and private investment of California. We did not do as well as we had hoped, transportation left for vacation, we got a few projects, even Clean Cities, we got a few projects that we will be taking advantage of some of our investment funds. But the battery component, battery and vehicle component manufacturing solicitation, with $2 billion, notably, we had zero success in that, no dollars placed in California. That having been said, we would like to turn the page now and provide a State solicitation that will have several categories in it over the next weeks, not months, to make sure that a lot of those folks that had excellent projects

from our standpoint, in California, we want to help get those realized and put on the books as soon as possible. So we are working quite diligently right now to prepare those solicitations that will feature the criteria and the desired outcomes that were are hoping for our program, many of which are in statute, so that we can come up with some of the best projects in California, that can be a model for the rest of the United States, and possibly the world, as well. That solicitation will be released, as I mentioned, in weeks, not months, and we are hoping to finalize the awards right after the first of the year, if at all possible.

Many of the policies that we are hoping to shape our solicitations around and provide benefit for, as I mentioned earlier, climate change reduction goals of AB 32, California's Low Carbon Fuel Standard, which will take effect in about a year and a half from now, and Gerhard from the Air Resources Board will be telling us more about that today. The Federal Renewable Fuels Standards 1 and 2 has a decided effect on how we go forward here in California, as well. I would like to add one to this, and it is the Bioenergy Action Plan and Bioenergy Goals that our Governor set in his Executive Order, and those are that we increase the amount of bioenergy resources and fuels derived from bioresources on a projected path of goals of use and production of that use within California. Those are

ambitious goals. We are number 1 in Agriculture here in California and forestry, so if any state can achieve those goals, I believe it is California. As we do that, we are keeping a keen eye to the emerging sustainability discussions that are going on. We want to make sure that what we develop here in California is done in the most sustainable manner possible, and we hope that what we do here in California can be a model for the rest of the world.

The Investment Plan for the first two years is highlighted here. Some of these funds were utilized, actually taken up by the Federal solicitations, we have quite a few of these dollars remaining for the solicitations, and I think an approximation of this is about $100 million remaining, or more, probably exceeding that. Some of the allocations that are not obvious here, and one particularly that I like to point out that is kind of hidden in the market development program support is the $4 million that we will be hearing more about a little bit later from John Mough of the Department of Food and Agriculture, Division of Measurement Standards, who is going forward on Fuel quality Assessments for Hydrogen and a type approval for a retail dispenser. So we will be hearing more about that, but I want to make sure that is not lost in the background noise here because that is something we have already committed to, and we think it will yield positive

results as we go forward in the hydrogen area so we can actually sell hydrogen at retail and make a better business case in the future.

Our next steps are the ongoing evaluation of some of the proposals, and especially meeting with those entities that were successful under the federal solicitation, using ARRA Investment Plan funding. And we will be preparing this California based solicitation in accordance with the current Investment Plan, the one that is in place. Why we are here today is for the next Investment Plan that will cover years 2010-2011, so we will be finalizing those solicitations for available funding, therefore, and releasing those very soon. We will be updating the Investment Plan for Fiscal Year 2011; that is what we are about the business here today for, and now we are hoping to be able to finalize that Investment Plan right after the first of the year, within month of the new year. Thank you very much for your attention and I look forward to a very productive day. Thank you.

MS. BAROODY: Thank you, Peter. Now I would like to welcome Gerhard Achtelik.

MR. ACHTELIK: Good morning. Thank you. And thanks for attending the California Energy Commission's Investment Plan Workshop. I will be giving an overview of the Zero Emission Vehicle Regulations, some of the drivers behind hydrogen, the Zero Emission Vehicle Regulation and

other regulations like the bus regulations, SB 1505, all the regulations currently in place at the Air Resources Board that drive some of the need for hydrogen specific and just electric drive technology, in general. And the goal of all these policies and regulations are really two-fold. Historically ground level ozone and PM were the primary drivers for the Air Resources Board, but we have transitioned or grown to include the greenhouse gas emissions reductions, and the big goal is the 80 percent reduction in 2050. And we are looking at these emissions not just at the tailpipe anymore, but we are looking at them both upstream and downstream on a rolled wheel emissions, so the fuel production and the use of the fuel. And for hydrogen, what the background for hydrogen, one of the big drivers was the Governor's announcement in the State of the State Address, and then also with the issue of the Executive Order that directed the State, the Air Resources Board, the California Environmental Protection Agency to work with academia and other government agencies and business to develop a blueprint plan. And out of the plan, this has become an evolutionary sort of effort. The Governor, when he announced this hydrogen highway effort, and we still get pointed at a lot of times, we talk about the plan being a goal to have a station on California's major highways at periodic intervals, but even the blueprint plan already

pointed out that we are going to develop this hydrogen infrastructure in a focused effort because the key thing is that the infrastructure needs to be where the vehicles are, and the blueprint plan came out and pointed out the geographic areas where we first expected vehicles to be, pointed at San Diego, the Los Angeles area, and the Sacramento area. That would be the first deployment of vehicles. And that is really what has proven true. And what we have come to now, what the blueprint plan is focused to now is we really are working now on clusters. We are working on clusters within those geographic areas. Vehicle placements are very targeted, and hydrogen infrastructure, as a lot of you know, is still at an early stage, it is still costly, and the volume is not there to be a profitable station, but yet the stations are needed for the vehicles. So we are now focused on clusters. The highway is still there, it is just that we are building the highway in pieces and just as our major interstates were not built overnight, we did not put a million miles all over the U.S. in a day, the hydrogen will develop in pieces.

The focus, I will show you on a later map, right now we are still focused on three primary areas, which would be the LA Metropolitan Area, the Bay Area, and the Sacramento Area. Just a slide here on the greenhouse gas emissions, are one of the major drivers for hydrogen is the

greenhouse gas emission reduction benefit, and you do get criteria pollutant benefits, too. But, as Peter had mentioned, a large single portion comes from the transportation sector, so the driver for hydrogen is the greenhouse gas reduction goals that can be achieved in 2050.

Here is a complicated regulation and a complicated slide. But this represents 2012, and this is the Zero Emission Vehicle Regulation for 2012, and basically a manufacturer can meet all of their obligation by producing zero emission vehicles. Since the technology is still in development right now, and this represents 2012, the manufacturers ZEV production requirements, whether it be 12 percent based on their annual sales, but the manufacturer has some optional compliance strategies, and right now a minimum of .79 percent of what they produce have to be the purer ZEVs, which would be either fuel cell vehicle or battery electric vehicle. And then we have the next category, which is now the .79 is a minimum where these other values represent maximums, meaning that the most -- especially at the 6 percent PZEV, actually, that is our Partial Zero Emission Vehicle, and those represent the traditional gasoline internal combustion engine, and also represents the natural gas fueled vehicles, and that is a car that is very clean, the emissions were estimated to be roughly about equivalent to what you would get from charging

an electric vehicle, and drive 150,000 miles. And these Partial Zero Emission Vehicles also have 150,000 mile emission warranties, so that represents one way the manufacturer can meet their ZEV obligations, and you step your way up to ATPZEV, which represents the hybrids, and actually that is where the Honda CNG vehicle fits in, and the new category that was developed in the 2008 March Board hearing was the Enhanced ATPZEV, and these vehicles will be using zero emission fuels, so they will be using electricity or hydrogen, so you could have the hydrogen internal combustion engine vehicle in this category, or you have the plug-ins, which we are expecting to start rolling out next year. So the ZEV regulation is met through four different paths, and the enhanced path, the enhanced ATPZEV segment is what is now considered the ZEV enabling, or ZEV development portion of the regulation.

The program has, although what started as a fairly simple regulation and, as you saw on the glass, has become pretty complex, it has been successful. We have had over 250 fuel cell vehicles deployed in California, or 4,700 battery V's and a very large number of neighborhood electric vehicles, all of them developing to cleaner air, not to mention even what I do not include in here, the large number of Partial Zero Emission Vehicles, which have provided tremendous emission reduction benefit.

So the program has provided a variety of cars that we did not see back in 1990, and all the products have an emission reduction benefit. And the program, the ZEV Program, will continue to become a more focused research under the development of battery electric vehicles and fuel cell vehicles.

Given this complex structure, where do we think we need to be? This slide here gives you an overview of vehicle sales only. This does not represent the mix of the fleet. But basically, in order to achieve the 2050 goals, we need to have 100 percent of our vehicle sales in 2050 need to be either fuel cell vehicles, or battery electric vehicles, and we expect hybrids and plug-ins, since they do not give us the same criteria and greenhouse gas emission benefits of the pure electric drive, their role will decrease as we go out in time. This does not represent the whole fleet. The whole fleet will also have, you know, hybrids and plug-ins still in operation, and some biofuel vehicles, but we expect the majority of the light duty vehicles will be fuel cells or battery electric vehicles, and biofuels, which is just like any other of our transportation fuel, a limited commodity, and will primarily be found in heavy duty application, and even airplane applications. So, while biofuels will help us get there to 2050, we do not expect them to be the major role in 2050 in

the light duty field. And the initial curves are fairly shallow. They are based around 4 percent of sales similar to the current hybrids. This slide gives you both the predicted and the required vehicle productions, and the top row where it says required vehicles is just what the regulation, as it stands right now, meaning that if a manufacturer chose just a single path, this is the number of vehicles they would have to apply that are the gold, or the fuel cell, or battery electric vehicles. And this is somewhat also depending on the type of vehicle they produce, and the regulation gives credits based on the range of the vehicle. And from the gold vehicle, gold fuel cell vehicles on down, those are staff's anticipated roll-out of vehicles. And this number -- what the regulation did in 2008, since staff saw a surplus of credits, it sort of forced that these credits be used early on, so you can see that, in our current phase that we are in, we clearly have a lower number of vehicles than what is required, but that is because of the early production of vehicles that the manufacturers prior to this time. So now those credits are being spent, and the vehicle roll-out of new ZEV technologies is going to increase. And these numbers are fairly conservative. In a survey that the partnership did, they came with numbers that were almost double, especially in the 2015-2017 timeframe. These are sort of minimum numbers. And the program goals,

as ZEV II is being reviewed December 10th of this year, the staff will go to the Board with a informational report, and again, as a result of the 2008 hearing, the Board directed staff to reevaluate the program and to harmonize it with the other regulations such as Pavley and LEV III. One of the things you see here is that vehicles that were in the ZEV regulation, like hybrids and the Partial Zero Emission Vehicles, the clean gasoline vehicles, PZEVs, will move into what will become LEV III. And the ZEV regulation will move towards developing the ultra low carbon technologies, the electric drives and the -- well, electric drives, be they energize just through batteries or hydrogen. The scale will be to assure that we can get the 80 percent reductions by 2050. And in order to get there, we need to start seeing significant numbers, in the tens of thousands, as was seen starting with the 2015 model year.

In addition to the Zero Emission Vehicle Regulation, we also have the Zero Emission Bus Regulation. And we have had eight fuel cell buses in operation in California. Three of them are still in operation here in the Oakland Bay Area by AC Transit, VTA, each operated three, and those buses are just in special service now, but AC Transit buses are in daily service, serving on scheduled routes, serving their customers. And some light transit, which is not a regulated, AC is also operating a fuel cell

bus. And starting in -- well, actually starting late this fall, we will see the first buses of the 12 bus demonstration being deployed in the Bay Area, and in this case, while AC Transit led the three bus demonstration with Golden Gate Transit, all five Bay Area Transit Agencies will be participating in this 12 bus demonstration, and will actually be sharing these buses at times. And we are looking forward to that. We expect all 12 buses to be in operation by the third quarter of next year. But, again, this points at a need for hydrogen. The purchase requirement, which is right now on the books, starting in 2011, is in review, and we expect to delay that a couple years. But there is a definite near term demand to meet the hydrogen demand for these 12 buses.

The production of hydrogen was required through the Legislature to meet some very strict environmental standards and it includes the criteria pollutants at 50 percent reductions for $NO_x$ and ROG, which is actually -- that is relatively easy for hydrogen to achieve, just almost just freezing hydrogen, and this is a well to tank analysis, meaning we are not even getting the benefits of having zero emissions, we are comparing this to a vehicle, but yet we are not even counting here the benefit of having zero emission miles while driving the car. The way the legislation is written, it required a 50 percent reduction

strictly well to tank. So, even just the production of hydrogen from natural gas is cleaner when compared to gasoline vehicle operation. It requires a 30 percent reduction of greenhouse gasses on a well to wheel, no increases in toxics, and this is an item we will be going to the Board with likely in June or July of next year.

The challenge for the hydrogen regulation is the 33 percent production of renewable sources. And what that means is 33 percent of the energy required to make hydrogen, so if you make hydrogen from natural gas itself, you could not meet the renewable requirement, you need to include some biofuels, or you need -- and you could blend that with taking all the electricity that you used from renewable source. But, just the electricity demand for hydrogen production from natural gas would not be sufficient, that would get you about, oh, two-thirds of the way there, it gets you about 20 percent. And the regulation applies -- the renewable requirement -- all of these criteria -- but the renewable requirement is the challenging one, applies to all stations that are co-funded by the state. And it will kick in to all hydrogen production and warrants a threshold of 3,500 metric tons per year has been exceeded. And there are some exemptions, but until the Board actually approves those, and gives the Executive Officer the right to implement those exemptions, they are not in effect. What is

in effect is the emission reduction requirements. The Clean Fuels Outlet Regulation is currently another regulation that has been on the books since 1991 and it was developed back then because it was believed that traditional gasoline vehicles could not meet the emission reduction goals that were required to meet the Ambient Health Quality Standard. But that has since clearly been disproven, the auto manufacturers are making incredibly clean gasoline vehicles, so now we are looking at potentially revising this regulation. We are going to the Board in December with an informational report, and that we will be studying the development of infrastructure. Right now, the trigger is based on 20,000 vehicles and, for hydrogen, and battery electric drive vehicles, that number is too large because, as they vehicles are deployed in the early phases, to reach the 20,000 trigger without established infrastructure, is not synchronized, will not work, so we are looking -- if we have to revise the regulation, we will be looking to lower that trigger. And what our objective will be is to assess over the coming year if the state funding will be used to deploy infrastructure, or if we will need to use the stick, I guess, will the carrot work, or will the stick work? That is one of our challenges for the next year. But the Clean Fuels Outlet will be focused on achieving the 2050 goals, so the fuels we will be looking at will be those fuels that

will get us to the 2050 goals, and we will be looking at, to the extent that the infrastructure is a hurdle to the deployment of the technology. So, with hydrogen, that is clearly a definite case because the cost of that infrastructure is prohibiting a lot of smaller companies from jumping into that. So, if needed, we will update that regulation late in 2020 in coordination with the ZEV II Regulation.

The Low Carbon Fuel Standard was adopted by the Board earlier this year and, as it stands, it looks at -- it requires the manufacturers, as Peter said, to reduce their carbon fuel by 2020 by 10 percent, and it is a graduated scale where the incremental reductions required an increase as you approach 2020, and it starts off relatively slow in the next year. And just as a point of reference, for hydrogen, one estimate is it would be the carbon value is maybe $50.00 per metric ton. Right now, in the near term, we suspect the driver for Low Carbon Fuel Standards will be the biofuels and not hydrogen and electricity, but that is something we are going to have to track and see how it actually spells out.

The interaction of the regulations -- the Zero Emission Vehicle Regulation requires a minimum number of vehicles, so therefore incentives, both the Air Resources Board and the California Energy Program have vehicle

incentive programs, and so incentives to vehicles are okay because it is the vehicle production that is regulated, and not the purchasers. So incentives to the purchasers can be provided. For the hydrogen production, if funding is provided for the production of hydrogen, you could still earn Low Carbon Fuel Credits. There is no restrictions on using credits from a station that was mandated by a clean fuel outlet regulation if we were to develop a clean fuel outlet regulation because, again, it is a station requirement, not a specific fuel production requirement.

The AB 118 funding -- so this is where we are saying that, if the fuel is subsidized, you cannot get credits, but if the station is subsidized, you could earn credits. If the clean fuel outlet is adopted, only the renewable portion of the AB 118 funding could be supported, not the actual building of the station. So it is a complex complex picture, but the regulations do interact, obviously. And so funding is available to vehicles and hydrogen production, and then, in the future, depending on what we see developed, some of the funding for stations might not be available anymore.

Where do we stand today? Peter did point out that this is the Investment Plan for the 2010-2011 timeframe, but one thing to keep in mind, where we are today is you are looking at the hydrogen needs, this is where we are today,

and to date no funding for stations has occurred through AB 118, so you look at your need from this point forward, this is a map I borrowed from the partnership, and we have four stations that we consider public access stations. There are more stations than that in California, but these are the four in Southern California that we consider public access. It would be UC Irvine down South, and the orange stations on this map are the public access -- Santa Monica, Burbank, and South Coast AQMD. This is what we consider the public access stations. So the Burbank one is actually in jeopardy of remaining open, and then the green stations are the ones that have been funded in the South by the Hydrogen Highway money through the Legislature in the past, and those are currently being built, and we expect those to open in 2010, next year. And while this map only shows Southern California, we do have two projects in the San Francisco Bay Area, one is at the airport and one is in Emeryville. And the Emeryville station is co-located with the Transit Agency, they actually have one side of the station will fuel cars, and then the other side will fuel buses, which is a pretty exciting opportunity. And there is a additional demand needed in Northern California. Now, I just showed this to Southern California because that is the only map that I have prepared so far and it is partnership prepared, so I will have to steal another one from them later when

they get the next one. But this is the start of our highway. We can see the start of our highway is the 405 corridor. We can go from UC Irvine, Newport Beach, up to Santa Monica, and we are looking to grow. So here is the start of our highway. Now, we are going to work from that, that is part of the Investment Plan is how we grow this plan. And then, in another slide I borrowed from the partnership, is we are now at the early phase, we are at the bottom of this curve here where hundreds of vehicles -- we are going to tens of buses, and we are just starting a handful of retail stations, and we are growing forward. We expect thousands of vehicles and we expect a number of buses to grow. Even with the station we funded at AC Transit, an additional station will be needed because then upgrades will be required to the station they have in Oakland. So we are looking to grow. There is a definite need for infrastructure. And I think that is my last slide.

There are links to all these programs on our website, and look for updates and look for changes. Thank you.

MS. BAROODY: Thanks, Gerhard. We actually have about five minutes for any questions.

MR. OLSON: I have one. Gerhard, I wonder if you could provide a source, the data for your vehicle -- in your slide, I am not sure whether your slide was a compliance

schedule, or whether that was just tracking right there.

MR. ACHTELIK: This one?

MR. OLSON: Yeah. And then the one prior to that, a couple prior to that.

MR. ACHTELIK: Okay. This is a compliance schedule here. This is what the first line -- the required vehicles is what the regulation requires. And the second line, the gold fuel celled vehicles, is what we expect to happen based on Management and staff's meetings with the OEMs. And all of these allow -- like the glass slide that said you do not have to build -- you do not have to meet 100 percent of your reserve requirements strictly through the pure gold category, so you can see that there is a lot of silver plus vehicles which represent the plug-ins and silver and bronze. Now, this slide represents the regulation as it exists today. The 2015 numbers could change with ZEV II, where the bronze and silver will disappear out of the ZEV portion and go on to Pavley, and into LEV III. But we do not expect the required vehicle numbers and the fuel cell vehicle numbers to decrease because the Board has been pretty consistent about requiring the gold vehicles. And in the last March hearing, just as an example, the Board basically doubled the vehicle numbers that were required from what staff recommended.

MR. OLSON: And can you go back a couple? That

slide and you had one previous. So --

MR. ACHTELIK: This is -- the achievements?

MR. OLSON: No, the next one.

MR. ACHTELIK: Okay.

MR. OLSON: So your legend there --

MR. ACHTELIK: Yeah, this is -- what this represents is a projection of -- it represents the vehicle sales we have to have in order to achieve our 80 percent reduction goals and, actually, this graph only gets us to 70 percent in 2050, that in order to achieve the 80 percent reduction, we actually need an earlier and steeper kick-off for fuel cell vehicles and battery electric vehicles, but the initial kick-offs on these curves represent, you know, where the lines are flatter, they are based on how hybrid vehicles accelerate.

MR. OLSON: Yeah, so I am trying to do a quick comparison of the Alternative Fuels Plan which had a different kind of scenario for 2020.50.

MR. ACHTELIK: Well, I think these are sales only, not the cumulative vehicle fleet. Now, the Alternative Fuels Plan showed fuel cell vehicles, plug-ins, hybrids, and natural gas vehicles out still in 2050, but what we are saying is that, in 2050, you cannot have sales of those vehicles and expect to meet the greenhouse gas emission reduction goals at that time.

MR. OLSON: And so, did the Board adopt this analysis?

MR. ACHTELIK: No.

MR. OLSON: Can you also explain, just go back and you made a comment about if fuel is subsidized, you cannot gain credits, but you can for the fueling. Can you just elaborate on what you meant by that? Is that AB 32 credits? Is that financial credits? Is that kind of policy credits?

MR. ACHTELIK: These would be -- okay -- this is a combination of -- my understanding and speaking with Management, what are the bounds for both AB 118 and the Low Carbon Fuels Program, and so what we have here -- it is my understanding is AB 118 cannot be used to fund a required program. And so, what this represents is that if, instead of funding the building of a hydrogen station, and the operation of it, you will just give a direct subsidy to the hydrogen, say, whatever, you know, a dollar per kilogram subsidy. Then you could not earn Low Carbon Fuel Standard Credits. But if you subsidized the building of the station and the operation of it, you are not paying for the fuel directly, so then you could still earn Low Carbon Fuel Standard Credits.

MR. OLSON: Yeah, there is that, so as you explained, the Low Carbon Fuel Standard has kind of a staggered Implementation Compliance Schedule.

MR. ACHTELIK: Yes.

MR. OLSON: So if we funded something that, say a fuel production type of project that is an early action before it is required, what is your timeframe for determining what constitutes early compliance?

MR. ACHTELIK: You can fund the production of hydrogen; that is alright. But you just cannot fund -- you cannot give a direct subsidy to the hydrogen, so even when the Low Carbon Fuel Standard regulation kicks in, you can still fund the production of it.

MR. WARD: Wouldn't that be complied with 1505 if we did, though?

MR. ACHTELIK: Well, 1505 requires -- 1505 in a sense allows the funding of renewable hydrogen because it requires any state funded hydrogen to have a renewable component. So 1505 in a sense creates a conflict, but if it came first and it required that state funds be used for renewables --

MR. WARD: And that is an existing requirement right now, though. Right?

MR. ACHTELIK: Yeah, 1505 is in legislation, it is a law, and it is just we have not developed the regulation that helps implement it.

MR. WARD: Do you have plans for the development of a regulation to implement --

MR. ACHTELIK: Yeah, we are looking for June or July of 2010, the Board hearing date.

MR. WARD: I noticed also that in the ZEV, you may be pushing back from 2011 -- you mentioned, when you go to your Board that it may be -- is that basically expanding the window of early opportunity -- two more years?

MR. ACHTELIK: I will go back -- I am not sure -- the regulation as it -- our expectation, the regulation is set through 2014, and when we go to the Board, what we are expecting is that the Board will direct staff to start changing the Reg, starting from 2015, and what we expect to see is that the silver and bronze categories will be removed from the ZEV regulation.

MR. WARD: Maybe I was referring to the Zero Emission Bus Program.

MR. ACHTELIK: Yeah, okay, yeah.

MR. WARD: The purchase requirement was in 2011 --

MR. ACHTELIK: Right.

MR. WARD: -- and it may be pushed back two years. Does that expand the window of opportunity there?

MR. ACHTELIK: Yes.

MR. WARD: I guess what I am -- this is kind of a floating window of opportunity at this point, depending on what your Board does.

MR. ACHTELIK: Yeah, it will be -- right now, our

goal also is, in late 2010, to set a new either purchase date or bus performance technology date criteria, and so, yes, that will be delayed to, you know, if I am guessing right now, 2013. And in part, because what we are really waiting for, there are two big demonstrations in the winter of 2010, the Olympics will be taking place up in Vancouver, and they will deploy a 20 bus fleet, and then starting some time the third quarter of 2010, we will have the 12 bus demonstration in the Bay Area, and they will be all 12 buses, and that is the data that we are going to rely on to let us know how far the technology has progressed and what our next steps should be. So did that answer your question?

MR. WARD: Actually, I think it did. What I guess I am also getting at, in general, and if you can give us a rule of thumb, the regulations that would be coming in to play, I think you folks have a rule of thumb that it is in here, or six months, or something prior to that, that early actions can be afforded without running up against the prohibition we have in our program to not fund any obligated party for a regulation mandate or law. Is that a rule of thumb at six months, or a year?

MR. ACHTELIK: I will have to look into that. I do not know.

MR. WARD: Thank you.

MS. BAROODY: Well, thank you, Gerhard. We

appreciate you taking the questions. All right, next we have John Mough with Department of Food and Agriculture.

MR. MOUGH: Thank you for the opportunity to be here today. I am John Mough. I am a Chemist with the California Department of Food and Agriculture, their Division of Measurement Standards.

What is going on currently is we have got the transition from demonstration stations to commercial stations. We are establishing national state codes for fuel dispensing device requirements, the method of sale, and the fuel quality. Draft codes have been developed by the U.S. National Working Group for Commercial Hydrogen Measurement, they have been introduced to the Regional Weights and Measures Associations, that happened last week in Las Cruces, New Mexico. Draft codes are there for the device design specifications, the method of sale, how we are going to sell this product, which is going to be by the Kilogram, and for advertising and labeling requirements for the dispensers and stations. They are also working on fuel quality specifications, which are taken from the draft SAE Technical Information Report and the current California Regulations. The National Weights and Measures Standards Development Organization are the people who are in charge of developing standards -- the National Conference on Weights and Measures. They will review the draft codes that were

just proposed in January 2010, and they will vote in July 2010 on these codes. The model codes and standards must be adopted by each state to become enforceable. Now, California adopts these regulations by reference, so they will automatically written into California law, but for any adjacent states, or any other states in the U.S., they must adopt these in their own laws. Also, the device code will not be enforceable, it will be a tentative code for the first couple of years. It will not be enforceable until it becomes a final code. And in California, the Division of Measurement Standards will have to write California regulations for the device design, the method of sale, and we already have the first fuel quality specifications in the country.

The people that we have been working with on the fuel quality specifications are ASTM in terms of developing the test methods to measure the contaminants, the SAEJ2719 Committee, and International Organization Standards, they have a draft out right now of 14687-2 for PAM (phonetic) fuel cells. It is interesting right now, the California regulations that we have in place, the SAE specification with the Technical Information Report, and the ISO Standard are all harmonized. So what is going on here in California is the same that is going on across the United States and throughout the world.

Current work at DMS is going on is the current AB 118 Investment Plan gave $4 million to DMS to research and develop the fuel sampling procedures because we needed to make sure that when we go out and take a sample that we have a manner of doing it which is truly representative of the product that is being sold to the public, and that everybody can take a sample in the identical manner, so anybody can go out there and take a sample and be assured of the results they are getting. We are also working on the laboratory analytical methods and the fuel dispenser testing methods, and the test methods for testing the dispensers. The Inter-agency Agreement between the Energy Commission and DMS is being finalized as we speak, it has been kind of a long tortuous process, but hopefully it will be within the next couple of weeks that will all be wrapped up.

For part of the next Investment Plan, we would like to see the validation of analytical procedures. Analytical procedures can be developed, but they are not valid until what is called the Round Robin study has been done on that, where a number of laboratories that routinely perform this analysis take a sample, test it, and inter-compare their results to see what is the standard error in the test measurement. That gives us, then, numbers that we can use to set guidelines for the enforcement standards.

We need to really establish a permanent fund for

alternative fuels. The problem is, the funding for the fuel quality program is not to be used for alternative fuels, so our current existing Motorola Assessment Feed that funds our Petroleum Product Program for the Division of Measurement Standards, it is not to be used for alternative fuels. The funding for dispenser evaluation is paid for by manufacturers who submit a prototype dispenser for certification. It is not enough to pay for development of new test methods and procedures. And general funds pay for the dispenser testing program currently, and that keeps on shrinking. Traditionally, it is county weights and measures employees who test fuel dispensers, retail motor fuel dispensers, but they have no expertise in testing new equipment.

Here are some useful links. The first one to the NIST, Weights and Measures Division, the proposed draft code for the devices is under the link through the U.S. National Working Group, National Conference on Weights and Measures, so the people who will be adopting those specifications, and here is something to our website, and then here is contact information for who you need to see at DMS. I am the chemist in charge of fuel quality requirements, Kristin Macey, she is the Assistant Director, she is on the U.S. National Working Group and on the National Conference of Weights and Measures, and Mr. Dan Reiswig, who is the

Manager of the California Type Evaluation Program. That is it.

MS. BAROODY: Thank you, John. Are there any questions for John?

MR. OLSON: John, this is Tim Olson with the Energy Commission. I wondered if you could just elaborate on, well, my understanding of this process is that the fuel line stations cannot sell hydrogen until this process is completed. And can you give us an estimate of what that timeframe would be?

MR. MOUGH: Currently, no fuel dispenser manufacturers have submitted any prototypes to us for evaluation. What their timeline for doing that is, is unknown. If we were to receive one today, we would take it through a draft code, since the National Conference on Weights and Measures has not adopted any code, we would have to use a modification of the procedure that we use for CNG dispensers at this time. But we would be happy to see any dispensers that came in and evaluate them. I would imagine that the timeframe to get the evaluation done would be on the order of six months.

MR. OLSON: And another question on the -- as you go through this process, how do you distribute the information? How do the implementers understand how to use your standard? Do you have a training program? And,

frankly, I am not sure if this was part of our interagency agreement, but if it is local Weights and Measure people who monitor and implement this type of program, how do they get that information?

MR. MOUGH: The Division of Measurement Standards has a rigorous training program throughout all the counties in California. So they will be trained on how to do it on a pretty much as needed basis. As Gerhard pointed out, it looks like the first concentration is going to be in the LA area, San Diego, San Francisco Bay Area, Sacramento Areas. So the affected counties with those dispensers would be the first that we would target for training on how to evaluate the dispensers.

MR. OLSON: And in your recommended actions for a future Investment Plan, do you have any estimated costs for those items you had on your list?

MR. MOUGH: No, I do not, but I would be happy to round up some numbers and get them to you.

MR. OLSON: Very good. I appreciate it.

MR. ACHTELIK: This is Gerhard Achtelik. I have a question, too, John. In your current funding, does that include the cost of the actual hydrogen quality test in your development of the standard, or if a station was to call you up to have the quality of their hydrogen evaluated, is actual testing included in that?

MR. MOUGH: There is some funding in there to do the actual testing. Because the test methods have not been standardized and finalized yet, and no validated test methods -- there are some draft test methods out there, none of them have been validated, we could not take any enforcement one way or another. The testing that we do, the numbers will be available to the hydrogen community.

MR. OLSON: One other question, John. I heard you say that this process in July of 2010, each state needs to go through an adoption process. Does that imply that, if we go through an adoption, that we have to wait for other states before we can actually implement our program?

MR. MOUGH: No. California adopts the National Conference of Weights and Measures by reference in their laws, in our laws, we adopt it by reference. Several other states do not. For example, Connecticut, which is looking and moving forward on some of the hydrogen infrastructure and hydrogen highway, does not adopt them by reference. So it will be kind of a piecemeal process as it moves across the United States. What we found so far in the hydrogen is that, what happens here in California is pretty much what happens throughout the rest of the United States. No other state in the United States has developed any hydrogen specifications yet, we are the first state to do that. It is my belief that most other states will just adopt our

specifications pretty much by reference.

MS. BAROODY: Okay, John. Thanks for your time today. I appreciate it. Well, we will move right on to our Light Duty Vehicle Panel. And I would like to introduce Bill Elrick of the California Fuel Cell Partnership, and he will be introducing our speakers today.

MR. ELRICK: Okay, thank you. Thank you for the opportunity to speak with you today. As the California Fuel Cell Partnership, a member organization with industry in government, educational, transit agencies, I want to give an update first on where we see the industry now and over the next couple of years. So I will jump in without some slides. What I want to show you first --

MS. BAROODY: Oh, hold on just a second. Pilar is getting a presentation ready.

MR. ELRICK: Thank you. Great. What I want to do is, I know you have seen some of this information before, but to review the Action Plan which was developed last year by the collection of industry and government partners. This plan explicitly outlines how we plan to move from this demonstration phase that we are exiting from, and through the Valley of Death, and into the commercial market. It calls for 40 new, in support of six existing stations. It focuses on three areas; they are light duty passenger vehicles in LA, transit buses in San Francisco Bay Area, and

development of necessary regulations, codes, and standards in the Sacramento Region. Altogether, the plan was developed to move us through 2014, and requires approximately $180 million by both industry and government together. The $40 million outlined in the CEC Investment Plan will continue California's leadership in this area, and move us purposefully into this commercial market. And it is very important that California remains the world leader in this area, not just because of the energy and environmental benefits that they offer, but so that we retain and expand the job creation and the economic benefits that the technologies offer.

Through 2014, automakers expect to place 4,300 light duty fuel cell vehicles in California. Most of these vehicles will be located in Southern California, concentrated in four communities of Los Angeles, those are Santa Monica, Irvine, Torrance, and Newport Beach. The Action Plan is designed to meet the needs of these 4,300 vehicles, while also building the foundation for meeting the needs of the almost 50,000 vehicles planned through 2017. We are now actually finishing the local community-based Action Plan, helping these communities so that they are working from the ground up, it is based on the Clean Cities Program.

Turning now to transit, the San Francisco Bay Area

Program is a unique collaboration of five transit agencies, and they are moving forward to jointly own and operate 12 fuel cell buses, with funding and support from the FTA, these buses will soon serve passengers throughout the Bay Area. This program will be the largest of its kind in the United States and it is closely watched by FTA as a crucial part of their electric drive strategy. By 2014, the consortium could have up to 60 buses in operation. This area, the San Francisco Bay Area Region, will also serve for up to 700 light duty fuel cell vehicles by the 2014 time period.

The third focus area is regulatory. California is the first state to regulate hydrogen as a transportation fuel. As John just pointed out, the California Department of Food and Ag's DMS Group and other regulatory bodies are creating those regulations, processes, and procedures required to sell hydrogen as a retail fuel. Transparent access to a state-of-the-art station in the Sacramento area is vital to their success, and that is included in this Action Plan. The commercial success of all the stations in the industry throughout not just the state, but even the U.S., will depend on their work.

So the question is, since the Action Plan released last year, are we making any progress? On the vehicle side, we are very close to the planned number of vehicles for the

end of this year. This data is from actually June of this year, so by that time we were right on track, and this is in spite of the economic downturn. In the case of transit buses, the 12 vehicles described earlier are on the plan to be deployed both the end of this year and the beginning of next, with the whole operation.

We are also seeing progress in the new station development, with the seven state funded stations and several private industry stations in various states of construction. These stations are now following the Action Plan's cluster approach developed from our early experiences. We learned that the hydrogen highway must start somewhere, and in this case, it is along the 405 Freeway in Los Angeles. This is similar to the development of the first freeway in the U.S., a few miles of road that stretched between Pasadena and Los Angeles, and now stretches over every reach of the United States. Several of these stations further illustrate the transition to commercialization, with hydrogen equipment being deployed in existing conventional gas stations. One of these is even a new independent operator that was funded through the state assistance.

Progress to date on the regulations, we talked about the SAE standards, they are going to bow it, as John said, we do have the CHAP process which is based on the

Clean Cities with a local community outreach plan for getting the grassroots, so we have top down and bottom up approach. We have been working closely with DMS on their needs, holding station builders' workshops and other outreach activities so that we get all the different players and stakeholders on the same page. We have even started to create a mobile application to get real time station status so that the early users, when there is still limited infrastructure, know before they drive to that station, if it is online, how much fuel is available. So we are building all the different pieces and putting all the people together so we make sure this is a success.

Okay, we see here as the previous demonstration stations, listed here as existing supply, are phased out and the newly funded stations come on line, that we are able to meet the infrastructure needs for the next few years. However, as vehicle deployment grows and we move from hundreds to thousands of vehicles, we need to plan and support additional hydrogen infrastructure. These next few years are critical to this long term success. Supporting the early infrastructure network until a critical mass of vehicles arrives, with OEM's planning for the commercial models around 2014-2015, and later reaching tens of thousands of vehicles by 2017, now is when these early station operators, most of them small local businesses, need

this government support. Once through this Valley of Death, government support will not be as crucial and the market will begin to pull additional stakeholders into the game.

So are we ready to move forward with hydrogen fuel vehicles? The vehicles are ready and you will hear next from the OEM's since they are moving from these R&D demonstration stages into commercial deployments. Large energy companies such as Shell and Chevron, and new start-up and independent businesses such as Propel, are moving forward in partnership with government with station plans. Government such as the hard work done by the CEC in their Investment Plan, and the U.S. Congress and DOE recent recommitting to the industry partners, are moving forward. New players are also entering the market both here in California and the U.S., such as Linde coming to compete with some of the existing equipment providers. They are building larger and commercial stations now, so the equipment makers are moving forward. We are seeing other fuel cell applications, forklifts, stationary applications, and back-up power showing early market success. Some, like Horizon, which made a profit by selling small hydrogen fuel cell model kits have now expanded their plans and have recently announced new vehicle plans, full scale light duty vehicles in the European markets. They are moving forward.

Industry is on track to meet, or exceed in many

cases, nearly every benchmark set up by the Department of Energy. The technology is moving forward. But most importantly, industry, all the stakeholders, the automakers, the equipment providers, the transit agencies, and government have clearly outlined a plan to move forward and are committed to this in the Action Plan. There is no question, we are ready to collectively make hydrogen fuel cell vehicles a commercial success.

That is what I wanted to do, outline just really quickly the Action Plan and what we did as an industry to get here. If you have any questions before we go to the OEMs.

MR. OLSON: Thanks, Bill, for a good presentation. I wonder if you could just elaborate on a couple slides there. So, for example, your demand table, I do not know if you can go back to that. The question I have -- right there -- you have got the row that says "recently funded supply," that in 2014 goes from 680 to zero, is that the ARB --

MR. ELRICK: Those are the ARB stations, so they are not the private stations right now, and the reason it goes to zero is we were very conservative in this plan, and when the stations, even though right now we are seeing a difference where the early DOE demonstration stations are ending up this year, they are starting to close because there is no funding moving forward, we are working on

keeping some of those open once it makes sense. We do not have, cannot say that in 2014 we have secured funding to keep going. We think, at that point, we will start to see more of a market pool and be able to do that, but we were very conservative and said, "At this point, we do not know."

MR. OLSON: So that 680, that means that the capital costs are covered, but operating costs are not in 2014? Is that --

MR. ELRICK: Yeah, by that time capital costs have already been paid for from the beginning, but there are no ongoing operational maintenance costs.

MR. OLSON: And what do you estimate that to be for those stations?

MR. ELRICK: It depends on the size of the station and the type of station, and I hate to say "it depends," but it could be anywhere around $200,000 a year, depending on the type.

MR. OLSON: And you have another slide that was your Action Plan rollout for vehicles, going back. I think it was -- that was one of them, maybe that -- yeah, right there. Do you have a breakdown of the clusters for Northern California somehow?

MR. ELRICK: Yeah, in the Action Plan, the full plan, which we can make available, or have made available, it breaks down many of those communities.

MR. OLSON: It would be good if you could put that into our record.

MR. ELRICK: Absolutely. It is one of your first Investment Plan records, but we will resubmit it.

MR. OLSON: And the date of this -- when did you do the survey?

MR. ELRICK: The last survey was 2008. We do it actually twice a year, a less comprehensive survey. We are actually gearing up right now for the '09 survey and we can have that by the beginning of 2010.

MR. OLSON: So is it possible that some of the -- because of the economic downturn in the last year, that some of these numbers might change?

MR. ELRICK: They might. We will see when they come. I think we will have to hear what the OEM's say next, but I can say that the early feedback is they do not change much at all. But we will know in a few months.

MR. OLSON: Okay, thanks a lot.

MS. BAROODY: Thank you, Bill. Now, would you like to introduce our light duty panel now?

MR. ELRICK: Absolutely. First, we have Alex Keros from General Motors.

MR. KEROS: Good morning. I am not sure who actually created the agenda, but I would like to thank them. I am in sort of a weird spot, they usually put me after

lunch. Obviously, I am a pretty passionate guy and excited to be here. So today is a big day, actually. Somewhere across the United States, there is an initial DOE subcommittee appropriations vote going to ballot, I believe, later this evening, which is pretty neat, and I would like to echo Bill's comments, where I would say a couple months ago I think many in this room were scrambling. We were facing a zero funding situation, perhaps negative funding situation. Most of the people in this room sort of had a call to arms and went and did something about it, and I know what is sitting on this vote today is actually a plus number, one that looks to the future for hydrogen. So it is pretty neat. I think we are here and I would call it a renewed focus, and to use this focus wisely and really expand the industry. So excited to be here.

Many of you have seen this slide, if not from General Motors, the fact remains it still applies. This is our alternative fuel vehicle strategy, if you will, our sort of "Let's Get Ourselves Off Petroleum" strategy. I was thinking, there is a magazine that used to come out called "Horseless Age," right? About 100 years ago? Who is going to make up a name for the next magazine? It is like "Gasolineless Age," or what not? But certainly we are talking about the right-hand side of this slide and, really, GM has continued to remain committed to fuel cell vehicles,

along with a host of other technologies. We like to say, "You pick the technology, we can build it," and, really, that is the focus. Today, let's talk a little bit about that right side.

So, really, what we are looking at is continued sort of interest in GM's program. People have heard me talk about it, we have launched our first vehicle two years ago, September of 2007, we took delivery of it. And all the engineers were like little kids. I can tell you, after two years, we are still like little kids, we love the cars. The people who drive the cars are extremely interested. Over 80,000 people have raised their hand on this program in the three target locations of Los Angeles, California, New York, and D.C., 116 vehicles have been on the road, continue to be on the road in four countries, a majority of those vehicles are out of our hub in Burbank. We have deployed a little bit up here to support ARB and what not, but most of these vehicles are down in Los Angeles. We are about 80 drivers, and we are talking family drivers, we are not talking fleet drivers, we have business opportunities with Disney and those sorts of things, but this is really key to everyday people that have been in it. We have estimated pretty successfully about 10,000 people have driven the vehicle. And frankly speaking, I do not know if I have heard a negative comment of those 10,000 people. We certainly have

some sort of people who swayed to a different technology, that is understood, but overall, people who get in this car are pretty amazed, including me, who continues to drive it every day and am still thrilled with it.

Another part of our program, which I will talk a little bit more, but 13,000 fills -- a lot of people talked about how the infrastructure is sort of coming along, it is, really in that year and a half timeframe, 30,000 kilograms is not insignificant. Obviously the gasoline saved there is something we are pretty proud of. Two winners -- in New York, I continue to see people scraping their windows of their fuel cell vehicles, another cool thing, these things probably were not thought of years ago, we have vehicles sort of 25,000 miles plus on them continue to generate amazingly so, any engineer in this room will tell you, the cars that drive the most are your best cars. So those ones that have 25,000 miles on, we are pretty most impressed with, we see the longevity of those cars continuing. And recently, everybody has heard, we have announced a million miles on the program in roughly those 18 months.

The other half of our program has been and continues to be -- I cannot sit up here and tell you GM is not committed to the fuel cell technology without telling you, yes, we have spent $12 million on infrastructure for our program. It means something to us. People know about

these stations. We went out there partly to support our program, partly to support the industry, and partly for our leadership to learn. We understand an infrastructure probably about as good as anybody out there at this point. We own, lease, install, operate and maintain all the way around on these. It is actually not the last year, it is 13 months now, we actually did first fills on another eight fueling systems in this country, three of those are sitting in Los Angeles, and at least two of those will be opened up to our competitors. We know all of the equipment providers, we continue to understand their technologies, we help them, we work with them, they work with us. It is an open dialogue at the end of the day. We are all over the world, people understand that. And really, when it comes down to it, why are we doing this? There is a lot of learning. Project Driveway is about learning, and obviously the technology development is a huge piece of it, and likewise the project management, you know, a lot of people come up to me and say, "What do we need? What do we need?" DOE asked me several weeks ago. And I will tell you straight up, we need Project Managers. We need to take this out of the sandbox and start making it happen. The technology is there. We are on the right path. We are certainly heading in the right direction on every level, now we have to sort of -- let's go execute a market. We have a lot of data,

continue to have a lot of data. We have systems with over 5,000 kilograms on them. In fact, one of those systems was the cheapest ones we installed. And one of the problems with not only myself, but the company, is the handshake to first fill at LAX, that clean energy station sort of showed an example of, you know what, we do not need a year and a half to install these stations, it could take five months. You know, a year and a half is a waste of everybody's time. That is why prices start -- you know, costs start driving higher, and those sort of things. So another one of those proud moments for us.

So next step, obviously we have 115 vehicles on the road, we will continue to have those vehicles on the road, give or take some, depending on situations. I think you have heard it from others, and I will reiterate it, the fact of the matter is, we are not going to go play in the sandbox anymore, GM is not going to probably sit around and do another 100 - 200 car fleet. Really, at the end of the day, I think we believe we have learned a lot of what we are going to learn, not to say we are not going to continue to learn, but, really, we are going to take the existing fleet, we will put in -- you will see some slides here -- "some technology insertions," meaning we will basically beef up the robustness of that fleet, and what we are doing right now, it is really putting our hands around what does a

reasonable automotive volume look like, how are we going to go do that? And I am sure most everybody here will agree, that is where we need to go. You can only play so much, if you will.

Here is the timeline. This timeline is something we believe in, we are shooting for 2015, sort of for these reasonable volumes. There are no numbers on that, and there is a reason why there is not, it is because of that bottom line. There is obviously some risk associated with the current environment, which includes, let's take today's vote, if you will, government policy, the ongoing infrastructure initiatives, we have to get there, to be honest. You know, GM cannot go and spend a lot of money on infrastructure again to be able to support a fleet. We need this to be sort of everybody involved in it. And also, I think it is fair to say these early vehicles are going to be somewhat more expensive and we need some sort of incentive to drive the market.

Some of you may have heard, we announced our fifth generation stack, and I have actually seen it in the lab working. Right now, it is sort of sitting up there, it is what you guys saw in the press release. Right now, the Project Driveway vehicles are sort of early development vehicles. The program life is, "Hey, go execute," really a full program, it was not, "Go execute a stack," if you will,

it certainly is a big piece of it. Right now, as we speak, we are doing those updates, those technology insertions to really drive forward. You can see in this slide our gut and these are sort of volumetric, if you will, we are going to double what we think our durability is on the stack. We are certainly moving towards those places. Our commercial stack, if you will, the fifth generation, meets every expectation.

Likewise, you know, when you talk cost, you are going to talk platinum, when you talk cost, you are going to talk about simplicity of the system, our fifth generation stacks are really driving out a lot of those costs. I think we had 220 pounds lighter stack, it about fits in the size of basically a 4-cylinder, it is roughly the half of the size of the existing stack in the Equinox, so we are really driving forward again to get to these things, so there are steep learning curves here -- in the positive direction.

So, if you will, largely the left side of the enablers is going to be economics driven. It is, I think, why we are here today. If we had the perfect business case out there right now, it would be being done, if you will. So what we really need, really, to drive forward the program is we need DOE funding involvement, certainly. We need development investment incentives for the OEM suppliers. We really want to continue along this path. Like I said, we

are not there, but we are heading in the right direction. And then, likewise, how do we incentivize the market side of things? The tax credits, the education, you know, carbon taxes, all of these things have to be a part of this policy moving forward.

The barriers, I think we all pretty much get it. I am not going to sit here and beat it into you, but certainly the cost is one side of thing, the infrastructure is another side of the thing. And right now, it is sort of the last bullet on the right side, as well as sort of the summary there, is we need some certainty, right? We need to understand how to drive this industry forward, and that sort of starts with our leadership in the country saying, "Hey, you know what? This makes sense, this is the path we are going to take," and sort of everybody jumps on board, if you will. And that certainly, in my opinion, would apply likewise to California. We have led the industry, to begin with, and we should continue to.

So where do we stand, sort of a little bit in summary here, frankly, I believe we are among the leaders. We have over 20 years of involvement in this, a lot of dollars spent. We continue after two years to brag about having the largest fleet. We basically believe we have the strength in all of the technical areas that we need to really drive this forward to the next step, these reasonable

automotive volumes. We estimate that the industry, and this is probably underselling it, there has been a lot of money spent, likewise. So you know, where do we go? We really need to balance the high volume introduction with the infrastructure, I think everybody has said that, I will give you another answer on the next slide to that point. We really need to focus everybody on sort of these policies that are consistent and longer term, both at the federal level and the state level. And certainly, the economics of it really help drive getting over this network effect. GM continues to aggressively pursue fuel cell technology. We sit up here very proud of where we have gone, and we are very proud of where we are going on this. That being said, there is a lot of risk and certainly in light of the current financial situation of this company, we cannot afford to ignore that. That is the honest truth at this point. We really need to basically get everybody together again on the policy side, and push forward. So the requests -- I have sort of said that, again, we really need to focus on the existing infrastructure, make sure that is good, build up some new stuff, we really need to keep sort of the conversation going at the DOE level, I think we all appreciate we were a little bit blindsided by what we thought was going to be an open administration, so obviously we need to continue to do outreach at every level, all the

time, and not rest on our laurels. And, frankly, one thing that I think extends a little bit from the great work that the partnership has done through the Action Plan is really to revisit how do you do hydrogen in this state. I think it would be a wise dollar spent, if you will, if we really sit down and start to integrate a lot of what Gerhard said, a lot of what Bill said, a lot of questions you have. This is becoming a very very complex problem, given how many laws there are in different places, the fact that renewables are here, and really, to take the Action Plan, how do we go execute the Action Plan? In some cases, I think there are notations there to go do that, "Hey, let's go to these communities and educate these people," and those sort of things, but how do we get from the natural gas to the renewables? How do we understand the requirements, the risks, the outcomes in these key priority areas? Really, to take a deep dive, in many ways these types of studies and market tools have been executed for Ethanol, and biofuels, they have been executed for other alternative technologies, maybe it is time to actually right now to evaluate in the next three to four years, before that, but we were going to use in the next year or so, to really drive down how to go make hydrogen happen. What does that mean in terms of renewables? And, of course, I am not a person who offers up a problem without a solution, GM is certainly willing to

help every aspect of such an effort. So that is the end, in case you did not see, that is a real picture, what our latest news release was, I believe last week, I think last Thursday, as part of the DC -- it was announced from Charlie Freese and whatnot. So I am done. Thank you. I go fast, so I apologize.

MS. BARODY: Thank you, Alex.

MR. WARD: Yes, I have a question, Alex. Thank you for laying that out very well for us and we certainly feel your passion on this, as well. We definitely want to try and find a way through to make sure that we can meet, I think, what is the most pressing, which is providing the infrastructure to make sure that the trajectory for the introduction of these vehicles is steady. Toward that end, I think I am going to ask you, but I am not just going to zone in on you, but I think we will be asking all of the auto companies, is what is their take, and how would they help us in making a business case for the retail infrastructure for hydrogen. That is, using the resources that we have available in the most capital efficient way, to make sure that these are not wasted assets going down the road. And I do not even want to infer that they would be, but this is going to be a very strategic look at, as you mentioned, your corporation has gone through some economic turmoil, the State of California corporation has gone

through a little bit of economic turmoil, as well. So we can see that we are going to have resource constraints. And given that reality, and the fact that you and all the automakers have worked well with the energy industry over time to match up, and sometimes you are at odds, but to match up the vehicles, and the fueling infrastructure necessary to support those vehicles. I think we are going to be leaning on you, as well, and you mentioned that you would do anything in every aspect of this to help with this, so I am probably going to take you up on that, but we would like to get your best ideas on how we can actually transform this from a government supported program to a retail and thriving infrastructure for the time, and we have a few years now before the roll-out of these larger numbers of vehicles to come. So it is going to be a question of all our automaker friends and also of the hydrogen producers, suppliers, and those who will be a host for stations. This is really, I think, where the rubber is going to meet the road, so that we can make sure that our efforts here are not just one, two, or three years, but are sustainable over the long period of time, and have a trajectory necessary to achieve success.

MR. KEROS: They will partly be vague, not on purpose, but because I think the answers are, they are sort of ambiguous to a certain degree to begin with, in my

opinion. First of all, I am going to pass the buck to the energy guys, the equipment providers, because at least on that side of things, personally, I see that there are some technology improvements on the station side that we can certainly take, meaning novel approaches, we are not making hydrogen on-site, maybe we are doing it as a cluster city where you do five stations, but only one of those stations is producing the hydrogen, and we are shipping out to other areas. So I think there are certainly novel approaches out there that can be executed. That being said, my biggest learning on the infrastructure side of things has really been go do it. I will be honest, some people have heard me -- I did not have the luxury of a timeline that went out years. I got phone calls from my counterparts in Chevrolet, who are executing a marketing program and all these things we have said, literally at 6:30 in the morning, "Where the hell are the stations?" And so, that type of market pressure, if you will, really makes things different, it changes your perspective, it sort of forces you to go execute. I have heard in many cases, and hydrogen is not the only one, it is all alternative technologies, "Oh, it takes that long to do something. Why?" That is the question we have to start asking ourselves. Why does it take a year and a half to permit something? And if it does take a year and a half to permit something in, let's say,

the City of Los Angeles, why aren't we doing something about it? So, in many cases, the simplicity of the answer is go do it. See where the weak points are, and then come back and start to fill in those gaps. To date, we really do not have a lot of good examples. Really, we have -- Gerhard said there are four retail stations -- the honest truth in that, there is probably one or two that, really, you could say, "Yeah, those are retail stations." So we are sort of the cusp of, "Okay, how do we go execute these?" And, again, to a certain degree it is the project management side of thing, to go and do. We really have to put some aggressive timelines on these things to go make them happen, and go make people -- we do not have the luxury of sitting around and waiting. I think Gerhard's slide, if I saw anything that really tells us that, if you are trying to get to 2050, you have got to start now. You have to start now. It is the power of -- so really, in one respect it is go do and really put some aggressive timelines on these that, you know, other industries put, you know, if not done by December 1st, you are going to start paying us, those sort of things, and I know that probably worries people, and I am not suggesting it happen, but I am saying maybe those are the type of situations that we have to start putting out there. In the same vein, that means it calls -- I will say -- the OEM's bluff, right? If you are going to put that

much pressure on people to go execute the infrastructure side of things, the cars have to be there. Right? If you put out 40 stations and they all look very good and we are sort of sitting around going, "Where is the infrastructure?" And it comes, really, now you put pressure back on, in my opinion, the OEM's to go start putting out product. So it is a little bit of a balancing show. Where I know there is a lot of good work that has been done, but we really need to balance the two carrots and sticks along the way, near term, to go execute it. So, again, it is somewhat vague in the respect of how do we do it, but I think we need to go do it. We need more examples under our belts to say, "Hey, you know what? Clean energy LAX took five months." And you know, what, to be honest, it probably took too long. It took me a month and a half to get the inspector to sign off on it, on an air compressor. So, I mean, and that is -- obviously, you see my perspective, it is a lot different than others who, you know, we are waiting for stations to a certain degree, so to me it is really knuckling down and making some of this stuff happen quickly, in constrained timelines.

MR. OLSON: Alex, this is Tim Olson. I wonder if you could, along the lines of your comments, elaborate on -- it sounds like you have 50 Equinoxes in California now, and are you willing to show us where your customers are located to help us in the siting of the stations?

MR. KEROS: The honest truth, and I have said it, and I am not going to speak on behalf of my counterparts, we go where the stations are. The first 10-15 stations, while I want a specific location, let's call it Santa Monica, let's call it Airline Torrance, the ones that we put out there in the Action Plan, those are real locations. But if there ends up being a station in Burbank, I am going to take advantage of it. It will get flushed out. So our customers have moved around with stations. Before our LAX station opened up the South Bay for ourselves and we went and basically tackled some customers there. As Culver City opens up, it basically makes Santa Monica and Culver City a little bit more attractive to go do. So I have said it, I will repeat it, I really think the next 10 stations are not difficult ones. I put in Culver City based on location. I put in LAX based on location. I put in Burbank based on location. People go there, they use them, they like them. We know LAX is a destination point and we know it is a good middle area. It does not show up on a California Fuel Cell Partnership Action Plan, but the fact of the matter is, some of those destination points need to happen in support of these clusters. People get in these cars and want to go. It takes them about 24 hours, they use up one tank in 24 hours every time, we hand them the keys, they use up for us about 200 miles, and then they come to us and go, "Hey,

there is a station out in Palm Springs, can I go out there?" It is so quick. The people get in this car and they -- the great thing about a fuel cell technology, you prevent some of the range anxiety, and people get it. They take advantage of it.

MR. OLSON: Maybe I can ask this question another way. So are you saying that the existing stations set up satisfy your customer demand?

MR. KEROS: We have developed a program to do that.

MR. OLSON: And that is to move the stations?

MR. KEROS: That is because, yeah, I mean, like I said, we put Culver City in because that made sense to us, Burbank, we have people going around Burbank. If we put something in Encino, I can tell you, my leadership will say, "Hey, let's go out to Encino and make something happen over there." It is certainly early on, in my opinion, we do not have to be so exacting. It makes a lot of sense, we have done a lot of coordination, and I certainly think there are some early target areas in the Action Plan that are honest, Torrance, Irvine, Irvine - Newport, same thing, Santa Monica, all make sense. Burbank, to us, makes a lot of sense, as well. They are our neighbors. So these early stations, the good news is we do not need 200 stations to make a good go of this. We really need probably 40-50. And

the funny thing is -- no, it is serendipitous -- but, you know, our studies show 40-50 stations in LA, partnership studies show 40-50 stations in LA, you give it a good go, it really makes it happen.

MR. ELRICK: Can I comment on that, Tim? Because I think that is a good question to ask all the OEM's, the half dozen or so up here, and as Alex described, they are all going to have their top preferences slightly different. But what the action plan did was collectively put all their input and thoughts together and said, "If we do this as a group," and that was what it was all about, "…what locations make the most sense?" So Alex points out Burbank which, in our model, was one of the secondary up and coming communities, because we recognized the importance there, but the four in LA, also San Francisco and Sacramento, were collectively where all of them said, "We can make it go in these locations." So I think you should ask them, and hopefully they will give you some details, but that is why those four communities popped out in LA.

MR. OLSON: Yeah, I guess any information you are willing to share with us, so, for example, if you are using the mobile system moving around for your customers, how did that work? If the station in Burbank -- is it used? Is it not used? Do you have any customer complaints about it? Those kind of things are of value to us.

MR. KEROS: Our mobile stations really were designed to sort of be semi-permanent, to be honest, so when we went and installed the equipment at LAX, Culver City, even Burbank, really, when we call them "mobile," it is probably not the air products with wheels attached to it, they come more, you know, bring a flatbed truck and move them. Again, we strategically located those because it made sense along the 405 Corridor, that is what the industry made sense, and likewise we wanted to open up target areas, the LAX station sitting at 105, and the 105 and the 405, you can go anywhere. So the answer to your question is, yeah, I mean, we are certainly willing to share what we can in that respect. Obviously, some of the work that I think UC Irvine is looking at doing, and those sort of things, it really starts to open up the customer perspective. But I can tell you, the customer perspective is, "I want to get going." You know, the second customer we had was -- the second day he had the car, second customer, second day he had the car, he was out rock climbing in Riverside.

MR. OLSON: Another comment on the -- so you have your 50 Equinoxes, you are in your fifth generation, do you anticipate any increase in that number in the timeframe we are talking about that Bill presented in 2015? Are you expanding that number in California?

MR. KEROS: No. Cars could move around, but

nothing significant. Ten to 15 cars here and there, but I would not see an increase.

MR. OLSON: And, in essence, this is kind of a refurbishment of the Equinoxes -- are you expecting a cost reduction in that genre?

MR. KEROS: Absolutely, yeah. Cost reduction, durability improvements, not at liberty to say, but significant improvements in range and the fuel economy associated with those.

MR. OLSON: Again, if you are more willing to talk about details, we are very interested in that.

MR. KEROS: Understood.

MR. OLSON: Thank you.

MR. KEROS: Thanks.

MR. ELRICK: Thanks, Alex. Next up on the schedule, Robert Bienenfield from Honda, for the Honda perspective.

MR. BIENENFIELD: Well, good morning, everybody. And thanks for inviting Honda to present our hydrogen program and infrastructure needs. I really appreciate this opportunity. Here is one of our customers in the South Bay, actually, in the Newport Beach Area, and we delivered in the last few months. I think we are here because everyone recognizes that hydrogen is a great choice, even with whether it is fuel cell, electricity generated -- sorry,

fuel cell, hydrogen generated from electricity, or even with methane steam reforming, it is quite efficient with zero, tell by emissions. When we look at greenhouse gas emission on a well to wheel basis, compared to a conventional mid-size sedan, the clarity in California is -- there are two numbers here, one is 68 percent reduction, the other is 74 percent reduction, and the 74 reduction represents SB 1505 conditions that one-third of the fuels generated with renewables. So actually we are looking at a nearly 100 gram per mile car in terms of $CO_2$ equivalent, which is tremendous and even lower than some of the estimates for electric vehicles.

Over the last seven years, we have been able to effectively increase the power to volume ratio by a factor of 4, and increase the power to weight by a factor of 5, and the result is a very compact, efficient, and powerful fuel cell stack. We are looking at the introduction step by step, we are in the limited introduction to market phase, with the period that we are in now, where we are looking at improving durability and reliability, extending practical range, and working on cost reduction, towards some mass production stage in the near future.

As I said, our first customers have been delivered already. We have got 10 customers so far, starting from July of last year, so about a year. We have got a fuel cell

dealership network that is in place in Santa Monica, Torrance, and Costa Mesa. They actually find the customers and make all of the delivery arrangements, and are responsible for the relationship with the customer. And we have got some dedicated fuel cell production at our factory in Japan.

So we think the fueling infrastructure, the dealership network, all of these steps are important towards realizing a fuel cell market. Everyone has talked about our three target markets, which we concur on, in Santa Monica, the South Bay, and the Costa Mesa - Irvine area. We have actually taken our needs down to the street level, or cross street, where we think we need infrastructure, and we are trying to shift the paradigm from chasing infrastructure to being more market driven. I mean, right now, we have tried to find customers where there are stations, and we are trying to move it the other way around so we can build some momentum. Our idea for market driven infrastructure, I think the industry has really coalesced around these ideas, the cluster concept is to start with small communities, identify the key streets, the highways, or between communities and destinations like work centers, resorts, and airports, and we need to develop clusters within those communities. There has got to be redundancy and back-up with primary about five minutes from the home, and back-up

less than 15 minutes. We think it is real important to have a Marquis kind of station that is an image station, where we can show people the potential, as well as the smaller back-up community stations, they have all got to be retail oriented for our consumers to find the refueling infrastructure acceptable.

I think several people have mentioned that fuel cells have been under attack. DOE had their funding cut, and the auto industry has been facing financial trouble. And even the CEC funding for hydrogen was under attack. We think that the reason for that is there has been some feeling that it is a zero sum gain and if hydrogen gets money, then that is money not going towards some other technology. But I think people are beginning to recognize, as was shared by Gerhard, that in order to achieve our long term goals for the state and certainly globally, we need all the technologies that we can bring to the market, including fuel cell. You cannot get there alone with just one pathway. So I think, as a couple people have mentioned, continuous long term support is crucial to the successful deployment of fuel cell vehicles.

We have strong support for fuel cell, we have gone, together with the industry, and met with Congress, White House, the DOE, and that seems to be bearing fruit. We think that funding is going to be restored. Our Clarity

Program is functioning well and surpassing expectations. We have had to slow down some volumes to match infrastructure deployment uncertainties, and certainly global economic challenges and other challenges, as well. It is early in the infrastructure building phase, there have been long delays between contract award and station opening. Even CEC's aggressive action to open stations could take another year or two, and station openings often include ramp-up issues, so that after the press conference, you are not really open for routine business. There is a learning stage in making sure that all the bugs have been shaken out.

And there is also an issue of the leadership and commitment in the partnerships that are developing these stations. We have had, in some cases, weak or uncertain partners at the retail, distributor, or energy partner level, and yet strong interest, of course, from equipment providers who want to sell equipment, the public funders like CEC or ARB that want to develop the stations, and certainly the OEM's that have a compelling interest in launching the stations. So we need to think about ways to kind of equalize the interest of all the parties involved.

We understand from discussions with CEC about our infrastructure needs that there is a challenge here, everyone is afraid of building infrastructure that is not used, and I think the OEM's are concerned about making

public commitments about volumes that may change as technological issues arise, or other barriers come up. And we have got a small proposal here, and that is, to reduce the risk of stranded investments, and to increase certainty, that what we could do is come up with a number, and my proposal here is something like 25 customers per location, to say, "Here is a market where we think we can bring 25 cars in a certain timeframe, let's say 18-24 months, from station development." This would give the investors like CEC an opportunity to focus on a location where they know that vehicles are going to materialize. And you have got the risk of stranded investment lowered, and the incentive that you are providing goes to the infrastructure, not directly to any OEM, or to any consumer. And, in fact, on a per vehicle basis, you kind of start off with a high cost per user, in this case, I am thinking 25 customers for many a $2 million station, is something like $80,000 per customer, but it declines over time as you backfill and find other OEM's who are going to market in that area with their own vehicles, so that more vehicles show up and the effective cost per vehicle goes down. We think that that might be a good compromise from asking every OEM to commit to a specific volume for each year. This way, we could focus just on the gaps and start to grow the infrastructure in a kind of a very careful and intelligent way. It is not

practical for the OEM's to share with each other where we plan to market the vehicles, but we think we can do that through the Fuel Cell Partnership, and I think the document that they have shown is a result of that kind of thinking. So this is to just take the Fuel Cell Partnership document and make it a little bit more granular, so that you could have more confidence in your station funding efforts. And that is it.

MR. ELRICK: Thank you. Questions for Robert?

MR. OLSON: Thank you, Robert, very good presentation there. I would like to ask you, in your interactions with DOE, and your kind of urging to try to get them back into this, are you -- I guess the question is, are you interested in government investment, whether it is U.S. DOE, or the California Energy Commission, or CARB, in vehicle prototype, or advancing the technology as an investment, as incentive investment?

MR. BIENENFIELD: Could you rephrase the question?

MR. OLSON: I will give you kind of a frame of reference. This may not be completely applicable, but we have set aside a pretty significant chunk of money for advancing technology in a couple of areas, hybrid electric technology, non-petroleum platforms, in the medium duty/heavy duty area, and in fact, hydrogen would be one of those candidates for maybe a bus technology, and it is

really pushing the technology to the next level, and with some of the medium and heavy duty, the costs may be in the range of -- from our investment -- in the range of $3 million per prototype demo. Is there a need for that in the passenger vehicle area, in this case in hydrogen?

MR. BIENENFIELD: Yeah, I think it is a great question, and what I would say is that, in the volumes that we are doing now, which are I would say not as limited as prototypes, but certainly a lot less than any mass production volume, the costs have been borne by the OEM's, I think without substantial incentives. I cannot speak for the industry, but from our viewpoint, at this level, we do not think we need incentives for the vehicles. The challenge comes in I think the next step up in volume, so in the kinds of volumes we are talking about, through 2014, probably not. But when we get to a step up in trying to cross the Valley of Death, I think we are going to have to really think a little bit more creatively because the challenges there can be enormous, even for large companies. So I do not think we have come down firmly on that specific issue, but I would say for the near term not such a big problem.

MR. OLSON: I have another question about your manufacturing. Do you make any of your components in California?

MR. BIENENFIELD: Yeah, the tank is made here.

MR. OLSON: That is something I think we would like to talk to you more about, just from the -- another initiative we have is we are about to announce is this manufacturing plant located in California, an incentive program that would be targeted for components -- batteries, whole vehicles, and we have got quite a few companies that are interested in this. The point of it is, some part of that is in California, that means more jobs here.

MR. BIENENFIELD: Absolutely, and we would certainly like to have you be in touch with our supplier on that.

MR. OLSON: I also wanted to thank you for your frank discussions not only in the public meetings, but also in our private meetings about where your company is going and how we can make this work with our program here.

MR. BIENENFIELD: Sure.

MR. WARD: Robert, again, thank you for your presentation. It was very clear and to the point. I did have one question. You had a reference in one of your slides that said 80 and 20, and I do not think you hit on it, but I would like to know what that refers to.

MR. BIENENFIELD: Oh, I am sorry. That should be 80 and 50. It is a little too aggressive. Sorry. Thanks for picking that up.

MR. WARD: And I will get to the question that I posed to Alex, as well to you. How do we reach out and have you folks from the auto companies help us in reaching out to the energy side of this, to make sure that we can plan not just for the future, you mentioned CEC as an investor, and how do we get to the point where we can back out our investments in this? I think it is politically unsustainable, as we all can appreciate, this cannot go on forever, so we would like to really enlist your support to help us with the energy companies, the fuel providers, how can we make this a business proposition going forward in a balanced way? And you had one question, how to equalize the interest of all parties, and I think that is the crux of the issue. Apparently there is not the same interest on the energy side as there is on the OEM side, and so that is something we would like to get to. I do appreciate your willingness to kind of slightly alter your needs as infrastructure is rolling out, and I like the idea of focusing your vehicles where the stations do exist now, it is a practical reality and I think it is one that is really helpful. So, I just wound up, and now here is the pitch -- and how do you think we would employ the good offices of the energy suppliers, the energy companies, in general, the retail oil companies, in making this a more balanced proposition going forward, and understanding that the public

funding of these stations is not tenable or sustainable for the long term?

MR. BIENENFIELD: Well, I do think that you are an important investor in making this market happen in the near term, and I would say that, you know, I heard you use the language of "making a business case" when you talked to Alex, and I think that, between now and 2015, 2018, I do not think there is a business case, I think you are in the investing phase, and you are enabling the future of a business case, I just do not think it is here in the near term. How to create greater interest on the part of some energy companies, I think there are some policy ideas that could be explored. I think what Gerhard showed earlier about kind of the ways in which you may or may not get credit for making an effort like this in your LCFS requirement, for example, there is an opportunity where the energy companies are under enormous pressure to comply with LCFS, maybe there are some ways of generating incentives or credits for participating early in these kinds or programs. But I am not an expert on that, but it just strikes me as an obvious place to start.

MR. WARD: Great. I am not denying that we have a role now to help with this at all, I am just trying to look out in the five year to 10 year horizon to see, you know, we are going to have to get to that point someday, and the

sooner we think about it, the better off we will be, and you mentioned also thinking and investing creatively. I think that is really everybody putting their thinking hats on here to see what are the best mixes of regulations and incentives and continued -- and introducing private support for these things because it is going to have to come in at some point, and so I guess I am asking that you would be willing to shoulder some of that effort with us in a cooperative way.

MR. BIENENFIELD: Sure, absolutely.

MR. WARD: You always have been, I fully expected that answer was yes, and so I look forward to a continued cooperation you have shown to us in the future, that is, I think that is kind of the crux on where we need to get to, whether it is in five years or 10 years from now, I think we have to be able to back out of our investments and make sure these things are viable, and so that everybody has a vested interest. You folks have one now for regulation, perhaps the energy companies will be having a vested interest through other means, as well, in the future. We will leave that open at this point.

MR. BIENENFIELD: Absolutely.

MR. ELRICK: Other questions for Robert?

MR. BIENENFIELD: Thank you very much.

MR. ELRICK: Next on the agenda from Toyota, Mr. Justin Ward.

MR. WARD: Great, thanks. All right, good morning, everyone. Thanks for giving Toyota this opportunity to come here and share some information with you. This is kind of -- I am going to give a summary of our progress and our challenges in our fuel cell development program over the past few years. I have a bunch of slides, so I think I am going to be competing with Alex on talking speed, but feel free to interrupt me at any time to slow me down or try to get some more information on these slides.

First off, I am just going to start by comparing electricity and hydrogen because we get asked that a lot, how do we feel these technologies play together. One thing we like to show, and it is a slide maybe everybody sees, is the volumetric energy density comparison, you know, when you look at energy density from a volumetric standpoint, for lithium-ion batteries, you can see as they compare with hydrogen, hydrogen does have a much higher volumetric energy density, but both are far lower than conventional fuels like gasoline and diesel, so there are challenges for these alternative fuels to really be able to provide a suitable alternative for the customers. We think have shown, I think, through our latest vehicle that we can achieve the quick charge, long cruising range, through our hydrogen technologies, through our fuel cell vehicle, but that is going to be a very hard target to reach for the current

generation of lithium-ion batteries, and even the next few generations of lithium-ion batteries.

The next comparison is where to fuel cell vehicles and batteries compare when it comes to range. And so, what this chart shows is, if you look at battery mass or volume, compared to range, that you need to -- that the battery mass or volume, you need to have a certain range. We have our RAV4 EV that uses a nickel-metal hydride pack on that solid green line, you can see there that if you want to get a 300-mile range, a practical 300-mile range, not a test cycle range, but a real 300-mile range, it is going to be pretty hard to achieve with a nickel-metal hydride pack that we use in the RAV4. If we look at lithium-ion batteries today, and we look at technologies for lithium-ion that are not out yet, but may be out in the next few years, you can get to that dotted line. Looking at that dotted line, you may be able to touch on the 300-mile range, but your mass and your volume is 2, 3, 4, times that of what we are able to do today with our SCHV system, this includes both the fuel cell and the hydrogen storage system.

So this is just kind of to give you a sense of where those technologies are in comparison to each other. Now, that usually leads people to think we are very negative about EV's and I get hammered all the time on the blogs about our position on EV's, but the reality is, we do think

that EV's are going to be part of the market, and they are going to be in that short-range, small commuters. And the people that cannot afford to have a second car, maybe they are going to move more towards the plug-in that is using a biofuel, but we do think a big part of the market is going to be managed by the fuel cell vehicles, specifically the large to mid-size passenger cars, as well as buses, that we saw earlier today, and then we will hear about later this afternoon. So we do think that fuel cells are going to be kind of the key, one of key players for a future sustainable transportation system.

This is a comparison of total efficiency. Here is another one that gets me in a lot of fun. This one shows the well to wheel efficiency, and you can see here that the fuel cell vehicle has a pretty big advantage compared to some of the other technologies. Of course, when you look at some of these assumptions, you can see we have for hydrogen production efficiency 67 percent, this is membrane separation in combination with SMR. For natural gas, we have 39 percent, and that has to do -- it seems low, but when you consider combined cycle and transmission losses, and local losses, it is not so off numbers, it is relatively close. But you can see the big benefit from both of those technologies come from the vehicle side of efficiency it is enormous, it is very very high compared to even our Prius

that we sell today. So one of the takeaways from the slide is do not look at it as picking a winner because, as I showed before, we actually think that there is going to be these technologies that live together to really fit a sustainable transportation system, and really what this slide shows is, although the fuel cell vehicle has a big advantage here, the reality is it is going to be fuel cells, electric vehicles, and hybrid technologies, maybe through plug-in technologies that really do form the pathway for a sustainable transportation system.

This is the evolution of our FCHV. We were the first to lease these in Japan and the United States in December of 2002. I think we might have beat Robert by about an hour and a half. But pretty much we are really happy about getting those vehicles out and, since then, we have made lots and lots of changes similar to what Alex had mentioned earlier today, you know, it is really an evolutionary process with these vehicles, and what we have experienced lately is very exciting for us, and hopefully out in the industry they find excitement, as well. But our current FCHV, the FCHV-adv, we wanted to add some more letters to that, it stands for Advanced, that vehicle currently has demonstrated cool start up capability to below minus 30 and it has a range far exceeding 300 miles. So we are really excited about those key criteria which were

unsolvable back in 2002. We now feel we have good solutions for those.

There are two remaining technical challenges that we have not been able to meet yet, but we feel we are getting very close, that is our stacker ability and our cost reduction. On this timeline, you can see that 2015 that has been mentioned a few times, this particular 2015 slide came from the SECJ Conference, I forget what that stands for, but I think it is defined later, and basically we got the automakers and energy and government together and we talked about where technology was, the timeline for development of these technologies, and we tried to find out when will all these technologies intersect to when commercialization can happen, and in Japan that number was 2015. When we looked at the United States and we tried to have these similar type discussions through the California Fuel Cell Partnership, and that 2015 number still looks reasonable, but it is not going to be across the entire U.S., it is going to be impossible to try to get stations across the entire U.S. But when we looked at cluster-based deployments, there is some feasibility to do cluster-based deployments by the 2015 timeframe.

Here is specs for our latest fuel cell car, this is a picture of the Japanese model, you can tell by the steering wheel being on the wrong side in that little mirror

there. The key takeaway from this slide is that, if you look at the LA four-drive cycle, our total range is about 455 miles, and our fuel economy on that drive cycle is about 72.4 miles per kilogram, or miles per gallon equivalent. So we are pretty happy about that achievement. Early last year, we actually were approached by the DOE, they really wanted us to prove that the car could actually do it, and that it was not just some kind of gimmick we were trying to play with everybody, and so they asked us to do a real world evaluation of our car. So it took us a long time to figure out what route we would want to use, and get the contracts and everything set up, but we ended up on this route which includes about a 50 percent mix of freeway and city drives, and the total length was about 330 miles and, during this drive, we had representatives from NREL and SRNL actually in the cars with the drivers to make sure we were not gaming or hyper-miling, or doing any kind of weird driving techniques. And following the flow of traffic along this entire route, we were able to achieve a fuel economy of 68.3 miles per kg, which if you do the math comes out to a range of about 431 miles. So very very impressive numbers. I think everyone who was involved with this was very happy with the results.

This imagine, maybe many of you have seen already, this shows the minus 37 start-up that we had done with our cold testing a few years ago. The picture in yellow is

actually kind of funny, that is actually below minus 37, it is a little under minus 40, but that was actually a PR shot, so we did not actually have the data to show, but the reality is the car can perform, even in temperatures below minus 40. And if you do not believe me, you can ask Jared Farnsworth, he is our engineer in Sacramento. He is the one that is lying in the snow to take this picture.

So cost reduction is one of the big things I think that a lot of people talk about with fuel cell technologies, so there are a lot of naysayers out there that we cannot get the cost down. And this is a cost reduction curve that we showed maybe as early as 2002, and from that point, we were showing, okay, well, starting at that vehicle cost, we really need to drop the cost by 1/100$^{th}$. And we know that we can drop the cost one-tenth through mass production just normally, we know that we can experience that through mass production. So, really, the key is how do we get that initial one-tenth cost reduction down from these first generation vehicles years ago? And there are a lot of people out there that say we cannot do it, well, I can report to you today that we can do it, we are doing it, and in some cases, we are ahead of target on our cost reduction curves. We think that, by the 2015 timeframe, we will be able to meet all of our cost reduction targets, and be able to get these vehicles out in a way that makes sense.

How are we going to do that? One way is through simplification, through the fuel cell system, hydrogen storage system, simplifying the stack, downsizing, down-weighting, reducing the platinum amount. Alex at GM showed the great image of their latest generation stuff, I think we are all really working hard to get those kind of same achievements. Materials, you know, making sure that the materials we choose make sense and that they are a lower cost. And then mass production technologies.

These are intended to be videos, but they are not going to play, but I can show you guys afterwards if you are really interested to see it, but what these videos are showing is what we have done to improve manufacturing. The web handling on the left-hand side, when it was originally flowing, it transfers -- basically, it is a thin film transfer system, it transfers then films about 50 meters per minute, that is not good enough if you want to do real mass production, so what we have done is we have improved that to over 180 meters per minute. On the right-hand side on the very top are fuel cell stacking machine, I guess you want to call it, and basically in the past the stacks were actually lined up by hand, there was some guy who literally stood there and dropped them down. Now, we actually do this through a machine, and the machine, of course, has much better accuracy, much better reliability, and we know we

always get the same product. And then the last one is the tank wrapping machine, and I wish this video worked because that is one of my favorite ones. The machine that you see here is the state-of-the-art machine that we had bought from an external company outside of Toyota, it is the best machine money could buy for tank wrapping. And it is a great machine, good results, but our guys hated it from the very get go, we hated it, it was so slow. It does not fit any kind of mass production scheme, so we started trying to work with the manufacturer to improve the design, but they were not willing to work with us. So we decided to make our own tank wrapping machine, and later I will show you, but our own tank wrapping machine actually increased the speed six times compared to this state-of-the-art machine, and not only did we increase it six times, but our project variability was way way decreased, so much improved compared to the original product, and our consistency was much much better. So we made huge huge progress in that, and we think that we only hit kind of the very beginnings of the improvements we can make on all of these technologies.

So how do we get to fuel cell mass market introduction, which is what we are here to talk about? And really, we need to make sure that we get some kind of benefit for every stakeholder. The vehicles need to be able to come out in a cost manner that makes some sense, the

energy providers need to get some kind of benefit, and most importantly, the customers need to have some kind of benefit without a proper balance of these key stakeholders, then what are we doing? So I think that is the challenge in moving forward.

There are many ways from an infrastructure pathways point of view that you can have a direct impact on that. But when we look at infrastructure, we want to make sure that we are always considering it from the right timing, right place, and right methods. We use that tag line a lot, in a lot of our materials, and it is really key not just for the vehicles, bringing the vehicles at the right time, right place, and right method, but also hydrogen infrastructure. Does it make sense if you have a small cluster to put in a huge network, a large station, you know, rip up the roads and put hundreds of miles of pipeline, if you have four customers in this one location. Can they be better suited with a mobile or some other application? And, for example, you do not want the opposite, you do not want a very small station with a whole bunch of customers, or you end up in situations where you cannot provide fueling when the customers need it.

This is breakdown of hydrogen cost, just as an example. This is the hydrogen station that was built in the Aichi Expo a few years ago, and this just kind of gives

people a sense of the difference in costs, when you look at the average cost of a gas station, to build gas stations on the order of about a million dollars. This is Japan, so maybe the numbers are little bit different. But you can see orders of magnitude do not change so much. And then you look at the building of the hydrogen station, this particular 35 mega station was $2.9 million, so you can see there is a big difference between these two technologies. And we need to work to make sure we can reduce that hydrogen station cost. And hopefully we are going to hear a lot about that this afternoon through those presentations.

This is just a little bit of a snapshot of the FCCJ and there is the definition -- Fuel Cell Commercialization Conference of Japan. And this kind of goes over how we feel the station and vehicles are going to have to roll out to meet that 2015 bogey. Looking at this kind of technology demonstration, kind of market preparation, early commercialization, and then full commercialization, you can see that the vehicle ramp is going to be relatively smooth, but the station ramp is going to be more of a step function, it is going to look more as a step function. And according to this FCCJ Plan, you can see in the 2010-2011 timeframe, there is a big increase in the hydrogen stations, and that is really kind of preparing the next phase of the market to get the customers more readily

to accept that technology. And then you see this additional big ramp in the 2015 timeframe, again, and that is really needed there to really kind of get that early commercial market up and ready. So in this early stage, there is going to be this kind of a period of, you know, with a station construction, maybe it is sped up, or there is a larger need for a station. But as we move in that commercial time, you will see that they will kind of grow in unison with the vehicle numbers. This may be easier just to see than it is to explain.

So in summary, fuel cell vehicles really are more suited for longer range and larger vehicle applications compared to electric vehicles, although electric vehicles are well-suited for short range commuter use. Toyota FCHV technology has been moving forward every year, every day, and now getting a range of well over 300 miles, and being able to start well under minus 30, which are key criteria that were not possible only a few years ago. Towards the 2015 target of large scale fuel cell vehicle introduction, we are really maximizing our effort now to address cost and durability improvements. We are pretty close on both of those, but we still need some time to dot the last few I's and cross the last few T's. And then, conditions for mass market introduction, really, we need low cost, easy access hydrogen supply network is a must, it is not a wish anymore,

it has to happen, or it is not going to happen. And then, further technical development and study of profitable business models for hydrogen supply networks, so maybe I am hopefully beating Peter to this question, and then a variety of governmental incentives are critical to form initial markets being on the 2015-2020. When we look at that further technical development and study profitable business models, I think one of the challenges we have is, when we look at how to do hydrogen infrastructure, we all look at it from our little paradigm and our experience, and I think the challenge that we are going to place out through the partnership and through our other efforts is to really start to look at it outside of our own little paradigms, and maybe we look at -- or maybe that forces us, or allows us to take an approach we could normally not do. And I think through efforts like at the Action Plan at the California Fuel Cell Partnership, we can realize a similar study and maybe come up with some very good and novel ways to find a profitable business model for hydrogen supply network. So that is the summary. Hopefully I did not run too long. If you have any questions, I look forward to them.

MR. ELRICK: I would like to start off with a question that I have not heard addressed yet, but from the vehicle side, when you are planning for vehicle deployments, how does the station -- obviously you need the stations

there beforehand, or you cannot deploy the vehicles because they have nowhere to fuel -- but when you are planning on from your end how long in advance do you need to see stations so that they do not disrupt those plans?

MR. WARD: Yesterday is fine. No, the reality is we -- depending on the model, for example, when we are looking at fuel cell vehicle development, or when we are looking at even conventional power train development, the cycles can be anywhere from three to five years in the planning stages. So if you are trying to set up your early market vehicle in the 2015 timeframe, that means next year you basically have to do all the planning, the preparation, and the materials prep so that you can start that production process or the design process to be able to implement production by 2015. So if I am looking at putting vehicles out in the 2015 timeframe, I really need to start to know where stations are going to be now, or at least within the next few months, so that I can make sure to line up the vehicle production with the station production. That is the ideal condition.

MR. ELRICK: Thank you. Other questions?

MR. OLSON: Tim Olson from the Energy Commission staff here. Could you elaborate on how many vehicles you have in California now?

MR. WARD: Right now, I think we just deployed

some on Friday, so I think we are up to seven or eight right now, and the number will continue to grow. And if the CEC wants to have our detailed numbers, then I would love to schedule a meeting to discuss our detailed deployment plan.

MR. OLSON: Yes, we would like that. I guess one other question is, can you give us a frame of reference on what you mean by mass production? At what level of mass production do you have to be to get that one-tenth cost reduction that you noted on your slide?

MR. WARD: Yeah. When we refer to mass production, we are just looking at typical volumes of vehicle production, so consider any kind of low volume vehicle -- what would be a good example of a low volume vehicle these days? Most of ours are pretty high volume. But looking at the tens of thousands of vehicles, you can get significant cost reductions.

MR. OLSON: And are you doing any of your manufacturing in California? Any component parts or any part of your vehicle?

MR. WARD: For our current FCHV-adv, no. All the components and the products are developed in Japan. But our testing and evaluation is done based out of our California office for North America.

MR. OLSON: I think we would like to take you up on the offer, hopefully if you are available within the next

two to three weeks for a meeting.

MR. WARD: Oh, absolutely, no problem. I can meet with you this afternoon if you really want to.

MR. PETER WARD: Thank you for your presentation. There was one development you mentioned, your long range capability with the vehicle has been enhanced. That is a definite achievement. And can you tell me what effect that has on the required stations and locations of those stations as we go through the development phase here from now and for the next five years? Are you meeting some of the needs from the station standpoint?

MR. WARD: Not so much because we are still -- from our idea, the cluster-based approach really does make the most sense, and we still need to have the home station, and so the customers will still fill there. What we are seeing now, that the customers have such a longer range, is that, like Alex had mentioned, they are far more interested now in filling up in far away stations, and so as we look at these different applications, we may see maybe a stronger need to enhance Burbank, or some other areas, that maybe we would not normally have been real strongly pushing. But right now, the data shows that the customers are just very very happy to be able to not have to fill up every day. They are very happy to be able to drive all week and only have to fill up once, or every two weeks, and that seems to

be a big big benefit right now.

MR. PETER WARD: The other point you mentioned, and I heard it loud and clear, is the low cost, easy access hydrogen supply.

MR. WARD: Yeah.

MR. PETER WARD: Can you relate what activities Toyota is undertaking in that regard to help us all pull together in that very important area?

MR. WARD: Yes, actually -- unfortunately, I cannot give too many details of what we are doing right now, but we have been working for the past couple years now to try to understand ways to develop new models, to realize a low cost solution, and we are now getting some confidence that our approach may work here in the United States, and so we are slowly now walking it through different stakeholders, we are going to talk to the partnership very soon to try to get a better understanding if it is going to work here or not, kind of the gut check. And if we get some confidence it is going to work, then we are going to be most likely handing that off to the partnership to run with it.

MR. PETER WARD: I would certainly like to hear more about that, maybe in that meeting we are going to have in the next few weeks about the roll out of new vehicles, that would be an appropriate time to do that if you were willing to.

MR. WARD: Absolutely, we would be more than willing to do that then.

MR. PETER WARD: Further, you mentioned that there is going to be further technological development and the study of profitable business model in anticipation of the question I was perhaps going to pose. I am happy to hear that, obviously, and I think we all understand the reasons for that is political, and sustainability, private investment continually, so I am happy to hear and, if there are initiatives that you folks are pursuing in that regard, I would like to hear about any studies that you have commissioned. As we are doing our Investment Plan, that is important information for us to fold in, if possible, even in early results.

MR. WARD: Okay.

MR. PETER WARD: Another mention you made was in the 2015 to 2020 timeframe, public investment will be needed. Our understanding was that it was needed now.

MR. WARD: Oh, yeah, it is needed now, so -- but it is going to continue to be needed into that early commercialization timeframe. I think that when you look at the FCCJ infrastructure preparation, there is almost a stair step function, and that is really the key -- you have the stair step function now, and then you have it again happening in the 2015, and those are kind of the key timings

that need to happen if we really want to realize a 2015 kind of early commercialization.

MR. PETER WARD: And not putting you on the spot, but I am asking more from a Toyota standpoint, do you really believe that public investment is sustainable for the next 10 years in this infrastructure development phase, as the principal investor in infrastructure that could be retail under certain vehicles?

MR. WARD: Yeah, well, I think that when we look at the infrastructure, and we look at how do we pay for infrastructure, everyone needs to play some part, whether it is through public funding, or private funding, or some combination which probably makes the most sense, of a balanced funding approach, and there are stakeholders and there are industry members that are going to be profitable in that industry when it exists, and so for them it could be viewed more as an investment opportunity. So there is going to be some balancing and harmonization that needs to happen. Considering that, we think there is a sustainable model that will get us through the next 10 years.

MR. PETER WARD: Okay, but I am saying, in view of the fact that you folks are developing much of your technology on your own, without public investment, or at least within the large public investment that is required of fuel stations, and so it is getting back to my question, how

do we reverse this trend that we are in right now, that public investment is essential for this, and when I heard that it was also going to be essential for 2015 to 2020, I have to tell you, that took me aback. I really think that if we are still in this model, public investment, a principal investor in this infrastructure, I think we are in deep trouble in 2015.

MR. WARD: Yeah, so it has to ramp down in that case, not as a principal funding source. We need to know how to ramp down in that same phase. But I do not think the private industry is going to be self sufficient by then.

MR. PETER WARD: Thank you.

MR. MUENCH: Just a small one. Would you mind going back to that slide, the pie-shaped kind of cost breakdown? Oh, sorry, Tobias Muench, with Energy Commission staff.

MR. WARD: If I could figure out how to work the thing.

MR. MUENCH: Yeah, that one, thanks. I would be interested maybe if people present at the panel here, maybe Gerhard or Alex, people with experience with hydrogen fueling station funding and construction, if they have similar numbers, if it matches their experience, and even other people in the room or this afternoon if we could talk about that kind of data, I think that would be important

data for us to know more about -- if anyone wants to comment or respond.

MR. ACHTELIK: The number, yeah, the total cost for the station that shows on the slide matches what we have experienced, and what we have sort of thrown in California, too, is renewable requirement throws in an additional cost. But we have started to collect individual breakdowns on the different components, and it does vary, but it looks in line with what we have found so far.

MR. KEROS: This is Alex from GM. Our stations have been cheaper. The focus has been on quick and fast deployment in some of these areas, so, you know, I actually like this chart, Justin. I have not seen it before, and it got me thinking, so I certainly would like to put together something like this for our own cost scenarios. I think there are ways to improve on at least that scale, again, depending on what you are trying to execute. You know, if it is 1,000 kilogram a day station, or 100 kilogram a day station.

MR. WARD: And I think that is one of the takeaways, too, from this slide. I mean, remember, this is 2005. Aichi Expo was not in 2005. So it is a little bit on the older side, this data. And we are talking about 96 vehicles a day fueling, so it is a relatively high capacity station. But, you know, there has been lots and lots of

progress on the station side since 2005, and I think maybe Ed Heydom or some of the others can comment on how accurate this number is today considering technologies that are available now.

MR. KEROS: And just to mention -- sorry to interrupt, but we keep forgetting there is a positive business model out there, it is sort of the guys in between that are losing money on this deal, but a lot of these suppliers are not necessarily losing money, so some of these component providers are making a realistic profit across the board, it is just we might not be seeing it sort of up front for some of these station providers who are not even capable of recovering some of their costs at this point.

MR. MUENCH: I think we would also be particularly interested in which ones of these components provide the greatest potential for cost savings. Maybe some of the folks this afternoon could say some details of that.

MR. ELRICK: All right, thank you, Justin.

MR. WARD: Thank you.

MR. ELRICK: I look around and I see we have Lance from Nissan on the schedule, but I do not believe he is here today, so we can go to Todd Suckow from Hyundai/Kia.

MR. SUCKOW: Since I see our time is supposed to expire for the morning session in one minute, what is the --

MS. BAROODY: Do not worry about it, we will go

past noon.

MR. SUCKOW: Okay, so I will try to be brief, though. Okay, again, my name is Todd Suckow. I am with Hyundai/Kia. I wanted to give you a quick overview of where we have come. We are a fairly relatively new player in the fuel cell arena, I will kind of give you where we are and what our current activities are, and a little brief touch into where our future commercialization plans are.

Since 2000, we have come a long ways from initially partnering with an outside vendor for the fuel cell to internally developing our own, and through activities with the partnership, and including the DOE program, which are currently ongoing, as well as the MKE, the Ministry of Knowledge Economy Program in Korea, we have brought forth several different vehicles of different -- basically an evolution of our fuel cell fleet from concept all the way up to small batches of vehicles.

Just an idea of where past and current, starting with UTC fuel cell, all the way to the current 2007 -- old technology -- internal stack, using powers such as lithium polymer, as well as super capacitors. More on the more recent developments, we have gone from carbon bipolar plates to the middle bipolar plates on some of our newer vehicles, and also expanding the ranges from current 186 miles on our current DOE vehicles, all the way up to over 400 miles on

our Kia Borrego. Buses have also been evolving, as well, going forward within the MKE program, starting at 160 Kilowatts and moving all the way to 200 Kilowatts, maintaining the same range while we are decreasing the amount of hydrogen stored on board.

In terms of evolution, we started fuel cell development back in '99 to approximately a year ago, and it was not until around 2002 we actually put fuel cells in the vehicles, and the technology has been evolving to a point where, around 2012, we are going to be -- we project about greater than about 2 kilowatt per liter in our fuel cell stacks. So, again, this shows you the range in fuel cell stacks, the development and power density. Talking about driving range, we did not publicize this, but we did also a range, more of an internal range, a range test for our vehicles immediately following the Borrego introduction at the LA auto show, and we were able to drive from San Francisco down to LA without refueling, and had roughly about 75 miles left in the tank. So that just shows you where we have come in terms of vehicle range.

Safety verification -- we have done various tests in terms of safety and verification from side impacts, rear crash, from all different -- basically on different vehicles, mostly the Hyundai's and the Kias, and different pressures within the tanks themselves.

Cold start-up, I know some of the automakers have mentioned cold start-up capabilities. Ours is currently around minus 20 degrees C, and we have done that and demonstrated that on our internal stacks. I believe this was done -- I think this was done -- I forget if this was done in Minnesota, or not. I think it was. Durability -- another key step in the evolution of the fuel cell vehicle deployment. We had a couple of data points, as well as a few reference points, in showing how our stack has been evolving in terms of meeting the durability goals set forth by DOE, and relative points back in 2006 and 2008 where we stand. Cost targets, probably the biggest -- another big factor, in terms of the bottom line, I just wanted to get a point out, and these are not necessarily a linear progression, these are certain scenarios based on timing and volumes. So in terms of the Hyundai Kia, where we are at currently is somewhere between 1,700 and 600 cost per system, cost per kilowatt, and again, there is a lot of change. Justin showed their automatic stacking and we are currently kind of using the semi-automatic approach of getting the bite going on fully automatic of course would reduce our costs, and again, mass production of the balance of plant material. I also want to point out again some of the goals set forth by Japan, as well as the United States in certain time frames, in 2010, 2015, and 2020. A little

background, again, we were involved in the DOE program within the United States, here in the California, Northern California, Southern California, as well as Michigan, deploying 33 vehicles, partnering with others -- our technology partner is Chevron and UTC. In addition to the U.S. Program, we also are participating in the Korean Government Program, which is very similar to the U.S. DOE Program, in which we have deployed 30 vehicles, and buses, as well. And the vehicles we have deployed, again, at various different technology levels or advancements as shown in one of my further slides, and one of the big things in this program is that the government, as well as other industry partners, are developing stations throughout Korea, mostly in the Seoul area, mostly through natural gas reformation, and there is even a project using biogas north of Seoul. So some of these program associations are currently built, and five more are going to be built by the end of the program, knowing that there is going to be use for those stations afterwards.

Product strategies, this just gives you kind of an evolutional high level view of where we are at in terms of back in 2000, we are figuring out this technology, which is actually worth it, before it was what is the advantage of fuel cells, and once we got beyond that and verified the feasibility, again, we started to road test in 2004, began

prototype development that I showed you earlier, and then targeting 2012 for a small scale production.

The next generation vehicle, the small serial production, will be based off our next generation Tucson, Hyundai Tucson vehicle, which is going to be on the market in the U.S., I believe, next year, 100 Kilowatt stack of metal plates, lithium polymer battery, 60 percent system efficiency and -20 cold start-up capability. Again, this is where we are putting all of our efforts in developing this generation, this vehicle for the small serial production. By "production," I am referring to hundreds to low thousands in terms of vehicle production.

In terms of vehicle production for the next generation vehicle, we are targeting two markets, mostly Korea and the United States, and Northern and Southern California, as shown, or as described in the California Fuel Cell Partnership Plan. So we are working on -- I am working on locations, identifying locations for stations that would be best for our customers. So I welcome a meeting later and we can talk further on discussing with a little more detail on locations.

Finally, just to give you kind of the commercialization, kind of a simple five-step program, starting with step 1 through 5, and identifying we are kind of in the step 2, step 3 program right now, and then step 4

is small serial production of our fourth generation vehicle, and then scaling up after that. So I wanted to be brief because I know we are running short on time, so that is all I had.

But addressing your questions, can I start right now? In terms of getting these infrastructure, I guess, into a profitable state, I think earlier on I know we were having difficulties right now in just getting the ability to sell hydrogen as a fuel on a per kilogram basis, I think that is the big -- in the immediate timeframe, I think that is -- Bill maybe can speak to this a little better, but I think it scared away some of the people that are interested in investing in hydrogen initially because they did not see developing -- selling hydrogen on a per vehicle, or on a per fill basis, is not hard to understand, I guess, from their perspective. Other things that I could think of is Robert's idea of kind of guaranteeing the number of vehicles at a certain site, or being based there, or as a home base, or in a location where the customers would work, I think is a very valid idea. I think those are the two big things that I can see in moving away from the government fully funding the vehicles. Again, if you can guarantee a necessary demand for a station, I think you can get a lot more investment into the stations by the investors. So any other questions?

MR. ELRICK: Questions following up how he has

anticipated some of the first ones?

MR. OLSON: Todd, this is Tim Olson. I would like to -- do you have any investment from the Korean government, similar to what we are hoping DOE will do?

MR. SUCKOW: Yeah, the Korean government has invested from the MKE Program in the past and it is my understanding they will be investing more into the future. I do not know the extent of it, but there will be federal monies from the Korean site going forward.

MR. OLSON: Very good. We look forward to talking to you in more detail.

MR. SUCKOW: Thank you.

MR. WARD: You initially started out with a Ballard stack. Is that right?

MR. SUCKOW: We started off with UTC as our technology partner.

MR. WARD: Oh, I see.

MR. SUCKOW: So they developed some of the initial stacks, as well as the stacks in our current fleet of demonstration vehicles.

MR. WARD: So they are your stack provider now?

MR. SUCKOW: Well, through the end of the year, so the program ends at the end of the year, and we have vehicles, and we have demonstrated vehicles here in Sacramento and Southern California with our own proprietary

technology unit. So we have both right now, but we are going to be ending the DOE program by the end of the year.

MR. WARD: Going on to your own stack, then, your own developed stack?

MR. SUCKOW: Yeah, like I said, we will continue to develop that.

MR. WARD: Okay, on one of your slides you mentioned the roll out as thousands in the 2010 to 2012 time frame, and then I think there was also mention of tens of thousands in that same time frame. Did I get that wrong?

MR. SUCKOW: Let's see here. I think what I mentioned was in the fourth generation vehicle will be -- we are targeting hundreds to low thousands of vehicles produced.

MR. WARD: But as I mentioned, I think it was on one of your slides that --

MR. SUCKOW: Oh, these are scenarios, sorry. These are to try to put the cost numbers in perspective, so at numbers, for example, in the '10 to '12 timeframe, tens of thousands of vehicles, the cost numbers will be down around $180.00 per Kilowatt per system.

MR. WARD: Okay, so those are separate and distinct scenarios.

MR. SUCKOW: Yeah, these are different scenarios in terms of how we view material costs over time and based

on volume.

MR. WARD: Okay, and just to be clear, hundreds to low thousands introduction vehicles is in your estimation going to occur when?

MR. SUCKOW: Well, I mean, probably in 2012 is when we are targeting.

MR. WARD: So you have a minimum of 100 and a maximum of a thousand?

MR. SUCKOW: Yeah, somewhere around.

MR. WARD: We can have these discussion later, I will not make it uncomfortable here at all. And was there private investment in the Korean stations?

MR. SUCKOW: Yes. Yeah, there is a lot of -- the exact numbers, I cannot say. My understanding, what they have told me is that there is 50-50 cost share of the stations in Korea between MKE, as well as the industrial gases and SPG Chemical, and all the other -- I do not know if anyone else here can comment, but that is what I have been told.

MR. WARD: Well, that is helpful information. I would like to learn more about that and I think there is something we can learn from that and apply here in California, and I look forward to discussing that further with you. Thank you, Todd. Well done. Toby?

MR. MUENCH: Maybe just a side note or a question.

Ten stations, 30 vehicles seems very -- what is the strategy behind it? Is it like funding, it is maybe geographical reasons?

MR. SUCKOW: Well, part of it is anticipation after this interesting period, so five of these stations will be built by July of next year, and the program ends next year, so the plan is the deployment of additional vehicles that would be utilizing those stations. Right now, they are using five stations and by the end of the program, they will be using -- well, after the program, they will be using all 10.

MR. MUENCH: So it is anticipation of more vehicles.

MR. SUCKOW: Uh huh.

MR. MUENCH: Thank you.

MR. WARD: Thank you. Are those -- at what pressure and at what cost were those stations, if you have that information? If you do not, we will get it later, but certainly this is obviously an example that we would like to follow-up on.

MR. SUCKOW: I think both pressures.

MR. WARD: Oh, they are both pressures, okay.

MR. SUCKOW: Yeah, like I said, there may be other people that may be able to answer the question better. My understanding is they are both pressure.

MR. WARD: Okay, and the costs of the stations? Any idea?

MR. SUCKOW: I cannot give you -- I do not know that, but I should be able to find out, though.

MR. WARD: Yeah, I would appreciate that. Thank you.

MR. ELRICK: Great. Thank you, Todd. On the schedule now, Rosario Barretta from Daimler. Another energetic speaker to give more of a conclusion on our light duty session.

MS. BAROODY: Yeah, I am sorry we are going into our lunch time. If you will bear with us, we will go through this one more presentation and then we will take a break and resume at 1:00.

MR. BARRETTA: So, hello everybody. Thank you very much again to receive the opportunity to speak about our fuel cell activities. My name is Rosario Barretta. I am responsible for the fuel cell activities and fuel cell corporation here in California.

Let me start with the overall slide which was shown probably also from one of the other car manufacturers. This is a portfolio of different technologies to ensure sustainability. You see on the left the optimization of the conventional power trains, and in the middle you see the further increasing of efficiency for those combustion

engines, and on the right side you see the emission-free driving which will be only covered through battery vehicles and fuel cells.

So let's see here on this chart where the fuel cell and the battery electric vehicles are located, you see on the bottom the best efficiency is if you would use a battery electric vehicle with just fuel pipe, 100 percent renewable electricity. The fuel cell is a little bit worse in efficiency if you use your renewable electricity, but the better benefit on refueling, the time fueling and also the range of the vehicle. And you see on the combustion engine down on the right side, so they are regarding $CO_2$ emission and also regarding well to wheel energy consumption worse than the one I described before.

So this is a map of our vehicle operation. We started to have a worldwide vehicle operation in 2002, so we deployed more than 60 passenger vehicles and more than 36 buses and also sprinters. We collected more than 2.5 million miles in the last few years, and important for us was to deploy those cars in the market to gain and to make or collect data, experience, and to let flow those experiences in further development, which we will show the results in the next generation. Also important was to put these cars and these vehicles in operation to build up a certain amount of hydrogen infrastructure together with

other partners from the industry.

So this is a picture which shows you that Daimler started already in '94 to build the first fuel cell vehicles, which was the Necar 1, and since then we built more than 20 vehicles. And then, in 2002 we introduced the first pre-production series of fuel cell vehicles which was the A Class and we are still running today. You see on the left on the bottom the investment we have done in the last 15 years. We spent more than $1.6 billion to make that possible, to build up those vehicles to bring forward the technology, and we reached -- we had achievements in two passenger cars, light duty vehicles and buses, we have shown the three star capability and we have shown the technology could be operated in various geographical climate areas. So the improved performance, stack life time and reliability, and we reduced the weight and production cost.

This picture shows our road map to the commercialized use of vehicles. I mean, as I said before, we started to work in fuel cell technology in 1992, and we are convinced, if we come to commercialize, fuel cell technology is the best solution compared to the two days combustion engine vehicles in that respect. So the first generation which we have shown with the F-cell was the technology demonstration. And I need to say also that the passenger car has the [inaudible] [69:46] and the other, the

sprinter and the buses followed those projects. So the second generation which will come by 2010, so early next year, the purpose of this generation is to gain customer acceptance and to build up also additional fuel hydrogen infrastructure. So the aim of the third generation will be the cost reduction, number one, and with introduction of generation 4, which will be around 2015, we will have the market introduction with cost of production 2. In 2020, we will introduce the generation number 5, which will be basically the mass production, and in that time the hydrogen infrastructure should be available.

So this is a very nice picture that shows our commitment from Daimler what we are doing. If you see in the bottom of these charts, the A class, which we are still in operation, the B class, which will start to be in operation in 2010, and also already the involvement and development of the further generation, so that means that we are already doing our work, our homework, in order to bring in 2015 the first cars to the market. Important also is that, if we include today how many engineers are working on the A class and B class technology, we have more than 500 engineers which are daily working in this operation.

Also very nice chart here on the left, again, the picture I have shown before, the $1.6 billion we have spent in the last 15 years, and on the right side you see the

chart which shows you basically the major coast driver for the technology is the build-up of vehicles. That means, in other words, to make further -- to move with the technology, you need to collect data, but the question is, you know, how many cars you need to bring in order to go forward. So to build up a small fleet like we are doing with the B class, it costs us around $400 million, so to make more experience, and to bring the next generation would be enough to go less, or to build up less number of vehicles, and so this is our -- if you want, this is our effort, to show that it is interesting, it is very important to us that we can build here hydrogen infrastructure. So we bring the cars and we need the infrastructure there.

So you see here, this is the two locations where we have our fuel cell activities, we are based in Southern California, in Long Beach, we also have an office and a workshop in Northern California, but we will receive also with deployment of the next vehicle support from our Mercedes dealerships in different locations. Important to say here is also that the most of the vehicles we will deploy will be in the south in California and the LA area, and we fully support the California fuel cell partnership cluster hydrogen station, which will be built in the four cluster in LA.

So this is the B class which we will introduce by

the beginning of next year. You see, this is a vehicle platform which we use in Europe to -- we sell it with the normal combustion engine. What we did was just to replace the combustion engine with the fuel cell, and we had no disadvantage in -- the truck is fully available, and so you can see four to five persons in the car, so it is a car which you can compete with a normal car with combustion engine. So the car has undergone also in the safety measures which all the Mercedes have to undergo in their development. It is a very safe and a very nice vehicle and if you see on the technical data on the right side, it is a vehicle which can compete in every respect with a B class combustion engine.

Some numbers, how many cars we are going to bring here in the next years. The idea -- well, the plan is we are going to build 200 cars and we will place the 200 cars worldwide, and let's say up to 50 percent of them will be deployed here in California between 2010 and 2011.

So what are the demand differences between the A class and the B class? So we reduced the size stack by 40 percent, increased the power 30 percent, and consumption is 16 percent lower, even though the car is heavier, and the range is increased by 150 percent. So beside that, we increased the stack lifetime from 1,000 to 2,000 hours, and the range from 160 Kilometers to 400 Kilometers.

This is a picture of the packaging, what it looks like in the B class, so most of the technology you see is underneath in the so-called sandwich bottom, you find the tanks in the area where it is very safe, the fuel cell stack, and some other components is in front of the bottom, and parts like a module -- what do you call that part -- the coolant? The cooling module, we have it here, the cooling module is in front of the vehicle. So in the real part under, or between the rear axle, we place the lithium ion battery.

So this is the system, what are the main differences to the A class? We have still the screw compression, we changed the humidifier which will make it possible to operate the vehicle at the -25 C, we increased the power, and the system is in total higher efficient and less complex than the one before.

So this is the last slide, I think. So the achievement of the B class, the first year produced the vehicle with the zero emission fuel cell drive. This vehicle will have the same quality assurance process employed for other vehicles at Daimler, and this vehicle will be without any restriction regarding passenger luggage space. And the F cell offers high driving performance standards as standard two liters gasoline engines. So that is ready for the customer for everyday use. So I am pretty

sure the B class is a milestone on the road of conceptualization of fuel cell vehicles. And the last comment from my side, if you help us to bring hydrogen stations in this area, we will bring the fuel cell vehicles. Thank you very much.

MR. ELRICK: Thank you, Rosario. Questions?

MR. WARD: Rosario, thank you very much for your presentation. Well laid out and, as you mentioned, you folks are very committed to the tune of $1.6 billion over time. That is quite commendable. I think that the development that you folks have shown is truly remarkable and you are a leader trying to bring this technology not just to Germany and the rest of the world, but to California, as well. And the roll-out of your vehicles is a considerable number, and it seems to be a fairly large number from what we have seen, 200 cars rolled out in the 2010-2011 timeframe, half of which are coming to California -- up to half, you said?

MR. BARRETTA: Yeah, exactly. This is, I mean, the last two or three weeks was the International Car Exhibition in Germany, in Frankfurt, and so upper management, they committed to these numbers -- 200 vehicles will be the total number of vehicles for the B class and up to 100 vehicles will be deployed here in California. And if I say up to 200 vehicles, it means we make it also -- it

depends on the infrastructure. If we do not have sufficient infrastructure, we are probably going to reduce the number of vehicles, but the idea is to bring it up to 100 vehicles here.

MR. WARD: In Germany, how many stations are you planning on constructing to support 100 vehicles that you would have there, or up to, or possibly over 100 vehicles there?

MR. BARRETTA: That is a good question. I will try to answer as good as possible, but I understood the next one and a half years they are going to place around 15 hydrogen stations and, as you heard from weeks ago, there was an MOU among Daimler and Linde, Shell, some other energy providers in Germany, where they are trying to put together a consortium to build up an infrastructure, so the first task will be to build up the 15 stations, and then to go on from there.

MR. WARD: Is Germany putting up funding for this, as well?

MR. BARRETTA: Yes.

MR. WARD: Do you have a ratio of that? I know you have many privates mentioned there, and I am honing in on this because this is the type of model that we are trying to replicate here in the United States, specifically here in California, and I think the money is well placed if it is

seed money for private investment.

MR. BARRETTA: Yes, there is money, they are providing money to build up the infrastructure. If I am not wrong, it is 50 percent, but I can check that again for the hydrogen station, and I think -- I am pretty sure they are also providing funding for the vehicle, to build up the vehicles.

MR. WARD: Are these going to be 700 bar or --

MR. BARRETTA: The station?

MR. WARD: Uh huh.

MR. BARRETTA: Yeah, I am pretty sure there will be 700 and 350 bar.

MR. WARD: Okay, do you have any approximate costs of those stations? I know it is projected right now, any idea?

MR. BARRETTA: No, I mean, regarding this, I think our partners from Linde, they can give you a much better outlook on the situation regarding costs. I do not know. I mean, I can say something in the number, I saw before, around the $2 million per station, this is what I heard, but I do not have exactly number.

MR. WARD: Are your stations looking at the retail environment, station?

MR. BARRETTA: Definitely. We are behind the proposal from the California partnership and the number of

vehicles which I said today, that covers our part, which you can see in the survey.

MR. WARD: Thank you again for you presentation. I did take note of the agreement that you folks signed a couple weeks ago. When we meet with you one on one, I would like to learn more about that because the wording I was not quite sure, a lot of the details of that, maybe you can fill us in on that at a future time.

MR. BARRETTA: Definitely.

MR. WARD: I appreciate your presentation. Thank you.

MS. BAROODY: Thank you. Well, before we go to lunch, we have one WebEx question and I believe it is for John Mough. So thank you very much for your speech.

MR. BARRETTA: Thank you.

MS. BAROODY: Okay, Pilar, if you would unmute the WebEx. Go ahead, please identify yourself. Is she still there?

MR. SMITH: I believe it is Nico Bowkamp. I might be mispronouncing that. I believe I wrote it down. The question to John Mough was, "Where will you do your hydrogen station testing based on the budget you have developed for hydrogen quality and dispenser testing?"

MR. MOUGH: Our station testing and the quality testing will both be done out of our headquarters office

here in Sacramento. We also have a facility in Southern California in Anaheim, but it is currently, it is a laboratory facility and office space, and we do not have the space to do any station testing there. So everything will come up to our Sacramento office.

MR. SMITH: Thank you. I think that will answer his question.

MS. BAROODY: Thank you. I just want to thank the light duty panel for your participation this morning, and sorry we had to go over lunch. So we have about 35 minutes for lunch. And we have heavy duty at 1:00.

[Off the record at 12:29 p.m.]

[Back on the record at 1:10 p.m.]

MS. BAROODY: We want to get going with our Heavy Duty Vehicle and Off-Road Applications Panel. I would like to welcome Dr. Arnold Miller with the Vehicles Projects.

DR. MILLER: Thank you, Madam Chairwoman. Thank you for the invitation and the opportunity to speak with you today. What I would like to do is describe a project which develops an application of fuel cell, hydrogen fuel cell vehicles, which has a number of benefits as an early, really, entry into such a market, over automobiles, which you have heard about this morning. Cars have to be very fast, beautiful, spacious, and cheap, finally, whereas industrial vehicles, especially locomotives, do not have so

many constraints. They mainly have to make money for the company that operates them. So this is the locomotive that we have built, it is a switch locomotive, and it will be arriving in Los Angeles next week to begin its demonstration in Commerce, the City of Commerce Rail Yard owned by BNSF Railway. This shows a rear view of it. This is a public private partnership. BNSF is the private partner, private funding source, and my company, Vehicle Projects, is the technology developer, and then we have the US Army, two logos here, the Corps of Engineers and the Defense Logistics Agency is the provider of the funding. As cost shared project, BNSF has put approximately half of the cost into this project. It started in May of 2006.

Now, why fuel cell rail, in general? Well, it marries the best features of conventional locomotives, that is (inaudible) electric over electric locomotives, and diesel locomotives, but avoids their disadvantages. For example, it has the emissions characteristics of an electric locomotive, but it has a much lower infrastructure cost, which is similar to a diesel, and moreover, for rail, the infrastructure is linear, it is a long railway, so it is much simpler than for road vehicles, which have a two-dimensional infrastructure. Now, if the primary energy is renewable or nuclear, and it uses electrolysis water to produce hydrogen, then you have no carbon in the energy

cycle, there is no $CO_2$ emissions or any other kind of emissions in the vehicle's operation. And it is significantly more efficient than an electric locomotive. The electric ones, contrary to what you might think, are the least efficient because you have to look at where you get the electricity for them, and normally it is a co-fired power plant, and so it is a heat engine, ultimately. The diesels are a little more efficient than electric locomotives and the fuel cell will be more efficient, perhaps 10 percent, it is not going to be dramatic. That is not the driving force, the driving force is lower emissions, and you will see, lower fuel costs right now, or in the future, as well. There are issues and I will discuss these more. I will try to answer the questions of the Commission. There is relatively high cost of fuel cells and, of course, that is an issue for all fuel cell vehicles. Now, as we will see in a minute, the fuel cell stacks that we use in this vehicle are the same as the Ballard P5 stack modules, which are used in the cube buses, the first generation, we have about 2 million, my kilometers of operating experience. Then you have entrenched competing technologies in fuels, this is not a small issue, it is sort of an unspoken issue, but it exists, and then hydrogen storage; among technical issues, that is the most significant. The fuel cell itself is mature technology.

Now why hybrid for our rail vehicle? Not all rail vehicles, and certainly not all vehicles in general are necessarily good as hybrids. I have written a paper, it is in the Journal of Power Sources on this -- 2006 -- on which rail vehicles make sense as hybrid, and this really tells the story here, this is the duty cycle, the red curve is power, and it is power vs. time. And at narrow peaks, they go up to about 1.2 Megawatts, and then you have long periods of idle, being idle in the rail yard. And even though you have those high peaks, the average is only 75 Kilowatts. This is over a huge amount of data. And so this is ideal as a hybrid, it can be easily recharging the battery either during this troughs or the outright idle periods, and then when you need to go over these high peaks, the battery can assist with that, and it is a parallel hybrid where the fuel cell and the battery are additive in power.

This project has two specific objectives, one is to demonstrate reduced noise and air pollution in urban rail applications, including sea ports, and that will be demonstrated starting in early October through December in Los Angeles, and then, because you have a benign power source, the fuel cell power plant, it opens a new application for large fuel cell vehicles, and this is the military interest, it is what is called power to grid, where it can provide back-up power to military base or civilian

disaster relief efforts.

This shows the vehicle over a year ago under construction. This is the battery rack, and this part -- this whole area here is the fuel cell power plant, and it replaces what was originally a diesel gen-set. This started life as a commercially available diesel battery hybrid, some of which are operating, or did operate, anyway, at Port of Long Beach, as diesels. This, of course, has no diesel engine whatsoever, and there is no emissions whatever.

These are some of the specs -- it is 240 Kilowatts continuous net power for the fuel cell prime mover, 70 Kilograms of hydrogen at 350 bar, and the hydrogen is carbon fiber composite tanks, standard tanks that are used on buses. Now, we have money already from the Department of Defense to upgrade this, to go to a more advanced battery, and then we will have six times more hydrogen storage, more tanks, and it will be 700 bar rather than 350 bar. Then the traction battery allows transients substantially above 1 Megawatt, probably closer to 2 Megawatts, and then this technology is a lot lighter in weight than the diesel. So you have to add ballasts because locomotives have fixed operating weight and so we had to add 9,000 kilos of extra ballasts to bring it up to its operating weight of 130 metric tons, or 287,000 pounds. Here it shows an expanded view of it. This right here is the power plant. And we

developed all this, some of these components, as I mentioned, the stacks, we purchased, we developed -- and the hydrogen tanks -- but otherwise we developed it and we designed it, and we are involved in the fabrication. BNSF Railway actually fabricated it, including the power plant, did almost all of the fabrication.

Okay, now, this shows it under tests. Right now, it is still at a DOT Proving Grounds in Pueblo, Colorado, it is operated by TTCI. Now, we are going to see a video here of impact tests. It works better to run this from the Windows Media Player, and Pilar has promised that she would do this. It is a fairly large file. You can run it, Pilar. The vehicle is not actually running when you see it here, it is pushed, and allowed to coast into that consist that I showed on the preceding -- on the PowerPoint slide. It does not seem to be -- oh, yeah, there it is. I wonder why it is not showing up. Well, maybe we will not see this. For some reason it does not want to display, but it is running somehow. Do you have any idea, Pilar? Because we had it operating earlier, running off my memory stick, yeah. Ah, okay, back to where we were. So maybe do it last. We will do that at the end.

So in any case, this is a consist of three rail cars that are loaded, they weigh 700,000 pounds altogether, and the last car is braked, as well, so we have taken up to

5 mph, the video is at 3.8, but -- and that is with the fuel cell operating. And there has been no problem. You have well over 10 G's of force chalk load, and there has never been any problem. We have had no problem whatsoever with this vehicle. So if we could proceed now with the PowerPoint?

Okay, thank you. There was a lot said about refueling stations, and this is the one we have, it is temporarily set up here at the proving grounds, this will go to the City of Commerce yard and if there is interest in this, I will explain how it works, but you can see it is fairly small, and it is inexpensive, it was only $150,000 for that entire refueling station. If you wanted to buy something for automobiles, it would be a few million dollars because it has to be very pretty and customer friendly, and so forth. Now, here is where it will be. Here is the Commerce -- or sometimes called the Sheila Yard, of BNSF, and the refueling station will be right there. This is where BNSF tests their new locomotives. And then it will go also to the -- down here it says "to Hobart." There is a yard not too far away that will be connected to, and it will operate both between the yards and in both yards.

One of our important contractors is Air Products, and they are providing the hydrogen presently in Southern Colorado, and will be providing it here in Los Angeles. As

many of you know, they have a pipeline, red line in this drawing, it serves seven gasoline refineries in Los Angeles, built actually to serve eight, and the eighth one will be coming online fairly soon. But it transports 400,000 kilos per day of hydrogen at 55 bar pressure. The hydrogen is produced at Wilmington, which is a very large hydrogen plant dedicated to hydrogen in Carson Hydrogen Plants. But it is 26 Kilometers long and 6-10 inches in diameter, varies along the length. Here are the results. The locomotive is complete and has approximately 30 hours of operating time on it. The operating interface is identical to conventional locomotives, it is silent in the cab, which is eerie if you have ever been in a diesel, a vibrating diesel locomotive. And outside of the vehicle, beside the power compartment, it is sufficiently quiet that you can carry on an unstrained conversation. We have videos of it operating before it was painted, that is why I did not bring them, but people -- it is operating and people are standing on the walkway outside and carrying on a conversation, and the video camera and recording system picked up their conversation. So the locomotive will arrive in Los Angeles in early October, it will stay here until the end of the year, approximately. Then, this is a quite positive result among others that we will demonstrate as we go along, but if you would take hydrogen from the Los Angeles pipeline, the energy cost

would be lower today than diesel, that is, it would be between $1.50 and $2.00 per diesel gallon equivalent, there is almost a 1:1 or almost identical energy content to a kilogram of hydrogen and a gallon of diesel fuel. So that would be the cost of a kilogram of hydrogen. And what we like to do is, after this is demonstrated, it may go to the Port of Long Beach, that has not been determined yet, but that has certainly been a possibility we have been considering for some time, but also operation at one of the refineries, and taking the hydrogen from the pipeline would be a nice adjunct to the demonstration of the vehicular technology. I think that is the end of it. Do you want to try to run it? So she is going to -- ah, okay. Very good.

MR. OLSON: While you are trying to set that up --

DR. MILLER: Sure, I will be happy to answer your questions now.

MR. OLSON: Yeah, a question on -- I did not see the front part of your presentation. Where is this cost-wise in terms of this is a prototype demonstration? Where would this go next in terms of development?

DR. MILLER: Well, it is going to be upgraded, I mentioned that. We have actually two years of Department of Defense funding to do that, so that will be a couple more years, but it would be close to commercialization. This is an experimental prototype and you have to go through several

prototypes to get it to a manufacturing level, but then you would have to go through a manufacturing prototype -- okay, I do not know if we have sound or not, apparently not, but this shows it running into the 700,000 pound consist to test its ability to withstand impact. But if you could hear this, you would hear the crash and you would hear the track noise, but actually in this particular one the fuel cell is not operating, so --

MS. MAGANA: Do you want to show it again?

DR. MILLER: Yeah, let's show it again. Can you make the sound operate?

MS. MAGANA: No.

DR. MILLER: So it is quite rugged. One nice thing about locomotives is there is a good psychology associated with them, of power and strength and durability, which we just demonstrated here. So some people still think fuel cells are appropriate for golf carts or something like that, but they actually can power locomotives quite nicely. I think we have finished the PowerPoint. I would be happy to answer any questions of the Commission or anyone else.

MR. OLSON: Yeah, so I have another question on the -- and maybe this is really addressed to the Air Products, but when you said that the price of hydrogen -- the cost of hydrogen fuel was lower than diesel, do you have anymore details on that?

DR. MILLER: Well, the reason for that is the cost of hydrogen closely tracks the cost of natural gas, because that is what it is made from, and that is cheaper because it is a domestic product, rather than imported fossil fuel.

MR. OLSON: And they are making hydrogen for the refinery, so --

DR. MILLER: Yes, exactly. Oh, they make it on a massive scale, as you saw, 400,000 kilos a day. Now, the price of gasoline and diesel fuel are not so high right now, on the order of $2.00 a gallon or a little bit more than that, but if it goes back up to $4.00 or $5.00 a gallon, then obviously this is going to be extremely attractive, just for the price of fuel. And we would like to ultimately make it from renewable or nuclear power, so you would not have any greenhouse gas emissions, even in greenhouse gas emissions, there is clearly no such emissions from the vehicle, but if you make hydrogen from natural gas, you do have $CO_2$, but it is a lot better -- a lot more $CO_2$ than you would have for a straight chain hydrocarbon.

MR. OLSON: So in your last bullet there, so is the price in the range of $2.00 a kilogram?

DR. MILLER: That is correct. It is less, actually. It is between $1.50 and $2.00 a kilogram at the refinery.

MR. OLSON: Maybe we will hear more from Air

Products on that idea.

DR. MILLER: Yeah, it would be good to do that. And we work with them fairly closely and, also, we would be pleased to have the California Energy Commission to be an observer at this project, or your delegate, or whoever you would like, and come and witness this, and --

MR. OLSON: This is now at the rail yard in City of Commerce?

DR. MILLER: Well, it will be. It will take about a week, perhaps, for it to be transported out here, but it is going to be finished with its testing in Colorado this week, and then BNSF will transport it out to LA. They do not -- it is not going to be Express delivery, so it may take several days to get out here.

MR. OLSON: So, I am just curious, we have had a lot of discussions with Burlington, Santa Fe, Union Pacific, it had not really appeared to be any strong interest in anything but diesel, and they had said they tried a lot of different options, and is there a serious interest as a follow-up to this?

DR. MILLER: Oh, absolutely. Well, BNSF has put about half the money into this, and there has been quite a few millions of dollars since May of 2006, and they have about a thousand switchers in their fleet, and I do not know the exact number, but I would guess close to -- well,

probably about 400 of those, maybe it would be in California because they operate only in Western USA and California has the largest population, by far, of the states. Now, they are interested in retrofitting those locomotives, and even though there are not that many switch locomotives, they have a disproportionate negative impact on the environment, especially in the cities because they operate in urban environments, in rail yards, and they are surrounded by people's homes. And so they have about, in California, about 5 percent of particulate emissions come from -- or 5 percent of total locomotive emissions come from switchers, the rest of them are line haul locomotives. But the switch locomotives are disproportionately harmful because they have like this bubble of particulate matter over these rail yards, and the CARB is quite aware of this, and they have been very influential, actually, in making the world aware of this, and been a leader. So to answer your question, BNSF is interested, they are, by contract, they own all the intellectual property for this, on this locomotive, and so presuming that it works as well as it has so far, then they would be, I believe, interested in trying to commercialize it.

MR. OLSON: Okay, very good. Thank you.

MS. BAROODY: Thank you so much for your presentation. We appreciate it.

DR. MILLER: Thank you.

MS. BAROODY: Okay, next we have Paul Scott with ISE. If we can just try to keep the presentations to 12 to 15 minutes, I know it is difficult, but we have a lot to fit in, still, today.

MR. SCOTT: Hopefully I will fly through some of these, as a result. And I have got to go backwards here, I think, to give you a preview of what we are going to talk about.

This slide points out a number of the vehicles we have done, it is pointing out here most of these are hydrogen vehicles. And this is a gasoline hybrid, this is a diesel truck, this is a natural gas, all the others, that is our first vehicle, our second, our third, our fourth, and our fifth generation hydrogen bus designs. So this just gives you a little bit of what we do. Our focus is exclusively on electric drive, heavy duty vehicles, 140 employees, we have got about 300 vehicles -- near 300 vehicles in revenue service every day with about 50 million to 20 million miles, I do not think anyone is counting anymore, but Long Beach Transit, for instance, this is one of the customers, and that is illustrated below.

What we do is -- this has a little bit of a lag to it, so I overshot here -- what we do is take components from Siemens, Ford, or Cummins, for instance, for the engine,

battery fuel cell, for instance, we have also used UTC fuel cells, and couple them within the case of the rotating engines, electrical generator, inverters, electronic components, and we build a lot of them, all the ones in yellow background here are things we build ourselves because we have not been able to find satisfactory outside -- so we are an integrator of these machines.

And you will hear from BAE today, they are a key competitor in this industry, Ellis is the other one, and they hold the diesel space, we hold the gasoline space, and the zero emission.

Just to give you a status report, we have got about 250 of the gasoline hybrids delivered in revenue service, we have got 50 of the 60-foot articulated buses going into Las Vegas in the next few months. I mentioned the hydrogen buses, I will mention battery electric, all of these, with the exception of battery electric, are full performance buses. Freeway speed, hill climb, the fuel cell bus, for instance, going to Canada will do a 20 percent grade. And I am going to talk about some of the harsh realities. First of all, the diesel is an excellent way to store energy. Ethanol is also good. When you include the tank mass, CNG is about as good as ethanol, and hydrogen is a factor of 3 behind, but it is still pretty good as compared to a battery, you notice the battery is a factor of

10 behind in energy storage capabilities, so you can do things with hydrogen in a ZEV vehicle that you cannot do with battery -- a key point. And it involves some complexity. Basically a fuel cell system, or a rotating shaft engine, the various electronic components you need to drive a motor energy storage, and the auxiliaries we drive directly from the electrical system, so all of the auxiliaries are electric.

That is strange. We lost about half the presentation.

MS. BAROODY: Just take a minute to change that laptop here. For those of you listening online, we are having momentary technical difficulties. Hopefully, just a few more minutes.

MR. SCOTT: This is a slide that you have seen before from a number of different presentations, the NRDC program, for instance. The point of this, this is the third hard fact here, is that whether you go biofuel, whether you go battery electric vehicle, you still need to have hydrogen as part of the long range picture. Fourth key point here is the heavy duty vehicle is used typically up to 100 hours a week, using 12,000 gallons a year, it is equivalent of 40 cars, so putting money into heavy duty vehicles makes sense in the sense of being cost-effective.

And the other interesting fact, sort of a hard

fact for us, there are now 12 firms competing in the fuel cell bus space. You have Daimler, of course, is a key European, you have companies in Korea, in Japan, China, you have within the USA E-Bus, Proterra, ISE, and a combination of Venhul (phonetic), UTC, and AC Transit, all competing. And the final point here, there are -- here is the outlook for greenhouse gas reduction, there are several points here, one is that the hybrid drive allows you significant advantage, secondly, that you get significant advantage by going to lower carbon fuels such as CNG, battery and fuel cell offer large efficiency gains, about a 50 percent reduction in greenhouse gases, and the final point here is that, with a wind generation system, you can make renewable hydrogen, and that could be game changing, especially as people catch on that this is truly a zero emission solution. And it allows us to avoid importing hydrocarbons.

Here is a news item from just last week lifted from a HyFLEET promo, "Is a clean future too expensive for us," is the point. And the answer I have got in green down below here, "It was not too expensive to spend $10 billion a year on corn ethanol as a subsidy." And there are subsets of what one can do with lesser amounts indicated on here, as well. I will talk a little bit about the technologies. Here is the London Bus that we are doing, the artist's conception on the lower left, a breakdown of the fuel cell

system here. As you see, there are a lot of parts involved. It is quite accessible. It is in a sense a full solution to the zero emission problem, and this is a relatively inexpensive fuel cell system. These buses go out at under $2 million, well under $2 million. The BC Transit bus is 150 Kilowatt fuel cell in the back here -- I am just rushing through these. Here are the BC Transit units in production a few months ago, no longer in production; we do not have further orders for them. We also are doing an all electric bus, in many ways this is much more difficult than a fuel cell bus. There are challenges -- funding being a key. We just do not have enough people contributing to do this. Insulation, support of electric infrastructure is going to be a continuing concern, but above all, the battery cost, the mass, and the volume. The bus is limited to a range of 150 mile range, that is just the best we can possibly do with a battery electric bus. The answer here is, you know, the ultimate answer is renewable hydrogen, as illustrated in this slide.

Getting on to the questions, and the fiduciary matters, we make about -- we have the capability of making about 300 vehicles a year. Cost reduction is extremely important to us. There are significant cost reduction strategies available with investment and, of course, public monies have been virtually frozen, venture capital nearly so

in the last year. I am giving you some projections here for the next few years, 2011 and 2015 in two separate columns here. Gasoline hybrid is now about $550,000. I am guessing that is going to come down maybe 10 percent, and then another 10 percent in another four years. Natural gas hybrids will be about $50,000 more. Hydrogen -- full service hydrogen buses, BC Transit, should come down to about a million dollars, as we get a number of buses in production. European money is very important on this. And then we have battery electrics here, and these are speculations since there has not been too much activity in that arena.

Federal monies, our only significant sources of AB 118 match funds, but our recent experience has been negative in that respect. ISE invests modest amounts of equity funds to the extent that we can get monies available to invest. Our urgent needs? First of all, an assurance of a market with money and interest, indeed, for improved vehicles. Secondly, an assurance of a cost of carbon-based fuels. We do not know enough to make a projection whether oil goes to $200 or $30, nor does anyone else. So there has been the cost of fixing the cost of fuel, by means of some government program that is under discussion, I guess, is all we can say on that. We need hydrogen fuel at competitive cost, and by competitive cost, we do not need $3 hydrogen, we need $6

hydrogen, because we have a factor of 2 gain just in the efficiency. Development funds for component development -- we urgently need to get automotive quality components at competitive prices, and these are large components, they are not going to be developed by the automotive industry. We have to do it ourselves, or someone else. And there are many open opportunities, including CNG, hybrids, things other than hydrogen. And finally, availability of loan funds. Powerful incentives? One is for ARB to maintain, as originally conceived, the zero emission bus rule such that there will be a market in the state for zero emission buses in the next few years. Secondly, the possibility of DGS, Department of General Services, purchasing alternative fuel vehicles. Similar rules for incentives for university and college purposes. I mentioned award preferences for firms developing renewable gases, fuels, and we can discuss all these in more detail if you want. And there are opportunities for NZEV approaches, which generally have not been of interest to anyone. Once people see a fuel cell, they want a fuel cell, and that is understandable. Thank you.

MS. BARODY: Thank you, Paul. Next up, we have Rudy Tapia* [42:23] with Vision Motor, although, hold on, do we still have Jeff Grant on the WebEx? Jeff was going to maybe make some comments. Is that right, Paul?

MR. SCOTT: Jeff indicated he was open to answer any questions on fuel cells.

MS. BAROODY: Okay, we will move on then.

MR. WEISDORN: Good afternoon, ladies and gentlemen. My name is Lawrence Weisdorn, the Founder and Chairman of Vision Industries. We are dedicated towards providing a solution for the heavy duty class A trucks that are operating in and around the Port of Los Angeles and Long Beach. On the slide, on the right side -- or the left side of the slide itself -- is our freightliner, that is a zero emission hydrogen fuel cell/electric plug-in vehicle, it is currently undergoing testing in the Port of Los Angeles. It was assembled for us by the freightliner dealer out in Whittier, California, which is about 10 miles east of downtown. The truck on the right side of the screen is a Kenworth T660 that we are currently assembling for another client. And both these trucks, again, are zero emission. What we will be talking about today basically are solutions, the hydrogen vehicle solutions, fueling strategies, and future applications.

What we realized early on is that the chicken and the egg problem that everybody is well aware of is something that had to be overcome, so we have come up with a solution that is specific to the Port of Los Angeles, and as the previous speaker mentioned, there is a hydrogen pipeline

that flows in the Ports of Los Angeles, up along the Domingas* [44:28] Channel and 405 out to 180, and so using that as a supply for our hydrogen, we can effectively fuel up to 4,000 trucks per day off of that pipeline itself, so the egg problem is already solved within the ports. So then the chicken problem is the truck itself, and we have already produced that. The situation for the fleets that we have talked to is basically they are looking for a turnkey operation, in other words, here is your truck, here is your fueling solution, and ultimately to get wide adoption of the hydrogen zero emission program, you have to be able to operate at cheaper per mile than diesel. So with the availability of the pipeline diesel in there, and then based on early testing of the trucks, we are finding we are getting approximately the same mileage from a pound of hydrogen, as made available through a gallon of diesel, so were are finding one pound equals one gallon of diesel in the stop and go traffic that you experience on the Port, which would not be true on open highway driving.

Again, the situation at the Port is very interest. The trucks all come back to the Port numerous times per day, so there is no point in trying to fuel them out at their destinations. By simply putting in three fueling stations, one by the 710 Freeway, one by the 110 Freeway, and the other one by the 103 Connector, you can effectively fuel the

entire fleet of trucks from three large truck stop stations right in the Port. The fleet operators are also very interested in receiving long term supply contracts for their hydrogen. So, in other words, you can get fixed pricing, it stabilizes their cost per mile, and it allows them to become extremely competitive when competing against diesel engines. Ultimately, you want the hydrogen trucks replacing the diesel trucks because there is zero emissions.

1806, the very first internal combustion engine ran on hydrogen; 60 years later, they invented the internal combustion engine that ran on gasoline; 1892, Rudolph Diesel came up with his, and it has been diesel and gasoline ever since then because essentially they are cheapest per mile. So the key to getting wide adoption to this hydrogen program is to make sure that it is cheaper per mile than the other competing fuel, which is diesel. Technology and manufacturing and the producing of hydrogen have come down to the point where hydrogen can now be produced very cost-effectively, and most importantly, the consumption of hydrogen in the fuel cells, the fuel cell technology itself, has been dropping rapidly, and we are now at a point where an inflection has been reached, and so, with commercialization, you can actually drive or travel cheaper per mile on hydrogen than you can on diesel and gasoline, and that is very important to make sure that the broad

market adopts the hydrogen. Hydrogen costs, again, with the supply from the pipeline gas, we are looking at stabilizing between $1.50 and $2.75 per pound. We like to discuss it in pounds as opposed to Kilograms because we are finding a pound gets you as far as a gallon of diesel, so it is very easy to equate.

Why hydrogen? Everybody is pretty well aware of all this stuff, it is cheaper per mile, zero greenhouse gas emissions, our trucks are extremely quiet. When you go to our website at VisionMotors.com, and view the truck, we actually have to have them honking the horn every once in a while so people understand that we have not cut the audio feed. You will see cars going by, and the cars are noisier than the truck. These things are truly, you know, the only thing you hear is the tire noise. There is no idling, substantial increase if torque, hydrogen fuel cells create electricity, so you are running an electric motor. You have got your torque available from zero, we actually have to limit our torque, depending on which transmission is put into the truck. Hydrogen is made right here. The hydrogen we are looking at is right in the Port of Los Angeles, so it is domestic, it is secure, there are technologies that are coming up that, over the next one or two years, we believe will make renewable zero emission hydrogen available at competitive pricing. As you all know, hydrogen can be made

from a variety of sources, water, CNG, there is even technology that converts municipal solid waste to hydrogen.

Numerous car companies that you heard from this morning, they are all rolling out hydrogen. The beauty about that is they are going to be in charge of educating the public about the benefits of hydrogen, the safety of hydrogen, and basically they will be spending millions of dollars educating the public and we all receive the benefits of that education.

State and federal support -- in the early stages, obviously, it is very desperately needed to make sure that we make this transition from basically demonstration projects, or early demonstration projects into commercial viability.

Very quickly, this is comparing the three clean technologies operating on the Port. There is the 2007 clean diesel emissions LNG trucks, and then our Vision Tyrano* [50:23]. Horsepower, which is your ability to maintain speed once it is attained, is more than enough. Torque, which is what the truckers are interested in, is your get up and go, this is your pulling ability, your ability to accelerate. Again, we have got up to 3,200 foot pounds available, which will shred most transmissions, so it is limited to whatever the transmission can take.

Very important for the people looking at

infrastructure, the hydrogen truck will consume approximately 10,000 pounds of hydrogen per year. And so that is something -- it is equivalent to somewhere between 60 and 65 cars, and so putting one of these trucks on the road, you will have to put in an equivalent amount of infrastructure to support 65 cars, so by commercializing the fleet and getting them deployed into the Port, you are going to really speed up the adoption of infrastructure, the production of fuel cell grade hydrogen, the ability to distribute it, and everything else. So putting the money into the trucks and getting them out there will really really accelerate your infrastructure roll-out for all of the cars.

As you can see, the particulates, everything else, you know, it is zero emissions. But when you get down to the $CO_2$ numbers, these are substantial numbers, you know, by running a hydrogen truck versus a diesel truck, that is about 100 tons of $CO_2$ reductions per year, and even compared to CNG, which is a misnomer calling it "clean," it is just a cleaner fuel. You know, the 70 ton reduction over the CNG's. And, again, zero noise pollution, so the possibility of operating in neighborhoods or off-hours when trucks are currently not allowed to operate.

Okay, that one did not come in -- basically it shows -- obviously as more trucks are priced, are sold, the

price comes down. Our initial prototype, the first one through off the line was approximately $950,000, we are down to about $400,000 per pop on the next three or four trucks, and what we are looking at is a 20 truck demonstration program that we have partnered with the Port of Los Angeles and Swift Transportation, and we are looking at a cost of approximately $280,000 per truck on that demonstration program, and it drops to around $250,000 fairly quickly after that, and we believe in about two to three years out from now, we can be down to around $160,000 per truck, which by the time you have your cost savings from the cheaper transportation fuel and also some of the federal tax credits, it will actually be much cheaper for you to drive with hydrogen than it will with diesel. Fuel cells, pretty well everybody in the room knows how one works. And no pictures attached.

But other projects we have got coming up are -- we have been approached by several of the cities in Los Angeles with the possibility of looking at our drive train in a refuse truck. Obviously anything that is stop and go traffic, where there is a lot of idling going on, absolutely perfect application for the zero emission drive train.

Finally, ultimately these things have to be bought by commercial interests, so what you are looking at on the purchase side is currently there is a $40,000 federal tax

credit for heavy duty alternative vehicles, and then we are discussing with numerous departments as to what type of state credits and regional subsidies and credits can be established. Again, for early adoption on this, some of the commercial truckers, they are willing to step up and take a risk on a new technology, especially if it has got the promise of operating cheaper per mile, but they are going to have to have some significant subsidies to take the chance on the initial purchases. So for the first couple hundred trucks, we are looking for significant subsidies from the government to get these guys to adopt it, fall in love with the technology, and then allow it to become fully commercialized. Again, when you are operating these hydrogen trucks, we are looking at 35-40 percent discount per mile over diesel, if you have got an increase in power and performance over diesel, there is no exhaust, they are very quiet operation, you have got re-gen braking, so in other words, you are allowed to use your Jake Brake within City limits now. What we are hearing back from Eaton, who is running an electric hybrid situation on their trucks, typically in the old days, the brake shoes would be replaced several times per year, on the early trucks with the full re-gen braking, they are in over two years now without having to replace their brake shoes, so a dramatic drop in the maintenance costs.

No oil changes. And probably most important, at the end of the day, you are not coming home to your sweethearts smelling of diesel. And with that, I would like to thank you and hopefully I kept it down to 10 minutes.

MS. BAROODY: Thank you, Lawrence.

MR. WEISDORN: Any questions?

MR. OLSON: Yeah, a couple questions here. So how was your -- I did not catch -- how was your first project, that prototype, that was all your investment from your company?

MR. WEISDORN: Yeah, we are a private -- we have been privately funded. We have put about $3.5 million in to date over the past three years, and now we are at the point where we have proved out the prototypes to the point where we have developed a production version, we have partnered up with Freight Liner where we will drop ship the components to Freight Liner, they will assemble it in Whittier, and then the truck will be marketed and sold by Freight Liner as a Freight Liner with a Vision drive train in it. And they have also agreed to service it and do all the warranty work on the program.

MR. OLSON: And refresh my memory of the Port of LA Agreement. Aren't they about to put out a bid, or are they in the midst of putting out a bid for this? Is that --

MR. WEISDORN: Yeah, correct. They are in the

midst of -- I think it is RFP or RFQ where they are looking at adding us officially to the program to qualify for the Clean Trucks Program down at the Port. One thing I would like to mention also, Freight Liner, the present capacities are that they can assemble 35 trucks a month for us, starting immediately, and within a six-month period, they could be up to approximately 100 trucks per month. So we are in a situation that, if we received an order for 50 trucks tomorrow, the first of those orders would come off the line 16 weeks from now, so this is a shovel ready project, as they say at the Feds level, and it is ready for roll-out.

MR. OLSON: And are you open to showing some of the performance data, what you have come up with so far in your prototype?

MR. WEISDORN: Absolutely. It is on my computer on a different file, but we can share all that with you.

MR. OLSON: Okay, very good. Thanks.

MS. BAROODY: Thank you very much.

MR. WEISDORN: Thank you.

MS. BAROODY: Okay, we have about 25 minutes left before our next panel, so I would like to welcome John Maddox and Tom Apalenek with BAE Systems.

MR. MADDOX: Good day, everyone. Thank you for having us here. If you are not familiar with BAE Systems,

we are based in London, England. It is a fairly large company, about 105,000 employees, and we are in over 100 countries now, in 37 states, a large defense contractor and annual sales are approximately $33 billion.

This is to show you quickly our footprint worldwide. A little less than 37,000 employees in the country and, more importantly, 5,700 employees in the state of California. One of the notable things about our company, and we will tell you why you should know about hybrid technology a little later in the presentation, but we have in successful service today over 2,300 diesel hybrid electric series products across North America, the largest fleet being in New York City and, as you can see, several other large cities, including London, and an order in Seattle for 500 additional.

The largest single fleet in the world is in New York City Transit. At the present date, there are 1,222 units in service, of which 241 of those have the new lithium ion now phosphate technology battery system, 453 more to be delivered.

The third largest hybrid fleet in the U.S. is in the City of San Francisco, with Muni, 86 40-foot and 30-foot units delivered there a couple of years ago, and there are also 17 units in service in the City of London, and that is an Alexander Dennis bus, which we have an exclusive

agreement with four dual axle, double-decker buses, and 12 meter single deck buses. And at this point, I will ask Tom Apalenek, Senior Systems Engineer, to come up and talk to you more specifically about fuel cells.

MR. APALENEK: Good day, everybody. And this last slide that John put up here kind of shows our experience over the years. We have been working on hybrid electric and, actually, fuel cell vehicles, since about 1996, and in the bottom row there, the bus on the left is a fuel cell bus we did with Georgetown University back in 1997. And we did a second one with them in '98, '99. We have also done chargers for all-electric vehicles, and we are looking at re-exploring that market as we move on. One fuel cell program that we are working on currently, which is a little bit unique in the fuel cell bus area is we are working on what is called a compound hybrid fuel cell bus, this is a program through the FTA in conjunction with CalSTART out here. This is going to go into revenue service testing in March of next year at MUNI in San Francisco, and essentially this is a diesel hybrid electric bus with a fuel cell power unit on the roof to provide all the auxiliary power for air conditioning, power steering, lighting, air compressor, and so on. We are using our next generation system and electric accessories that we are currently integrating into the bus, and we are trying to combine the best of both. One of the

key ideas behind this was to help provide a means of commercializing fuel cells a little earlier in the process by using a smaller lower powered fuel cell, so that we could start to bring them into commercialization, rather than going with the full size power plant. Also, this demonstrates the electric accessory technologies, and I know Paul from ISE talked about electric accessories on those, on their systems, which are key to commercializing fuel cells. And I kind of already covered this, but how does the hybrid activity support alternative fuels and hydrogen initiatives? And the key part of it is that all of the technologies that we have to develop for the hybrid vehicles, particularly for a series hybrid vehicle, are the same technologies for the rest of the vehicle that have to be developed and commercialized for a fuel cell bus, so it truly is the path to the future.

This is just showing some of the product improvements that we have made. John mentioned that we have got several hundred of the lithium ion energy storage systems that have gone into production now. The previous system was lead acid, we have upgraded to that. The other key part that we are adding to our next generation is support for electric accessories and the integration of electric accessories, again, key to fuel cells. And actually, the lithium ion, I will talk to in a minute here.

That is going to be very key to supporting fuel cell programs in the future because of the weight reduction. Again, electric accessory support, all the cooling systems, air compressor, power steering, air conditioning, auxiliary systems clearly have to be electric for fuel cells.

This is our next generation traction system, it is a little bit of an upgrade from the previous system that is in service in a lot of the cities today, and we call this a modular traction system and the key part about it that is modular, if you look at the picture on the lower right, that is our system attached to a standard diesel engine. One of the things that we did to simplify integration for the bus OEM's was make it so that it looks very much like a transmission, but one of the key aspects of it is that the generator that is needed with the diesel engine system literally comes right off of the traction motor, so you could separate it and just use the traction motor portion of it.

Some future vehicle development plans that we are doing today. We are working with CalSTART, some of the ZTUG* [66:09] partners, and a number of leading suppliers of fuel cell, buses, hydrogen fueling, toward the development and the deployment of 50 or more -- we would like to see it more -- fuel cell buses in multiple states, including California. Right now, at least 25 buses are targeted for

deployment in Southern California. All of the technology is based on proven systems from each of the team members, and our goal, if we can get funding for this, is to get these vehicles deployed before the beginning in 2012. And one of the key things that we are hoping here is that a larger fleet size will help to bring down those costs.

In the agenda, there were some panel questions that you had asked that we try to address, and I put a couple of the key ones up here. Regarding challenges and opportunities, I do not think that we are aware of any challenges other than the main ones that are known out there today, which is fuel cell cost obviously has to come down, robustness of service life needs to be improved, and, actually, in the morning session some of the other automotive suppliers, some of the things that they are doing with the fuel cells was very encouraging in that area, so hopefully the automotive marketplace will help with some of those things. And obviously the hydrogen fuel sources and facilities.

As far as opportunities, and I will talk about this in conjunction with the overlooked applications, I think one opportunity that we see that can really help in the heavy duty market, particularly with transit, is to look at the retrofit option. One of the things that we have talked about whenever we have made presentations is that a

series hybrid bus is fuel cell ready, we have called it, because all of the components are the same. But we have always talked about it in terms of generalities, and I think one opportunity for funding that might really help spur this on would be to do a specific demonstration program to develop two vehicle types, a CNG hybrid bus, and what is key about that is, by going to lithium ion and some of the more advanced energy storage and reducing the weight of the system, you can now make a CNG hybrid practical and have it fall within the weight that you need a transit bus to be, and then the second bus type would be a fuel cell bus, and the key part of this demonstration would be that you make the two buses 100 percent identical, except for the power plant. And the key thing that this does is it provides a mechanism where transit operators could begin ordering CNG hybrids that truly are convertible to fuel cell as soon as the fuel cell power plants become commercially available because they would be able to literally pull it out, pull out the engine, and the generator portion of the system, this could be done at the six-year major overhaul interval that a lot of transit operators do, and also any existing orders for those in the future, when in production, could be converted from CNG to fuel cell at the OEM's factory, again, when the fuel cells become available. So I think that is an opportunity that would be worth looking at as a future

possibility. And this is just basically a little graphic illustration of that, you have got the system, you pull out the engine and generator portion of the system, and you put in a fuel cell power module, and the rest of the bus remains untouched.

So, in summary, I think all of the people that are working on hybrids, and particularly series hybrids today, that experience applies very well to the fuel cell technology. The series hybrids supports the future goals. We currently have thousands of vehicles in service proving the technology, so we know that that portion of the technology is reliable and, of course, you get all the quieter operation, smoother ride. Retrofit options, I think, re a key one that needs to be looked at, and we believe that we can be a reliable systems partner for that. Thank you.

MS. BAROODY: Thank you, Tom and John. Any questions?

MR. OLSON: Yeah, a couple questions. This is Tim Olson. So your recommendation on a demonstration program -- is that something that you have the capability of doing both of those, the CNG hybrid and the fuel cell bus?

MR. APALENEK: Yes, we do. We have worked on a number of fuel cell bus programs, actually, one of the vehicles that was in that large picture of all those

vehicles actually was a CNG hybrid. We did a CNG hybrid taxi for New York City a number of years ago as a demonstration program with NYSRTA. So we have experience with both of those.

MR. OLSON: And would you work with other vendors on that? Or do you manufacture everything yourself?

MR. APALENEK: No, no, we would work with a fuel cell partner for the fuel cell portion of it. We would work with a bus OEM for the actual vehicle, so it would be a partnership.

MR. OLSON: And do you have any of your manufacturing in California for assembling?

MR. APALENEK: At present, the manufacturing is not in California. We have a number of facilities in California, and we are actually looking at making California into an application center, where we would be able to do integration field service.

MR. MADDOX: The fuel cylinders are built at SCI in Pomona, and the cage for the fuel cylinders is built by a --

MR. APALENEK: Fab Industries, Inc. Yeah, some of the partners that we are working with are in California for some of the components on this current bus. And actually the hybrid -- the compound hybrid that I mentioned, all of the integration with the fuel cell portion of that is going

to be done in Ontario, California.

MR. OLSON: And do you have any similar information that the Vision owners, the people describe in terms of through-put for the hydrogen version of this? Fuel through-put on an annual basis?

MR. APALENEK: I am sorry, fuel through-put, or number of vehicles?

MR. OLSON: Hydrogen fuel through-put?

MR. APALENEK: No, I do not have any data on that at this point. We can certainly develop that and provide you with some estimates and projections.

MR. OLSON: And what did you say the cost of your prototype was, and where you are going on the next step?

MR. APALENEK: The cost of the prototype, actually, I do not have for you. John may be able to provide that, the FTA program, I know, is the public information. I do not know if you want to address that, John?

MR. MADDOX: That particular program runs for three years and it is approximately $5.6 million program, but there is a lot of support that goes with it beyond the vehicle itself. The 50 bus consortium, we mentioned earlier, you know, the price to win goal there is $1.8 million.

MR. OLSON: Okay, very good. Thanks a lot.

MS. BAROODY: Thank you again. Next up, we have David Pfeil with Plug Power.

MR. PFEIL: Thank you. Now, I want to talk about Plug Power and what we do. I am primarily going to focus on the hydrogen infrastructure to supply our project, which is one of our major challenges at this point. Plug Power, our market is electric lift trucks. We replace the lead acid battery with hydrogen fuel cells. The different classes that we target, Class 3, is the pallet trucks, Class 2 stand-up reach trucks, and those two are typically lumped together in the high through-put fuel distribution industry, companies such as Wal-Mart, Target, Kroger's, etc. And then the sit-down lift trucks, those are mostly in the manufacturing industry, Bridgestone, carpet manufacturers, etc. And what our customers want is a product that simply plug-in play, so it replaces the lead acid battery with the hydrogen fuel cell, so they do not have to replace their lift truck, itself, but just take out the battery, put in the hydrogen fuel cell, and they operate as normal.

So the material handling business in California, it is a multi-billion dollar North American market. And there is a large opportunity, obviously, to supply California, which is one of the biggest states in terms of the materials handling market. So in California, there are over 50,000 electric lift trucks operating in the large

fleets, and we typically are only going after large fleets, not the one or two installations, so it is mostly the high through-put. And this provides California and it provides different states with the ability to roll out distributed hydrogen re-fueling. So if you look at each warehouse, it is up to 300 plus kilograms a day of hydrogen, it is high utilization rates, so these are operating 20-24 hours a day, seven days a week, and obviously using hydrogen. It is a predictable and rapid adoption rate, so when you sell the lift truck, you provide the hydrogen station with it, so it is not like automotive where you have to first install the fueling stations and then wait for the vehicles to catch up, this, you install at the same time, so there is no -- typically wasteful by the industry -- the chicken and egg scenario. And then, also, because you are not charging lead acid battery, you are reducing the load on the grid, and the options obviously for renewable hydrogen where you can get clean green hydrogen to the left trucks.

Also, we have spoken to a lot of the customers are leveraging the hydrogen infrastructure at their sites and to be able to use it for automotive or truck fueling, as well, so there is an option for that. The hydrogen fueling at materials handling sites is typically the same as for automotive, you know, you have your installation, you have your components, your hydrogen supply, your compression and

storage, etc. The biggest difference is that we have indoor dispensing, so we need to dispense these lift trucks inside the warehouses, they do not go outside. And so we need to safely and effectively do it indoors, and that is our strongest value proposition is making sure that the lift truck operators are on the floor doing their work, as opposed to changing out batteries, and then the operation, as well. And typically that is how the hydrogen to the customers is processed, a fixed portion which is the installation, and then the capital costs, and then the operating costs, which is the hydrogen molecule, and the maintenance.

Installations, so we have inside a distribution center, these are on the order of magnitude of about a million square foot. We have sort of two to five dispensers typically installed within the distribution centers at various points that makes sense to the operation. And we have either, if you can see on the top left here, we are running the tubing on the roof of the distribution center, we have also run it in the trusses inside, or on the walls and we have also done in new distributions, we have run the hydrogen piping under the floor before the concrete is laid, and then stub up at the dispensing points.

This is an Air Products also liquid supply, horizontal tanks, and these are industrial settings, so we

comply with NFPA, all the international codes, and make sure that the setbacks, etc., are within code. Luckily, most of the places have enough space where we can adequately site the liquid tank, and that is mostly what we have used is liquid supply at the distribution centers. But we work with the fire departments, the code officials, etc., to make sure that we have all the correct permits and approvals to install these systems.

So supply and compression, I am sure most of you are familiar with these. This is an Air Products site with a vertical liquid tank, so the liquid tank vaporizes compression, and then high pressure storage, and those are all situated outside the distribution center.

This is a Linde system where the liquid tank obviously arrives and discharges to the liquid storage tanks, which are located on site. We also are looking at natural gas reforming, which is the potential and we are looking to see if that makes economic sense, as well. All the places we have done it thus far, it has not made economic sense to do that, and we have just used liquid supply.

This is another Linde installation, and what one of the biggest, most critical factors at these distribution centers is making sure that there is reliability of supply because, the way they are operating, if we stop supplying

them the hydrogen, their product is sitting on their floor, not moving, and all the premise with just in time supply, that obviously cannot happen. So we built in a lot of Linde products and we work with both a lot of redundancy to ensure that we have continual 24/7 supply of hydrogen. And here you can see the containers contain the compression and storage, and there is some redundancy in there, as well as the vaporizers.

Indoor dispensing, pictures of two Air Products dispensers, we have stand alone ones, as well as wall-mounted dispensers. We have on the Class 2 and 3, which is the grocery distribution, we have 250 bar pressure, and then, on the Class 1's, which is the largest sit-downs, we have 350 bar pressure.

If you look, these are Linde stations and, up to now, we have worked mostly with Linde and Air Products. If you look at the top left hand with the operators fueling the lift truck, we have three connections, we have the hydrogen connection, we have the de-watering connection, which removes the water when we are fueling, this allows, because these lift trucks work in the freezer operations, which goes to -20, we cannot have truck vaporized water and we cannot leak water onto the floor, because that is a safety hazard, so we store it and then remove it during fueling. And then we also have a ground and data cable, as well, which we

connect when we do fueling.

So the plug power commercialization status to date, so today we have over 1 million operating hours of fuel cells in lift trucks, and this is at customer sites, this does not include our testing, these are commercial sites and commercial operation. We have just over 106,000 fuelings, as well, without any safety incidents to date. The only instance we have is driveways, so operators pulling away with the hydrogen hose still attached, but the breakaway has worked on most occasions, sometimes we have damaged the nozzle, but we have not had any releases of hydrogen in those instances either. So right now, we are averaging about 330 Kilograms per day of hydrogen, and we expect our projection to more than double by March of next year.

These are some of our current customer -- Wal-Mart, Bridgestone, and above the line is other customers that are currently installed and currently operating. Below the line are the customers and the locations that are under construction, or about to start construction. As you can see, most of them are in -- we have not had any in California, as yet.

This is a picture of the roll-out at a company called Central Grocers. They are based just outside of Chicago in Illinois and they were our first Greenfield site,

so it was a distribution center which was made full purpose for hydrogen and did not have any battery charging infrastructure in, and this was our first order of 140 lift trucks which obviously fit into the Yale lift trucks, pallet trucks.

So barriers to commercialization in California, there is a strong interest from companies here because of higher electricity costs, as well as they see the productivity benefits that they have been getting from using fuel cells, as opposed to acid batteries. Our largest barrier at the moment is hydrogen competing against the grid electricity. The companies know what the cost structure of doing this, and we need to break through into that, and we need first movers, and then we have seen in other parts of the country that other people learn and follow. The companies with their head offices outside of California, they are looking at the moment and doing business where there are states that are giving funding, for instance, a company called Wegman's, their head office is in New York, but they just did a project in Pennsylvania because they just received funding from Pennsylvania State.

So what we are looking for is incentive to the customer up front and to cover the costs, with a portion of the cost of the installation costs of hydrogen, and which obviously reduces their ongoing operating costs. And we are

working with them and working out of different sites, we are getting customers to overcome the scare of the dark type perception of hydrogen and the complexities thereof, and we are getting them to work with Linde and Air Products to try to simplify the hydrogen and the cost structure to the customers. So that is what we are looking for, so short term incentive which will immediately bring customers online in California, and then help and cause other people to follow suit. Thank you.

MR. BARODY: Thank you very much, David. Are there any questions?

MR. OLSON: Yeah, I have a question. Can you just walk through some of the cost benefits of hydrogen? So you are displacing, you said, the acid battery --

MR. PFEIL: Correct.

MR. OLSON: And I can see where that might be beneficial just from the time spent not moving product and dealing with -- can you describe what that cost differential might be? Or what the benefit is?

MR. PFEIL: It is mostly in the labor cost, you know, if you look at a site which has around 300 lift trucks, and each operator, when they change their battery, it can take, you know, if there is no line-up, it can take 10 minutes to change it. If there is a line-up, sometimes it takes them 30 minutes to change that battery. And their

run time is a lot shorter, as well, on a battery versus a hydrogen fuel cell, as well as with a lead acid battery, you get -- as everyone knows, with batteries you get a battery drip, the AC technology has taken care of some of that, but you still get some drip in your battery, whereas a fuel cell, on our technology, it takes approximately 30 seconds to two minutes to fuel. And then you are not getting any of that battery drip, so it is operating like a fresh battery all the time. So if you look currently on payback, which is what most of the customers look at, they are looking at sort of under two-year payback, and that is what we -- on the ones that have gone commercial -- we offer that.

MR. OLSON: You had mentioned that you thought California was a $50,000 lift truck market. What is the turnover on that? What is the annual turnover? Is that --

MR. PFEIL: Well, in the U.S., you are getting about 175 to 2,000 sales of new lift trucks every year, so I have not broken that specifically to California, but that is what you are getting within North America. But our product can fit into the existing fleet, we do not have to wait for new product, new lift trucks.

MR. OLSON: Have you been approached, or have you looked at this potential business model of combining your big box warehouse type of operations with maybe some of the transit or potential truck -- more industrial -- is there a

potential to locate a fueling site that would benefit both on-road, medium duty, heavy duty, maybe, and also your forklift -- your lift truck?

MR. PFEIL: Yeah, there is. And we have spoken to customers, as I say, like Wal-Mart and Kroger's, and people like that about it, and there definitely is -- you could use the infrastructure that is outside the warehouse and have a automotive style dispenser at their location. We are currently doing that at Aiken, actually, where we supply -- our infrastructure is going to supply two warehouses, and then it has an automotive style dispenser, as well.

MR. OLSON: And what is the lift truck, whether it is electric or hydrogen, what is the base cost on that?

MR. PFEIL: A pallet truck is probably around $10,000, if I remember correctly, around there, and they can go up to $20,000 or $30,000.

MR. OLSON: Okay, thanks very much.

MS. BAROODY: Thanks, David.

MR. PFEIL: Thank you.

MS. BAROODY: We have an addition to this panel, and that would be AC Transit, Jaimie Levin.

MR. LEVIN: While she is pulling up my presentation, I direct the Alternative Fuels Policy Program for AC Transit, which is a fancy description of what I really do, which is to run our Hydrogen Fuel Cell Program.

And so let me just start out by acknowledging what Peter said at the start of this workshop, that what the state would like to see our model projects and model development efforts that can be really an example to the rest of the world, and anyone who knows what we have been doing at AC Transit, which is now expanding to the Bay Area Region, anyone who knows this project in terms of what we have accomplished, what our goals are, what our prospects are for the future are, will clearly acknowledge this is an international project, it is largely funded by the state of California, and our objective is to keep rolling, and so let me give you a quick background as to where we are and where we are going, and what the Energy Commission can do to support that effort, and in fact has been supporting us in some measure.

So Phase 1 of the project, which has been in operation for three and a half years, been funded to over $21 million -- public, private contributions, and the Energy Commission actually gave us a million dollars early on to fund the station that we built with Chevron. The performance in the last three and a half years has really been quite remarkable. You can see that we have reached close to 200,000 miles of passenger service, we have carried over 450,000 people. We are getting 70 percent better fuel economy, even though these vehicles are 8,000 pounds heavier

than their diesel counterpart, which we do careful testing with a control fleet. And also interesting to note is that the fuel cell buses utilize air conditioning, which is a pretty heavy parasitic load. The control diesel fleet does not have air conditioning. So that fuel economy number is something that we are very excited about in terms of performance. And even though we make our fuel by reforming natural gas at our Chevron station, our grid analysis shows a 43 percent reduction in greenhouse gases. So you can imagine with renewable fuel what the ultimate benefit is. And then, fuel cell durability has been climbing steadily. Our partner is UTC Fuel Cells, we are seeing some phenomenal numbers, which I am not at liberty to share with you under NDA, but it is showing us as the end user, that there is really potential here for our industry. The public? They love this. I think the gentleman from GM talked about how people love driving the cars. The people love riding our buses. I am a bus user, I take a fuel cell bus to work, believe it or not, and that is entirely coincidental. But the bottom line is, these vehicles are quiet, they are smooth, they represent a different mode and our public loves it and wants us to continue.

So second phase of our expansion, which we are involved in now is over $50 million, funded by a variety of sources. Now, one of our goals beyond proving the

technology is to replace the guy in the lower left photo with this guy, but for those people who are not in the room, but are on the Web, I want to offer a disclaimer, this is a Photoshop version. But, in fact, we have received a major stimulus grant from the Obama Administration, and we believe our next generation vehicle is going to really open up the doors, the gateway for what we think will change our industry.

This next program is a Bay Area program, Gerhard referenced that, it is not just AC Transit, although we are the lead, it is these other four transit operators that are working in partnership with us. What is really exciting here is I am going to go over just some of the very few basics of this new design. What makes it different from our existing vehicle design, of which we are building 12 of these, first of all, we are 6,000 pounds lighter, so this new bus is only 2,000 pounds heavier than a diesel bus, secondly, it has been fully integrated by an OEM, and we have realized significant benefits in component design and engineering, as well as the weight. We are introducing lithium ion batteries in this technology, actually by a U.S. company, Enterdale* [95:03], which recently received a big stimulus grant for their efforts, and our fuel cell warranty is up to 10,000 hours with this new vehicle. So our objective with the vehicle is to show that it is fleet

ready. But, if we are going to convince the industry and our decision makers that this technology is in our future, we have got to do more than show that the vehicle works, we have got to show that the infrastructure and the fueling side of this works, as well. We have to expand from our current capacity of 150 kilograms per day to over 400, and to help us with that, we just received, I mentioned, a stimulus grant from FTA in the amount of $6.4 million, which will go towards a solar installation to expand our solar capacity, to 1.7 Megawatt hours per year, and all of that power is going to go into renewable hydrogen so that we can satisfy our CARB grant for light duty fueling at our Emeryville station that we are building, as well as provide green power for our efforts at our Oakland site. Our Oakland station, which we run now, we produce over 41,000 Kilograms of fuel, and this has been a great partnership with Chevron. But, quite frankly, we have been spoiled. And Chevron has done a fair amount of investment and been a marvelous partner, but there is not a business case for them right now, so we have to go out on our own and find a partner and a company that we can make this more commercial, and we have out on the street, as we speak, a solicitation to build two new hydrogen stations, one for Emeryville, and one to replace our Chevron station in Oakland, and we have some hungry companies in the industrial gas business that

are preparing their solicitation, some of them I see sitting in the audience, I thought they would be at home working on their proposals, but whatever.

So what do we need to do on the infrastructure side to bring this to commercialization? First of all, we have to be able to fast fuel our vehicles. We have hundreds of buses that are fueled in five to seven minutes, each. So that is a labor issue, just like the lift truck dilemma, as well. Secondly, we have to be more energy efficient and reduce -- try to keep our costs down and fuel production, thirdly, we need to push towards a green footprint solution, and then, lastly, it has to be scalable.

Our current program is three buses, we are growing to 12, we see ourselves as the center of excellence, we want to be able to go to 20, 30, 50 buses, and do it fairly easy. Here is the station in Emeryville that we are moving forward with, and we are looking with our partners on the auto side, Hyundai is a partner with us now, we are looking to both Toyota, Daimler; GM and Honda have expressed an interest to actually use this Northern California station, which is right across the street from Pixar Studios. There are some images of what the station would look like from the street side, with respect to public access, and then you can see how we share the bus and the private or light duty fueling at the same location. We have a continuing evaluation

program with DOE and the National Renewable Energy Lab to track what we are doing. And we also have a pretty aggressive education program that we work through U.C. Berkeley's Lawrence Hall of Science, reaching out to all of our high schools, secondary schools about the work that we are doing.

Here are our next steps. The 12 bus program is what CARB is looking at very closely in this next year. But we hope, with these new buses and this new infrastructure, to really be able to grow this as a center of excellence to up to 50 buses, and prove to our industry that, indeed, this is our future. So the punch line to this presentation, which I will direct to the Energy Commission, is that we responded to the last solicitation, we put a dynamite proposal together, but we were rejected right up front because the Oakland station that we are seeking additional funding for is not a true public access station, it is an industrial area, it is very difficult to get to the fueling pumps where there are located, as opposed to the Emeryville station, which is very accessible to the public. And here is this state project that is world renowned, in which we are not asking for, in the fleet application, for a multitude of stations, we are asking for funding to build one station as part of this demonstration which has so much potential in terms of vision and future. So that is what I

pose to the Commission and the workshop effort, is that you consider some aspect of the state's funding going to fleet applications that do not necessary have public access. If we can provide it, we will be the first at the door to do it, but that is not something in many locations, for fleets, it is not something that we can easily do. So with that, if there are any questions, I think we are way over time for the next round.

MS. BAROODY: Thanks, Jaimie.

MR. OLSON: Jaimie, this is Tim Olson. What does it cost for these buses?

MR. LEVIN: Well, let me start with -- the first buses were $3.2 million a piece. These buses are $2.5 million a piece, not acceptable numbers when a diesel bus, we can buy with the 2010 emissions standards at around $400,000; however, when you look, especially on components with the fuel cell box, there are some handmade pieces, manifold pieces, that you could probably buy at a Home Depot for $100, but which cost maybe $12,000, $15,000 to make for these research vehicles. So supply chain economics have not kicked in to this. And this, I think, came up previously -- what is the state's role? What is the federal government's role? That role is really to enable these visionary technologies, if we can prove performance. And it is going to take -- to get across the Valley of Death -- it is going

to take some investments. And it is not the state's responsibility alone, it is the federal government is going to have to step in because, in the end, it is a public policy issue of is it worth it to us to have silent vehicles in our neighborhoods, to have zero emission in urban neighborhoods, is it worth it to us to really do away with reducing greenhouse gases, so long answer to your question, but I think it is important to realize that we are driving the costs down, and the state, as well as the federal government, can help realize that objective.

MR. OLSON: And what is the cost of your fueling station that you are looking at in Oakland?

MR. LEVIN: Well, I can tell you what the budget is, but I maybe even should not say that because we have got some people in this room who are bidding on our hydrogen systems. I hope to be able to come back in another month, a month plus, to tell you what those costs are. I can tell you that, for the Chevron station, we put $2 million into that project and Chevron put in a whole lot more than that, as a research station, and it is not realistic to what the true costs are, and we want to be able to come back and share with you what they are costing us in order to get this rolling.

MR. OLSON: Yeah, just a comment on -- I think it is a good point you are making about the public access.

This needs to be on the table for this next round of funding or even, for that matter, this round that we are going through now. And part of the rationale for that from our Commissioners was that we have got 20 some odd stations throughout California, and many of them are not operating or they are not public access, so it just kind of minimizes the use, and we did not want to repeat that. So I suspect that is a smarter spending of money and strategic targeting of where we actually put money.

MR. LEVIN: I understand that point of view, but I would just ask you to consider what we have accomplished with the state's money and investment, this is a world renowned program, not just because we have got all these miles and fuels consumed, and what have you, but we have developed technology with a true prospect for the future. So we would ask you in this round to open up at least some portion of that funding to fleet applications. I think the LA project with trucks, and the lift truck projects, those are other fleet operations that I think merit attention, as well, even though I might be competing against those projects, but I think they all merit consideration.

MR. OLSON: And do you own the fueling station, AC Transit?

MR. LEVIN: We do own the fueling station, and we will own these other fueling stations, as well. But the

Chevron station was really a very advanced R&D effort, and so, with our agreements with Chevron, we will be decommissioning that station to make way for the new station that these companies are bidding on, as we speak.

MR. OLSON: Okay, thanks a lot. I appreciate your comments.

MS. BAROODY: Thank you, Jaimie. We appreciate it. Okay, we are going to take a real quick five minute break and we will be back at 2:55 with our next panel.

[Off the record at 2:56 p.m.]

[Back on the record at 3:05 p.m.]

MS. BAROODY: Next up is our Fuel Production and Distribution Panel. Is Dr. Tim Brown available? There he is.

DR. BROWN: Hi. I am Tim. I want to thank the Commission for letting me speak today. I am going to talk about UCI's views on the whole hydrogen fuel cell vehicle subject.

Transportation problem -- before we look at alternatives, we need to define the problem, and I think the transportation problem is being driven by three forcing functions, which you are all very familiar with. Of course, there is air quality, and that can be summarized here in California by the Carbon Strategic Action Plan, the strategic plan, as well as the EPA Natural Ambient Clean Air

Standards, Global Climate Change, again, California AB 32 and Pavley Bill, and last but not least, petroleum dependence, which leads to many things, including geopolitical instability, price uncertainty, on down the line. But these three forcing functions do not stand alone, they are all integrated, tied together by one common theme, and that is market acceptance. No vehicle option can meet these three goals without being accepted by the market. So any successful alternative is one that will meet the needs of the consumers and the economy. And we believe fuel cell vehicles are really the only option to this point that can do this -- meet our goals, and meet the needs of society.

Continuing on, to talk about greenhouse gas emissions, the little picture there. The well to wheel greenhouse gas emissions are drastically reduced, regardless of the mix of hydrogen generation technologies. We have done some modeling to show -- excuse me, my graphics are kind of screwed up, you will have to give me just a second for my graph to show up. We even went through this earlier and it was working.

MS. BAROODY: Those of you online, we are just fixing the PowerPoint presentation.

DR. BROWN: All right, greenhouse gas emissions get reduced regardless of hydrogen generation method. On the vertical axis, we have greenhouse gas emissions and $CO_2$

equivalent. This analysis was for the entire state of California. On the horizontal axis, we have two different scenarios, one for 2030 where we assume a 12.5 percent penetration of hydrogen fuel cell vehicles, and the other in 2060 where we assume a 75 percent adoption of vehicles, and for each scenario, we have three bars, orange being a baseline case of gasoline vehicles. And it is important to note that these are not today's gasoline vehicles, these are future advanced, more efficient gasoline vehicles, as projected by the CARB IMFACT* [5:10] model for each of the years 2030 and 2060. And for each scenario, the blue bar represents hydrogen that is generated from a more fossil fuel scenario, so it is Scenario F, and the green bar represents hydrogen generated from more renewable sources, so that is Scenario R. And there are two sort of important takeaways from this, the first being that, for either scenario, the hydrogen fuel cell scenario, for either fuel cell scenario, reduces greenhouse gases significantly compared to baseline gasoline vehicles. The other important thing is that, regardless of the hydrogen generation scenario, be it more fossil fuel or more renewable, there is not too much difference in greenhouse gas emissions. Sure, the renewable case is better, and this renewable case actually is the 33 percent case as proscribed by SB 1505. So fossil fuel is not as good as renewable, but not

drastically. These results were published in the International Journal of Hydrogen Energy.

Sticking on greenhouse gases, it turns out that the greenhouse gas emissions for the vehicle scenario is reduced regardless of the hydrogen delivery method, so, again, same sort of graph. $CO_2$ emissions on the vertical axis and three different categories on the bottom here, with Scenario F, again, fossil fuel generation primarily, Scenario R, more renewable generation, and a baseline case. Now, both the fossil fuel generation and the renewable generation includes some of each, just the renewable is more slanted toward renewable fossil fuel, more slanted towards fossil fuel, and here the orange line is the baseline case of gasoline vehicles; of course, all the fuel of today is delivered by truck for gasoline vehicles. The other two scenarios, the blue line is for all truck delivery of hydrogen and the green line is all pipeline delivery, so we have bracketed the two bounds of how this may happen. Realistically it is going to be a mix of both. But you see that both cases are better than gasoline, and both cases are relatively similar. It turns out that the delivery method makes relatively little difference for greenhouse gas emissions. And the last scenario for greenhouse gas here is that it makes very little difference of where the hydrogen is generated, whether it is on-site or a central location

with delivery. And a similar graph, $CO_2$ emissions vertically and our two cases of 12.5 percent penetration, or a 75 percent penetration. You can see that the orange line, again, baseline case, gasoline vehicles, the blue line is an all distributed scenario, where all the hydrogen is generated on-site, the green line is all centralized, where it is all generated at a central location and delivered to the stations. Again, for the outline case, 75 percent adoption of these vehicles, the centralized case is not as good as distributed because of the emissions associated with delivery, but they are relatively similar and they are both far better than gasoline.

Moving on to look at air quality, this same modeling tool, which is called STREET that we have, Spatial and Temporally Resolved Energy Environmental Tool, and we can use this to go a step further than the greenhouse gas emissions I showed to actually look at criteria pollutant emissions, and the formation of pollution in the atmosphere. And if we look at two scenarios here for hydrogen generation, again, both graphs represent a 20/60 case where 75 percent adoption of hydrogen vehicles, a big portion of the hydrogen actually generated in the areas shown here, and this represents the South Coast Air Quality Management District, rather the South Coast Air Basin, and you can see Los Angeles, Anaheim, Riverside, try to get your bearings,

the left of this black line is the ocean. The plot on the left shows eight-hour ozone concentration, again, 75 percent vehicle penetration, a lot of hydrogen generated in the basin. The plot is actually a Delta, it is a difference plot showing how much improvement or how much worse the air quality is compared to our baseline, and this is, again, a baseline for the year 2060, so it has improved over today. You can see that, in the Riverside area, out towards the east, there is actually eight parts per billion in improvement and an eight-hour ozone. The standard today is 75 ppb, so this is nearly a 10 percent improvement due to the hydrogen infrastructure. On the right-hand side, there is a particulate matter plot showing similar air quality results for this time for particulate matter and, again, there is nearly a 6 microgram per cubic meter improvement. And these results were just published in the *Environmental Science and Technology Bureau*.

Hydrogen displaces petroleum, not a very exciting graph here. It is pretty straightforward. Fuel cell vehicles can significantly lessen our dependence on oil. The year 2030, both the fossil fuel and renewable case, lower petroleum use, and in 2060, similar results. Again, our fossil fuel generation of hydrogen in both cases involves coal, petroleum coke, natural gas, it does not involve any petroleum, so that is why there is no difference

between the renewable and fossil fuel cases.

Moving on to the market, again, this is in our view a big bonus of fuel cell vehicles over other alternative fuel options. Fuel cell vehicles provide ranges competitive with current gasoline vehicles. And you have seen this already today, several times, Kia Borrego, 426 miles, Honda FCX Clarity, 240 miles, Toyota FCHV-adv 431 miles, and from what I saw this morning, my numbers might be a little low, actually. That is all I am going to say about vehicles.

Moving on to infrastructure. We have a station at UC Irvine. UC is just continually increasing. We initiated the station as a research facility for a fueling and vehicle research, but we have sort of moved beyond that point and it has become the staple of refueling in the area. We are currently operating near our design limit of 25 kilograms per day. It is not uncommon to see two or three cars waiting in line, actually, for fuel. Here is a plot of our usage for the past four years, pretty dramatic increase each year. Currently, as of mid-day last Friday, we dispensed nearly 4,200 kilograms this year, which is already a third more of the total for last year. So we are projecting out for 2009 we are going to be nearly 6,000 kilograms this year, so it is a pretty big increase in fuel each year.

You heard earlier today about the Fuel Cell

Partnership surveys, sort of a blind survey of the OEM's to say how many vehicles are they going to introduce, and where they are going to put them. The survey shows nearly 40,000 vehicles in Southern California by the year 2017. If we plot the row out as produced by the Fuel Cell Partnership, view the graph like this, very little action up until about 2014 and there is this huge spike in the number of vehicles. If we do a very crude assumption here of, say, 1 kilogram of fuel needed per car, per day, which is roughly what we are seeing at our station now, and we go one step further and assume, you know, a kilogram of -- a dollar of profit per kilogram, maybe in the early years, early providers to the market can make this profit. In 2013, it is $330,000 per year profit industry in Southern California, nothing to get excited about, in 2015, $3.6 million, and by 2017, it is $15 million per year. If you look at the growth from 2015 to 2017, as well as the numbers, this seems like something that could be profitable and enticing to fuel providers without government incentive, I would think. I can let them speak to that on their own. But are these numbers realistic? To jump from 40,000 vehicles from 2015 and 2017? Compared to the roll-out of hybrid electric vehicles in the same area, again, this is Southern California, if we overlay these two plots, you can see that the projected number of vehicles for fuel cells are very modest, only about a third as many as

were actually sold for hybrid electric vehicles. If you go a step further and look at, say, for the first four years of hybrid electric vehicle sales, there are only two OEM's producing cars. For seven years, there are only three OEM's, whereas we heard this morning from six OEM's, we know there are several others, as well, that are all looking for commercialization around 2015. So the manufacturing capacity and the probability of funding the market for this number of vehicles seems very strong, and I would think this number of 40,000 vehicles by 2017 could even be much higher with the right market drivers.

How do we get from 2009 to this potential commercialization? Infrastructure needs to reach a threshold for commercialization. OEM's can only sell vehicles if fueling is sufficient enough for normal day to day requirements. Of course, this leads to the cluster concept, where there are a number of stations in a localized area. U.C. Irvine's STREET modeling tool can optimize the station location in the near term to help overcome this activation energy necessary for commercialization. The modeling tool uses a roadway network optimization algorithm as well as details about land use, travel density, population centers, stakeholder input, and some OEM customer data to help develop our station siting logic. So a blueprint for hydrogen station clusters, if you look at

Irvine as a case study, we have applied this analysis to Irvine, it turns out there are 34 gasoline stations existing in Irvine, which is actually just sort of low per population density compared to some areas. Eight well-placed hydrogen stations can sort of reproduce the level of service that those 34 gasoline stations provide, so if we show a map of Irvine, you can barely see the gray outline of the outer areas of Irvine, all the brightly colored areas in Irvine, the two main roads here forming a V are the four or five, and the five freeways give you some bearing as to where you are at. We have placed eight hydrogen stations in here using our optimization algorithm. The red area are places that are covered by a two-minute level of service, so that means that anywhere in that area, you can get to a hydrogen station within two minutes. And this assumes -- this uses real world driving speeds, you know, U-turns, one-way streets, all the actual real travel times. Blue line is three minutes, greenish is four, and yellow is five. You see some areas of this gray that are not covered? Those are actually undeveloped areas of Irvine that do not need to be covered at the present time. To make this a little more quantitative, we can compare the level of service of these eight hydrogen stations to the 34 gasoline stations. You see the bottom right here that 34 gasoline stations means that 73.5 percent of Irvine is within five minutes of a gas

station. The eight well-placed hydrogen stations get you 66.4 percent of Irvine within five minutes of a hydrogen station, not quite as good, but fairly competitive and we believe this is over the threshold. Where the discrepancy between the gasoline stations and the hydrogen stations begins to show up is down in the three and two-minute areas, where you see at two minutes you are still at 42 percent of Irvine can reach a gas station in two minutes, whereas only 24 percent can reach a hydrogen station. So there is a difference, but we believe the eight stations puts you at the threshold. And if we go a step further and add two stations that have been funded, shown here, one being the OCSD station, Orange County Sanitation District, that we are working with air products on, it has been funded by the ARB and the AQMD, and the other station funded by the ARB is the Shell hydrogen station in Newport Beach, and if we add the travel times to those, we can begin to see how this cluster expands, and if we go a step further and add our algorithm to Newport Beach, we can locate five additional stations there to round out the entire area of Newport Beach and Irvine, as developed by the California Fuel Cell Partnership Action Plan with their hydrogen communities.

So it is not just enough to determine where the stations need to go, nobody is going to build seven stations in Irvine overnight, we need to have a roll-out plan as to

when to put the stations in, and how best to do that. And this is one particular scenario we have come up with where we place stations one by one, and this addresses OEM needs as to where their customer base most likely is, puts stations near population densities first, and you can also see how there is a progression, so there is some redundancy. Oftentimes stations are not working properly, or whatever, there is some redundancy built into this cluster approach, and this just shows the first six stations.

So a final slide, what are our recommendations to 118 for investment strategies? Infrastructure. No surprise there. Infrastructure planning. Renewable hydrogen generation technology, that has become a bigger issue as more stations need to get rolled out. Technology needs to reduce fueling pressure, this is an efficiency hit and, you know, storage issue that we think could be improved. Fuel cell specialty vehicle deployment, we just heard about that as, you know, all these mentioned markets including forklifts, even buses or trucks to the port, not only have a lot of benefit on their own, but can also help the infrastructure and the technology for the vehicle sides with the personal vehicle sides, as well.

Consumer vehicle usage behavior. This is an ongoing subject if we are going to design a fueling structure, do we necessarily want to duplicate what has been

done with gasoline stations? We still need some more education as to how best to do this.

Hydrometric fuel cell, hydrogen tri-generation, I did not talk much about this, but this is what we are working on at the Orange County Sanitation District, it is a technology that we have developed, that we are very high on. It uses a hydrometric fuel cell to tri-generate heat, electricity, and hydrogen for vehicle fueling, and we can use various things as a fuel for this, including biogas. Hydrogen compression technology. I think there are some improvements that can be done in the compressor efficiency. Hydrogen leak control. I do not see a lot of work going on in these issues in the whole pipeline from generation to delivery to dispensation. And consumer safety goes along with that. Work in odorants or sensors. And last, but not least, weights and measures, which we heard about this morning, not only metering the fuel, but also guaranteeing the quality. That is all I have. If there is any time, I would be happy to answer questions.

MS. BAROODY: Thank you very much, Dr. Brown. Any questions?

MR. OLSON: Yeah, I have a couple questions. Just going back on your greenhouse gas comparisons, in your renewable source of hydrogen, did you include biomethane as a feedstock?

DR. BROWN: We did for a portion of that. I have the details that I can provide if you would like, actually.

MR. OLSON: Yeah, we would like to see it --

DR. BROWN: Now, I cannot tell you offhand which portion that is --

MR. OLSON: If you are willing to share that so we can check it with our pathway studies?

DR. BROWN: Okay.

MR. OLSON: The other question is about your STREET model. Who are your clients for that right now?

DR. BROWN: We do not have any clients, we are doing that independently. We are working with a number of OEMs and providers for feedback, but we are not being funded for it.

MR. OLSON: So you do not have any real -- it is still kind of a research project, there is no --

DR. BROWN: Well, it is. The background, the air quality modeling and these papers that have been published, that was funded by the DOE CHIP program which included Honda, Toyota, Air Products, that is a past effort, and that funding is expiring or has expired. That was a five-year effort to get us to the point where we are today. The tool is actually extremely useful.

MR. OLSON: And does that model have the capability of kind of mapping not just OEM hydrogen fueling

demand or need, but also other sources of -- other demand sources for hydrogen and other alternative fuels?

DR. BROWN: Absolutely. It is very modular, so right now we have applied it primarily, as I said, to Irvine and/or the State of California for hydrogen, but the versatility would allow us to look at other fuels, as well as the entire pipeline of generation, to delivery, to dispensation for any fuel.

MR. OLSON: And to what extent is fuel through-put a significant factor in your model?

DR. BROWN: It is not currently because we feel that the early issue is comfort for consumers to have a station nearby, not so much the capacity of the station. We feel that initially -- we have been siting our stations at existing gasoline stations. If you can imagine one pump initially being hydrogen, as capacity becomes more important, a second pump would be made to hydrogen, build in some capability to expand for these stations.

MR. OLSON: Okay, thank you.

MS. BAROODY: Thank you, Dr. Brown. If we could have the panelists come forward to the tables here, we forgot to call you up earlier. Charles is going to put up the nameplates. Thank you. All set, okay. Next up with Praxair, Tim Busch. Is Tim Busch here, with Praxair? Is he on the WebEx? Maybe he missed the plane today. Okay,

moving on. Propel, Rob Elam.

MR. ELAM: Thanks and hi. I thought it would be interesting to hear from a pure retailer's perspective on H2 opportunities and challenges, so I prepared a few short slides. Propel is an alternative fuel retailer, an alternative fuel retail platform. We have an interest in hydrogen and learning about how we can apply our knowledge taken from other retailing opportunities to the hydrogen challenges. We are currently working on a project with Linde -- Bob, it is nice to see you today -- SFO that was funded by the ARB solicitation earlier this year. So we are in that process. I think ultimately we have talked today, a lot of discussion about the need for alternative fuel retail, and for hydrogen retail locations, specifically. But I think there is a question of who should take the risk here and what are the costs associated with it. When you ask a station owner or a retailer to take the risk associated with opening a hydrogen fuel station, I think we get a number of reasons why that is a difficult expectation. The technology is very new, obviously, the operation and maintenance costs of these facilities have not yet been defined, and the ability to retail the fuel and demand are really not yet clear.

When you talk to a fuel retailer, you will hear a lot about unit economics, and from a unit economic

perspective, the three essential factors for a retailer are what are the costs associated with the equipment and overhead, the costs of managing and running the site, what is the volume of fuel that can be sold and the margin associated with that volume, which gets you to a break even point of how many gallons -- how much margin do you need and how many gallons do you need to sell to be able to cover the costs associated with running the site. Above and beyond that, then you have the opportunity to actually get profitable for the site. Taking the assumptions as we know them today, if you are talking about opening a site that had 50 vehicles associated with it, I think that we saw earlier there was an expectation for a dollar a kilogram profit, which would be, as a gallon equivalent unprecedented, but as we see the actual need from a break even point of a 50-vehicle station based on the data that we have from the other alternative vehicles that we currently serve, we would have to sell to cover all of our costs the fuel at approximately $101.00 per kilogram. So to sell the fuel for $102.00 per kilogram and make that dollar profit is actually from a marginal -- that is probably achievable, but ultimately nobody is going to pay $101.00 a kilogram, and we know that. I have my cohort out there, but he does not have the right copy of our PowerPoint either.

So I guess fundamentally what we would look at

from Propel's perspective at this point is we do not have enough definition into really what the costs are, what the market looks like, we have worked with the fuel cell partnership to understand what the OEM's are talking about for vehicle roll-out's, we think that the concept behind the clusters in Los Angeles is a good one, and that that is the right approach, but we need to understand more from a retailer's perspective to be able to step forward and really make that commitment to operate a site. And in the absence of that information, or even more well prepared with that information, we would still be talking about costs that would be largely -- the economics would not work from a business perspective. And I think we all -- if we look around and say, "Who is going to bear that risk? Where are those costs going to be covered?" I think we know that the private sector, investment sector, is not in a position right now to fund hydrogen, and they have traditionally, you know, there had been a period where they did fund a number of aspects of hydrogen, they have sort of fallen off that wagon a little bit, we need to know a lot more to be able to go back with a fundamentally sound business case to be able to get the private funding community back into the hydrogen game here. So, from a timeline perspective for us, we would like to see -- we are about a year, best case scenario, away from being able to open up the station at SFO. Bob, do you

think that is about right?

MR. BOYD: Yeah.

MR. ELAM: So in about a year we will have a new station with latest and greatest technology that is public, and the other stations that were funded through this year's ARB funding scenario should also be opening around that time. We would then have the opportunity to gather real world data with new updated equipment, get more current operational maintenance costs associated with managing those sites. We would like to see about a year's worth of data to be able to really understand what we are looking at from a risk perspective, from a capital deployment. So, realistically, two years from now would be when we think we would have the appropriate data to really look at starting to -- I would not even say "scale," but starting to get out of the R&D perspective, and into a more functional, reasonable model for public access to hydrogen stations. And moving faster than that, it would be difficult for a company, a retail focused company like Propel, if not impossible at this point, to be able to take the risks associated, even if the State of California paid every dime of the cost of the station, which in itself seems to be a bit of an undue burden at this point.

So sorry I did not have my full PowerPoint here, so a lot of that last part was off the cuff, but Propel is

very interested in helping to unlock the barriers to widespread hydrogen roll-out, it is extremely costly, there are not a lot of vehicles out there right now, we have seen some movement that looks encouraging in that direction, but we think we need to be measured in our expenditures towards the retail side of things until we know a little bit more. I would be happy to take any questions.

MS. BARODY: Thanks, Rob. Go ahead.

MR. MUENCH: Rob, thanks for being here today. You may have touched on some of these issues already, but let me ask the $64,000 question, within the next three to five years, how can we assure that private partners and investment are present to back-out the need for continuing public funding, which is becoming increasingly untenable and politically unsustainable?

MR. ELAM: For hydrogen, specifically?

MR. MUENCH: Yes. What is your take on that?

MR. ELAM: That is a good question. You know, I mean, I think we need to see -- and let's clear the definition between when you say private funding -- there is the sort of investment capital side of things, and then there are the investments made by the companies that are in the industries themselves, towards the objectives. You know, I think that, as we know more, as we have more data points towards the true costs, and begin to see real

progress towards lowering those costs, and towards the efficiencies of scale, the private sector will begin to look again at the opportunities. Believe me, if the opportunity is real, aggressive investors will begin to put money into the sector. The challenge is what metrics do they need to see to believe it is real, and how do we show them with credibility those business models? And I think we just need some time to collect the data to be able to do that.

MR. MUENCH: Thank you.

MR. OLSON: So, Rob, just to kind of follow-up a little bit on that, one of the -- we want to explore this in a lot of ways, and we appreciate your just willingness to be here to talk about this. Part of the thing we are finding is, if government is funding 90, 80, 70 percent of all infrastructure, and then including operating costs, which can be every year pretty significant, and the cost of the systems for kind of permanent retail could be approaching $3, $4, or $5 million per site, are there any things that we should explore from your view that might be -- well, I guess the goal for us as government, how do we get this to the point where, like we are with other fueling infrastructure, covering a 50/50 type of investment what for the most part is one percent of the marketplace right now; we hope that expands. And so we have heard some things today, for example, little hints of things that fuel through-put may be

a factor in this, that if you can boost this station from 25 kilograms a day to 500, 400, and then we are hearing some that it could be close to 1,000 in terms of users, and also keeping in mind that some of the users are going to be -- I am not saying that this is particularly one specific site, but some of the users are going to be medium duty buses, transit, trucks, others are going to be passenger vehicles, is there anything in that area that could offset some of the risks, if you can get more concentrated through-put, and these cluster kind of options?

MR. ELAM: Yeah, I think absolutely. I mean, I think it makes sense -- today you see the successful projects as far as through-put are primarily based around a fleet usage environment where the vehicles can be procured by a single source. Generally they are oriented as far as their traveling around, you know, to a base of operations, so for filling -- I think that has come up a couple of times today, as a sort of public-private, maybe half in the fence, half out of the fence, the question that has a good solution from a cost-share perspective, the question that is in there is how many of those locations are ideal for public access. And then that is where it becomes more problematic because, generally, vehicle storage bases are not in public locations by design, so I think we could look at the opportunities around that and it sounds like there are a couple of

opportunities on the table in California that would make sense for that type of an initiative.

MR. OLSON: And are there options that, from your view, can other fuels that you might sell in a fueling station, can that carry the lesser volume of hydrogen that might occur?

MR. ELAM: Right, as a sort of portfolio of fuels from a single site. I think it would be difficult. Every one of these fuels, even the most well established, still have serious economic challenges. To ask something like even E85 ethanol to bear the cost of hydrogen on a site, I do not think would be -- it would be very difficult to make that economic argument. I mean, it is clear that even fuels like biodiesel and ethanol which have relatively large embedded vehicle numbers compared to something like a fuel cell vehicle are barely getting over starting to see a path forward to be profitable and have a viable economic model. So it would be difficult to pull those margins backwards to support hydrogen on a site. You could get efficiencies potentially on OEM, get efficiencies on real estate cost, you could have some efficiencies around marketing, but the actual cost of the equipment the number of vehicles, the cost of hydrogen of the fuel itself would be unaffected by the efficiencies that you could potentially gain by a sort of platform approach to a retail station, although we are

certainly working very hard at understanding how we could -- how those numbers could benefit hydrogen. We just simply do not have enough data at this point to be able to make a strong economic case. And, as we all know, in this day and age, making a strong economic case is critical. People are very risk adverse right now in the capital markets.

MR. OLSON: And another kind of question, similar line of thinking here is, to your knowledge, is there an advantage if hydrogen is available at a cheaper price than gasoline, diesel, other fuels, is there anything there that can offset some of the risk?

MR. ELAM: Potentially. It is interesting, I mean, I think the research that we have seen in the data points there are around cars that are flexible fuel by nature. So if someone has a choice to put a petroleum product in, or has a lower cost, you know, of gasoline versus ethanol, biodiesel versus diesel, but there is a choice and they can always switch back, when someone purchases a hydrogen vehicle, they cannot put any other fuel in there, so price needs to be a driver in the purchase decision, but then they are essentially stuck, right, with whatever the pricing scenario might be. So I am not sure how reducing that price when they make the purchase decision, I am sure they would want to see some predictability of what their fuel costs would be going

forward because you would really be stuck then, right, if you had a hydrogen car and the prices went through the roof. So you would want to have some sort of predictability, I would guess, but I do not know if dropping it 20 percent would help. And I am not sure ultimately for a retailer that margin is even visible at this point, you know, to be able to see where those positive -- potentially positive economics could come.

MR. OLSON: And we are aware that you have a relationship with Shell for your E85 islands, and both Shell and Chevron have had an interest in this hydrogen in the past. If they have a renewed interest in this area, and they could offset some of the risk, would you be a partner with them? Would you consider a similar kind of partnership like you have with the other fuels?

MR. ELAM: Absolutely. I would not want to speak for the hydrogen industry, but I think we are all looking at any productive partnerships, any and all productive partnerships should be on the table.

MR. OLSON: Very good. Thanks for your comments.

MR. ELAM: Thanks, Tim.

MS. BAROODY: Thanks, Rob. Okay, next up with Linde, Michael Beckman.

MR. BECKMAN: Okay, thank you. Yeah, my name is Mike Beckman and I am with Linde. I run our western region

and, as such, a lot of the alternative fuels activity goes on in California, which is what I manage. So I am going to talk a little bit today about the infrastructure and what Linde is trying to do. I first have to say, it is exciting to hear a lot of the enthusiasm in the room from the speakers previous to me, that talk about what they are doing from an OEM side, with the number of cars that are going to be out there in the future, and the money that is being spent on R&D to deploy those cars, as well as other infrastructure suppliers, and that is going to help the industry overall, so we are all for that.

My first slide is, I am not going to go into too much here, you know, from our perspective, we look at the competing technologies and we are obviously in a lot of different alternative fuels, we have got an LNG plant that we are bringing under commercialization, and some other areas. Hydrogen is one of those, and as hydrogen competes against other technologies in the automotive industry, you know, we see this as a clear winner down the road. You have heard these things before around comparing electric drive vehicles, and battery electrics, you know, today it is pretty clear that the long range goals are going to be met with hydrogen, I think that is just really what I want to say here. Batteries weigh more, take up more space, more greenhouse gas production, especially when you look at the

current mix of our grid today with electricity, and of course, the cost is more. So we see this as a winner and we are here to support the infrastructure, and we are doing a lot of exciting things around that. I will mention some of those things here today.

You know, we see advances in infrastructure as the way to commercialization here, and I think it is fair to say that there are some things that will help us along that path, I will talk about those here. We have made some advances around commercial technology that meets the retail expectations here, and when we say fueling is one of those, you know, I think what we have seen in the past in our industry is, whether it is here in the U.S. or in Europe, or other places overseas, is that the initial stations were kind of exploratory demonstration stations that, while they have got hydrogen in the tank, they did not do so in a quick manner that really met retail expectations. And I think that, going forward, what Linde is trying to focus on is really release aid and above. And release aid kind of standard is 5 kilograms in three minutes, the ability to fuel multiple cars in succession, and up to four or five cars in an hour. And, really, yes, the initial stream of cars when you have five cars fueling at a station in Irvine, it is okay to maybe wait behind one car. When we start ramping up and have 10 and 20 and 30 cars trying to fuel at

one station, and even more, 100, it is going to be pretty upsetting to the consumer to be able to stand in line and wait for 25 minutes to fuel their vehicle. So we are trying to address that problem with some of our technology, and we have got stations out there today deployed in Germany and elsewhere, that are already meeting that standard.

Any kind of technology like this in an infrastructure roll-out obviously, you know, Tim is talking a lot about cost, well, how do you get that cost down? You know, clearly there has got to be incremental change in our efficiency, in our cost to provide the components necessary to do the infrastructure, but then also there is typically step change in when there is roll-outs of this type of technology, and we think that within Linde we have got a step change technology called ionic fueling, or ionic compression technology, which is really our next step. Now, we are doing this already with forklift truck fueling, and David mentioned that with the plug power, and we see this coming with automotive and bus fueling, and so forth, down the road, too. And, really, this technology is all about making it more cost effective, reducing costs, both O&M costs, and operational costs, and maintenance cost. And, you know, the ionic compression technology is volumetrically efficient, isothermal compression, contamination-free, it really helps us achieve the conversion of electrical energy

into power, into compression, gas tight system, we really think this is going to help us kind of get that next step. Now, we are not there today with cars, and that is going to take a little bit of time. We need to deploy the existing systems today that are in commercial operation, and then get to this point.

I will give you an indication of what that means. Again, kind of focusing on the cost piece, you know, we see today indicative cost reductions in these areas, just with our first systems, of around 30 percent total. So you can see kind of the different cost components there from a capital standpoint up top, you know, through the OpEx and then maintenance pieces, and each of those are significantly reduced with this type of technology. We want to make it bigger, we want to make it cheaper, and this is going to help us to get there.

You know, this is the standard business school graph of more cars helps it make it more efficient, you know, you have got really the name of the game is we have to be able to spread our technology, spread that infrastructure cost over more vehicles. Today we are looking at, you know, five, ten vehicles per station, in the future we have got to look at 100 to 200 vehicles per station. Clearly, the costs will come down significantly in that alone, but also, as we deploy more of these stations, the components will become

cheaper, we will achieve economies of scale with more mass production, we buy in bulk some of the key components such as the compression, the storage, and so forth, and that helps drive cost down overall. Clearly, that is where we want to get to. Now, today, obviously we are not there. To be able to get to that point, as a big industrial company with multiple avenues to invest in, we are not going to take that investment on loan and we need government support to be able to do that, as I think you have heard here from others.

As you look at kind of how these are deployed into the future, you know, one of the issues is that, as you move into -- you take Dr. Tim's presentation around Irvine, and he talked about putting five or eight stations to cover all the City of Irvine, well, that is fantastic, but the problem with that is that you have to put 100 kilograms a day station in, again, that is going to serve two or three cars. So how can we as an industry, as infrastructure providers, how can we do that more efficiently? And so, at Linde, we are looking at ways to get the stations in more cost-effectively, time to go to the next slide with this, we are looking at -- well, let me back up a second -- there are some things we can do to help kind of address that problem, and I will talk about a couple of those. The first and foremost, again, is quicker ramp-up of cars, and I think the boys from the automotive companies are going to be able to

do that, as they talked about today. But the next thing that we are looking at doing is making modular designs. So if we can -- and scalable designs -- if we can deploy stations that are easy to put in, so kind of a station-in-a-box concept, which is really what our San Francisco Airport, our initial station that is going in, is going to be, very easy to deploy, so it reduces the infrastructure cost and the time to install it, but then we make it so that we can add additional storage, upgrade the pre-cooling so that we can take a station that serves, say, 100 cars a day, or 50 cars a day, and very quickly and easily, as those cars ramp up and the demand ramps up, be able to adjust to that. So that is one thing that we can do, and we are looking at being able to do that. We also want to make stations that, again, can be easily deployed, but then easily redeployed. So you take a station that is perhaps suitable for 50 or 100 cars, as that demand ramps up in a certain area, we will redeploy that station to another area, and put a larger station in. We want to be able to do that cost-effectively and, again, this has kind of been our approach and our thinking along these lines.

I guess, kind of in closing here, yes, we want to deploy these stations. We need government support to do that. We still have some challenges to overcome, and Alex with GM kind of mentioned one of those, which does not get

talked about a lot, but we have got some significant issues around permitting, for instance. You know, you talk to anyone who has put in stations today, or is in the process of putting stations in, and that is a laborious process that, frankly, the cost going into that as we model this are somewhat unknown. It can add tens or even fifty -- thousands of dollars to the station deployment and it extends the time to deploy by months, if not longer. That is one area where I think government can assist. Again, these are areas that can be overcome. The Codes and Standards piece, and commonality around that, a lot of work being done there, that is also an area that can be worked on. You know, we see that over the next several years, with additional station deployments, with us, as well as other infrastructure providers, we are going to continue to improve that efficiency and the cost will come down, but, again, initially government support is going to be needed for the next several years at the same levels we see today. So any questions?

MR. MUENCH: Tobias Muench, Energy Commission staff. Essentially, you have touched on some of this, but I would like to ask you the same question that I asked before, and I am going to repeat it. Within the next three to five years, how can we make sure that private partners and investment are present to back-out the need for continued

public funding which is becoming increasingly untenable and politically unsustainable?

MR. BECKMAN: Yeah, I guess the first thing you could do is increase the price of gasoline significantly. You know, all kidding aside, we look at this in Europe and they pay four times more for a gallon of gasoline. The hurdle rate to overcome that, obviously a lot of that is government taxes and so forth, but the hurdle rate to overcome there is significantly lower. And the expectation from the consumer is that they pay more for an equivalent gallon to go 100 miles. I mean, that is one of the first things that we could do. I heard it from, I think, Jim Boyd at one of the conferences I was at a few months ago, who talked about -- it might not have been him -- but somebody was talking about putting a ceiling or an artificial floor on the price of gasoline through taxes to support some of the alternative fuel investment. That is one thing the government could do. You know, gasoline is going to go up, our efficiency is going to increase as we deploy more stations. You know, we have deployed only a handful of stations in the States. I mean, to be fair, we have got to deploy 10, 20, you know, 50 stations before that becomes significantly down to a point where it is commercial and stand alone. That is not to say that the CEC or California should bear the burden of investing at the same levels they

do today, that burden, we would expect, would come down as we pick up more of that. Again, this is going to come with additional deployments, though.

MR. MUENCH: Thank you.

MR. OLSON: Mike, I wanted to ask a question about your manufacturing here, and maybe I should have described this earlier, it is part of our program of opportunity solicitations we will be putting out soon and one significant initiative will be a kind of expansion, retention, recruitment of manufacturers primarily on electric drive, but it really could be across the board on any fuel technology. And the nature of that would be -- it is a job creation, job sustaining type of activity. We are willing to put money into expanding your ability to increase manufacturing, component parts, batteries, whole vehicles, systems, and so part of that is it has got to be in California, and we want -- if any of you are interested in this, we definitely want to talk to you about this process. And I guess that is it. Are you planning anything here that is either assembling or manufacturing of any of the component parts or whole systems?

MR. BECKMAN: Yeah, so certainly there will be some assembly here in California, I mean from a jobs perspective. Every time we deploy a station, obviously there will be infrastructure jobs that will be created

because of that. We have got operation and maintenance personnel that, as we build out our capacity to be able to service these stations and deploy them on a wider scale, clearly we will drive what we would see a green jobs associated with those deployments and the upkeep and maintenance of those stations. We have got partners in the states, perhaps not in California, that we work with to Americanize these stations and to build some of the components and to assemble them, so that is where we are at right now, and we are continuing to look for additional, I guess, U.S. grown infrastructure and deployment.

MR. OLSON: Another question I have is, is there any issue at this point on the kind of standardization, if you want to call it that, the 350 bar, 700 bar option, so we know, for example, Honda, their Clarity is really designed for 350 bar pressure. From your view as a fuel supplier, any issue there that is unsolvable?

MR. BECKMAN: No. Absolutely not. I mean, you know, certainly there is a little bit more cost associated with higher pressure, I mean, I guess that is common sense, but we think that with the technology that we have, that cost is not that significant, and our approach is to design stations that would meet multiple technologies and meet the needs of multiple OEM's as they design their cars, fuel cell vehicles. And so, from our standpoint, no, I mean, we are

going to adapt to what the industry needs, and we do not see any insurmountable hurdles there, nor do we see that as a gigantic cost adder.

MR. OLSON: Okay. Thanks a lot.

MR. BECKMAN: Thank you.

MR. BAROODY: Thanks, Michael, for your presentation.

MR. MUENCH: I have another short one. I am sorry. Can you say a few words to Linde's involvement and philosophy ideas about renewable --

MR. BECKMAN: Yeah, I mean, so from our standpoint, obviously that is the Holy Grail -- how do you get renewable production? And we are looking at some methods to be able to do that today, nothing I could speak of specifically, but we are exploring that area and we have had those discussions. You know, there are some obvious paths that are out there, there are some economic issues with those today, you know, things that we think can be solved. If you stand back a second and look at when these hydrogen production -- we have got one of the only plants in the world that really is a renewable hydrogen plant today in our Magog Plant in Canada, which is a byproduct from a sodium chloride production, and is driven by a majority of hydroelectric power up in Canada. So we are already kind of meeting a need. Now, it is not recognized as such by the

GREET modeling, we would like it to be, but the fact is that that is really green hydrogen today. So we are looking at other opportunities like that, as well.

MR. MUENCH: Thanks much.

MS. BAROODY: Thank you. Okay, Airproducts, Ed Heydom.

MR. HEYDOM: Thank you, everyone. I am pleased to be here to talk about Airproducts' perspective regarding hydrogen infrastructure and the impact on the planning going forward regarding the investment development for AB 118.

Just a quick overview of Airproducts. We are the largest merchant supplier of hydrogen in the world. We produce about 2 billion cubic feet per day, worldwide. We have been involved in over 100 hydrogen energy projects since 1993 with stations around the world, but with a strong focus in California. We have talked a bit today about -- and there have been references -- to low cost ways to produce hydrogen, and how do you get there. And as some of the speakers have mentioned, there are already ways today to produce hydrogen at the point of use at low cost, at attractive cost for use in transportation fuels. And most of those focus on central production -- large facilities, economies of scale, again, just some of the points that previous speakers have mentioned. The challenge is, how do you get that low cost molecule to the point of use? One low

cost way that has been mentioned is by pipeline, where those assets make sense based on the volumes that are being distributed. But hydrogen can also be distributed by truck, either as a liquid or bulk, and there is also some specific hydrogen fueling products that we have developed to meet the emerging fueling market. We have also looked at distributed hydrogen production from a variety of sources and there are opportunities worldwide where that would also make sense for hydrogen.

But what we have been focusing on in the past few years is looking at ways to look at delivery systems for hydrogen, getting it to vehicle fueling. We have done work back in the early part of this decade, looking at on-site reforming, we have looked at electrolysis, we have looked at other modes, and now we are looking at trying to get some learning on some other means of providing hydrogen. Tim mentioned the UCI station, which Airproducts provided under a DOE program, and that is supply by liquid delivery system. We are developing a station off of the existing hydrogen pipeline in Torrance with Shell Hydrogen, looking again as a means to try to provide that low cost molecule into a refueling station environment, trying to get that learning as to how you do that and what ways you could scale that up. And then something called "pipeline delivered," which is the station that ARB funded, what we call South Torrance or

Harbor City, looking at ways to move the molecule from that low cost point of production into a retail gasoline environment.

So those are some examples of trying to take advantage of existing assets. We are also, as Tim mentioned, the lead in developing the project with ARB and DOE at Fountain Valley, California, Orange County Sanitation District, which is the incorporation of the high temperature fuel cell coproducing electricity, hydrogen, and heat, and that system is going through shop testing at the fuel cell provider's location, Fuel Cell Energy in Danbury, Connecticut, and then we will be bringing that online next year.

Now, people have mentioned why hydrogen, and this is just our view of the benefit on a well to wheels basis, that hydrogen, as you look at all modes of production, distribution, is going to be the clear winner from an environmental basis. It also has the advantages of sustainability with respect to other fuels.

What I thought I would do today, to talk about -- since you have the challenge of coming up with a plan going forward for the funding through AB 118, is to first take a look back at some of the earlier programs that have happened, and to try to glean some lessons learned out of those activities. And what we have seen is that, in a lot

of stations, most of the station capacities exceeded the early vehicle demand, which made sense because, you know, they were normally designed for one or two cars at the outset, and just doing some economics of the deployment of those stations, those stations were oversized. So in any of the programs, you have to think about underutilized assets that you measure as you go forward, I think.

As I mentioned, we looked at multiple options for production and delivery, as some of the other participants say in the DOE Tech Validation Program. Now, some of those we probably should be looking to eliminate just because of cost and scalability, as we have talked about today, you know, the key to get to is what the future is, and how quickly you can get there. And our engineering folks have told us that some of the smaller station configurations, you can end up with over 19,000 different configurations. We are all driven by productization and coming up with a standard approach. So as you go to larger stations, lower cost solutions, you are probably going to get down to those fewer options, and the key is to try to get to that as quickly as possible. And what we have seen is that the low cost production methods at the existing facilities and can be used today for the transportation market, and for a funding agency, that means minimizing additional funding based on taking advantage of existing capacity within the

systems where they exist, and they do exist in California. And the key is really the supply chain. How do you get it from that point of use where it is used in industrial applications into the retail fueling market.

Now, renewable sources, as I mentioned, our project at Fountain Valley, that is one aspect that we are looking at, but those need to be also developed. As Mike mentioned, there is probably some cost impact compared to conventional steam methane reforming in the early years, and then you have to also figure out how to move those molecules if they cannot be dispensed at the point of production.

So the first thing I would say is focus, stay focused on what the objectives are moving forward. You have heard talk from the OEM's and the other suppliers today that critical mass is important, both on the vehicle side and the station side, we support the cluster concept and the work that California Fuel Cell Partnership did with regards to the Action Plan, it is a good step and it has helped, I think, all of us to be able to understand the plans for roll-out of vehicles, maybe not the specific numbers, but also to understand how those vehicles can become just in terms of production techniques on the vehicle side. So critical mass is going to be a key component. And then target the geography, and Southern California, as everyone has said today, makes a lot of sense for a key geography,

although there are opportunities in other parts of the states, in other parts of California, depending on the vehicle deployment plants. Obviously, SB 1505 has to be considered as a key component of this.

We like the opportunities to try to deploy at retail gas stations because of the ability to gain customer acceptance more quickly. If there are opportunities to come up with stations, the dual use facilities, certainly that makes sense. But in the dialogue I have with the OEM's and the feedback they get from their users, you clearly hear that the retail fueling environment is what people are looking for. So we have to continue to drive to overcome the hurdles that Rob mentioned earlier today.

You have to install sufficient stations in order to make the step change that Tim and Mike had mentioned earlier. You should look for opportunities, again, as Mike mentioned, for mobile stations, to get some of the economies of scale and to get the infrastructure out all at once, and to continue to look for opportunities to develop those relationships and the installation of those stations.

You need to manage capital infusion at the station operator. Good thing I was not working on this when Rob was giving his remarks, but that is clearly a component, is the risk management for the station operator because, at the end of the day, they have the largest at least public exposure

and potential for financial exposure if stations are under-utilized.

Infrastructure should really meet some key criteria. It needs to be scalable so you can go from the low volume periods during this 2010 to 2015 timeframe up to when there is full deployment. The infrastructure should look to minimize that site investment at the point of use. It should consider systems that provide value today for applications maybe beyond traditional light duty vehicle fueling. That way, if there are delays in the market, or if there is, depending on the roll-out time for vehicles, there are opportunities to redeploy those assets, so it minimizes the idle asset capital for all of the funding participants.

And then, obviously, the program has to think about going forward when there are tens of thousands of vehicles in the 2015 to 2017 timeframe -- station sizes, you know, 500 to 1,000 kilograms a day are probably sustainable from the business case standpoint, and that will be the time as we move away from the government incentives during the early deployment period, and more into a standard business case when we start looking for tax incentives and other ways to continue to sustain the industry. But I think that is key, to look at those opportunities where it is not the time to deploy very small stations that have no opportunities for growth if we are going to meet the demand requirements that

the OEM's have talked to us about today. We need to be looking at ways to get to those large stations very quickly, otherwise, when the tens of thousands of vehicles arrive, it will be a challenge for the infrastructure providers to be able to provide that on an ongoing basis.

So those are my remarks. I tried within those to answer the questions that were included within the packet that was sent out. So I look forward to questions, and thank you for your attention.

MS. BAROODY: Thank you, Ed. Any questions?

MR. OLSON: Yeah, this is Tim Olson.

MR. HEYDOM: Hi, Tim.

MR. OLSON: So, when you kind of look across the development stream of this of this, is there -- what is the best point where you are going to get cost reduction, cost break? It is probably not going to be in vehicles, infrastructure we have heard here today that there are a lot of challenges there; what about on the fuel? Is there a chance that you are going to have -- that you can produce hydrogen that is going to be cheaper than other fuels?

MR. HEYDOM: I think there was talk today about, given the price spread today between natural gas and petroleum fuels, that on a per -- we will call it on a per mile or per kilometer use within the vehicle, that hydrogen is made today that can support vehicle infrastructure at an

equivalent cost per kilometer compared to gasoline. So the question is really scale, and how you get it to the point of use. So there is no real surprise as to how to do that, what we have to do is incorporate the renewable component into our hydrogen production infrastructure going forward and obviously we have that requirement in California, and we will be looking to meet those requirements, both for State requirements and also specific to SB 1505. So we are not at the point -- I think most of it is now -- any of the cost issues are, again, small stations that have high unit costs for components such as maintenance, delivery, items that, if you look at gasoline stations, those items get blended out in most, you know, when I am at my local station, there are always dozens of cars that are filling up, so those costs can get merged in, so you are looking at technologies that can come to that low cost, but also getting enough volume to be able to spread those costs out across a number of users.

MR. OLSON: And can you just elaborate a little more about the SB 1505? Can you produce renewable hydrogen today and at a price where you can sell it?

MR. HEYDOM: Yes.

MR. OLSON: That would be from your pipeline stream or other --

MR. HEYDOM: Well, we are evaluating from all points of production -- again, because part of it is supply

chain, at both the point of production, and then the final point of use. So you cannot just look at it at one location, at the specific point. The pipeline has obvious advantages because of the scale of the system, but we are looking at renewable hydrogen at various locations in order to serve different markets. And, again, the total cost will be the sum of that cost of production, cost of distribution, and the cost of dispensing.

MR. OLSON: And that feedstock, is that feedstock biomethane?

MR. ELAM: It can be. That could be something that --

MR. OLSON: Or wastewater treatment?

MR. ELAM: It could be. The wastewater treatment concept through the multi-carb fuel subsystem, that is part of the ARB project, the ARB DOE project that we are evaluating, and to see how that would fit into a supply of hydrogen on a renewable basis.

MR. OLSON: Can you make that in sufficient quantities to match the roll-out of vehicles?

MR. ELAM: That is part of the key is to be able to obviously get to scale. That system at Fountain Valley is sized for 11 kilograms a day. Again, that is really just the demonstration of the technology. Clearly, going to greater scale is better from the power production side of

that system, and the power economics still have to work on those and still -- and electricity generator by nature that co-produces hydrogen, it is not a hydrogen system that also makes electricity. So you need to have the right mix of power costs and hydrogen pricing. But clearly, scale on the fuel cell makes sense and scale on the hydrogen side would also make sense. But I think we are looking at systems -- fuel cell energy has a fuel cell product that produces nominally 2.8 Megawatts, so part of our evaluation is looking at co-production of hydrogen off of systems of that scale, so that would be over a ton a day of hydrogen, easily.

MR. OLSON: Very good. Thank you.

MR. WARD: I have a question. Regarding the -- you mentioned scalable several times in your presentation and I am wondering, under the present definition of 1505, you are not making that renewable hydrogen, there still would be requiring a regulatory fix there to make it more energy logical?

MR. HEYDOM: That is a loaded question. No, I will answer a different question than try to answer that one. We are looking at the broader application of energy and what is the best use of renewable sources, so when there are opportunities where it makes sense to produce hydrogen, then that is the right thing to do, and that is the type of

project that we are looking to participate in. If there is better uses for that renewable component, or if there are other needs for it, then obviously we are competing against that, but I think that is my answer so far.

MR. WARD: Would you suggest a clearer path to renewable hydrogen than the one presently contemplated under 1505?

MR. HEYDOM: I think the current definition of 1505, as I understand it, could use some clarification based on the lack of early acknowledgement of other sources of renewable hydrogen, for example, the anaerobic digester gas produced from wastewater treatment was not originally envisioned as a renewable component within the statute. So I would think that some analysis of that, looking at available feedstocks that could produce hydrogen, and what their evaluation is under GREET or similar models, I think, would make a lot of sense.

MR. WARD: I think we agree because I think the intent is something we can all universally agree on, but how it was actually formatted might be the challenge. You also mentioned scalability, getting to stations that could be 500 to 1,000 kilograms a day. Is that a potential for the stations we build now, could be modularly scalable to get to that point, so we would not have to go through the permitting repetitively?

MR. HEYDOM: Well, part of that, I think, is you would take the strategy, if you could develop a site that is amenable to a larger station, you would go ahead and permit it on that basis. One of the challenges with hydrogen, especially in Southern California, is footprint, is how much hydrogen can you -- how much equipment can you fit given all the setback requirements within the NFPA requirements? So you have to look at the different sites and say, "How much infrastructure can I put in at that location?" I would then go ahead and try to permit for that maximum value if that is of interest to the station operator, so you would not have to go back and repeat the process.

MR. WARD: Not necessarily build to that maximum, but go ahead and permit to it? Is that --

MR. HEYDOM: It depends on the site. It depends on how you choose to get to that larger capacity. We worked on projects where we have done it on a modular approach, a stepping stone approach, for example, the UCI station, that way where we started at 25 kilograms per day because of the original intent of the station. Now, there is clearly enough demand in the area to look to increase that, so opportunities that UCI is trying to develop to increase the capacity of the station, we think, makes a lot of sense based on the demand at the station. And there are other locations that look at it that way. I think there is merit

to limit the capital investment at the start, but you also have to be able to anticipate the growth and how quickly that growth is going to come.

MR. WARD: Okay, that is what I am getting at, trying to find the sweet spot between those two issues.

MR. HEYDOM: As you look at the slope of the curves for the deployment and the action plan, it is going to come very quickly, and that is why the graph that Tim and Mike showed, that shows that stepping forward approach, and I think the presentation by Todd Sukow this morning on what they are doing in Korea is the same thing, it is showing that pre-investment on stations to be able to anticipate a rapid growth of vehicles. I think you have to be able to look at sites that can do that and look at technologies that can be rapidly deployed and modified to be able to meet that growth.

MR. WARD: Thank you, Ed.

MS. BAROODY: Thanks, Ed, for your presentation and answering all those questions.

MR. HEYDOM: Thank you.

MR. MUENCH: One more, please. May I ask you the same question? Within the next three to five years, how can we assure the private partners and investment are present to back-out the need for continuing public funding, which is becoming increasingly untenable and politically

unsustainable?

MR. HEYDOM: Okay, I was thinking of an answer when you asked it to the other speakers. You know, the key really is, as the others have said, is to get to that market driven approach, to get to the right station size, and potentially looking at maybe a sliding scale of government support. This early round of funding where you need a lot of geographic coverage without a lot of through-put, you probably end up with the potential for a larger government participation, but as usage goes up over time, there is no reason for the government participation to continue at that basis, and once you get to the point where you are deploying stations in that sweet spot, if it is 500 or so, or 1,000 or so kilograms a day, where for station operators, you point, it makes sense to go ahead and make that investment on their own, they you get the answer automatically. So I think having the foresight to do the pre-investment with the strategy of being able to quickly add capacity to those stations, but knowing once you have added the capacity that you have a way to back out of the funding, I think, makes the most sense from my perspective.

MR. MUENCH: Thanks.

MS. BAROODY: Thank you, Ed.

MR. HEYDOM: You are welcome.

MS. BAROODY: Okay, we have one more speaker in

this panel, Hydrogenics, Kevin Harris. Mark Schiller is not here today, so we will end with Kevin and then we will go to Public Comment.

MR. HARRIS: Thank you. First of all, thank you very much for inviting me to this panel, and thank you to the audience members here and online for being diehards. I will try to go through this as fast as I can, but basically today I am going to be talking about electrolytic hydrogen and how we can tie in production of hydrogen via electrolysis and also enable renewable energy to be a more, larger factor in the grid.

So just a little bit about Hydrogenics. The bullets are a little bit off, but hopefully we will be okay. We are based out of Canada in Toronto. We have facilities in Belgium and in Germany. There is also an office in California. We make electrolyzers and protonic exchange membrane fuel cells. We have over 1,700 hydrogen products out there and we have been doing that since 1948.

Just to show you some of the refueling stations that we have been involved with, many around the world, but several in California. The picture there of the Santa Monica station at the top, and the Oakland station at the bottom. This just shows you a picture, if you are curious to know what our products look like, the one on the left is our 130 kilogram per day hydrogen production unit,

electrolyzer, and then the other units are fuel cell, either for back-up power, or for mobility power such as buses or trucks.

So one of the first things I wanted to mention is that, for all intents and purposes, I am -- we are -- for hydrogen and against nothing, and what I mean by that is, you know, there is going to have to be a myriad of solutions to solve the climate change issues that we have here, and we, in fact, believe that there is a great marriage between the two technologies of batteries and electricity, and hydrogen and fuel cells. And we, in fact, endorse the battery dominant, smaller fuel cell plug-in hybrid power train architecture. And two examples are shown here, one is a bus that is currently operating in Columbia, South Carolina, which is a 32-Kilowatt fuel cell, and then also we heard Lawrence Weisdorn talk from Vision Industries, his truck also contains our fuel cells, but it has a battery dominant type of architecture. And I can get more into that later, but today I will be talking mostly about our electrolyzer products.

Okay, one of the main things I want to convey to you is that hydrogen is an energy storage medium, but it is also an energy transfer medium, and it is a renewable energy enabler. Let me explain what I am talking about. First of all, let's talk about hydrogen as energy storage and where

it fits in with some of the other technologies. So on this chart, on the X axis, if you will, we are seeing the level of power and, on the Y axis, the amount of time that you can run that particular technology at that particular power, or, in other words, the energy content. So you can see hydrogen is really up at the top. It has the ability to store large amounts of energy with only really pumped hydro and compressed air energy storage being able to do more. So just to show you an example, this graph in the background here shows the wind energy feed-in at the E.ON control area, which is in Germany. And it shows you basically how much power is being fed into the grid via the grid. Now, you can see that if you have a reservoir that is about how much energy storage in the lower left-hand corner that can be stored with that particular technology. And then, likewise, with compressed air technology, it is even less. But if you were to take that same cavern and store hydrogen in it, you are looking at that much amount of energy that can be stored, so really a tremendous amount. So I think this shows how well hydrogen can work. Then, also, a more conventional way of storing hydrogen, you can see the tube trailer, in electrical equivalent it can hold enough hydrogen that is the same as 4 to 6 megawatt hours of electrical energy, that is after the hydrogen is passed through a fuel cell. And you have no leakage, no parasitic

losses over time. But what is maybe the most important point on this slide is the cost, the incremental storage cost is less than $100.00 per kilowatt hour, so it is a fairly cheap way to store hydrogen.

Okay, let's get into renewable energy and energy transfer, as well. So the energy storage problem, renewable energy is driving the need for energy storage. We all know that wind and solar are intermittent and, incidentally, when I am talking about renewable energy here, I am more in the mind set of renewable electricity such as wind or solar. Consumers and governments are pushing for more renewable energy to be on the grid, and we know recently Governor Schwarzenegger signed an Executive Order to reach 33 percent by 2020. Other parts of the world, we have seen that problems occur, though, when you put on greater than 10 percent of renewable energy onto the grid because of its intermittent nature. And what that means basically, for every kilowatt of wind power you put on, you have to have 1 kilowatt of some sort of back-up, like a natural gas peaker, or whatnot. And I will get into this a little bit later, but instead of doing it that way, maybe you can control the load instead of having back-up power, meaning if the wind dies down, maybe you can drop your load off. I am not sure if SMUD has this program, but where I live, Southern California Edison has something they call the Summer

Discount Program, and they will pay you a certain amount to take control over your air conditioning unit, so this is something that I subscribe to, and it is similar to what I am going to be talking about in a few slides, but basically over the months of June, July, and August, I get approximately a $35.00 credit on my electricity bill just to give them the option of taking control of that air conditioner. Incidentally, last year and to date, this year, they have never had to turn off my air conditioning unit. The bottom line here is that higher renewable energy penetration raises the need for energy storage.

Now, combine that with the fact that an electrolyzer is what I call "manipulatable," meaning that you can ramp it up, ramp it down, and turn it off. We have done research into our electrolyzers and there really is no problem with turning it on and off, and you can see that the drop is instantaneous as far as turning off that electricity and then turning it back on again. So what this allows, if you are an operator of an electrolyzer, you are obviously consuming electricity to produce hydrogen, but it allows you to enter into what they call a grid ancillary services contract where, again, you give control, or temporary control, of your load to the utility, in exchange for either a lower rate, or for some sort of credit, essentially.

And these are different types of grid ancillary

services that you can get involved with, and basically they vary from the amount of time that they are on, the amount of time that you have to react to the situation, and so on. The first two are the most important ones, at least for myself, regulation is more like second to minute and spinning reserve is more, you know, minutes to hours type of deal. Incidentally, these do not really occupy a lot of hours in a particular year, so if they are going to turn you off, for example, we are not talking about hundreds of hours per year, we are talking about maybe tens of hours per year. So when people think of hydrogen and energy storage, they typically think of this scenario where, if you have excess power or renewable energy, you would create your hydrogen and then, when you have a deficit, you would then use that hydrogen through a fuel cell to recreate electricity. Okay, we are not talking about that. That is something that we have looked at and, economically, it is difficult to justify. So what we are really talking about here is the opportunity to not immediately, but at a later date, maybe in a decade or so, where you can actually overdrive the grid, if you will, and have an abundance of renewable energy, and then use the electrolyzer to basically correct it so that only the proper amount of electricity is going into the grid. So you can see -- you take the excess energy, put it through the electrolyzer, you store it, and

then you dispense it. And this is just a way of showing this with pictures -- you have solar or wind going into hydrogen generation, that electrolyzer, then your are compressing it and storing it, and then eventually dispensing it. Now, putting it into vehicles is not the only way to use the hydrogen; if you can, if you have a customer you can also use this for industrial hydrogen uses, whether it is a hydrogenated oil plant, or whatnot.

So the advantages of hydrogen -- long term storage. So you can store this hydrogen essentially for days, weeks, and conceivably months, which is not something you can do with batteries. And there is essentially no leakage, and it is flexible for many uses. Like I said, it could be used for fueling vehicles or for industrial uses, this system is a zero emission throughout, so creating the hydrogen to consuming the hydrogen, as well. And then, of course, the hydrogen technology will continue to develop and efficiency will get better, and so on.

So this shows an example basically of what we are talking about in price differences if you get involved with the grid ancillary services contracts while using electrolysis. So in this particular case, we are taking a 2,000 kilogram per day unit and then showing that we can get about $8.25 a kilogram with just business as usual. But if you get involved with a grid ancillary services contract,

you are essentially looking at revenue to you of about a million dollars per year, and then resulting in about a reduction of $1.25 a kilogram, resulting in $7.00 a kilogram. And this takes into account also the extra storage that you may need to install just to make sure that you have enough hydrogen when they decide to turn down or turn off your unit.

So to translate this into vehicles, we just did a simple calculation here using very recent numbers that were published from DOE, Enrol, Savannah River, and Toyota, but basically you have the hybrid gasoline vehicle getting 440 miles, approximately 26 miles per gallon, and then the fuel cell hybrid vehicle, it is the same vehicle, 431 miles, so approximately the same range, but in that case 68 miles per gallon, and where I came from today in Santa Clarita, gas was at $3.15 a gallon, making the total for filling up that tank of $53.31. If we use $8.00 a kilogram, for example, then we are looking at $50.71. So that is basically the breakeven point right now for -- that is where hydrogen needs to be. And basically just showing that we do have a large scale electrolysis that is accessible today, I mean, we are not the only ones, but we do have this available, definitely.

So just some closing remarks here, hydrogen -- my main message is that hydrogen is an energy storage and

transfer medium, it can be considered a good form of energy storage, particularly when large amount of energy have to be stored, and for long periods of time. Hydrogen can be used as an energy transfer medium and what I mean by that is you can take the energy from the renewable energy sector and transfer it over to the transportation sector, and it can be done at reasonable cost, we believe, with the help of grid ancillary services contracts. And, of course, hydrogen can help smooth out the intermittency of renewable energy sources, which I think is a very important point since we are trying to reach higher levels of grid penetration of renewable energy. So this type of scenario will just feed on itself, enabling further penetration of renewable energy power sources into the grid mix. So the end result is basically lower petroleum consumption, which means increased energy independence and lower cost, less air pollution, and less greenhouse gases. That is my presentation. Thank you for listening. I will be more than happy to take any questions.

MS. BAROODY: Thanks, Kevin. Questions?

MR. WARD: One question. You mentioned the intermittency problem with renewables. This is just a transmission problem of renewables, too, or can it be done on site of the --

MR. HARRIS: Yeah, I mean, it can be done in a

variety of ways, either the electrolyzer can be located very close to the renewable energy source, or it can be located downstream. So obviously, if you cut off that power to the electrolyzer, then those electrons that would be flowing would also not be flowing through the transmission lines, and then you would be alleviating those transmission lines.

MR. WARD: Thank you.

MR. OLSON: And could you also just elaborate on the size -- how big can you go in storage?

MR. HARRIS: In storage, well, I mean it really depends on how much real estate you have, the pressure tanks, like that one -- to take an extreme example, but the cavern, this is basically 600,000 Megawatt hours of energy, so if you divide that by 15, approximately, then you are looking at how many kilograms you can actually store of hydrogen.

MR. OLSON: But is the medium really the tube trailer idea? Is that --

MR. HARRIS: Yeah, that is one way to do it. I think normally, if you were going to set up a project like this, you would not necessarily use a tube trailer, but you would use tanks that are similar to that, that are on the tube trailer, and have it more of a stationary system, so you would not have to pass the DOT regulations, and so on.

MR. OLSON: Just to clarify, you get a cost

reduction with that process comparing $8.25 a kilogram to $7.00?

MR. HARRIS: That is right, just by entering into that contract. It does not really cost you anything, you just -- you are a participant in this and you may lose hydrogen production for some period of time, but the fact is that you can buffer yourself, whatever your process is, whether it is refueling buses or cars, or if it is hydrogen used in some process, is that you can buffer that hydrogen in tanks and really not have to suffer anything.

MR. OLSON: Have you explored any of the credit system, the renewable energy credits, or the -- the system does not exist for AB 32 yet, but is there a credit for you to do this, say, off-peak, to basically create through the electrolysis, create the hydrogen off-peak when many of the renewable sources are available? And then also bank credits? Have you explored that at all?

MR. HARRIS: Not at this point in time, but something we should look into.

MR. OLSON: That will be a topic of our next workshop in San Francisco on October 12th is what is the utility role in this, in essence, how do we extract electricity as a source for either electric drive or hydrogen or other sources. And then kind of how do we get to a more comprehensive renewable mix that we can use in

transportation, and how do we do that through some of the existing utility tariffs and other programs.

MR. HARRIS: Sounds good.

MS. BAROODY: Any other questions?

MR. MUENCH: One more. Tobias Muench, Commission staff. I am not going to repeat my same old question to you again, but along the lines of that question, your system you are presenting, the electrolyzer, it sounds like something that could present a viable business case to hydrogen fueling and hydrogen as a fuel for transportation. Could you kind of make a few remarks about that in relation to my question? I will be happy to repeat it, if necessary.

MR. HARRIS: Well, maybe you should repeat it, just so I could understand it a little bit.

MR. MUENCH: Sure. Within the next three to five years, how can we assure that private partners and investment are present to back-out the need for continued public funding, which is becoming increasingly untenable and politically unsustainable?

MR. HARRIS: Yeah, I think the answer is similar to the other folks, is we need to get to a certain volume and size because, really, where hydrogen becomes less expensive is using economies of scale, you know, once you get to the 1,000 kilogram per day, and so on. So we need to get to that point, and once we get to that point we can

start backing out the government support. One thing I would like to mention, how we can I guess continue to fund some of these programs, we talk about renewable energy credits, and we all understand how that works, you know, you have someone that produces wind power, they get a renewable energy credit, then someone will actually pay for that renewable energy credit. Another way to help fund these programs is selling gasoline, not necessary at a higher tax rate, but attaching what I call domestic energy credit, so we all talk about energy independence and the importance of providing energy domestically, and if you can attach a premium, whether it is two cents a gallon, or whatnot, for gasoline that has a domestic energy credit attached to it, so meaning that the gasoline that I buy, it is going to be made from some sort of, you know, Made in the U.S.A., or Made in North America, or whatever the case may be, I think that would -- people would buy that because we are all saying that domestic energy is very important, and then those two cents per gallon can go towards all these programs that we are talking about, that leads to even more domestic energy. So instead of a wreck, we would be talking about a deck.

MR. MUENCH: Thank you.

MS. BAROODY: All right. More questions? Thank you, Kevin, for your presentation. We will head into the public comment period. And I think we have a couple of

people. Is it Bob Boyd? From Linde?

MR. BOYD: Hi. I just wanted -- we are talking about step changes in terms of installed costs, and I just wanted to touch base on a little bit of what is sort of a relatively unknown group called the HIPOC which is the Hydrogen Industry Panel On Codes, and this was set up a number of years ago by the DOE to help facilitate coordination of Codes and Standards development and changes. With the -- the text has kind of changed -- but to facilitate the successful energy commercial decisions in 2015. And originally this was set up with members of what is called the International Codes, or the International Code Council is actually sort of a revitalized fire code, building code, development organization. It used to be Western Codes, and Southern Codes, and a whole bunch of different codes and standards development communities around the country, and it has all kind of been reorganized under the International Code Council. And, for instance, the State of California adopts a series of building codes, fire codes, mechanical codes, electrical codes, and now the 2007 California Codes are based on the 2006 ICC Codes, they are not actually what I would call "International," that is just a name, they are really national, the United States. Who is represented at HIPOC is actually a fairly senior bunch of folks there from code enforcement, from the fuel cell

industry, representing fuel cell vehicles, we have got the Chair of NFPA 2, the Chair of NFPA 52, it is a very wide group, this is all sponsored by the DOE, there are alternates to each of these representatives, there is someone from Airproducts that is my alternate, there is strong alternates for most of these categories. What is going on today, well, just sort of -- NFK52 is all fuels for transportation, so that has CNG, LNG, liquid hydrogen and compressed hydrogen dispensing technology. The 2010 edition is about to ship from the printer and it has a lot of new provisions for fueling, and NFPA 2 is another code that is going to be all hydrogen and it is absolutely a great code. I mean, most people are pretty bored looking at codes, but the folks have done a great job reorganizing that. And so more work is needed, but the DOE, knocking on wood, is continuing to fund the Code and Development Standard process and we are making some good progress towards our target to see some mature hydrogen codes by 2015. Now, when we say "mature codes," we mean codes that work, that are easy for regulators to interpret, and we believe that this will help make the installation of stations a lot easier. There is a whole bunch of codes and standards, I just picked a few out. They are all sort of in progress of developing. One of the things that we really need is to be able to list devices. There is a group at CSA America that is working feverishly

to develop a whole series of codes and standards that aim toward the component level, the components of the hydrogen station, and it is probably worth noting that we do not really have codes and standards that we can list to at this point in time, so that really raised the cost of doing these hydrogen installations over the past five years. So we are making some progress and it will enable us in the 2015 to 2020 range to be able to deploy stations at a lot lower cost than we can today, or even in the next five years. Anyway, it is getting better every year. More of this can be seen at the website up there, and all of the meeting Minutes are public, and if there people that want to get involved or submit a proposal, there are ways of doing that. So, Toby, are you going to ask me your question?

MR. MUENCH: I do not think that will be necessary. Michael already responded to that. Unless you have anything to add.

MR. BOYD: No. Thanks.

MR. WARD: Bob, thank you for putting a human face on codes and standards. It made it actually interesting. But I would suggest you call it HIPOC, it just sounds better for some reason.

MR. BOYD: HIPOC, yeah, I do not -- yeah, some people call it HIGH POC, and some people call it HIPOC.

MR. WARD: HIPOC, that is kind of catchy. But you

do think that this will -- and it is imminent, you say, that this is printed, and this could help us for the next stations that we will be developing?

MR. BOYD: Yeah, 52 will help a little bit. There is more specific descriptions, particularly around indoor fueling for forklifts, there is a good bit in 52. And I really -- and there is a little bit of nuances to all of this stuff at NFPA, just as an example, NFPA 55 sets the separation distances between the storage tank and any adjacent structures, and things like that. And some of the technical committee at 52 did not like what 55 was doing, and 55 was doing some really advanced research that has been funded by DOE and Sandia in terms of trying to get our separation distance a bit more rational, whereas previously our separation distance were based on, "Well, this fuel is good, so let's just leave it that way." Now we have actually got a scientific reason for why we have setback distances, and those codes in 55 have only changed for compressed, we have not addressed liquid setbacks yet, so we are still using the old setback distances. But the HIPOC group actually made some testimony at the technical committee that had to decide would 52 be allowed to keep the old setback distances, or did 55 have precedence, and so we have actually been successful in focusing on those type -- bringing testimony to people that have to make decisions

about this stuff. We have been able to bring some logic, I think, to some of these questions. So NFPA 2 is actually an extractive document that will extract some from -- I am sorry, did I say 52? NFPA 2 is this big huge all hydrogen document, that will extract all the stuff that is relevant from 52 plus all the stuff that is relevant from 55, and put this into an all hydrogen document that is promising to look very very good, and be very helpful. Right now, where that is, is the way NFPA works is they will have a request for proposals, a period of time, people will put in proposals to make changes on the code, in the case of 52, that has already happened. Now, the technical committee and the staff are trying to pull all the approved proposals together, there was a big technical meeting in August, where the good proposals were accepted, and the proposals that did not quite get accepted are still out there as potential proposals for change. And then we now go into what is called the ROC, which is Report on Comments stage, so that the public will have a chance to look at the proposals that did not get accepted during the ROP stage, and then bring added testimony to the technical committee that then may be able to make some further changes in this particular edition of NFPA 2. So it is a long arduous process, and each one of these codes has a different technical committee, and each organization has a different way of working. But we are

making some progress across the board.

MR. WARD: You mention that DOE is continuing to fund this effort. Were they continuing to fund it even with the budget cut? Was that one of the baseline continuations -- or are they renewing new money?

MR. BOYD: Yes, it was, although there was a lack of funding, and there still is a lack of funding. There is a lack of DOE funding that are some contracts that were supposed to be paid, that were not paid, and so there is a reduction in travel right now, some people cannot travel because they are not funded, so there is still a bit of uncertainty with the DOE funding for this, but in principal it was retained.

MR. WARD: Is the Congressional restitution of that funding promising for smoothing that out?

MR. BOYD: Cautiously, and promising though.

MR. WARD: Okay, great. Thanks very much.

MS. BAROODY: Thank you, Bob.

MR. MUENCH: Bob, could you make any of those codes when they are released finally, can you make those available to us, please? Is that possible?

MR. BOYD: Yeah, I can make you aware of them when they are released. You have to purchase them.

MR. MUENCH: Yeah, I would be interested.

MR. BOYD: I get free copies, but I cannot share

it with you.

MR. MUENCH: Thanks.

MS. BARODY: Thank you, Bob. Asemblon, are you in the house? Okay. Mike -- is it Ramage?

MR. RAMAGE: It is Ramage. Well, I have got to tell you, this has been a wonderful day for me. I have really enjoyed this. It is almost like Christmas morning for our technology because everything I have heard, we can enhance or assist all of my colleagues. So without further ado, you will notice we are in Redding, Washington. I am from Washington and I am here to help. And I hope that does not make you cringe to hear that. We have developed over the course of about four years and about $11 million in private equity funding a simple organic molecule that carries hydrogen. It is liquid over a wide temperature range. It is stored and transported at normal temperature and pressure, so there is no need for cryogenic or pressure treatment. It uses the current -- or will use -- the current fueling infrastructure, so everywhere that there is fueling now for gasoline, we can use that infrastructure for this product. It is as safe as gasoline or diesel, it exceeds the DOE goals, and I will have a graph on that here in just a moment, and it enables renewable energy, which is clearly very important to you for your 2020 goals. And it releases hydrogen, as needed.

So to give you a graphic as to how it works, this is very simplistic, the HYDRNOL is run through or in contact with a catalytic surface and a certain amount of hydrogen is released. That molecule with the remaining hydrogen, or the spent HYDRNOL, is then moved to a re-hydrogenation catalytic surface where it is re-hydrogenated with HYDRNOL, and it goes back into service. So we are showing in the lab in excess of 1,000 recycling moments, but we are advertising about 100 in recycling that molecule for commercial use.

So the vehicle implementation would be that you hydrogenate the hydrogen, preferably at the source, it does not need to be, but it could be at the source, so let's say you have a methane, or a bovine plant, or a waste landfill, and you hydrogenate there, and then you deliver the HYDRNOL, which is what we call our molecule, it is hydrogenated to the service stations, and I would like to point out that you do not need cryo or compressed vehicles in order to do it, you can use a conventional gasoline tanker, which greatly reduces the cost. A gasoline tanker runs about $90,000 to $110,000 a piece, and it is my understanding that the compressed tanker is on the order of $500,000 to $600,000, and cryo tankers can be in excess of a million dollars. So we are looking at a very limited CapEx for delivery. So the HYDRNOL station is around a tenth of the cost of a cryo compressed station, and I am just talking about the station,

I am not talking about the hydrogenation capability for the moment. So when we talk about 200 stations in the Governor's plan for the hydrogen highway, if you are just talking about the stations at 120 kilograms per day, we can do that for $40 million. Again, recycling on that molecule is 100 times. This is the DOE target chart that will show you what their ultimate targets are with the 2010 or 2015 target. It is a little complicated, but the takeaway message that we have been working with our S47, which is 4.7 gravimetric capacity of sulfur molecule for a number of years, just because it is easy to work with in the laboratory. We have now moved to a series of nitrogen molecules, the N67 indicates that it is 6.7 gravimetric capacity, or 6.7 percent weight -- weight by weight. HYDRNOL N108 will be 10.8 percent gravimetric capacity, and we also have an 11.6 that is in development. So we are already well in excess of the DOE targets. And if you look just quickly -- because I have got only five minutes -- if you look quickly at the chemical hydrites and various other types of storage media, we are well at excess of all of those. HYDRNOL, we feel, is a transitional technology. All day today, I have heard about people wanting to transition to renewable energy sources, and make maximum use of the existing infrastructure. Hydrogen can be initially derived from natural gas, initially, and then renewable sources as

they become available, so you can bring this online with the technology when it is the appropriate time. You build value from the first installation, so you are not just doing one off for, you know, X number of let's say 45 kilograms a day, you are actually able to expand this technology and the deployment thereof. It does not require significant user re-education. You fill up your tank with a liquid, just like you do with gasoline. Diesel co-combustion can be very quickly implemented at Long Beach, Port of Long Beach, for instance, at a very low cost. We estimate the Class A vehicles can be retrofitted for this purpose for about $10,000 a piece. There is a low capital cost to deploy, including an existing vehicle retrofit, there are 230 million vehicles in the United States right now, that most of them can be retrofitted for a HYDRNOL purpose. And what that means is that the adoption of hydrogen as a usable fuel can be greatly accelerated, and we will be talking in a moment about what that means in terms of revenue generation for the State of California. And the optimal fueling points are already established for gasoline. One of the speakers today talked about selecting a fueling point that is located at the point of greatest use. Well, over the course of decades, the oil and gas companies have located those fueling stations based on population density, so that is already done for us. If we could use those fueling stations

and that infrastructure for a liquid that is transparent to the user, just like gasoline, then we can adopt much faster than we have already anticipated.

We talked a little bit -- I think Kevin talked about what we call "power shifting." In North Dakota, this is a slide that shows a number of wind farms and the problem is that the production does not match, in fact, the inverse of matching the need. So what you need to do is shift the maximum production of that energy to the point of maximum need. And you can do that by storing that through an electrolyzer process in the HYDRNOL molecule. We have shown that you could store 4.2 Gigawatts of power in HYDRNOL as hydrogen in a 30 foot X 60 foot conventional gasoline tank, which is about a million gallons.

This is our hydrogen technical roadmap. You will see that the perfect concept is already done, as an R&D company, we are well out of the R and we are into the D now, we are in the development process, and we have a number of teaming partners that are helping us with that. We are looking for more. The Alpha scale is underway right now with the N67 molecule, we are developing a Beta reactor with Patel Memorial Institute and their Hydrogen Division, it is -- we have a number of teaming partners, there are too many for me to mention in the one minute remaining to me. So I am happy to talk with anyone about our progress in the

development path. What I would like to point out is that this really fits very nicely in terms of providing a usable fueling infrastructure to all the OEM light duty vehicles, and all of their plans. They are all looking at 2012 to 2015, this fits very nicely.

So some of our demonstration partners include Clemson University, International Center for Automotive Research, it does much of the work for BMW and Mazda, we just received a Letter of Endorsement from Mazda on a proposal, an RFI that we submitted to ARPA-E last week with PACCAR and ICAR. For static, we are working with Basin Electric and DOE, there is a wind hydrogen project that we are taking over, actually, in North Dakota here in the next month or so, so we will be demonstrating a footprint for a HYDRNOL station and also a co-combustion. And then small engines, there is significant interest with Enrol, again, at Clemson University and SCIES, South Carolina Institute for Energy Studies. And there are numerous other projects we are working on. Our objective over the course of 18-24 months is to demonstrate all of the applications for HYDRNOL which would include onboard, it would include cell tower back-up power, smart grid energy storage, diesel co-combustion, and we are looking for partners to do all of that at this point. We intend to be fully commercialized in the next 24 months. So we see the California opportunity as

being this: we can help you to cost-effectively meet the 30 percent -- now 33 percent -- by 2030 renewable requirement. We can absolutely reduce diesel emissions, and we can accelerate the hydrogen adoption, and the resulting tax revenues to further supplement renewables. Tobias asked me that question. And then, conversion of legacy internal combustion engine vehicles, versus waiting for a fuel cell vehicle availability. What is important about this is we are not attempting to supplant anyone that is providing energy, or anyone that is going to intend to provide fuel cell vehicles. We want to provide that hydrogen infrastructure and the hydrogen availability to everyone, so that when they get there, it is there, and it is an incentive for them to actually invest in the production of those vehicles. So if there are any questions, I would be happy to answer them.

MS. BAROODY: Questions?

MR. WARD: I am just wondering if this storage that you say is on the vehicle, it is liquid form like most vehicles have right now, would it be the same range characteristics that you would have with, say, high pressure storage at 5,000 bsi* [4:24] on a vehicle?

MR. RAMAGE: That is a great question. There are a number of molecules. The molecule will initially commercialize -- the molecule initially shown in our beta

version will be about 20 gallons on board with a 300 mile range; the next molecule will be the 10.8 nitrogen molecule, and that will be about a 15 gallon tank with a 300 mile range.

MR. WARD: Do you have auto companies interested in your product at this point?

MR. RAMAGE: We do.

MR. WARD: Care to tell us anything about that right now?

MR. RAMAGE: I would be happy to behind closed doors.

MR. WARD: I see. Great, thanks very much.

MR. RAMAGE: Thank you.

MS. BAROODY: Thanks, Mike, for compressing your presentation into 10 minutes. Are there any more -- do people want to say something during the public comments phase? Pilar, anybody on WebEx?

MS. MAGANA: They are all unmuted.

MS. BAROODY: Anybody would like to say anything in our online audience? No, okay.

MR. WATKINS: This is Larry Watkins.

MS. BAROODY: I am sorry, can you say it again?

MR. WATKINS: Sorry, this is Larry Watkins. I thought it was a terrific set of presentations.

MS. BAROODY: Great, yes.

MR. WARD: Thanks, Larry. It has been a very illuminating day, and a long day, and I really want to thank everybody, the folks that are still in the room, and the ones that are still on the phone, well done. And thank you to all the team here at the CEC, as well. It has been very interested, it is very informative, and we will have a lot to digest as we move forward. Thank you.

MR. MUENCH: Just one more side note. If anyone on the phone or on the WebEx, or here in the room has any important documents they believe we should see, please submit them through the docket process, it is on the website, to make sure that we look at these things outside of what was presented here today. Thank you very much. I think this has been a great first day of various new points. I appreciate all participation. Thank you.

MS. BAROODY: And those comments are due to the docket by October 6th. Also, the audio and transcripts and presentations will be on our website hopefully within the next week. I think that should do it. Thank you so much, again, for all your presentations and for being here today.

(Whereupon, at 4:55 p.m., the workshop was adjourned.)

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CERTIFICATE OF REPORTER

I, PETER PETTY, an Electronic Reporter, do hereby certify that I am a disinterested person herein; that I recorded the foregoing California Energy Commission Workshop; that it was thereafter transcribed into typewriting.

I further certify that I am not of counsel or attorney for any of the parties to said meeting, nor in any way interested in outcome of said meeting.

IN WITNESS WHEREOF, I have hereunto set my hand this _____ day of October, 2009.

_____
PETER PETTY