>>Tara Clark:
We are going to get started everybody. Thank you for your patience. This is the first one of these that we are doing so obviously we will have a few kinks so please be patient with us. So good afternoon and come out one minute please ... I've got to make sure I am recording. Excellent okay. Good afternoon and welcome to the first FTA webinar on best practices deploying low or no emission buses. My name is Tara Clark and I am the Program Manager for the low or no emission program and I also would like to introduce my commission chief, Adam.

>>
Good morning, everybody, thank you for joining us. Alright, thank you. I would like to thank Fred Silver, his wonderful team for agreeing to do this and put this webinar on for me. When I spoke to Fred and the guys at CALSTART I had really no idea what all I wanted to do so they just kind of took the concept and ran with it and I would like to thank everyone, Jackie and Kim and everyone who was instrumental in putting this together and also all the speakers, thank you also much. A little bit of background on the low and no program. The grant program originated in our office of research innovation office darting in FY 20/13 under the Fast Act. The program was moved here to the office of program management, $55 million a year is available until fiscal year 2020. Last year fiscal year 2016 was our very first competition. Eligible projects include purchasing or leasing low or no emission buses, releasing facilities and equipment, rehabilitating or improving existing transportation facilities to accommodate low or no emission buses. The fiscal year 2016 competition was really awesome, it was really successful and we received 101 projects from 32 states requesting a total of $446 million and we were able to fund 20 projects around 13 states. For additional information on the low or no emission program go to our webpage add transit.DOT.gov. There you are able to drop down the program and you can navigate and find your way to us.

Now I am sure with quite a few folks wanting to know, the notice of funding opportunity for fiscal year 2017 is currently under development and there is no timeline released as of yet. I've been getting a lot of questions about when we think we may be able to release the notice. As you know, we are in a transitional phase. We just had a brand-new president so we are not really sure honestly exactly when we will be able to release, but I will state that anyone who was interested, please feel free to send me any questions that you may have on the program and also please feel free to go ahead and get your grant applications started if you are eligible to apply. And I also want to invite you to sign up for gov delivery. We now have the low no program topic so if you already received gov delivery which I'm sure a lot of you do because you are here today, go ahead and sign up for the loan no topic so you can receive all low no related information. The purpose of this webinar today is to provide information on the low or no emission bus industry only particularly on battery electric and hydrogen fuel cell so that being said I will not take any questions on the actual low no program at cell for the 2017 notice of funding opportunity. So do not ask me any questions that deal with the program or notice. All programs should be referred to Fred and they should be on the information presented today. Once the NOFO is released we will host a webinar

specifically on the NOFO, just as we did last year. I also want to say one more thing, whatever presidential administration change it's usually a period of uncertainty and sometimes you just have to work things out until things settle but I want to remind you FTA's grant programs are authorized and legislation enacted by Congress. So that being said I want to invite you all to enter in the chat window, you can ask questions, Fred you could tell everyone exactly how you want to take questions. I am very excited to have everyone here today and I hope that you all will go away from this with a lot of information. So Fred, if I've forgotten anything, please give me a ping, but for now, take it away.

>>Fred Silver:
Thank you so much, Tara. By the way, Tara, I'm having some challenge with my Adobe so if you are able to move my slides for me on request, is that possible?

>>Tara Clark:
I sure can.

>>Fred Silver:
Okay, great. Thank you, everybody. My name is Fred Silver. I'm the bus initiative lead at CALSTART. 25 years in background working on bus technology mostly in the early days on research and very excited to actually be helping facilitate the deployment of this early deployment of these vehicles. So I am very excited to help on a nationwide basis to facilitate that in any way. The way we will do this today is I will speak for a short while providing some background information on the industry, we will hear from three panelists who have experience with the low no program and have up -- ongoing operations with ZERO emission buses and go through each one and after each presentation we will have -- I will ask a few questions of my own then I think would be important to the attendees to hear and at the end all three panelists will have Kim here to keep track of questions that you provide us on the chat box. You will see a checkbox in the bottom left-hand corner so please feel free to ask your questions as they come out. We will ask them at the end so Kim will keep track of that and after I will go through all three panelists we will come back to the general questions and allow the audience to ask more. So on that note, I'm going to move on to the second slide which tells you a little bit about the ZERO emission bus industry and where it's going in the last two years. In 2009 CALSTART was solicited to plan where we brought the industry together and came up with a roadmap for electric drive and low emission technologies. And this chart came out of that activity and the chart shows on the left-hand side the number of buses. On the right side you see a blue line that shows the growth in that market that was anticipated through 2030. The goal of that publication was to get to 12,000 cumulative ZERO emission buses by 2030.

CALSTART has been tracking that for the last several years to see where we are. At this point, I'm very pleased to announce as of the end of 2016 we have accumulated 600 ZERO emission bus orders or select these or vehicles in operation as of this time. And we expect that number to grow as much as 1,000 buses by 2019. And again the goal here is to get to 12,000 cumulative buses by 2030. We are starting to see the

ZERO emission buses approach parity with hydroelectric buses so that's very promising and the price of some of the battery technologies out there we expect continuing decline in the conventional present performance of battery buses or ZERO emission buses where we expect them to increase performance overtime depending on who architects the project so some regions of the country, I'll talk more about that, opportunities to buy down those prices even further getting it down in the neighborhood or even less of the cost of a natural gas bus or in some cases parity with diesel technology.

Why don't we go on to the next slide. Okay, so there is a growing list of manufacturers of users throughout the country. More than 50 properties power testing or deploying and several of these properties have announced their interest in opting the first, a lot of first out here send one keen DOT and wants to have the first all-electric in the country and we have Valley transit who is looking at being 100 percent ZERO emission by 2018 out of Lancaster California. We have foothill transit also an early pioneer in this technology announcing they will be 100 percent ZERO emission by 2030 so we have a significant number of properties that are starting to really look at deploying these technologies and take it very seriously and we will be learning a lot from these pioneers in the industry. Moving on to the next slide.

Okay, so with eight minutes here I don't have a lot of time to go into great tutorial, but I think for the most part just want to reflect what people probably know today there are two different technologies we are seeing fuel-cell bus technologies which offer high performance ranges up to 300 miles per refueling activity. And in many cases people are starting to realize the value of centralized refueling for similar to natural gas so it is simplified revealing processes that are a great asset to some and the great performance of these buses have a great miles per day for those that really have hills and veils and require extended range. Then we have the battery electric buses that typically provide about 150 miles of operating range although we have seen extended range buses over the next few years be deployed. There are two operational schemes on those kind of ZERO emission buses, the opportunity for on route charging which allows buses to operated and extended period even as much as 24 hours a day if that was required. Overhead couplers ranging from 50-500 kilowatts of wireless charging systems that go from 50-200 kilowatts systems that's operational charging scheme for wireless. We are also see depot charging which provide centralized refueling back at the maintenance facility. Depot chargers ranging again from 50-500 kilowatts defending how fast and how many buses are at the property and I think we will start to see in the very near term a hybrid version of these will receive some on route and some charging and these are the various operational schemes we are seeing on route today. If we could move on to the next slide.

Okay, well there is pretty much any ZERO emission bus you can think of that is available today. We are seeing a variety of 40-foot buses that are overhead an opportunity charging and recently we are seeing bus companies come forward with double-decker electric buses as you see on the top from left to right. Small cutaway buses that are ZERO emission buses being operated. We are starting to see some

articulated buses, 60 footers being deployed. We are also seeing some vanpools that are available, trolley buses come up motor coaches which are really exciting technology so 45-foot commuter express kind of bus technology that is available and a whole bunch of new fuel cell buses that have come online in the last year. And of course, on the left-hand side you see the opportunity charging aboveground we are seeing some very interesting and convenient embedded wireless charging systems becoming available. If we could go on to the next slide.

So the one suggestion I have is as you think about going forward especially for those that are dipping their toes into the pond for the first time with the ZERO emission bus technology -- I don't know why that happened. Tara, did I lose your material there?

>>Tara Clark:
Got it. Can you see it now?

>>Fred Silver:
I cannot but I will go on with my own presentation just give me one second. So I can see where I am. Okay, so I was on the slide that said do not go it alone. And to those who are really dipping into this space for the first time, I think you should -- there are a lot of resources and assistance of their available to you and I suggest you take advantage of them. They will certainly improve your prospects I believe for capturing funding and being selected as well as having successful deployments. Of course, it would not be right if I did not do our sales some justice here and talk about our consortium which is the part of FTA since 1992 manage more than 700 million dollars in medium and heavy duty technology and 161 members nationally including 21 transit fleets and nearly every ZERO emission bus maker in the industry so we have some good knowledge of where they are going, good knowledge of what they are best at and more than happy to kind of be a compendium of sorts to help you sort through what is out there and what is available. We also have a wonderful activity called the vehicle technology evaluation services. These links will be available in the slides as you download them. We have a multitude of reports we have performed on testing ZERO emission buses so you can actually see how the vehicles have performed in the past, get some good insights in the efficiency of these vehicles, challenges and opportunities for their success that are discussed throughout these publications that we have completed. Most recently we've completed a publication for folks looking at fuel cells technology and looking at deploying hydrogen buses so best practices and deploying hydrogen fueling stations is the most recent publication there. We also administer three regional ZERO emission bus voucher programs. And I would encourage you if you are in any of these regions, New York State, Chicago and the state of California to take advantage of these. This will help you I think in many ways be more competitive at the FTA since you can take advantage of these programs and you will be in a position to be asking for fewer dollars of the FTA which they like to hear and each of these is a voucher for ZERO emission buses can provide you as much as $150,000 and buy down funding per bus and that's provided as almost an instant rebate as the time of sale is made. You get the discount right up a time of transaction and the final transaction and delivery stage. If we go on to the next slide which says take

advantage of FTA Lo No key partnering.

So on this slide I think it's important to know and I believe the next will look similar to the past where they have allowed key partnering rules to apply and these key partnerships even include the bus supplier so there may be some properties for either size or other regions find themselves in a place where they do have to compete. The bus suppliers and partnerships and those that are in position to allow the FTA rules on this program to be the primary rules of the competition, this program will allow you to meet the competitive requirements usually associated with FTA just by being selected under the FTA program. So if you choose to follow this route you will certainly want to do some diligence on which bus partners to keep up with, but that will certainly let you get involved early, allow you to work with key partners that will provide you with support writing proposals or providing technical information and other activities that really will help you reduce your resources and workload in this area. The areas we suggest you look at when you key partner is determined the appropriate ZERO emission bus size and product preference. Will be glad to help you in that regard and partner with one of the bus makers so they can really do a deeper dive if you want corridor analysis and understand how these vehicles best operate for the territory. Work with you on centralized hydrogen refueling strategies or grid issues associated with electric buses and depot charging which we are pretty intimate with those issues as some of our bus makers are as well. And other operational issues such as maintenance and training. So again I encourage you especially if you are dipping into this for the first time to look at taking advantage of the FTA Lo No key partnering ability on their Lo No grants. So if we move on to the next list of potential key partners, this will be provided if you download and share this material, I think for those of you that our tech savvy, there seems to be a space on the Adobe site here that allows you to download these and CALSTART will have a link set up for those that want to download these presentations later today as well. This list of key potential partners is in alphabetical order. No preference given to anybody particularly when you start with the BAE system supplying ZERO emission buses, Ballard power systems fuel cells and you just go down the line here, be why D motors for electric buses, complete coach works for power, El Dorado not national California, green power a new bus maker who set up shop in Porterville California. Offer a number of new products, Hydro Gen X the fuel cell buses, new Flyer, nova bus, Pro Terra, Zenith motors, and wave technologies. So if we go on -- if you have Terra here with this last slide if you've got my latest presentation, if not I will just talk to the Lo No bus catalyst so at this point, I am going to tell you that we have a wonderful panel set up for you here today and if you can see this slide I don't know, but if not I will tell you that we have Kirt Conrad the general manager for the regionals transit Authority, a real leader in the industry, Donna a general manager of San Juan team and Mark Manning out of Chicago transit Authority. So at this point, I am going to introduce our first speaker and Terra, if you could arrange the webinar here so that Kirt slides are available to him to work with and I will introduce Kirt Conrad. So Kirt Conrad is the Executive Director and CEO from Sarta since 2009 and he has worked for the Metro regional transit Authority in Akron prior to that for the prior 13 years. He is presently president of the Ohio Public transit Association and he is a real advocate for hydrogen and recently set up a big fuel-cell center in partnership with the Ohio State

University Center for automotive research and also again, thank you for funding for that activity that the Center of Excellence from FTA. So at this point, I'm going to turn this over to Kirt Conrad.

>>Kirt Conrad:
Thank you, Fred. Like Fred said, we are located in Canton, Ohio which most of the world knows us for the home of the football Hall of Fame so if you ever come to visit Sarta and see our fleet you can also see the football Hall of Fame. We are a smaller system about 100 buses and 200 employee is. Our budget is about $18 million routes to Akron and Cleveland. We have 30 routes and do countywide paratransit and service area is about 520 square miles. We've had a history of extensive use of technology here at Sarta. Here is a breakdown of our vehicle types so we have a very diverse, if you will types and our fleet. We have CNG, we have diesel electric hybrids, we also have the remainder of our fleet uses B5 biodiesel. At one point we lovingly refer to a Frankenstein bus which was a dual fuel CNG bus so we have a pretty long history of being involved in alternative fuels and promoting them. One reason why we got involved in the ZERO emission space was really to move the industry to ZERO emission vehicles and two electric drive. Condo if we like to be involved in research and pushing the envelope so to speak in the industry.

Originally some of our funding came from what is called the National Fuel-cell Bus Program. It's been going on for about 10-12 years now. $90 million put into it from FTA perspective. The goal was to demonstrate that technology. We actually got two buses funded under that and 5.$5 million under that program. Generally here is what a fuel-cell bus looks like. This is a 40-foot one. You can see on top is 4 hydrogen tanks that can carry up to 50 kilograms of hydrogen. You go back a little further you can see the electronics and the cooling and on the backside of the vehicle itself is where the fuel-cell and the propulsion is. That's actually a hybrid vehicle that actually then recaptures the energy as it flows down and that actually puts it back into the battery and the batteries themselves. There are actually 2 different types of fuel-cell vehicles. One is a fuel-cell dominant bus which runs about a mile or so on the batteries. The other one is a battery dominant fuel-cell extender where we charge the vehicle or batteries themselves on the fuel-cell and then would actually add some additional distance onto the vehicle.

This is a picture of our fuel-cell vehicle. It's actually one of the operations at Ohio State University for a year. The reason we are doing that is part of the demonstration under the National Fuel-cell Bus Program itself that will allow us to move that forward. Here is the back end of the vehicle it's kind of funny when you open it up people are expecting to see a diesel engine and you see an inverter which is the solar thing that is on top of the parallel and if you look underneath that, the black box, so to speak underneath it is actually 150-kilowatt fuel-cell. It's fuel-cell. The interesting thing about the fuel-cell if you don't know much about a fuel-cell, it actually takes hydrogen and combines it with oxygen from the outside and then actually produces an electron and that electron is used to power the vehicle. The only output is water. And if you are really interested here is more about the bus itself. We had a demonstration where

a number of us including some people at FTA drink the water it is so clean. You can look it up on YouTube. Nobody actually died so it's actually very clean water.

Here is more of the vehicle itself. The one thing about a fuel-cell is hydrogen you do need to have a facility. This is ours under construction. We actually have what's called a liquid hydrogen facility. The large tank is a 40-foot, 9,000-gallon liquid hydrogen tank. The other vertical thing you see in there is called a vapor riser. It takes the liquid hydrogen and evaporates. There are a number of other pipes and things on their, as you can see. These are actually the compressors, they compress the hydrogen up to about 7,000-psi. This is a ground storage where the hydrogen is stored before it is dispensed into the bus itself. These are other station controls that actually work on the various hydrogen.

So basically why did we get involved in fuel cells? We really wanted to help disseminate information and really move along this industry. We really think that transit can be leaders as we move into the electric world so to speak of vehicles. And one of the other things we really wanted to was really help out the supply chain and get the price of these vehicles down. I think the ultimate reason why we want to support this ZERO emission is one, it's better for the environment and better for our writers ultimately. So with that I will turn it over to the next presenter.

>>Fred Silver:
Let me just ask a couple of questions before we go on here, can you tell us a little bit about the cost of the hydrogen and how does that equivocate to diesel?

>>Kirt Conrad:
Sure. Right now we are looking for hydrogen. This is not what the cost of equipment. It's about 5-$6 per kilogram. A kilogram is about the same energy release that a gallon of diesel will have. So we have a contract now for diesel and I think it is $2.70 per gallon. So with the efficiency of the fuel-cell bus being a hybrid and a much more efficient using electric drive, we are getting probably double the mileage, so to speak. So in essence the fuel cost and operational cost is about the same.

>>Fred Silver:
Okay, very good. All are these buses tested and proven?

>>Kirt Conrad:
These buses have been operational now, I think about -- this specific platform is undergoing alternative testing and should be done by the mid-part of this year.

>>Fred Silver:
Great, great. And are there other bus manufacturers making fuel-cell buses besides the one you are operating?

>>Kirt Conrad:
The platform we are operating, the El Dorado platform with the fuel-cell then new flyer

is out also making a 60 and a 40-foot fuel-cell vehicle.

>>Fred Silver:
Okay. Thank you, Kirt, appreciate that. Okay, and now I see the slide is up for Donna DeMartino. So let me introduce Donna who has 30 years of experience in transit, 14 years with Sacramento RTA and the last 16 years CEO of San Joaquin RT E. She is also a past chair of CEO committee and a past chair of the California transit Association. So welcome and thank you for presenting, Donna.

>>
Thank you. I'm happy to be here. Delighted to be here to share some information about our experience with deploying Lo No emission buses. If you go to the first slide where we have a map of our service area, I want to tell you just a little bit about RTD. You can see our service area. We serve a very large geographic area about 1440 square miles with also the area where we provide the highest concentration of services. That large white area is our entire service area and you can see our proximity to the bay area and up to Sacramento. The pink in the middle shows [inaudible]. We are in Sacramento in the bay area and we run commuter services to both areas and also connect San Joaquin County residents to Bart eight times a day. Our commuter buses are our only left over depot buses. We are running the 45-foot [inaudible] but we have funding in place and 2017 for replacement hybrid coaches.

For the purposes of this presentation I want to let you know we've been shifting to cleaner technology buses for over a decade. We started out with electric hybrid buses in 2004 and by 2015 [inaudible] with a diesel electric hybrid buses or all electric buses. So if we could go to the next slide.

As a public transit provider we value the opportunity to transport as many passengers as possible with thief with as few emissions as possible so the impacts of pollution and emission can be mitigated or eliminated. We are very proud of the fact that since 2013 RTD introduced Northern California first 100 percent battery electric buses into service. Our current Proterra buses and these are the only 2 we are operating so far saved us an average of over 500 gallons of diesel fuel per month and average the equivalent consumption of over 20 miles per gallon. Moreover they reduce greenhouse gas emissions by over 15,000 pounds per month. That is the equivalent of planting over 300 trees per month and is pretty overwhelming when you think about it so a little bit about our electric buses. We started on this journey when Dan Hill was there. I was familiar with the electric bus demonstration project and they came to me and asked if I would work with Proterra to apply to the California energy commission and apply for grant with them and have some buses that RTD. We were successful in our application and ended up with our all electric buses and a charger with no out-of-pocket cost to RTD. I have to admit when Dale and Dorn talk to me about operating buses that only had a 40 or 50-mile range I thought they were crazy. How in the world could we do that, but it's worked out really quite well we do what is called inground charging and you will see in a minute we have a charger at our Downtown transit Center, but most of our routes including our bus and transit routes are 60 miles long so 60 miles out

and back so 40-50-mile range works quite nicely in our application. We've been running the two electric buses since 2013. I must admit we've run into a few glitches along the way but overall we have been quite happy with the buses and quite happy with Proterra as partners. We have received additional funding that allows us to expand our fleet and we will be considering and configuring some of the buses to operate on what we believe will be the first all-electric cord or in the United States. I do want to let you know we have received 240-foot Proterra buses last month and we are expecting 13 more to be delivered over the next three months.
On the next slide I have a video and it will show you how they charge and work. If you would please. [video playing]

>>Tara Clark:
Are you able to see the video? Just checking.

>>
I can see it.

>>
No I can't.

>>
You have to go on a different tab on top to see it.

>>Tara Clark:
I think what we probably should do is make the link available and then everyone -- I will put it out in the chat and folks can look at it at their leisure. Is that okay?

>>
That would be great. Thank you. [Overlapping Speakers]

>>Tara Clark:
Forgive me but we are trying to figure this out.

>>
Thank you, Tara. Appreciate that. We will send out the link. We have a YouTube video available and once you get there you will see some other YouTube videos out there as well. It's about a one minute video that shows our bus in action and we can pull into our downtown transit center and board and offboard our passengers while the charger is actually charging the vehicle. It takes about a 10 minute charge for a full charge although it will work with the partial charge us well. Clearly we don't have to charge it every time we pull into the downtown transit center. However, we usually pull it in, top it off and this is where operators take their break, run in the break room and get back and go ahead and pulled the bus out. The video to follow and if you could advance to the last slide please.

This is a little bit about our Metro express, are bus rapid transit corridor in Stockton

since 2007. It's interesting, people were skeptical when we talked about starting up bus rapid transit route. About that time is when we started getting our fleet, our full fleet of diesel electric hybrid vehicles so we were introducing for the first time in our community not only bus rapid transit corridors, but also low emission buses and we've been successful and have three corridors and play already and if you look at the map on the right the green line shows the three corridors we have in place. The bus rapid transit in Stockton no less has been so popular that we were standing room only [audio disruption]

>>Tara Clark:
Hold on for a moment. Were you able to see that?

>>
Over on the right-hand side is the last slide.

>>Tara Clark:
I wanted to make sure everybody was able to see it because I'm not able to see it. I apologize.

>>
My presentation will be available online for anyone else having problems viewing it but we are planning to open to new BRT corridor so I wanted to say that ridership was so high that we have introduced articulated buses on the BART one route which is pretty unheard of in Stockton is a big university city but we are operating articulated buses and throughout the day they are completely full many times and we are averaging 70 passers -- passengers per hour on the BART corridor so the next project we are moving out and I mentioned we plan to use the new buses coming in on the new BART corridor. This will be on the new Martin Luther King corridor where we will be making a significant investment in a disadvantaged area of our community. This includes the nation's first all-electric BRT corridor. This is actually in South Stockton. This corridor we believe will bring both innovation and improved air quality in health outcomes for community that really need said. We've made it a point to invest in new technologies not just as a matter of innovation, but as a matter of mobility, and environmental justice and public health. We've been in the area for a long time so cleaning up the air and being part of the environmental cleanup process has been very, very important to us as part of our strategic planning to be environmental partners. With these projects and the continued increase funding for ZERO emission buses we believe we have the best chance at leading California to achieving climate change goal while cleaning up the are in making important investments in disadvantaged communities in our region. I'd be happy to answer any questions now or at the end of all the presentations. Thank you for your time and attention.

>>Fred Silver:
Donna, let me ask you a couple and we will take questions at the end when we finish everybody from the audience, but to remind everyone please put your questions in the chat box and Kim will keep track of those and we will make sure as many of those get

asked as possible. Donna, I'm sure a lot of folks are wondering, what kind of availability and pull out are you seeing these days and what are your expectations for that?

>>
We have gone from having the buses down seven hours a week to really improving their availability. We've been able to run both buses pretty much full-time recently and we are not seeing a major downside for a out or down time and the first glitches we found were mostly bus glitches not technology ... they were things like windshield wipers or doors on the buses. So Proterra is building the buses from the grounds up and I think those are the biggest challenges they found.

>>Fred Silver:
Okay, and tell us a little bit about what your expectations are into experience with the cost of fuel compared to your conventional diesel buses.

>>
That is a good question, Fred. Thank you for asking. It varies. There was a time when I use to tell people that the diesel buses were about 3 miles per gallon and hybrid buses were operating efficiently at almost 6 miles per gallon and our electric buses were operating at about 20-mile per gallon equivalent. That was variability of the cost of the electricity and the downturn in the cost of fuel, the results are not quite as exciting as they used to be and we are still excited about the omission results, but we are concerned especially now, many of us we just completed a two-year waiver from our utility supplier and we've been working closely with CALSTART and their resources board to see what we can do about a longer-term recognition of the need for waivers and options for electric bus adapters so that we can regulate the cost of our utilities. We are looking into energy storage opportunities and even solar power for our facility. Looking for options as we expand our fleet to stabilize the cost of the electricity.

>>Fred Silver:
I think that will be very regional throughout the country. There are some regions that are extremely low in the cost of electricity. I believe the Pacific Northwest has an outrageously low cost rate so working with your local utility will be important as a partner to best design the infrastructure solution for being the most cost effective to both parties.

So at this point, thank you, Donna, for that. I'm going to ask Tara to put up Marc Manning who is our next speaker. Market works for one of the largest transit agency in the country and with the cup -- Chicago transit Authority he is the equipment engineer and with the ZERO emission bus Program Manager at CTA and he has graduated with an account engineering degree from Georgia Institute of technology and a Masters in mechanical engineering from North Carolina State University so interesting he's gone from the mechanical side to the electric side and also did a lot of work on diesel engine so a real conversion here for Marc and looking forward to what you are hearing to say.

>>
Hello everyone this is Marc Manning. This is the first picture that launch the bus and you get good view of what our delivery looks like where we built the buses and if you want to go to the next slide. Or I can do that. What I'm going to talk about briefly is our electric bus, what we got and this is with our current funding in place that we had. Of course, I will expand a little bit on what we will be doing from the Lo No grant we got last year to an extent. I will talk about the charging instrument infrastructure and the daily revenue service we are actually doing daily, what are buses look like so you can see what promotional we are doing and then we have promotional, so people understand what they are getting into when they get into the bus. In terms of the bus we are operating the new flyer with 300-kilowatt battery capacity and we have basically six different strains. For the most part the operators have said this operates like a normal bus which is about as good of his experience as you can say. The only thing that is unique for us at CTA is the strings on the top of the bus do make it a little more top-heavy than our current diesel fleet so primarily a diesel fleet. We have some diesel hybrids with transmissions and I will talk about more about the electrical charger. The infrastructure, what we do is we have 2100-kilo lot capable chargers stalled at two of our garage is. This is showing at one point we had both buses operating out of one garage. What we have done to help with alignment purposes at the garage is actually the operators look at a poll to kind of make sure they are aligned with where ever the charging port is. Additionally to help with range et cetera and make sure the bus pulls out a comfortable temperature we have condition charging and we are about 80 percent state of charge. The HVAC system will turn on that way we have enough time -- basically we did that because we have to pull down and pull up test to say that the bus would have enough time to get to temperature by the time the operator pulled out. Additionally it does save range.

In terms of daily revenue schedule. I apologize for the eye chart. Basically what we do right now is we operate the buses the equivalent of about 14 hours a day. What we do is we do a 50-60-mile service which is about six hours. We pull out of two different garages, one is in the morning and it does the 52 route which is the average a.m. weekday for that is about 12,000 rides per weekday. On the PM out of that which is right up here and you will see a line right there, we run a route which is Route 21 which is about 10,000 weekday borders. Just in this last, in August -September we decided to move one bus down to our south side garage which is seventy-seventh Street and it's actually a good benefit of that is now we have the bus operating on one of the heaviest wider ship routes to truly test it. So that route on the 2016 data was the heaviest ridership route in terms of weekdays and that was 27,000 rides per day so if you want to look at what the ridership is for each route you can click and go to that hyperlink there.

When we first started the buses we were actually operating them 45 miles a day and that's because we wanted to have a consistent operator. One operator pulling in and pulling out of each vehicle blocked. As of now, this is how we are operating now. So operating at these routes consistently, same vehicle blocks every day to keep similar operators getting used to the buses. Vent allows them to get comfortable with the bus,

understand state of charge and everything so that they know if there is any kind of issue they can report it because they have the built in knowledge now. As I said we are getting about 120-130 miles per day. Over all the buses have operated pretty well. We've had over 2000 -- 200,000 riders on this bus. What -- the good thing about what we've done now is the low cost infrastructure for us to test out the electric buses. What we've found is that as you can see, this is our most optimal way to get buses out with the most mileage is doing an AM service with about 50-60 miles, a midday charge and going out in the PM. Obviously with all of our scheduling et cetera, it could be difficult to get the 3-5 hour charge. You have late pull in's and things like that to where it could limit the amount of buses that we could actually scale this up too. So in our next procurement which is what we got the Lo No 4420-30 buses we are planning to do in route charging. So the next slide shows the livery, we did one that has a green leaf and you can't really see it, but there's actually a battery at the back of the bus and we did one with more of a lightning electric kind of thing. And then in addition we put the livery and it is color-coded based on which bus that is, green or blue and it says 80-120 miles, breathe easier, talking about the sound. The one thing I did mention is one reason we kept it at 80 miles as we wanted to make sure the operator did not have to worry about a range of variation during the day. We wanted to make sure 100 percent he will have no issues getting back to the garage. That's the other reason we kept it, but in all honesty, the 80 miles allows us to get the most mileage per day anyway. And so any other questions?

>>Fred Silver:

Thank you, Marc. So I do have a question for you, you are in a fairly cold climate there in Chicago. Can you tell us about heating issues, vehicle battery performance, et cetera? What are the issues you are running into and how are you engaging them with respect to a cold climate.

>>

I'll do a shameless plug on the performance in cold weather. That is a good report to kind of show some of the things that new flyer did. What we actually had to help with cold weather is I would say the biggest one is that we do have a diesel fired heater that helps with supplemental heat below freezing temperatures so anything below 32 degrees it will kick on and help provide additional heat. I think as I also mentioned the condition charging also helps because when the bus is in service, it is not having to worry about getting up to temperature. The buses, we also have decided to deploy these at garages that we park indoors as of right now. That way we don't have to worry about the buses being stored outside in the cold conditions and then having to get up to temperature as well. That is some of the things we have done to help that I think are the biggest factors. Obviously we have larger battery packs to help with range, but what we have tried to do is try to deploy it in such a way that no matter what the temperature is outside, we always will come back to the garage 100 percent. So the 80 miles, 70-80 miles seems to be a good sweet spot to where we won't have operators complaining about mile variation and things like that. They are always going to be successful because we don't want to see road calls.

>>Fred Silver:
And last question, what about fuel costs? What do you anticipate or what are you seeing? What is your experience as compared to conventional fuel?

>>
I would say the number we actually put on the livery is pretty exact. That was our estimate when we first started. What we are seeing is of course demand charge for us is about $6 per kilowatt. What we think is that our average miles for our buses is somewhere around 36,000 or 40,000 miles. With the buses that these were placed, we think it will still be in the neighborhood of 11-$15,000 in savings just on fuel -- please standby. Technical difficulties.

>>Fred Silver:
A small town and a small bus so a lot of buses available for 12 plus handicapped accessible city buses so the answer is yes, there are a number -- at least three manufacturers I can think of and that makes it a 12 person van and all electric and then there is Phoenix motors who makes a small cutaway bus, perhaps 18 or so passengers and in their configuration and a third company called automotive and they make -- you saw the picture in the presentation and they are operating that bus right now in Mountain View California and that's a little larger bus so these things do come in smaller sizes. Somebody else asked questions about sizing as well so just to walk through all the sizes available, there are some manufacturers that are offering a 30-foot busted, transit, 33-foot, 35-foot, 40-foot, 60-foot, motor coach, 60-foot articulated in commuter express with the stairs going up. So pretty much for the most part we are seeing every bus configuration, not necessarily from every manufacturer being offered, but every bus type being available.

The next question and maybe we could relate to Kirt it asks about time for fuel cell buses could you tell us about your experience?

>>Kirt Conrad:
The fueling time for fuel cell bus is approximately what we could see for a diesel bus may be 10 percent longer and it also depends upon configuration that you have for the nozzle itself.

>>Fred Silver:
Okay. The next question from Steve, I think this was during the Donna presentation is how long does your corridor run, the BRT I think he is referring to. Donna, are you still online? Or are you muted?

>>
I was muted. Sorry, can you hear me now?

>>Fred Silver:
Yes.

>>
If you are talking about hours of service, the BRT corridors run from about 5:00 in the morning until about 10:00 o'clock at night.

>>Fred Silver:
How many miles is one run?

>>
All of the corridors we have in place in the future ones are about 6 miles per corridor and I don't know the overall mileage but I did see a question about how many passengers so we are a little over 4 million trips and over 2 million of those are currently being operated on our bus rapid transit corridors. This is fast efficient service and people really flocked to that.

>>Fred Silver:
Right. The next question also for you Donna, I think, how many writers do you get per year on your BRT system?

>>
That would be a little over 2 million.

>>Fred Silver:
2 million. Okay. [Chuckling]

Next question from Chris Payton and I will let somebody kind of choose who wants to answer, what sort of savings are you seeing per month on maintenance for the electric bus versus deal -- diesel hybrid versus CNG?

>>
This is Marc. To be frankly, honest, we have had the buses for two years, I would say the data is not really there to give me the best answer, but obviously we are not changing feel will oil filters, fuel filters, so in general every time we go through an inspection it's a quick process and there's not a lot of consumables, but the proof in the pudding is going to be as we probably all know will be year six and year eight. I would love to give you good data but right now I feel it's a little premature on that.

>>
I would agree with that. It is hard to get the really good data on the new technology but I did ask our maintenance manager about the PMI savings and he said that on the PMI for the hybrids we were spending about $590 per inspection and on the electric we are at 357. We are saving money per inspection, labor and materials and also a lot on the brakes and these are -- the savings is even more when you consider the comparative to the diesel buses that we are still running.

>>Fred Silver:
The next question I think is for all three perhaps, what is your major source of power so

maybe Kirt, start with you and if you could tell us a little bit where this is generated and then we will go on to Donna and Marc.

>>Kirt Conrad:
Most hydrogen is sourced from Ontario, Air Products liquid plant and the interesting thing, most of their electricity is hydro that makes it and then it's reformed from natural gas.

>>Fred Silver:
Marc, what does it look like for you?

>>
It's about 50 percent nuclear power, 30 percent call and a mixture of CNG.

>>Fred Silver:
I see. Okay. And Donna?

>>
We are purchasing our electricity through PG&E. We had put in some additional transformers and we will be doing some more of that so we are just typical electricity and that's why the demand charges are so important to us. We are looking at energy storage via batteries for the future. We are also looking at -- actually that would be our next big project we are looking for money for solar power for facilities and chargers to help bring down the cost. I did notice, not to jump ahead a question about the difference between depot overnight charging versus the overhead charging in route. And this is only our experience and I know Proterra now has the overnight charging and it is a little less expensive to charge per kilowatt hour overnight but charging time is a lot longer so I have not seen any real clear evidence we can save a lot of money by doing overnight charging at our depots yet. So just by way of comparison if buses are running eight hours per day and pulling into the charger every hour for 10 minutes that would be a maximum of 80 minutes of charging, but the overnight chargers would have to at least stay on the buses for six hours.

>>Fred Silver:
In California, where Donna is, we have outrageous schools regarding -- and they are powerful goals and it seems like we are meeting them's in terms of renewable energy and grid so the power we are seeing will be the prospects for getting increasingly cleaner energy in the state of California is very high and we are exceeding in that space.

The next question is from anonymous, does traffic have an impact on fuel usage? So perhaps if somebody wants to let us know what the performance of their vehicles are when they are in stop and go traffic versus continuous high-speed. Does anybody have a sense of that?

>>Kirt Conrad:

This is Kirt. The fuel cell actually because of being a hybrid actually works better in stop and go traffic then continuous operation.

>>
This is Donna. Surprisingly, we have found good performance on our hybrid vehicles even in our larger longer runs. We first started using hybrid vehicles in the downtown Stockton area because we were convinced we would get the best efficiency in the stop and go traffic, but as we transition to our entire fleet over to the hybrid buses and started running some of those in the longer run we still got great efficiency out of them and we didn't notice a big increase in miles per gallon. So I was surprised. And I'm not the maintenance experts but we have still found very good performance because as I said almost 6 miles per gallon on the hybrid buses which those of us that operate buses knows that's a big jump. I don't know what other folks are getting, but we were averaging about 3 miles per gallon on our diesels.

>>Fred Silver:
The next question is almost requires a tutorial, but we should do our best here to provide some feedback on this. The question is for Bruce, can we hear more about decision-making and infrastructure decisions in the implementation of e- buses? Let me start first and say that CALSTART has been working on this for years. We have a publication we produced available on line which is peak demand and demand charges for electric buses and compares conventional buses to depot charging to overhead charging, but it's very generic in nature. We only looked at 26 utilities throughout the country. We found some of them have outrageously high cost when it comes to demand charts and some are very friendly on that and it is changing because of the climate change goals some of the states they are in fact, moving toward more friendly issues, they are finding at least in California in the next couple of years the movement toward renewable energies is going to actually incentivize peak charging perhaps during the daytime. A Valley of power that is needed to be produced to keep the generating stations online because so much of the overall electricity is coming so it's clearly something that is very regional, but it's certainly worth looking at. But let me ask each of the properties here to just tell us what was your decision making process here. I think we will start with yours, Marc, because you are still going through that process a bit. What is the decision-making process in terms of whether you wanted to go with depot or why you are going forward with route charging and how do you go forward with that kind of decision-making process?

>>
I think we learned a lot from the first 2E buses we had and just understanding as we want to scale trying to have in depot chargers for us is not fully scalable solution necessarily. So what we decided to do was we looked at every route in the system and four in route charging, the key thing is you had to have a certain distance between the charge points and we looked at what other people have done, what the industry says and we looked at our routes and that we figured out does CTA own or have some property rights at the end of each route. So that was a key criteria because it would obviously help us permitting and things like that. And from there we kind of looked at

okay, which ones will impact the most customers so we looked at heavy ridership routes. I mean that is basically what we did. We were looking at the intangibles and tangibles that dictated what we could do. If a route was super long and we only owned one piece of the one way, then that one was x because we did not want to try to buy real estate just to employ the technology. So that was basically our decision in the whole thing is we were looking at routes that made the most sense that served the most customers and the whole demand charge thing is you want to make sure really as soon as possible bus is off the quick charger you want to another bus immediately following it so you can spread that cost. So that was the other consideration and we wanted to see which places we could potentially scale. We wanted to make sure if we scale at one location we can fully scale it up. We did not want to be landlocked by real estate as well.

>>Fred Silver:
For some of the smaller properties that don't have the resources of a larger agency like GTA, CALSTART technical and evaluation services happy to work with you to do some analysis and determine what the options are for you given what we have seen from others and talk to your utility as well. The next question has anyone looked into off grid depots and how much solar power it might require? I think there is a lot going on in this space. CALSTART just helped Fresno rural transit in the central valley of California with an application for as many as 30 solar and several will be using at the foot of the umbrella will be a 200 kilowatts of energy storage which will be off grid for extending the operations. We will try and report on that and those that project is deployed. We are seeing a lot of interest in solar. I know that the folks at antelope Valley Transit Authority in Lancaster are off grid in the early 2020s and still working with BYD that makes solar systems and energy storage containers so they have a really strong partnership on a program to do off grid for a decade. And so a key thing that is not mentioned is energy management systems and there's a lot to be learned as you deploy your feats. As much as a skyscraper so we start looking for technologies that come out of the stationary side and management systems, energy management systems are very common systems available that we are seeing in large buildings where there is a mixture to optimize energy use in building and air conditioning, lighting, the elevator systems, so we are going to start seeing those and those are existing technologies, but they need to be applied to the electric transit bus space so I think this is a whole new space we are going to be seeing new project demonstrations in. Donna, did you want to talk a little bit about your interest in this space are what you may know?

>>
Thank you. I'm glad to have a little bit of a chance to give a plug for the California transit Association at this point. They are a group of us within the association meeting on a regular basis with the resources board to talk about many of the topics related to the implementation of ZERO emission vehicles that concern us. While we are big believers in it and want to keep moving forward several things concerned us. The infrastructure investment piece is very important and before making a decision to move into this environment, it's important you consider your own facilities and the

infrastructure that will be needed to support the technology you are moving forward with. One thing I just want to say is that Steve Miller who is the Director of Maintenance for Golden gate transit has done some pretty amazing work with lifecycle cost for various forms of ZERO emission vehicles. So you might want to reach out to him if you want to get into the technology and the life cycle cost a little bit more. For us having a grant available allowed us to build or improve our infrastructure, our transformer at our downtown transit center and install insulation of the overhead charger was a big incentive for us to get started. There is a lot to consider. Steve talks about the effect if they were to go all electric he would need to double the energy availability at his facility so we are talking major investments. It's great we have Lo No and other programs available we can work with to help offset those costs.

>>Fred Silver:
Very good. Okay, so the next question is from Chris Payton and the question is the on route electric charge works overnight on peak versus off-peak so I will put a plug in for our peak and demand charge document publication funded by the FTA that we developed three years ago that kind of gives you the parameters around that and you can plug-in your own utility rates and issues to make your final determination. We do find the one common theme is that the optimum scenario when using overnight opportunity charging on routes used to be that you would need eight to 10 buses for on route charger to make set docents when you are in a couple of bus areas you are paying a premium for demand charges, but when you're able to prorate them over a number of buses it mutes the impact a bit. But let me leave this question also for our panelists what their thoughts are on any comments on the electric charge system more expensive than an overnight system?

>>
This is Marc. I would shamelessly plug your research paper because we were using it in some of our analysis. I think it really just depends on how many buses you are going and how you want to deploy. For us, if we were to have -- go do the same scenario that I pointed out where we have 50 buses and then they go back to the depot and I'll have to charge at the same time, then it is probably much more costly because all the buses have to charge at the same time. We have to put in a huge infrastructure piece in order to handle that and we also have to have three potentially few hours to charge the buses during the middle of the day. So I think it really just depends on how many buses you have and what makes the most sense. I think that is what everyone should be looking at, what works that CTA would not work at a smaller transit agency or any other transit agency. I think it depends on the size, what ComEd, your electrical supplier tells you in terms of your pricing because for us our demand charges are not expensive as they are in California and other areas so that also could play a factor.

>>Fred Silver:
All right, Bruce Abernathy has a question, have you seen any battery degradation.

>>
This is Marc again, we have not seen any, but we've only had the buses two years. I

think much like on the maintenance cost, we would have to evaluate that again in year six or year seven to see what it looks like.

>>
Donna have you seen any battery degradation?

>>
I'm not aware of any, but our buses we have been operating about three years.

>>
I think it's early on this area and there are a couple hundred thousand miles out there, half-life or so of a bus, not seeing a lot of battery degradation in general that I am hearing about. The good news is that the bus makers, at least in the early market here because it's a concern of many properties are offering -- some of them offer a standard 12 year warranty on the buses and I think they guarantee some level, not further then a certain level of degradation for that particular bus. Some offer as an option that's not an expensive option and certainly in the early market, those are worthwhile warranties to consider. I think as we get more experience we will actually see what the results are and decide whether beefing up the cost of a bus with a security blanket kind of warranty is necessary. Hopefully we will learn more and get close to having every year more information on this and we will certainly through the research programs that the FTA does we will certainly try and report back on that information.

A question is are there maintenance cost savings due to fewer components on the buses?

>>
My answer is yes, as far as PMI. The information I was giving before was related to that fewer parts.

>>Fred Silver: I think the vision for sure is that these buses will be -- I know this is a conservative industry and having a vision is not a guarantee of anything. It is certainly the vision that that is the aspiration of this industry given the simplicity of some of the ZERO emission bus technologies that we will see that. We have seen that in other technologies like electrification in airports with the equivalent internal combustion engine vehicles have proved to be lower cost to maintain then there electric vehicle counterparts. Over time we hope that is what we will see here and we are certainly all studying that and I'll believe that that is a likelihood what we will see out of this space. The next question here, somebody made a comment that Phoenix motors makes light duty cutaway vehicles which I mentioned earlier. The next question is all the 12 year complaint buses. Kirt, why don't we walk through quickly and see if that is true. Kirt, why don't we start with you is your buses 12 year FTA complaint buses?

>>Kirt Conrad:
They are being built to comply.

>>Fred Silver:
And Marc?

>>
Yes, they are.

>>Fred Silver:
And Donna.

>>
Same answer, yes, they are.

>>Fred Silver:
Okay. So I think 90 percent of the buses that they showed you are have gone through Altoona testing or 80 percent and should be asking this question when you approach it any of the manufacturers and ask them for their long-term Altoona testing plan and for the most part we are seeing that's very high preponderance of providers in the industry are providing 12 year FTA complaint buses by American compliance and walking through either going through the Altoona testing now or have done that in the past. Kirt, are you looking to go for 10,000-psi fueling is the question.

>>Kirt Conrad:
We are looking at that and looking for some different funding sources to do that. We actually want -- an example of a European city which is Aberdeen Scotland where they are not only doing fuel cells in the bus fleet but across the municipal fleet so we are actually looking at potentially working with some companies, FedEx have a fuel-cell vehicle and potentially looking at some other so 10,000-psi is something we want to do.

>>Fred Silver:
So the next question here is from -- Canon agency include a bunch purse this deponent and [inaudible] under the Lo No caps program?

>>
Go ahead.

>>
I just answered in the chat the Lo No cap program is sponsored by our research office so any questions about loan no caps should be directed to Sean Ricketson. I'm sure his information should be on the NOFO. If not, I'd be more than happy to provide that information off-line.

>>Fred Silver:
I think they are referring to the Lo No component assessment program that was recently announced by the FTA, Auburn University and Ohio State University. I think this is the same answer. We really have not -- the project has not been released yet. I don't think there is an opportunity to include a bus purchase with that program. But

that is a TBD. CALSTART is a partner with the Ohio State University so we will be as the contract gets left, we are more than happy to work with you to figure out what your needs are in that space and answer your question better at that time, but it's very early at this time to understand how to answer that.

Another question here is: is anyone interested in quantifying total cost with battery chemicals and side by side especially for applications? Donna, I think you are aware of what is going on here in the space. Maybe you can talk about this and the quantifying of total cost of ownership analysis that is going on.

>>
Again -- thank you, Fred. I would refer back to Steve Miller and the work he has done. He has put up spreadsheets, he's looked at the different types of electric vehicles and then tried his best to do real life cycle costing on the different technologies. I am not certain how we could share that but I do believe if you were to contact Steve Miller at Golden gate transit, he would be happy to discuss it or share what he has.

>>Fred Silver:
Okay, well we have reached 11:30 a.m. and I am sure we are out of questions here as well. I am understanding will be another webinar next week. Did you want to take a moment to advise folks about that?

>>Tara Clark:
Yes. Thank you. There will be another webinar sponsored by the Center for transportation in the environment that will be next Wednesday. I believe the information was in the same e-mail blast. I believe it is 2:00 p.m. Eastern time. At CTE has not yet sent their final agenda to me yet, so I am not sure specifically who is going to be on their panel. But I am pretty sure it will be similar to this and that they will be discussing some of the same things that Fred and CALSTART and the team and the panelist discussed today. Please, please, please register for that. You are more than welcome to register for both. And Fred, before I do closing, did you have anything else you would like to add?

>>Fred Silver:
No. Thank you very much. Appreciate the attendance in the opportunity. It's been a bit of a passion for me over 25 years and I am so excited to see this stuff happening instead of moving to the research phase, deployment. Thank you for the opportunity today.

>>Tara Clark:
Thanks so much. You guys did a phenomenal, tremendous job, I can't even begin to describe and I am seeing questions about whether or not the presentation will be available. In the top left you may be able to see a file share. If you cannot download the file there, I will be sure to have the file posted on the Lo No page in addition to the transcript. And all of the presentations here and yes, the CTE webinar is next Wednesday, February the 1st. Again thank you also much for participating. I look

forward to speaking with some of you possibly next week. If you have any more questions, feel free to contact me and I can definitely put you in contact with Fred. And in the materials, I am not quite sure if some of the speakers have their contact information, but just contact me and I will definitely direct your question to wherever it needs to go. On behalf of everyone here, my division Chief, Adam, I would like to thank you all and I will see some of you next week and you guys have a good day.

>>Fred Silver:
Thank you. Goodbye