Andrew: Good afternoon, everyone; thank you all again for joining us in our webinar. We are excited to get to talk to you about planning for fleet transitions to zero emission vehicles and we have a great set of content for you coming up. Real quick; if you are new to the N-CATT world, we are the national center for applied transit technology. We are funded by the federal transit administration, and we focus on small, urban, rural and tribal transit agencies and how they can apply all of the new both shinny and less glamorous technologies that are out in the world to improve upon the emission and to better serve your communities.

So, we focus a lot on technology as a tool and how that can apply to your needs and your challenges, and you want, and your community’s wants and then how you can go about implementing them and incorporating them into your work. And so, we do this through resources such as this webinar and the webinar series we also have podcasts, guidebooks and fact sheets so that way we have a nova round door approach to how you can learn about the different technology topics that are out there. And then we also provide in depth technical assistance.

And this is through our strategic technology strike teams which is one on one work with transportation agencies around the country and our state technology summits where we work with state DOTs on applying and prioritizing technology at the state level. And the whole goal of this is to really enable transferring technology that exists out especially with larger agencies and helping it become applied at small scales around the country. And also, we hold hands on workshops, and we are hoping to keep developing this part of in cap so that way folks can out in the field can upscale themselves for free.

And so, we have so far focused on data management, digital tools to facilitate system redesigns and then also free GIS tools to get the basics of how GIS works and to access it for free or low cost and then be able to run your own analysis on your own if you need to. And so, the GIS course we actually we will have at CTAA’s expo in Louisville and what is apparently only two weeks now, so we look forward to seeing anyone there if would like to sign up. All of our information you can find it in n-catt.org and also, I mentioned that we are FTA funded TA center.

We are part of a whole family of those that you can see on the screen here and we coordinate a lot with each other and then we also want to point you towards resources on coordination. That way folks can work together on different challenges that impact them and then you will be able to combine forces and then this way you can see different ways of doing so based off of all the resources that this whole suit of TA centers has developed. So that is the transportation technical assistance coordination library, so feel free to visit that at any time or ask us about that as well.

And then I am Andrew, I am the direct of N-CATT and also, we are joined with my colleague Marcela who I will hand it off to briefly.

Marcela: Hi everyone, my name is Marcela Moreno; I am the transit technologist of N-CATT.

Andrew: Excellent. And then also before we get started there is a certain grant opportunity that is out in the field at the moment. I want to remind everyone that this webinar is not about applying for the low or no emission vehicle program and that is out there, and you can find more information about it at transit.dot.go/lownow and we highly encourage you to look at it but this webinar will not provide any guidance on how to apply to that grant.

This is more for folks who are in the beginning stages of planning to transition and then potentially in the future could be interested in this grant or others, but this is mainly an exercise in how to prepare for the future of different types of vehicle fuels. So, I would like to remind everyone of that and with that I will hand it off to Moses Straits from Fresno County rural transit agency. So, take it way Moses.

Moses: Alright, how to get off of mute there. Good morning and east on the west coast here and good afternoon my name is Moses Stites general manager with Fresno County rural transit agency. And I just want to take this opportunity to really compliment CTAA and FTA for taking on this webinar because I wish I would have attended one of these webinars back in 2016 when we started our venture, next slide please Andrew. And it is really for us the takeaways and lessons learned because we are a small rural public transit agency located in central California between San Francisco and Los Angeles.

We happen to cover approximately 6,000 square miles in our county. It seems large but quite honestly from end to end based on our fixed routes that we in the service area the longest one-way route is approximately 64 miles and that is Klinger into Fresno and the other three routes that cover the east and west southern portion of the Fresno County and approximately between 28 and 42 miles one way. We are a demand response real time dispatching in the incorporated cities in Fresno County and because we are a rural operator, we serve 13 incorporated cities, and you will see them in bold print there with the green, black dots.

And we have anywhere from 6 to 8 fixed routes that are inner city and those are coming in from the rural areas covering the east and west portions of the county and the incorporated cities depending on their population could have anywhere from one to four vehicles serving those communities again based on population and ridership. What we try to do is coordinate and integrate the services so that the demand response services within the cities can connect with an inner-city route coming into Fresno. Fresno is really the hub of the county as is Clovers they are both urbanized areas operated by small to large urban transit operators.

And the reason this map is very critical to us, when you are planning and laying out your electrification plans transition plans regardless of what point you are in you need to take into account obviously the distance, the time and travel in these rural communities. And what we have done is taken into account the millage and the time that taking into these fixed routes for the demand response routes within those cities because they require smaller vehicles, we also take into account the daily millage, hours and service and the ridership and any layover that we have or dead ahead time.

And those are all very critical in developing your transition plans because the millage and range are going to affect what? The type of vehicle one that you get but also the battery capacity, next slide please. This is FCRTAs current fleet and I will get into why we have different vendors with different vehicles but if you look at this fleet of 122 vehicles we have no diesel powered vehicles, never have in the agency and we have 44 that are powered by compressed natural gas, we have 33 that are powered by electric batteries if you look at the lineup now glow.

And this is not an advertisement pro or con this is just letting you know the type of variety of vehicles that we have and why we chose a variety of vehicles. Any time we are going to transition your entire fleet, whether it is a fleet of 5 or a fleet of 100 you want to be able to research and analyze the type of vehicles that you are going to be procuring. And rather than buying 100 of one, we double in one or two of different types of vehicles. Our venture started back in 2016 with that zean of van, if you look at that zean of van it is on a dodge chasy and at the time this zean of van first generation had a range of approximately 85 miles.

And again, if you recall the previous slide with the map and the locations it is important to us that 85 miles because that tells that it cannot go 85 miles because you have to charge it at no less than 10%. So that would mean that it really would go 65 to 70 miles because you don’t want to ever go empty on one of those battery vehicles whether it is a bus, car or a bus or sedan. And just a quick side note, when we got the first zean of van we purposely knew that it was approximately 85-mile range battery range, and I am going to be talking a lot about that range because it is important especially for rural operator and really quite honestly for any operator; urban or shadow airport anything.

But when we got the zean of van we purposely took this van, gave it to a driver with no behind the wheel training, with no history on it and just go out and drive it. The driver class B commercial licensed driver experienced gets in the vehicle, read the operating manual and knew where the on off switch was and so forth, got in the van, got on a local freeway where the speed limit here in California is 65 and 70 miles an hour and we asked the driver to go from Fresno to Carmen; Carmen is a small incorporated city 18 miles west of Fresno and the driver proceeded to go. He managed to get on the freeway, go to Carmen 18 miles out.

On the return trip back, the vehicle ran out of juice, and he ended up on the side of the freeway. So, we had to bring him in with a hook, a tow truck. So, we come back into the yard and said what happened, he goes I ran out of energy. Come to find out this vehicle has a governor on it of 55 miles per hour. Obviously when you are at high speeds the millage rating is a lot less and you have to drive them very differently than gads powered or CNG or diesel vehicles. So, it was a lesson learned but we did this controlled experiment so that we can prove that the agency not only needed a transition plan with the battery-operated vehicles but also driver training and how to maximize and utilize the existing technology in these battery-operated vehicles.

The long and short, once he was trained once he got comfortable with the van, he was able to get between 75 and 85 miles just kind of a casing point. The bus on the far right is a 40-foot propeller bus with a battery range of 156-165 miles depending on how you drive. The chivvy bull there almost next to the zean of van dead center gets approximately 256 miles on full charge and we use this particular chivvy bull for micro transit which I will talk a little bit about. That is a big transition that we are currently doing. And the BYD bus on the far left is 35-foot bus that has a range of approximately 155-165 miles as well; next slide please.

And the reason we chose the different type of busses again is we wanted to check out one, the reliability of the product; two, the reliability of their charge and three, the customer service and warranty aspects of a major capital purchase and infrastructure. Having said that we also look at the different charging units and I wanted to give you an illustrated view of the different charging type units and for all practical purposes I am just going to assume that you know what a level one, level two and level three charges are and their basically the capacity and the speed of the charging that they have for output on the vehicles.

Whether it’s a bus, commercial or a private vehicle. We are very unique in that we have solar arcs and solar trees, and these are solar powered charging units. We did that here in California approximately, well back in 2016 to 2018; we were the first county in the United States to implement these solar charging units with the help of some state funding and also the San Wakin valley art district. That is why they have two dispensers; one for the general public and one for, and this is the bottom right and bottom left charging units; the two dispensers one for general public and one for municipal vehicles or micro transit cars.

The good thing about these solar arc units is that there is no drilling, there is no environmental reporting on these and they are basically self-service and they have been in operation for the last 4-6 years and they work quite well, their level two charger so they are not a fast charger but if you are in the rural areas and you can stop in get a two hour charge, get 18-25 miles it will take you to the next location; you can stop and consume some beverages, eat your sandwich, read your book during the layover of the charge and the biggest thing too is its free.

There is no cost, there is no cost to operate it, we have these at the city halls and at the libraries and electrify America came to us and said Moses can you use an additional tenancy chargers and we said yes, so we now have 24 of these and they work out quite well, they weigh about 900 pounds. My understanding is and I have not tested them, nor do I want to, they can withstand winds of 145 miles an hour. I would not recommend that nor am I going to try that. I will take their word for it; so, they are quite unique. The other chargers BYD charger and the propeller chargers you can see the different chuck sizes and also the juice box chargers for the chivvy bull.

This is more of a home unit but we use these juice boxes for the chivvy bulls and they require different types of electrification, different type of connections so you really have to do your due diligence not only with the vendor but your local utility company and your permitting agencies so that you will be able to facilitate this without any major bleaches. So, it is really important that you do your research on not only the buses but the type of chargers, manufacturers that they are providing; next slide please and I am sorry I am taking so long. I will skip through it real quick here. This is just some of the equipment that it takes into account of what is required.

A lot of excavation work; you can see there on the bottom left some of the circuitry, some of the electrification that is required for these large scale units and it really takes a lot of hose power to put these things together not only with the permitting, the engineering and a qualified experience contractor and then you want to have ample cost funding to support the installation of these chargers and again without promoting or demoting any of these chargers. Some take less time; some take less funding and others are more costly. So, you really need to do your research in finding out which is most suitable and available to you.

So, you really have got to do a lot of research on this, and I can’t stress that enough and talk to your utility company ahead of time. Our utility company happens to be pacific gas and electric and they have been really good as far as providing technical assistance for permitting on this side of the meter and also outside of the meter as well, next slide please. I talked a little bit about the solar charging units, I think I will just skip over this Andrew; thank you. And this is the location of the solar charging units, and we are the only county in the United States state of California that has one to two solar charging units in every incorporated city in the county of Fresno.

And it is really quite a fee because we are able to utilize the solar technology. Fresno for some of you who haven’t been here gets real hot and not like Barstow but it gets really hot; we can average temperatures in the summer between 95 and 110-115. So, we probably get 256-60 good daylight days out of the year, so we really capitalize off that free energy. Next slide please. The solar tree charging units are pretty big units; they are probably $400,000; they take a lot of hose power to put these up, but they will power level two and level three chargers at ease. They are comparable to a two-storey building and you can see the building in the background there.

This is at a local park in orange county California, and we have one in Klinger as well. Next slide please. The implementation of electric vehicle and chargers this is really important that you really take note of this for your particular agency and the municipality or the venue that you are operating in or will be and these are just some highlights of some of the things that we went through so that we could try and stay up with the demand and expectations however I can’t emphasize enough about the preplanning that you really need to do and the last one is probably the most important. The grid capacity for the charging infrastructure creates challenges for installation and charging, next slide please.

And you really have to plan this out; plan, plan, plan and as a result of our inexperience and being nervous at this which I don’t think there was a lot of experience at the time in 2016 it was just a mere thought and in California the compliance regulation was going to be for 2040 to completely transition. Our goal was 2025 and we are a third of the way there, but we are still trying. One of the biggest things that I would emphasize to all of you depending on where you are at is do an electrical grid study in your location so you can analyze what the grid capacity is.

So that one; you are not draining the system there and that you are capable of being provided the power that you need to sustain the electrical charges both onsite and offsite and also an analysis of what it is going to take to provide that type of infrastructure both onsite, this side of the meter your property and offsite; next slide please. What we did is that we did a grid analysis, electrical grid analysis and it was half a million-dollar study and keep in mind that we just finished this this year 2022; remember we started in 2016. We should have done this grid analysis first but better late than never.

It was what came first you know the cart or the horse and in our case the cart came first. So this grid analysis really provided a lot of information for us and I am not going to get into a lot of detail, it is on our website ruraltransit.org if you want to download that link or you can take a look at that grid analysis and we would recommend it for any entity that is going to be taking on this venture; next slide please. Part of the capacity of this grid analysis identified the network capacity as I talked about earlier and we work hand in hand with our utility company PGNE so that we could find out what improvements, what was needed.

Because the grid analysis was going to tell us the state of the union of that grid system county wise excluding Fresno and Clovers and it was going to tell us where the weak points so that remember we are a rural provider operating in 13 incorporated cities and 39 unincorporated. So, we are going to be going out there and putting in infrastructure in the entire county. What we need to know what is out there, what is the existing condition and if any of you have filed or followed the wildfires in California PGNE is behind the 8 law right now trying to catch up so they are not going to be doing any improvements in the near future on non-fire hit areas; next slide please…

As a result of that electrical grid analysis we came to the conclusion that micro grids and resilience hubs are going to be a key component and this is going to be the next generation and we are already starting out on this because what we want to develop is some micro grids solar and storage out in the rural areas that will be able to support not only our sustainability in this transition but also the rural communities and it doesn’t have to be rural; it can be an urbanized community. So, this is a lesson learned from that grid analysis. We are currently in the process now of doing a micro grid resilience hub storage study through our planning grant from the state DOT culture here in California to the tune of about half a million dollars as well. Next slide please …

This is a modernized electric grid structure and micro grid and if you look in the upper left that is kind of an ideal situation of what a micro grid would look like in a small urbanized or small rural incorporated city. What we are looking at for the micro grid structure in resilience hub is that the one on the bottom right where how many of you have driven by schools and other locations where you see those storage units for car structures and car ports none of them have that we have seen here in California level two chargers deployed from these storage units. What we are planning on in the micro grid study is develop vacant lots put in these storage units with micro grid solar and put in level two chargers so that these could be community partials for not only electric vehicles but also community gardens.

Next slide please. These are some of the statuses I mentioned briefly about some of the studies that we are doing. It takes a lot of planning effort, we are an operating agency, we operate our system with the subcontractor, but you need to do a lot of transportation analysis and we coordinate this with our local statewide DOT county trends and also our MPO the Fresno council of governance here in San Joaquin valley. Next slide please. Some of the future projects that I have talked about the micro grid and also, we are doing some affordable housing development with private developers and also local cities to partner with them so that we can go in and get some amenities like electric buses and other transit amenities.

Because transportation is a key to all of these affordable housing projects and we are able to benefit from it as well as get potential additional ridership. Next slide please. And that’s it and I am sorry I took so long but others quite a few projects that we are doing and if you have any question I will be more and happy to answer them or you can contact Andrew and visit our website ruraltransit.org; thank you.

Andrew: Alright, thank you Moses and now I will hand it over to Tim Witten from Blacksburg transit in Virginia. So, Tim you should be able to play with the control slides from your computer; let me know if you have any trouble.

Tim: Thank you much. And I am Tim Witten, and I am the ITS and special projects manager of the … started here driving a bus 28 years ago and I started having a bus about 12 hours a week. This is one of our electric vehicles we just recently had wrap for the public to be able to figure out which one has the big battery on it. Really quick I want to talk to talk to you about Blacksburg transit. We will talk about how we ended up with battery electric buses and some of the lessons learned a little bit of vocabulary and some operational questions you will need me to answer.

So, this is a typical class day; Blacksburg transit looks like this when Virginia takes full session, so that is about 18 weeks out of the year. We are operating buses bringing folks from off campus, on campus; we service a lot of rural areas, we service the next community over with the demand response service and some public transit but a lot of what we do is getting a lot of folks to one central location that I have to tell folks it’s wonderful. We know everybody wants to go to campus or they want to go back to their apartments, and it is a nice service and makes it fairly easy to do some of the planning.

We started out in 83 that is the original trailer where we weren’t able to hold onto it but with 32 staff all part timers, we did about 95,000 passenger trips. In fact, the first couple of months after the started we had to take the old blue bird, city birds and turn all the seats to where they were facing hands so that we could have more standing capacity. Today we have 53 buses where we run 16 routes in Blacksburg two in Christiansburg, I give you a pre Covid number we carry 4.6 million in 2019. During Covid we were carrying about 500 a day; much different volume, much different nature of service; it was actually very interesting.

Folks being majority of my [0:30:17.6] to really be carrying folks who needed our service at that level was a much different experience in carrying 35 or 40,000 like we do some days. We operate out of this facility looks just like that except my cars are there and we have about 165 staff right now and we could use some more if you know anybody in the area that wants to be in the counter for bus operator. We did alternative fuel study in 2009, we had been asked to look at bio diesel Virginia was at one time very large on a couple of subsidies from bio diesel factories. The biggest issue with bio diesel is they couldn’t guarantee delivery all year round and switching from bio diesel to regular diesel is a real headache.

At the same time, we looked at CMG, LPG and hybrid. You will notice from 2009 there are two things that aren’t there, one is battery electric; in 2009 that industry was still a little new. And the other one is fuel sales and if you are in California like Moses there is a hydrogen network, there is the ability to be able to have hydrogen to get fuel sell bus. And the air part of the world in this part of Virginia hydrogen is really not an option at this point it calls to be prohibitive. As a matter of fact, CMG is very tough for us because we have a pretty low pressure for natural gases which in this area also not a whole lot of takers.

And when we did that study in 2009, we ended up with hybrid buses and hybrid buses are a very low up start cost but you are using the same fueling infrastructure, the operators don’t have a whole lot of different experience, it looks very much like what you are already doing. So, the startup costs were minimal, and we received through our funding we bought 142010 new flower hybrid electric diesel buses 620 are first articulated to their fleet and 12-foot buses and we are still operating those today.

All in all, we are very happy, but I have to say that after 3 or 4 years the improvements in the diesel engine that you saw, and transit bus got to the point where we were not beating them with our hybrids that much the difference in miles per gallon was not huge. And so, when the opportunity came up for us to apply for the bus regular mitigation grant, we applied for battery electric buses as kind of a test like Moses was talking about you don’t want to jump headfirst into something, but we went with 5. So, we bought three 35-foot buses and two 60-foot buses. For those of you who don’t have articulated they are a different animal.

They come off of different production lab, they have different battery packs, different battery controllers; you see some of this when you buy them in diesel or hybrid but it is even more expansive when you get into electric buses and I realize a lot of you all may be going … we will never get 60 foot buses, we thought about that for years but for us it’s a capacity question that get one operator can carry 114% more people. So, we got those two and we got two deeper chargers with the stenchers and then the switch gear and electrical upgrades. We are going to talk a little bit more about that because Moses hit on it. You have got to be talking to your utility now.

So, at that point we did our first week transition plan and at the end of my presentation there will be a Googling and I don’t know if that document is in there, but it will be. I have got some other reference materials in there if you are interested. We did receive a line grant for 5 more buses, an opportunity charger and a deeper charger, some more dispensers and then our FL21. So right now, we will be 41% battery electric bus and FL2025. With the funding that we have now and provider we actually see bus deliver between now and then. We are not a huge system, we maybe bending in some world but that is a big chain in thinking about how you operate buses and how you do things.

And that is where the battery electric vocabulary I want to go over comes in. where does your power come from? Moses talked about he has a much larger service area but where does your electricity for your facility, where is your electricity nearest to your stop, where is your electricity nearest to your transfer centers, where does your power come from? We don’t often think about that. When do we contact IT; I wear an IT hat and an ITS hat? No one calls me and tells me their email is working. No one calls me and tells me their phone is fine. So, like electricity we often don’t think about it till there is a problem.

There is a picture of my transformer pad, some of you may remember the book if you give the mouse a cookie they are going to ask for milk and if you have an elementary aged child, if you get a big transformer then you are going to have to have enough clear space around and level ground that you get to build a padio like this. So, this is actually called Tim’s padio; there is a nice, barbed fence around it I went out there and set after work, but I could. So, you have got to think about where your transformer is, where is your electricity coming in, what kind of effort does that cost.

And then you have got to get the power from that transformer into your building or into your facility. And Moses had some pictures of dark bank; you can kind of see there where they are pulling this pad, that’s the path of the dark bank. And on the other side there is a picture of 9,500-pound rock hammer and I keep on my best piece of rock. We took out about 6 damn tracks full of rock because I don’t know if you have noticed but a lot of transit facilities are not always built on optimal ground and when you start digging up to put things like electrical conduits then you will find a lot of rock.

So, knowing where you are and knowing where your power comes from, knowing how it gets served regarding from your transformer into your building and especially with the larger chargers, as he talked about the level three, they next thing they are going to be talking to you about is switch gear. And I use this term to give you an idea of the picture because once you start talking to the engineers, they expect you to know a level stop. And you have got to know these things before you can line up the implementation plan much less ride a procurement.

So, this is the switch gear and because of our utility we have had excellent experience working with art collection which is part of the American electric power group. In order for us to meter this separately because we wanted to keep it separate from the rest of the facility, we had to bring a 2,000 kilo volt service into the building and what that means is that I have right here I have the ability to put 10 full sized bus chargers and we already have the switch gear in place. So, listen to your engineers and make a plan to be able to figure out how far you can go and how, many chargers you can put in.

I have to say that I did give you a picture of the charger and dispenser, but they are not very interesting. The charger is just a big box that turns AC power into DC power. I think there is a movie about test [0:37:36.2] book that a dispenser is simply what connects to the bus, handles that communication hand off and delivers DC power to charge the vehicles. And one of the key things to understand this is that when this started even 5 or 6 years ago you had the charger, and the dispenser was kind of a wonder one. Now what we have is a wonder three relationship with Ps and it may be going higher to where … there is terminology changes is important.

Because we have dispensers throughout the facility but all of our chargers are located against one wall so that we can maximize the square footage and also make the job of the retainers easier as the vehicles come in. now we don’t have any but this is an opportunity charger, there is two or three pans, the big ones you see are going to be a penagraph which is a French word which means [0:38:26.8] and so that’s where the … most of them are Americans are going to be the penagraph would come down connected bus, give it a whole lot of voltage for about 5 or 7 minutes.

They are also using an inductive charging and I am assuming Utah, and this is important to at least be aware of but with either of these you have to make decisions before you buy buses. Right now, new flier does not sell a bus with an inductive charger. So, if I wanted to do an inductive charging, I would have to select a different vendor. If you don’t order the bus with pedographs and decide later, you will need opportunity charging it is a huge cost to add it. And so, thinking about how you would do charging out in the community, out away from your facility is very important because it is going to matter what equipment you put on the bus to begin with.

My favorite word is scrapage and I was not really aware of scrapage as a word till I got involved to the bus wagon money and what that means is when I bought a bus, I had to scrap the old bus and I am old bus guy, so it really tore my heart up. But we actually had to certify that the frame was cut in between the front and the rare axis which is a picture you see here on my left and that’s where they are actually using that big claw to cut. And then the other one you have to put a three-inch hole in the engine. Rather than putting a three-inch hole they just took the big claw and broke it in half.

If you look in the Google folder, I gave you can actually see a video of them doing some of this work and busting stuff up. It was actually a really fun day to watch them break buses into smaller pieces. So, what do you think about putting battery electric buses in the service? The first thing is how much do you pay for electricity? And I haven’t had a lot of chance to talk to Moses but in California there is what is called tariff an d you can see on here my tariff is 347 which is I am a public authority and that’s the rate that I pay but it does not have a separate tariff in Virginia for electric vehicle charging because I understand California does and that they would be able to budget a constant rate.

So first off how much are you paying is determined by your tariff and then you have to look at on peak versus off peak and in Virginia a lot of systems, a lot of public schools are adding electric school buses and they are planning on charging them during the day. So, they do an early run charge to a late run and the reality is that they are going to be paying a lot more for electricity than they expect because that’s on peak, during the day. You will also get into demand charges, I am not going to try to explain demand charges, it takes me like 15 or 20 minutes in a chart but basically your power bill is determined on how much electricity you have used at the peak 15 minutes in the last 90 days.

So, if everybody turns on every welder in your facility for the same time you pay for that for extra 90 days. The ability to be able to draw that much of electricity again and it is important to know that because of you fire up all of your chargers at 2 o’clock in the afternoon and do a test, you could be impacting your electrical rates for months. NTV even if you are not an urban system you may be reporting your traffic, they will want to know separately how much electricity is actually going into the vehicles. As you get into starting to study this, one of my favorite websites is EIA and that is going to tell you how much you are paying for electricity in your area compared to other places and help you do historical research.

So, what is going to impact how far your bus will run? Moses was talking to some of the things I am just talking about what size bus you get, what size battery pack, what kind of route you are on; we went through a few of those. The first one and the biggest factor we have, I love this picture; who is this young lady? This is Goldy Locs is ambient temperate. So, for us we have a problem where if it hits below 45 and we have to have a diesel accelerator heater on our buses so that we are not using electricity it is a 30% reduction in range at 30 degrees and below.

And when we get up to 80 or 90, we see where we have to run air conditioning. And so, we are looking for the Goldilocks zone; just like they talk about the planets there is an agile temperature for us. If you are somewhere where you are never going to be on the bottom end don’t add diesel heaters but if you are you need to be aware of what your ambient temperature is and how they impact on that range is wanting to be. You have to think about your route design, your log profile and think about all of that regenerative breaking. If you don’t have routes that have time built in for the operator to be able to regenerate break, you are not going to get the range that you expect.

So, there is a real job in training your operators so that they will be able to get the maximum range out of the buses. And your battery specifications, what type are they, what size are they when you go to buy a new flier there is 5 different sizes so what are your ages. And one of the questions to think about is I can’t answer your question today about range because as these battery packs age they are going to act differently. And so, this is an exercise that you just do once; you purchase a bus and run it for 10 or 12 years or 5 years, you have to constantly be aware of how much range you are going to get as the batteries age out over time.

There is my contact information, there is some information there on the Google drive and I apologize for being a little bit over; back to you Andrew.

Andrew: Not a problem. We are right on schedule actually. So, this works out great. As a reminder and as I said in the chart to feel free to ask questions in the QNA box; so, send those in if you have any; but then also as both Moses and Tim mentioned feel free to contact them after the fact as well with any question. But to start off I have lots of questions about electrification in particular. And so, to start is in your planning for this, you talked a lot about the infrastructure and but then also Moses in particular you touched on training your staff, so what considerations did you have for transitioning your work force in training them for those new vehicles?

Moses: You know that’s a very good question Andrew and I think Tim can add to this too but not only did our agency have to train the drivers and the mechanics, but the vendors come up with a week to two-week training for the mechanics and Tim tested this. When they come out the vendors to train the mechanics, they come out in these like hazmat suits when they are dealing with the electric buses because it is new technology, and everything is the electrical power it is based on the charge. As a matter of cat when we had our first bus that was damaged and it had to go to an outside vendor to a repair shop, there is a lot of precautions that your outside vendors have to take into before they even touch that body or frame otherwise there may be a fatality

This is serious business, and it is at a whole different level. So, I have to give credit to one of the vendors they all do that probably not only for safety but for efficiency. But we had to train the drivers where we develop a driver training manual to drive electric vehicles so that we can maximize the usage of the vehicles, no different than private driving. So, people like to break car speed up and things like that; I mentioned to you about that governor on that van, that affects the drivability. The generative power breaking whether there is grade in the area also the millage is affected; Tim talked about the ambient temperature and those variables.

There is also freeway usage and also local miles that are driven. The weight of these vehicles is important; it affects the local roadway system. These buses I can’t speak for the articulated Tim but our buses the 35- and 40-footer they are pushing 27,000 to 30,000 pounds. That is a lot of weight, and I don’t know how many of you know little bit about the roads and the engineering but the TCIs meaning the grade of the level that is required these buses affect the roadway systems. So, depending on the speed, the turning radiuses and what type of roads that you are on really affect the drivability, the efficiency and maximizing that battery use.

So, you really have to reengineer, rebrand your drivers because they are commercial drivers; they are class speed drivers in California, they have all of these endorsements and credentials, but you really have to give them in their mindset and some of them are afraid; oh my gosh. The technology, the site distance; you have to adjust the mirrors. I can’t tell you how many aftermarket modifications we had to make to those side mounted mirrors because wherever they are designed and whoever worked on them didn’t take into account different size drivers and their capability of reaching the peddle; different things like that. There are blind spots on some of these vehicles.

Because of some of the equipment that is used so you really have to be geared towards above and beyond your standard buses. It is just a different level, and I will stop at that. Maybe Tim can add to that too.

Tim: I think our biggest issue is we made an assumption that the regenerative breaking on these electrics will be similar to what we see on the diesel hybrid but without that transmission it is a different feel in mechanically when you are actually driving the bus and so that is one of the things we felt like we didn’t need much training for the operators it turns out that we did. The other part is yeah, you have this fast man search, you have all of this lock out procedures and I think sometimes it creates a hesitancy in the mechanics because this is a big change.

They may know what to do but they are not comfortable with it and I think that’s probably … everything takes a little longer even after the training and I think just understanding and knowing that this is a big transition, and the bus will show up I give you your training and you have got it figured out. We are just now giving these buses to where I think they would have been shipped out in about 12 months; so, all of this takes longer than you might expect.

Andrew: I am curious to see these hesitancies so also those types done the importance of working with your utility, so do you have any recommendations on how to approach or and work with your local utility and get that started?

Tim: I will go first. American electric power which covers a lot of the northeast they have a course where they actually teach you fleet electrification. I have sent two different staff members to that, it is open to public, private there is no cost. Take advantage of those types of opportunities, if it is a larger utility, they are going to have folks who work with government, and they are going to get you somebody who works with your particular account. You have to do a little bit of work with them. What I have found with AEP is they are very interested in this.

It is a little bit different environment in California and they are a little bit ahead of the curve on some of these but I will tell you that everyone that I have talked to in American electric which is based out of Columbus they have been terrific and if you run an AEP watershed and you want a contact let me know. I have been pleasantly surprised. Once you get down to actual door construction you follow everything to the job and peddle and that it is covered but that initial outreach, and I have talked to local utilities too and they are very interested and supporting this.

Moses: Just to add to Tim’s comments there, here in California we have a in my area specific gas and electric and there is also southern California Edison south of us here but more importantly is I mentioned contact in early on and be very proactive in your planning because it’s going to affect the permits that you apply for ultimately. Here in California, there is this saying that there is real slow and then there is slow, and I won’t mention which utility companies, but the rare roads are included in there, some of the other agencies but you really have to contact them early. I was fortunate enough to at one location where we put permits, I was able to get permits in 6 to 8 weeks and that was very quick.

I have heard actual horror stories where it has taken 8 to 14 months to pull a permit meaning the final permit to construct, to operate after the submittal of the drawings, the engineer plans and the analysis of the power available to the site, so it is really important and I think Tim touched on a few things about the acronyms and knowing the verbiage of this new technology because the switch gears, the transformers, the underground utilities, the overhead; all of these things he touched on inductive charging; that’s a whole different concept and Tim if you don’t mind I will add to it.

He mentioned a couple of critical points; it is going to affect the type of bus that you buy because you have to get an inverter for that bus and that inverter nowadays, I have priced a couple in the last month, and they are up at $28,000. So, all of this stuff the line items add up very, very quickly and just to add to that and I am going to close with this it is very important. We had one of our 40-foot buses that was rebranded on state wrap 99 by a 5-axle rig. Well, you know those big 5 axle rigs to trailers they can do a lot of damage. Fortunately, it was only doing 145-16 miles an hour, but you have seen those big bumpers on those tracks. They are no different in California they are just as heavy and as ugly.

And they did some damage on that 40-foot bus on the rare and it took out that entire rear bottom portion above the bumper to wrap around the two rare wheels and hopefully all of you are sitting down. The estimated cost on that rear carbonized panel was $56,000 for a piece that was 4\*8\*2 and we only needed about two thirds of it. I hit the wall, I went up the food chain of this company, this vendor and they dropped their price to $24,000 plus tax. I could have bought a digital printer and constructed this piece for 10 or $11,000. Tim is laughing because he knows it’s true, keep all of this mind because it is not just the product that you are buying.

But the post parts; the body parts all of these things $56,000 just think what you could budget in that for that. So, these are things that you want to really research and investigate and base your questions with these vendors in the RFP or the interviews to this effect what is the warranty? What is the availability of parts and also what are the cost factors on some of these parts; these are all very critical.

Andrew: Thank you, that is wild.

Moses: Wild is an understatement.

Andrew: I was trying to think of webinar appropriate words. So one last question for you two before letting you get back to work is, is there a factor or a detail or something else in beginning this planning process in embarking on this path that you have seen can kind of escape agencies they would necessarily think to think about it while they are creating their plans and what should agencies who are beginning this process make sure that they directly address from the beginning? You have touched on a lot of it but is there anything else?

Moses: I will just add one thing. I think it is a learning process for the state agencies Andrew and all I can share with you folks is that it’s a team effort and if we are going to get to the finish line we all have to be on the same page wearing the same uniform and we all have to be driven with the same objective and that is to finish this transition. And it’s a learning curve for the state DOTs and you have to have a willing partner and we are all learning through it regardless of Tim’s experience or my experience and the key is the takeaways we learn from all of this. Tim would do things different.

I would do things differently and I think the vendors will do something differently as well. and I think what you are going to see is we need to be resilient and open to new technology in battery swap outs. I am trying to work here with vendors in California to little result of a battery exchange where if we have an outdated bus that outdated meaning 3 or 4 years that the technology was 156 mile range I want to be able to trade that in for 60, 80, 90,000 get a new battery that is more efficient and sustainable with a 300 mile range. They can recycle, recirculate, refurbish that old battery as a battery back.

We need to be open to this technology and these ideas so that we can all advance and then we don’t have to replace that three quarter of a million-dollar carbon fiber bus; just replace and upgrade the battery pack. So, we all have to be open to this type of, in my opinion, acceptance of new technology and new concepts. Tim: Some of what I said is going to arc what Moses said but I think we make about, and I think about transit buses because I am a transit operator. We make less than 10,000 in transit buses a year and less than 10% of those are electric it’s probably close to 5% or less. I think right now there is only about less than 1000 battery electric buses in service in America.

So, whether you chose battery, electric or some other technology is realized that comparing that to using diesel buses for the last 100 years give or it it’s a really new technology. And so throughout that entire supply chain so it is whether you are buying electricity or buying a bus or refurbishing a charger that a lot of this is new and I think my biggest is that flexibility. I made an assumption going in that a new flier bus that looked like a diesel bus was as mature as the technology as the diesel bus and I have learned again and again that this technology is not quite as mature as you would expect.

There are standards, there are processes, but we are still learning a lot and I don’t think I am on the bleeding edge, but I am close. So, realize as we get more of us in zero emission vehicles or battery or electric or anything else we are all going to get better at it. First thing thinking transit we really have a local government in general we have a real failure and I think here we have to understand we are going to have days that we are going to swap buses because it dropped 30 degrees. I had a day two weeks ago it dropped 30 degrees and I had to swap buses out and we just deal with it and move on.

We will figure it out, we will get better at this but right now don’t be afraid to say hey I don’t know and that’s the other thing. A lot of the times we are the experts in our building; we know about buses; we know about technology. One of our role is don’t be afraid to say, I don’t have a clue. Know your utilities, build your network, know who to talk to, make sure those things are going to be really important because you are going to hit obstacles that you didn’t expect just as we hit 45 feet of rock.

Andrew: Excellent, well thank you both very much for your time. I learned a lot and thoroughly enjoyed this so I hope everyone else who listened to it again will listen to the recording in future will as well. So, with that thank you again and everyone feel free to reach out to any of us with any questions that you have, and we are happy to answer them or point you to the right sources. So have a lovely day and we will be in touch and then also you can check out our website for these slides and for this recording and eventually the transcript in a few days at n-catt.org; so thanks Tim and thanks Moses.

Tim: Thank you

Moses: Thank you all.