

**Brian:** Hello everyone, and welcome to Episode 66 of the HydrogenNowCast for November 25, 2022. The HydrogenNowCast is sponsored by [New Day Hydrogen](https://www.newdayhydrogen.com), who's helping fleet owners meet their zero-emission vehicle needs. If you're with a fleet or a transit operator, and your fleet is wondering how to convert to zero emission vehicles but still meet your operational needs, New Day Hydrogen can give you the option of fuel cell vehicles by providing public hydrogen fuel stations near you and showing you the available fuel cell trucks, vans and buses. So to find out more information about both the vehicles and fueling, visit the [newdayhydrogen.com](https://www.newdayhydrogen.com) website where you can also submit requests on the contact page.

Well, fleets around the country are turning their attention to this transition to zero emission vehicles, and here they face a choice between Battery EVs and Fuel Cell EVs. And as you can imagine, the choice needs to be based on tradeoffs between infrastructure cost, operating cost, and performance. So I thought it be really helpful to our fleet listeners to interview a fleet that has real-world experience and data around this decision, and hear of their experience. So I'm very pleased to introduce Salvador Llamas, who's the chief operating officer with AC Transit in Oakland, California. Sal, welcome to the show!

**Sal Llamas:** Hi Brian, thank you very much for having me on the show. I'm really excited to be on the HydrogenNowCast and share all the experience that AC Transit has been benefiting for the past 20 years.

**Brian:** Well, thanks Sal. We really appreciate your time to be with us today. And I'm really interested to get this information out because I think it will be helpful to so many people. So Sal, as the first help orient us, would you give us an overview of AC Transit – things like fleet size, the size of the service area and the terrain and the climate?

**Sal Llamas:** Absolutely, Brian. AC transit is located in northern California in the San Francisco Bay area. We operate public transit service to approximately 1.5 million people on the west side of Alameda and Contra Costa Counties. We're governed by seven publicly elected board members, which is very similar to Colorado and Denver, Colorado RTD, and also here at BART in the Bay area, and their direct representatives to the community.

Our service area spans about 364 sq mi. We have seven facilities throughout our service area. There are four operating divisions, a central maintenance facility that also doubles as our central warehouse, and that's where we do our heavy repair. We have a training education center where all our frontline employees go through their initial training before they are assigned a property or a facility to work at. And in downtown Oakland, we have our general headquarters building.

We have 637 public transit buses that we operate in our fleet. 43 are zero-emission buses consisting of 36 hydrogen fuel cell buses and 7 battery electric buses. We're receiving 21 more battery electric buses this year, which will total the zero-emission bus fleet to 64 buses by the end of 2022.

We provide approximately 16.7 million annual service miles. Our ridership currently is about 2.1 million per year. We average on a weekday approximately 100,000 to 110,000 riders, and currently we're providing 128 lines. Pre-pandemic, we were at about 158, and we're slowly starting to go through the process to build back and add our service. One thing that's unique about AC Transit is we're a regional connector. We connect to 60 other transit agencies in the area, 23 heavy rail stations, six Amtrak stations, three ferry stations, and we have 66 local routes and we provide 44 school service routes, 18 that are trans-bay that go across three other bridges that connect the east bay over to the peninsula and San Francisco area. And we also operate six lines that we call All Lines. They run 24/7.

Our climate is very moderate compared to Colorado and other regions of the country. The coldest temperature that I think we've ever experienced is probably around 38 degrees as an extreme, and it does get hot sometimes. We have heat waves throughout the year. We've had some that reached as high as 110 degrees.

**Brian:** All right, well thanks, Sal. I had no idea that AC transit was that big, and I think that speaks well for a sample size as we think about using AC transit's experience as examples for other transit agencies.

So I know that you mentioned the battery and the fuel cell buses that you have, and I understand you've had these for quite a while. How long have you been using both the battery and the fuel cell buses?

**Sal Llamas:** Yes, well, our experience with zero emission buses in general started way back in the early 2000's where the California Air Resources Board (CARB) enacted a fleet Rule that required any public transit agency that had a fleet of 200 buses or more to either choose an alternative fuel path or to demonstrate a hydrogen fuel cell bus technology. Primarily because, during that time, the lithium-ion battery technology had not been developed enough to be able to propel a heavy 40-foot public transit vehicle.

In southern California, a lot of the transit agencies went down the path of testing methanol liquid, natural gas, and eventually compressed natural gas which became the primary fuel source. I happen to have worked at Los Angeles County transportation authority, LA Metro, during that time, and I was there during that transition. In northern California, specifically in the bay area, the transit agencies decided to demonstrate hydrogen, and AC transit started with a 30-foot Thor bus as a bus that we borrowed to learn the technology. Then in 2006, we purchased our first three hydrogen fuel cell buses and put those in service. They're the first-generation buses. We learned a lot from the design and the performance of those vehicles. In 2010, we purchased a larger fleet of 13 buses. Six of those buses are still in service today. Then we received a federal grant to purchase battery electric buses in 2017. That was our first attempt at learning the battery electric technology. And at the same time, we received a state grant to buy ten more hydrogen fuel cell buses with the newest and latest technology. And so that's where we had the idea of starting to run both buses side by side, because just the timing was perfect. The procurement process allowed for both fleets to arrive in the same year. So this is a fantastic opportunity for us.

**Brian:** Excellent. Well, thank you, Sal. As our listeners around the world may know, California is pretty progressive as far as trying to really decarbonize transportation – with the hydrogen fuel stations that are out there, as well as just mandating that a certain number of vehicles be zero emission by a certain date. And I understand that AC Transit intends to transition to 100% zero emission vehicles by 2040. And I know that to help inform that transition, AC Transit recently completed an analysis regarding the comparison between battery and fuel cell buses, and that was titled "[Zero Emission Transit Bus Technology Analysis](#)". I understand this is considered one of the best publicly available sources of a comparison between battery and fuel cell electric buses. Could you give us a brief overview of what that study really set out to do and what the study's intended to be used for?

**Sal Llamas:** Absolutely, Brian. This is where I get really excited. So, as I mentioned, we just had this opportunity that, frankly was not planned to be that way. But when we realized we had five battery electric buses, it was our first time to operate. Then we knew nothing about operating a battery electric bus. We knew a lot about hydrogen. So we decided to establish a control fleet. And initially the thought was to have the battery buses and the five fuel cell buses run along the same routes utilizing the same operators out of the same facility. And the best part was, both buses were built by [New Flyer](#), the same manufacturer in the same operating environment. And once we realized that, we established the back-end process to collect the data and what type of matrix is we're going to monitor and keep performance indicators, we realized, why don't we compare those zero mission buses to the other fleets that we have? So we added a five diesel buses, five diesel-hybrid buses, and then we also added what we call the five legacy fuel cell buses, which are the original fuel cell bus fleet that we've been operating in since 2010.

The difference between that fleet and the new fuel cell fleet is on the older fleet, the legacy, the battery is very small, about 25 kilowatt hours, and the fuel cell provides direct power to the traction

motors. So it's what we consider a fuel cell dominant vehicle where the new design from New Flyer has a larger battery and a smaller fuel cell, and the fuel cell acts as a recharger to the battery while the bus is in service. So we thought it was going to be very neat to see the difference between the design of both technologies. So now we have this very comprehensive report that is collecting performance data, cost data, reliability, and we're able to see true side by side comparison that at a level that has not been done before in the United States.

**Brian:** Interesting. So you couldn't have hardly designed a better set of circumstances for a study. So based on this study, maybe you could walk us through the decision-making process at AC Transit regarding where you think you want to go in the future with your mix of battery and fuel cell buses.

**Sal Llamas:** Yes, that's a fantastic question because we absolutely have learned a tremendous amount since we initiated the study. So just to give you a little historical reference, part of the California Air Resources Board Innovative Clean Transit Regulation, we had to prepare and provide a board approved zero mission transition plan. We did that plan and started the process, developed that plan in 2017, we finalized it in 2018, and at the time we were estimating to have 70% / 30% mix of zero mission buses across the district. 70% was going to be battery electric buses and 30% were going to be hydrogen fuel cell buses primarily because at that time the only experience we had was with hydrogen. And we knew a lot of the limitations that hydrogen had. Most of it was just the cost of the fuel, the cost of the maintenance of the stations themselves. There were not a lot of hydrogen vehicles available on the market back then, so we were favoring battery.

Well, fast forward a couple of years later and once we started to realize that there are also some very incredible challenges with battery electric bus technology. We wrote a new zero-emission bus transition plan a year ago and now we flipped it. So now we are definitely intending to deploy. 70% of our fleet will be hydrogen fuel cell buses and 30% of our bus fleet will be battery electric buses.

So it has definitely opened our eyes to be able to look a little beyond just what's available in the market. We're looking at reliability, we're looking at the feasibility of the technology to operate the service levels that we need to operate. We made some commitments early on that we were going to use our guiding principles. And the guiding principles is that we're going to replace the bus fleet per transit asset management plan, meaning that we're not going to operate them any longer than the useful life and try to replace them at those intervals. The second part of that is that we were going to purchase zero emission buses that are able to deliver the service levels that we have for our riders, understanding that AC Transit exists to serve the public and our communities with the needs that they have, and mobility needs that they have, throughout the region. And then the next guiding principle is to purchase the vehicle that is most cost effective to operate. And so because of those guiding principles, we were able to start to make decisions a little clearer using the data from the study.

**Brian:** Interesting. So it started out 30% fuel cell, 70% battery, and then based on your experience and data and everything else, it switched to 30% battery and 70% fuel cell. So what are you seeing as the biggest benefits of the fuel cell buses over the diesel or battery electric buses?

**Sal Llamas:** Yeah, great question, Brian. What stands out the most is having the ability to maintain control over not only just the deployment of the vehicles to serve the routes, but also the entire process, the procurement and the design and purchase of the infrastructure itself.

So I'll give you an example. Right now, in order for me to increase my battery fleet, I have to add chargers and I have to add infrastructure. I have to time the construction of the infrastructure with the buses themselves. And that was the challenge we had with the battery buses. We had buses on property, but the infrastructure wasn't completed primarily because our utility company delayed their part. So that was a very serious challenge we had on our hands. On the hydrogen side, I can build a hydrogen dealing station that can fuel 200 buses in a ten-hour window from 06:00 PM To 04:00 AM for about \$10 to \$14 million. You build it once and then you order as much fuel as you need as we start to grow the fleet. So I no longer have to do construction anymore, and we just start

to procure buses at the asset management intervals required like we do today with the conventional fuel fleet. So that is a huge benefit when it comes to programming capital dollars and operating expenses. And then the other benefit is on a hydrogen fuel cell bus, I can fuel one bus in six to eight minutes with about 30 to 35 kg, and that bus will run 300 miles without a problem. And we've proven that with our data. Where, on the battery side, it's going to take anywhere from 3 to 4 hours to reenergize a battery bus. And that bus, at best, it'll run about 170 to 200 miles, and then I have to bring it back and charge it again. So that adds a complexity to our operating mode that we just can't have a large fleet that has to go through that process.

**Brian:** Well, thanks, Sal. We started out the podcast talking about providing advice from your experience to other fleets. And maybe at this point, do you have some lessons learned or other advice that you'd like to put out to your transit agency peers and other fleets that are looking to transition to zero emissions.

**Sal Llamas:** Yes, Brian. The best advice I can give to everybody right off the front is it's okay to be nervous, it's okay to be even afraid, but don't let that create a freeze on wanting to move towards clean zero emission technology, and specifically hydrogen technology. There's a lot of myths out there that we frankly have just demystified. Hydrogen technology is here, it's available, it can scale up as large as you want it to scale up. We've proven that technology with our hydrogen fuel station designs.

And also I just want the peer agencies to understand, to take your time, to understand the profile, the operating profile of your organization. What are the routes, what are the blocks, how long are they out there, what is the topography, the weather, those kind of conditions so that you can understand what's going to be the demand of that vehicle when you're deploying a vehicle to serve your customers. And then do a lot of early planning, get consultants to help you attend conferences, listen to podcasts like HydrogenNowCast so you can become more familiar with some of the lessons learned, like the ones that AC Transit has experienced in others of your guests. I also noticed that on episode three, you had the episode, and NRL, the National Renewable Energy Laboratory, did the study for us with our initial hydrogen fuel cell demonstration. It's a zero emission Bay Area advanced demonstration. It's on their website. They did a study for almost 15 years. There's a lot of incredible data there on the initial challenges and the unknowns that we have. So that's a good resource. So plan ahead.

I would also advise transit agencies to have guiding principles do that early on. That has helped us when we as staff and even staff, soliciting support from board members. When we were not all in agreement, we reverted back to our guiding principles. And the guiding principles helped us make the decision because we had some established early on what was going to be ultimately our goal.

**Brian:** Well, thanks Sal. This is just such helpful and useful information to fleets out there. And I'm sure this podcast will live on for a number of months and years and people can refer to it.

So, listeners, I've been talking with Salvador Llamas or Sal, who's the chief operations officer with AC Transit in Oakland, California. And AC transit's website is simple. It's just [actransit.org](http://actransit.org). But Sal, if listeners do want to try to reach out and contact you, what's the best way to do that?

**Sal Llamas:** The best way to contact me would be through an email. If the listeners would like to send me an email at [sllamas@actransit.org](mailto:sllamas@actransit.org).

**Brian:** Okay. Thanks, Sal. Well, is there anything that I haven't asked you about that you'd like to mention?

**Sal Llamas:** Yes, the only thing I would like to mention is to definitely look at the resources that are available at the state level and the local level. Certainly, government funding is a resource, but we've been very fortunate to have a grants department that has been very creative and innovative at stacking and bundling funding sources through our air districts and other sources to help us finance their emissions bus deployment, because it is going to be above and beyond what conventional fleets cost. But what I do like to share with folks is the cost is really not, and should not be, the

barrier because the benefit to communities, the benefit to the environment, and the benefits that are yet to be realized which are definitely priceless. We can't even put a price on that. And knowing that we're making a difference in the early stages when there's gaining momentum and there's definitely a dire need to make a difference, to me, that just speaks volumes to take action.

**Brian:** All right, well, thank you again, Sal, for your time to be with us today. I know you're a very busy guy, with a lot of responsibility, but I'm sure that your experience is going to be helpful for other fleets around the world that are considering acquiring zero-emission vehicles.

**Sal Llamas:** Yes, absolutely. And thank you very much for having me here today, and I want to thank all your listeners as well, and I wish you all the best.

**Brian:** All right, well, thanks again, Sal.

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And once again, we'd like to thank New Day Hydrogen for sponsoring the hydrogen now cast. New Day Hydrogen is working to build out and deploy hydrogen infrastructure to enable any of us to convert to zero emission vehicles.

And lastly, if you'd like to contact me, I always love to hear from you and you can reach me either through the website at [colorado-hydrogen.org](http://colorado-hydrogen.org) or on LinkedIn. So until next time, this is Brian DeBruine wishing you health and prosperity. Goodbye.