ACT Workgroup Meeting Summary

Monday, August 29, 2016

Cal/EPA Headquarters, Sacramento, California

Attendees

Following is the list of workgroup members who participated in the meeting in person or identified themselves via telephone or email during the meeting.

#	Name	Organization
1	Abas Goodarzi	US Hybrid Corporation
2	Alan Abbs	CAPCOA (California Air Pollution Control Officers Association)
3	Anthony Poggi	ARB
4	Bernie Kotlier	Labor Management Cooperation Committee (LMCC)
5	Bill Habibe	Orange County Transportation Authority
6	Brandon Bullock	Orange County Transportation Authority
7	Charlie Ker	Cummins Westport Inc.
8	Chris Young	Cummins Pacific
9	Daljit Bawa	Ballard Power Systems
10	Dana Lowell	Ramboll/Environ
11	Danielle Chambers	ARB
12	David Renschler	City of Fairfield
13	David Warren	New Flyer of America
14	Donna DeMartino	San Joaquin Regional Transit District
15	Eileen Wenger Tutt	California Electric Transportation Coalition
16	Fang Yan	ARB
17	Fred Silver	CALSTART
18	Hannah Goldsmith	California Electric Transportation Coalition
19	Jack Kitowski	ARB
20	Jaimie Levin	Center for Transportation and the Environment
21	James Pachan	Alameda-Contra Costa Transit District
22	Jeff Grant	Zen Clean Energy Solutions
23	Jennifer Lee	ARB
24	Jessica Johnson	ARB
25	Jesus Montes	Los Angeles County Metropolitan Transportation Authority
26	Jimmy O'Dea	Union of Concerned Scientists
27	Jing Guo	ARB
28	Jing Yuan	ARB
29	Jordan Ramalingam	ARB

30	Joseph Policarpio	Gillig
31	Katherine Garrison	ARB
32	Kaylin Huang	ARB
33	Kent Leacock	Proterra
34	Lauren Skiver	SunLine Transit Agency
35	Len Engel	Antelope Valley Transit Authority
36	Leslie Goodbody	ARB
37	Marty Mellera	San Francisco Municipal Transportation Agency
38	Mathew Williams	ARB
39	Michael Masquelier	Wireless Advanced Vehicle Electrification (WAVE)
40	Michael Pimentel	California Transit Association
41	Mona Babauta	Solano County Transit
42	Naveen Berry	South Coast Air Quality Management District
43	Paul Arneja	ARB
44	Ray Pingle	Sierra Club California
45	Rick Ramacier	Vice Chair of Transit Agency Subcommittee / Central Contra Costa Transit Authority
46	Ron Zirges	Victor Valley Transit Authority
47	Sam Wade	ARB
48	Shirin Barfjani	ARB
49	Shrayas Jatkar	Coalition for Clean Air
50	Steve Miller	Golden Gate Transit
51	Steve Otten	ARB
52	Steve Schupak	Los Angeles County Metropolitan Transportation Authority
53	Tim Carmichael	Southern California Gas Company
54	Todd Campbell	Clean Energy
55	Tony Brasil	ARB
56	Yachun Chow	ARB
57	Zach Kahn	BYD Bus & Coach

This was the third meeting of the Advanced Clean Transit Workgroup. This meeting was webcast and recorded. The detailed agenda, meeting materials, and video recording for this meeting are available at http://www.arb.ca.gov/msprog/bus/actmeetings.htm. The following were the primary agenda items for the meeting:

- Update on previous action items
  - Summary of life cycle cost model subgroup meeting
- Cost Update
  - Literature review of bus maintenance costs
  - Literature review of battery cost and projections for heavy duty vehicles

    - How LCFS credits change over time
    - Electric Bus Charging Cost Calculator
- Summary of transit fleet survey results
- Selection of individual transit agencies for cost analysis case studies
- Action items
- Topics for next meeting

The following is a brief meeting summary that highlights the major items discussed, comments about meeting materials, and agreed upon action items. The webcast recording of the meeting is available at https://www.arb.ca.gov/msprog/bus/actmeetings.htm for parties interested in additional details.

Previous action items and life cycle cost model

Steve Miller, lead of the cost subgroup, briefed the Workgroup members on the subgroup meeting that took place on August 23rd in Sacramento about life cycle cost model assumptions.

- ARB staff compared the results of its model with the fleet costs model developed by Steve Miller and confirmed the results are essentially the same when the same assumptions are used.
- ARB's model must use constant dollars for a number of reasons, but the results can be converted to nominal dollars for interested parties.
- Subgroup members would like to see ARB's cost model despite having had discussions with ARB on model assumptions, input, and results range. It is also suggested that some transit agencies with experience of operating zero emission buses test the model.
- Members of the subgroup are now developing their own statewide cost model and going to share it with ARB and public soon.
- Subgroup members and ARB staff have agreed on many input assumptions, but have not settled on how to project battery electric bus prices and some other key inputs.
- ARB staff is seeking comments on posted materials to identify areas where there are concerns or if further work is needed. ARB will continue to reach out to transit agencies and will continue to modify the ARB cost model to a more user friendly format.
- Members will provide additional comments to ARB staff on the electric bus charging calculator. ARB will update the calculator to include multiple rate schedules including the SCE-TOU8 and will make the battery electric bus energy consumption input default to 2.1 kW/mile and will make it a variable that is easy to modify.
- Members commented that ARB should provide a better description for assumptions used in the cost model.

LCFS Credits Change Over Time

ARB staff released a discussion paper about how earned Low Carbon Fuel Standard (LCFS) credits change over time (https://www.arb.ca.gov/msprog/bus/lcfs.pdf). Sam Wade, Chief of the LCFS program participated in the meeting to answer any questions about the program:

Major areas of concern were reliability, life span of LCFS program, and where it should be considered in ARB's cost model:

- Stakeholders raised concerns whether the LCFS regulation would be around after 2020 or 2030. ARB stated that without further board action, LCFS will continue at the 2020 level for perpetuity. ARB clarified that LCFS is not connected to the Cap and Trade program.
- Should the LCFS credit revenue be included in the operating cost (fuel price) or as a separate item (funding) because of the uncertainty of LCFS after 2020? ARB staff commented that it doesn't matter whether or not the LCFS credit revenue is treated as part of operating costs or categorized as funding by transit fleets, but the analysis needs to be consistent for all fuel types. The value of LCFS credits for RNG and renewable diesel typically goes to the fuel producer and is reflected in the final price to transit fleets and may be difficult to separate. Transit fleets in the cost subgroup members plan to include LCFS credits on the funding side in their new model.
- ARB is required to consider the current approved regulations, such as LCFS and its longevity beyond 2020, as a baseline when doing official economic analysis and calculation of the emissions reduction impacts of a regulation.
- If the LCFS is put on the expense side and goes away for any reason, a requirement to use renewable fuels or electricity could significantly increase fuel costs. Would the regulation consider this as an off-ramp option? This is an area for further discussion.
- The LCFS program provides credits to incentivize entities that can help deploy the use of low carbon fuels for transportation, and LCFS program staff is currently in the process of considering amendments to clarify the point of crediting for hydrogen.[1]
- Under the LCFS program, renewable natural gas (RNG) providers are the first inline to generate credits. Because of the benefits of this program, as well as Renewable Fuel Standard (RFS), renewable fuels can currently be produced and offered at the same price of fossil fuels or even lower. There was some discussion whether the combination of the state and federal credits made the renewable fuel market lucrative for producers of RNG. Clean Energy stated that the program just makes renewable fuel economically viable for them.
- San Diego Airport Parking has some medium duty (MD) shuttle buses and commented there should be an EER for MD zero emission vehicles that is more similar to the EER for transit buses which is higher than the EER for the truck category.

Bus Maintenance Costs

ARB staff provided a short summary of a discussion paper that was a literature review of published studies that included information about maintenance costs for transit buses with electric drivetrains (https://www.arb.ca.gov/msprog/bus/maintenance_cost.pdf). The goal was to determine what conclusions could be made from empirical data about maintenance cost for zero emission buses compared to conventional buses. The discussion document included the review of seven studies including:

- King County (KC) Metro Transit diesel hybrid buses compared to diesel buses
- New York City Transit (NYCT) diesel hybrid buses compared to CNG buses

[1] Point of crediting for different fuels was previously discussed in Low Carbon Fuel Standard Overview Meeting on April 7, 2016 (https://www.arb.ca.gov/msprog/bus/04072016.pdf)

- Alameda-Contra Costa Transit (AC Transit) fuel cell electric buses compared to its diesel buses
- SunLine Transit fuel cell electric buses compared to CNG buses
- British Columbia Electric Railway (BC Transit) fuel cell electric buses compared to diesel buses
- Electric Trolleybuses for the LACMTA'S Bus System study conducted by LA Metro
- Stanford University independent study for its slow-charging battery electric buses

From these studies, staff summarized the following observations:

1. Propulsion plus brake maintenance costs for conventional buses are about 45 to 50 percent of total maintenance costs at the mid-life of a conventional bus.
2. Empirical data from these studies shows at least $0.19 per mile savings for an electric drive bus compared to a typical bus that travels 40,000 miles per year with an average speed of 12 miles per hour. The savings doesn't reflect any costs for mid-life repairs nor unplanned maintenance items.
3. The results are consistent with manufacturer estimated savings for battery electric buses that are on the order of $0.25 per mile for the full life of the bus.
4. The LACMTA report on trolley buses compared to conventional buses supports a savings estimate of 30 to 40 percent compared to a conventional bus (or about $0.27 to $0.37 per mile).
5. Midlife engine overhauls, battery replacements or fuel cell replacements are additive to the costs from the studies evaluated in this paper.
6. Brake wear and brake maintenance costs are higher for slow speed cycles compared to higher speed cycles
7. Preventative maintenance inspection (PMI) costs have no clear pattern of cost between technologies and differences in the studies suggests they are not significant.

Electric drive system cost savings from these studies are expected to be a lower bound estimate, because they do not reflect expected higher repairs for engine component failures that are expected later in the life of the bus (turbos, hoses, belts…) whether included in planned maintenance or unscheduled maintenance. ARB will continue to work with fleets on collecting additional data and will continue to refine the cost analysis as new information becomes available.

Following comments were expressed during the Workgroup meeting. These comments are grouped together as manufacturers, transit agencies operating BEB, and other stakeholders' comments:

- Gillig mentioned ranges between brake jobs and maintenance costs vary greatly between different agencies. Retarders should also lower brake wear on conventional buses and a larger data set should be evaluated. Gillig will provide additional data on maintenance costs comparisons for different technology buses.
- Transit agencies currently operating zero emission buses:
  - SJRTD– Proterra maintains BEB on-site. SJRTD has not yet realized any specific difference in preventative maintenance costs of different technologies.
  - AVTA –There is a learning curve associated with operating and maintaining BEBs. Therefore maintenance costs are expected to be higher at the beginning, but will go down further as fleets

become more familiar with new technology. Preventive maintenance inspection costs of BEBs are pretty close to conventional buses.
    - LA Metro: Doesn't have enough data at this time to generalize their results.
- Comments from other stakeholders:
    - A $0.12/mile saving because of regenerative braking is optimistic. Retarder in brake system of conventional buses extends the brake life. Therefore, there should not be a significant brake job saving for BEB and hybrid buses compared to conventional buses with retarders. NY Transit is an example that was cited. (The NREL studies what were evaluated by ARB included NY transit buses).
    - Maintenance cost saving would be significant in long term or after 3-5 years, not much at the beginning of deployment.
    - Foothill BEB and CNG routes are different; therefore, maintenance needs between BEB and CNG are different. (The average speed of the CNG buses was about twice the average speed of BEBs.)
    - Driver training plays a big role in fuel consumption and maintenance costs. Drivers can make 25% difference in fuel consumption.
    - The motors in trolley buses and transit buses are different. Maintenance cost between trolley buses and transit buses cannot be compared. The trolley fleet is the most maintenance intensive fleet in the SFMTA. Muni commented that SFMTA trollies represent the worst case scenario of relatively unique buses, because the manufacturer (ETI) was a new niche manufacturer at the time and trollies were required to operate in an extreme duty cycle. SFMTA added rather than a theoretical, warranty/vendor/on-site supported small or demonstration fleet buses, SFMTA can attest to the real world maintenance challenges associated with a unique vehicle mode, and little or no vendor support[2], the requirements to match diesel-like performance, and all the higher costs associated with such an "oddball" fleet. That is where BEBs and FCEBs are today. That will change in time, once ZEBs reach a total volume closer to diesel or hybrids, or even CNG.
    - Battery warranty was discussed briefly. Proterra and BYD provide standard blanket warranties.
    - There might be some maintenance cost saving associated with ZEB technologies in long-term, but in short-term because of some technology issues for new bus manufacturers, such as structural design, new software, component and hardware issues, in terms of battery management system, the maintenance costs are going to be significantly higher than conventional technologies. As an example, Altoona tests show more repair hours for some BEBs.
    - According to Proterra, most of the repair hours from the Altoona tests for the Proterra bus was predominantly because the test center was not equipped to repair the composite material of the bus. Most of the hours listed as repair time was actually travel time to a facility that was equipped to make the repair. In addition, the issue has been resolved and has not reoccurred in any fleet bus to date.
    - Steve Miller believes it is true that we should not expect significant difference in preventative maintenance costs, but corrective maintenance is the heavy weight to lift and suggested to continue working on it.

[2] Various SFMTA trolley bus manufacturers went out of business.

- To address the comment in respect to Altoona tests, OEMs of battery electric buses refuted comments that the technology was in its infancy. Various bus specific issues for models that are newly being manufactured in the U.S. and were identified in the tests are already resolved and are no longer an issue. Buses that are currently going through Altoona testing are more representative of the buses that are being manufactured today.
- There was a suggestion to illustrate the cost saving in percentage rather than a fixed dollar per mile amount.

- ARB recognizes there are differences among manufactures, including experience of building buses in the U.S. but emphasized that the O&M cost for electric drive systems should be looked at from a long-term perspective since the timeline we are discussing goes out to 2040. Multiple OEM's have electric drive systems as options for existing bus platforms and there are no other substantive differences with the buses other than the drive train. ARB staff also added once we can narrow the range of costs, then we can calculate the total costs of any scenario to understand the appropriate role of funding and consider risks for early actors.

Battery Cost and Vehicle Price Projections

Staff also conducted a literature review on battery costs for heavy-duty electric vehicles (https://www.arb.ca.gov/msprog/bus/battery_cost.pdf). Battery is the most significant cost component for a battery electric vehicle (BEV). The cost of battery could affect both the battery electric bus's price and their midlife overhaul cost.

Staff reviewed 7 studies and talked with several industry experts to identify the followings:

1. Three types of batteries -lithium iron phosphate (LFP), lithium titanate (LTO), and lithium-manganese-cobalt-oxide (NMC)- show promise in the application of medium duty (MD)- and heavy duty (HD) vehicles due to the strengths of long life span, high power and/or energy specific, and high safety performance.
2. Studies show that battery costs for (Light duty) LD BEVs has been declining rapidly during the last 10 years, and similar trends are expected for heavy-duty batteries especially with their increasing deployment. Staff aggregate cost estimates for LFP and NMC together, and their cost medians decline from $720/kWh in 2015 to the ballpark of $400/kWh in 2020 and to $220/kWh in 2030. By using these median values, a 324 kWh battery that is used in a bus that charges at a depot could have a price decrease of about $100,000 between 2016 and 2020 and is expected to decline further in price by 2030.

In summary, there is a clear expectation that the trend in battery price reductions for heavy duty applications will continue for the foreseeable future. The median of the expected battery price reductions are within the ballpark of bus price reduction projections from Proterra and the battery cost reduction estimate from BYD. Lower battery costs per kWh are expected to result in significantly lower battery electric bus prices, longer range (for the same battery pack volume), or both depending on market factors. Although midlife battery replacements are not expected for some buses, battery cost reductions are also expected to lower the cost for midlife battery replacements, if needed. Highlights of comments received at the Workgroup meeting include:

- There were two major points of views from bus OEMs: One view is that higher incremental costs for BEBs will continue to decline until they become comparable in cost to conventional buses, and then will increase like other buses. The other view point is that lower battery prices and higher battery

energy density will not result in lower BEB prices because customers will demand higher range buses with higher capacity batteries.

- Bus prices have been increasing faster than inflation because of requirements for increased safety features and equipment on buses and this trend will continue for the foreseeable future.
- Note that both Gillig and New Flyer, who have been in the bus market for long and fully utilized their production facilities, believe that BEB prices will not decline due to continued improved features equipped on the vehicles. BYD and Proterra, who are new entrants to the bus market and have not yet fully utilized their production facilities, believe that BEB price will continue to decline to a point due to battery cost deduction and volume increase.
- Proterra refuted that their buses are not made in large volume yet and there are volume and manufacture maturity savings yet to be realized on both the battery and the bus. And also added Proterra has contractual evidence of price de-escalation with battery energy density increase. Based on contractual evidence, Proterra states they can claim the price of buses will not increase in foreseeable future of 15-20 years although the battery capacity will increase.
- Steve Miller referred to OEMs two different points of view on future BEB price projection. According to him there is a disconnection there. This issue has to be resolved before putting it into the cost model. ARB tried to recap the discussion by acknowledging that the varied points are consistent but are dependent on how bus range might change. On one hand, bus prices would continue to decrease if we assume the bus daily mileage range remains the same. However, if manufacturers use the battery price reductions to increase the range for buses, then the lower battery cost per kWh may translate into the total battery price and bus price remaining nearly the same or potentially increasing. The issue partly depends on what daily ranges transit fleets need for a depot charging strategy and the timing of when the purchase would be made. At the beginning of a zero emission bus deployment many transit fleets could deploy existing buses for shorter routes (or blocks) and later incorporate longer range buses as the fleet expands. Ultimately, battery electric bus price projections and range assumptions are dependent on each other and need to be considered together.
- Gillig mentioned inflation on the glider still needs to be included. Gillig is going to provide detailed bus component price breakdown for the group to look at price curve more closely.
- ARB staff added although current battery electric bus range works for a significant number of transit buses, there are still needs for higher ranges for service with higher daily mileage needs. Longer range buses will eventually be needed and larger batteries (higher capacity) would be needed for nightly depot charging strategies. ARB reminded the group that any proposal that is put forward would not require transit agencies to purchase additional buses to meet existing service needs (ie. no 2 for 1 replacements).
- Battery costs in light duty applications were provided to illustrate a possible future trend of work that is being done to improve battery range and lower costs. For instance, the Battery500 research consortium announced by Obama Administration- aims to achieve higher specific energy, while making batteries smaller, lighter weight, and less expensive for LD vehicles.
- Some commenters mentioned that the price of precious metals in batteries will increase in the future as China controls 85 percent of the market. Also some precious metals are toxic or their mining has huge environmental impact. Others suggested that supply is not an issue because the US has capacity that is not being used.

- Table 2 in NREL report on Foothill Battery Electric Bus[3] was pointed out to illustrate the continued price reduction for battery electric buses.
- It is recommended to use bid price for the same bus specification instead of estimates by bus OEMs.
- Ballard committed to provide information on fuel cell electric bus pricing in Europe that received a bid for $650,000 Euro each and the deployment of 142 fuel cell buses under the 2016 call.
- Clean Energy stated they believe the near zero technology bus can be as clean as zero emission technologies. Near zero with RNG can provide significant GHG, NOx, and short lived climate pollutants emissions reduction, and recommended that ARB should encourage all technologies and should be technology neutral. Set the goal and let transit agencies meet it. They also referred to the LA Metro report that shows how it is possible to meet the SIP with the help of near zero technologies.
- ARB supports all range of technologies and recognizes that near zero technology combined with renewable fuel should be used where zero emission technologies are not feasible. The initial discussion draft for Advanced Clean Transit promoted the use of low-NOx engines, if available, in combination with renewable fuels plus a zero emission bus phase-in approach.
- Stakeholders brought up the benefit of using renewable natural gas and renewable diesel. ARB agreed that the use of low carbon fuels result in substantial greenhouse gas reductions. However, the emissions reductions from the use of renewable diesel and RNG is attributed to the LCFS program and cannot be double counted as achieving new GHG reductions as part of any ACT proposal. The LCFS regulation is working and in combination with the national Renewable Fuels Standard is resulting in renewable fuels being available at comparable prices as their fossil counterparts. Staff further pointed to the LCFS 2015 rule re-adoption ISOR in 2015 for policy statement and why the GHG benefits resulted by ZEBs are not attributed to LCFS.[4]
- ARB pointed out that LA Metro report also shows that a phase-in of zero emission buses can ultimately achieve more GHG emissions reductions than near zero.
- LA Metro report author commented, for today a bus operating on low NOx engine combined with renewable fuel can achieve the same emissions reduction benefits as a bus using zero emission technology. But for long term, as California's grid system gets cleaner, zero emission technologies achieve the best emissions reductions. ARB indicated that with a slow phase-in of zero emission buses timing matters a lot and that we are talking about a long term transition, which would be over a 20 year period. If we begin now, we can have a gradual transition that would result in a significant number of ZEB's to be in the fleet by 2030.
- Other comments raised questions about why we should burn up RNG in relatively inefficient internal combustion engines (ICE) instead of using it to supply steam methane reforming (SMR) to produce

[3] http://www.nrel.gov/docs/fy16osti/65274.pdf

[4] When doing emission reductions accounting, the LCFS program recognizes the need to isolate the effects of the LCFS from outcomes that would have occurred without the regulation, the baseline includes existing regulations and trends that influence the types and carbon intensities of transportation fuels consumed in California. The major regulations and trends include programs like the Advanced Clean Car program that fosters the market of electric cars. The LCFS accounting policy is stated in LCFS accounting policy from the 2015 Rule re-adoption ISOR (https://www.arb.ca.gov/regact/2015/lcfs2015/lcfs15isor.pdf)

hydrogen and use it in highly efficiency fuel cell. It should not always be strictly about cost. It is necessary to look at big picture and the States objectives, such as SB 32 too.

- LA Metro analysis presented at the APTA webinar in August shows for the short run they assumed bus replacement ratio is 1.7:1 and that for the long-run this ratio would be 1.3:1. On the other hand, ARB is committed not to require bus replacement if the bus replacement ratio is greater than 1:1. A comment was made that the 1:1 goal does not seem to be doable for on-route charging, because buses have to spend 10 minutes every hour charging and that would be 17% of time that the bus would not be working.
- Based on the survey results and discussions with a number of transit fleets, ARB does not believe that a more than 1:1 replacement is necessary for most fleets with shorter range routes and is less likely to be a concern with a moderate phase-in schedule. Staff plans to continue learning more from fleets that are operating zero emission buses and about operational issues from individual fleets to better understand how to guard against this concern.
- Steve Miller added, looking at Golden Gate Transit historical bus prices can also confirm that rate of price increase for a conventional bus seems to be around 4%. But when we look at the 5 year contract of Long Beach for basic BEB that includes price index escalator and compare it with price index escalator over the last 10 years, there is a disconnect between these price index escalators. It seems the long term manufacturer contract should include price de-escalator, not an escalator. By experience we know that would be possible for the long-run. This issue has to be resolved as well.

Electricity Cost Calculator

ARB staff provided a brief summary of a spreadsheet calculator for estimating electricity costs for charging battery electric buses with different utility rate schedules (https://www.arb.ca.gov/msprog/bus/ptfactsheet.htm). The tool estimates monthly electricity costs for BEBs that are charged at the depot or on-route for different chargers and other variables for 9 California utilities. The calculator approximates electricity costs on its own electricity meter. The tool does not account for BEB electricity usage commingled with existing facilities that could have lower costs. The tool currently does not model on-route charging with more than one charger per meter. ARB will try to keep this tool updated as utility rates change.

Comments on the calculator included the following:

- Add a disclaimer mentioning this is a draft version, not a final version.
- The calculator should be updated to calculate the electricity costs for two on-route chargers at a meter. Assuming that every on-route charging station has a separate meter makes a big difference in the rate and electricity costs.
- The calculator defaults to an on-route bus efficiency of 1.7 kWh/mile which transit fleets believe is too low and is not easily changes in the model. ARB will change the efficiency to default to 2.1 kWh/mile and make it easy to change the efficiency value.

Transit Fleets Survey Results

The purpose of this survey is to gather information about operations of transit systems and fleet characteristics at different divisions or depots which help ARB to better estimate individual fleet costs and understand potential barriers to deploying zero emission buses. This survey can be found at ACT website (http://www.arb.ca.gov/msprog/bus/transitsurvey032016.docx). ARB staff has put together the preliminary results (https://www.arb.ca.gov/msprog/bus/transit_survey_summary.pdf).

- Staff received 38 responses representing more than 50 percent of the buses in the State. Responses cover large, urban fleets as well as smaller or more rural fleets. These responses include a wide range of demographic and geographic characteristics.
- The responses provide indicators as to which fleets are more likely to have concerns with space and range limitations. ARB plans on following up with individual fleets to better understand specific transit fleet needs and potential barriers.
- ARB displayed the average daily mileage distribution split up by standard and cutaway buses. The 37 transits in this analysis included close to 5000 standard 40 ft. buses. This provides a perspective on what portion of the respondents' fleets will have the most challenges with a depot charging strategy. ARB also looked at how this distribution differed for smaller fleets.
- ARB also looked at the mileage distribution for different fleet size categories for standard buses. In general the mileage distribution above 150 miles for smaller fleets and larger fleets is about the same. ARB looked at mileage distributions to understand what charging options are available to individual fleets.
- ARB tried to identify what portion of transit fleets travel less than 150 miles per day and which transit agencies -with size of 10 buses and more- travel over 150 mile per day regularly. ARB acknowledged that transit agencies like Victor Valley and Riverside Transit Have longer daily range than the other agencies. Such information is helpful for identifying individual transit fleets that ARB should follow up with to better understand operations and barriers to deploying a depot charging strategy
- Most fleets purchase buses every year, but that about one third of the respondents regularly make purchases in 2 to 4 year increments. Infrequent purchase patterns are not limited to the smallest fleets. Orange County is not planning another purchase until 2021.
- Part of the survey tries to address concerns about stranded assets. ARB still need more information and input to better address this issue.
- In this survey ARB asked some questions about existing infrastructure to address concerns about stranded assets. Survey results show fairly wide distribution of when investments were made for CNG/LNG infrastructure. ARB still needs better information about CNG station life or upgrades to extend the life of existing stations.
- Staff plans to follow-up with respondents about incomplete information or apparent discrepancies.
- ARB is still accepting surveys.

Selection of Transit Agencies for Cost Analysis Case Studies

- ARB wants to look at costs at individual fleet bases and looking for any few transit agencies that are interested to go to that level of detail.
- ARB is going to touch bases with Foothill Transit, Antelope Valley Transit Authority, and Orange County Transit Authority.
- ARB also wants to look at some larger and some smaller transit agencies for case studies.

Action Items

- Gillig will provide data to ARB on maintenance cost comparison.
- Gillig will provide detailed bus component price breakdown to ARB for the group to look at price curve more closely.

- Ballard committed to provide information on FC bus pricing in Europe and also the deployment of 142 fuel cell buses under the 2016 call.
- ARB is seeking comments on draft discussion documents posted on ACT webpage and requesting all parties to submit their comments within two weeks, but will continue to accept comments and updated information as it becomes available
- ARB will follow-up on contract price escalators for zero emission buses.

Topics for next meeting

- What alternative mechanisms can be used to use to achieve the goals of Advanced Clean Transit.