

ICT Workgroup Meeting Summary
Tuesday, October 4, 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	Affiliation
1	Adrian Martinez	Earth Justice California Office
2	Alberto Ayala	California Air Resources Board (CARB)
3	Alex Padilla	Tuolumne County Transit
4	Andrew Papson	Foothill Transit
5	Anthony Poggi	CARB
6	Bill Spraul	San Diego Metropolitan Transit System
7	Brandon Bullock	Orange County Transportation Authority
8	Chris Peeples	Alameda-Contra Costa Transit District
9	Chris Young	Cummins Pacific
10	Cliff Thorne	Orange County Transportation Authority
11	Daljit Bawa	Ballard Power Systems
12	Dan Nevin	Cummins Pacific
13	Dana Lowell	Ramboll/Environ
14	David Renschler	Fairfield and Suisun Transit
15	David Warren	New Flyer of America
16	Diana Vazquez	Sierra Club California
17	Don Curry	North County Transit District
18	Doug Cameron	Clean Energy
19	Eric Bissinger	CARB
20	Fang Yan	CARB
21	Hanjiro Ambrose	University of California, Davis
22	Hannah Goldsmith	California Electric Transportation Coalition
23	Israel Salas	Southern California Gas Company (SoCalGas)
24	Jack Kitowski	CARB
25	Jaimie Levin	Center for Transportation and the Environment
26	Jeff Grant	Zen Clean Energy Solutions
27	Jennifer De Tapia	Trillium CNG
28	Jennifer Lee	CARB
29	Jimmy O'Dea	Union of Concerned Scientists
30	Jing Guo	CARB
31	John Drayton	Los Angeles County Metropolitan Transportation Authority

#	Name	Affiliation
32	Joseph Policarpio	Gillig
33	Katherine Garrison	CARB
34	Kaylin Huang	CARB
35	Lauren Skiver	SunLine Transit Agency
36	Len Engel	Antelope Valley Transit Authority
37	Linus J Farias	Pacific Gas and Electric Company (PG&E)
38	Lisa McGhee	San Diego Airport Parking
39	Mark Perry	Antelope Valley Transit Authority
40	Mark Weideman	Weideman Group
41	Matthew Williams	CARB
42	Michael Coates	Mightycomm/Nova/Volvo
43	Michael Masquelier	Wireless Advanced Vehicle Electrification (WAVE)
44	Michael Pimentel	California Transit Association
45	Michael Rosson	Butte County Association of Governments (BCAG)
46	Michael Turner	Los Angeles County Metropolitan Transportation Authority
47	Nico Bouwkamp	California Fuel Cell Partnership
48	Nicolas Pocard	Ballard
49	Nigel Browne	City of Fairfield
50	Norm Hickling	Antelope Valley Transit Authority
51	Norvell Nelson	Longbow Technology Ventures
52	Paul Arneja	CARB
53	Pippin Brehler	CARB
54	Ray Pingle	Sierra Club California
55	Richard Corey	CARB
56	Rick Ramacier	Vice Chair of Transit Agency Subcommittee/ Central Contra Costa Transit Authority
57	Ron Zirges	Victor Valley Transit Authority
58	Ryan Erickson	Trillium CNG
59	Ryan Schuchard	CALSTART
60	Sharon Cooney	San Diego Metropolitan Transit System
61	Shirin Barfjani	CARB
62	Shrayas Jatkar	Coalition for Clean Air
63	Spencer Olinek	PG&E
64	Steve Miller	Golden Gate Bridge Highway and Transportation District
65	Steve Schupak	Los Angeles County Metropolitan Transportation Authority
66	Steven Wallach	Platinum Advisors
67	Ted Harris	California Strategies
68	Thomas Lawson	California Natural Gas Vehicle Coalition
69	Tim Carmichael	SoCalGas
70	Todd Campbell	Clean Energy

#	Name	Affiliation
71	Todd Sostek	SoCalGas
72	Tony Brazil	CARB
73	Vincent Wiraatmadja	Weideman Group
74	William Musso	Voith
75	Yachun Chow	CARB
76	Zhen Dai	CARB

This was the fourth meeting of the Advanced Clean Transit Workgroup. This meeting was webcast and recorded. The primary objective of this meeting was to discuss a variety of control strategies and to discuss the latest cost information. The 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:

- Discussion of implementation strategies
 - Purchase requirements
 - CTA proposal on performance based approach
 - Bus manufacturer sales requirements
 - Voluntary based approaches
- Update on previous action items
 - Gillig component costs and maintenance costs
 - Ballard update on European fuel cell electric bus pricing
 - Summary of comments received on CARB posted discussion documents
- Update on Total Cost of Ownership
 - Bus prices
 - Annual maintenance & major mid-life
 - Annual fuel costs
 - Infrastructure
- Action items
- Topics for next meeting

The following is a brief meeting summary that highlights the major items discussed, and agreed upon action items.

Discussion of implementation strategies

Presentation material for Alternatives to Advanced Clean Transit is available online at <https://www.arb.ca.gov/msprog/bus/4thactwgalternatives.pdf> .

CARB's Executive Officer, Mr. Richard Corey, began the meeting by describing that transit agencies are CARB's clean air partners. Challenges in shaping effective and timely approaches are real, and there is a shared goal of reaching zero emissions and the question is where and how. We need creative problem solving in determining a path to cleanest possible transit systems to reach the final destination. CARB has not identified the path and is interested in determining the best way to meet the final goal. CARB, transit agencies, and other stakeholders have to work creatively together, need open sharing of estimated costs and other information, and we need to identify where there is disagreement or differing perspectives. Mr. Corey indicated he is confident that we can develop an approach that we can collectively stand behind, and affirmed the objective is to effectively move forward towards the destination without compromising services.

Purchase requirement

The existing regulation has a 15% ZEB purchase requirement that is currently on hold and was the first framework concept discussed. The purchase requirement concept described in the CARB May 2015 discussion document would require the use of renewable fuels when fuel contracts are renewed to support the LCFS regulation, would require the purchase of low NOx engines if available at time of bus replacement, and some of the bus purchases would need to be zero emission. Questions with this approach include how to adjust purchase targets to address cost concerns, how to enhance mobility, how to set appropriate off-ramps to avoid any potential for negative impacts on service, and the appropriate role of funding. The following are issues and comments that were discussed about the purchase requirement framework:

- Some form of regulation provides a clear market signal for manufacturers and fleets to make investments and to begin planning for future implementation.
- A 15% or 20% purchase requirement might look high at first glance, but pioneer transit agencies are proving it is doable. If the zero emission bus (ZEB) purchase requirement is 20% and bus turnover is 7%, then 20% of the 7% is a small number, and is gradual.
- Transition to zero emission technology would be costly, but these costs are not clear yet. There is also no guaranty for funding availability to cover these costs. Therefore, purchase requirement brings uncertainty.
- Studies by the National Renewable Energy Laboratory at Foothill transit and fairly recent cost analyses done by LA Metro indicate that costs are much higher than conventional bus purchases.
- CARB should identify the funding sources and should provide sufficient funding for transit agencies to purchase ZEBs.

- Emissions from transit buses are currently lower compared to decades ago because of the CARB regulations and requirements. This shows regulations are effective.
- Regulations are needed, because there is a need for protection of populations in dense residential areas and disadvantage communities.
- California has challenging emissions reduction goals. ZEB purchase requirement provides faster transition to zero emissions technologies in transportation sector.
- A purchase requirement is the least flexible option for transit agencies.
- Transit agencies would need off-ramps under this approach due to ZEB range restrictions and other issues. Use of off-ramps will require data evaluation and is time intensive and complicated. Transit agencies may need to hire extra staff to manage off ramps.
- LA Metro representatives mentioned they are least comfortable with the purchase mandate. LA Metro board is considering the motion of implementing ZEB technology and staff is figuring out the path forward, but the main challenge is access to money to support policies. The representative added, the additional revenue generated by LCFS is not guaranteed and does not cover the whole costs of charging buses.
- Zero emission technologies are more efficient than conventional technologies and providing the best use of renewable fuels. The combined efficiency of using renewable fuels for hydrogen production through Steam Methane Reforming (SMR) and usage in fuel cell electric buses provides a better use of renewable fuels.
- Everybody wants frequent services and higher quality ride. Higher quality means quiet and better ride for passengers and operators, and cleaner and easier maintenance and repairs for technicians. Zero emissions technologies can meet these expectations.
- Reducing methane leakage is important and needed.
- One transit agency commented the cost of transitioning from diesel to CNG on the path to zero emission technology is very expensive. CARB clarified the proposed concept would not require converting from diesel to CNG in order to use low NOx engines. The use of low NOx engines would be required only when this technology becomes available for the bus fuel type a transit agency would be purchasing. CARB expects low NOx technology for diesel engines become available around 2020.
- Transit agencies have not seen the whole life cycle of zero emission buses. More cost information for useful life of a bus is needed. A large-scale CARB funded ZEB pilot project could be helpful.
- Another transit agency echoed the same concern about lack of information for low-NOx engines.
- There are technology, rate tariffs, range, and infrastructure barriers to address with zero emission buses. Risks of operating zero emission technology are high. Managing ZEB technology is different. Therefore, more incentives are needed to cover these risks and costs.

- A natural gas representative mentioned, 15% purchase requirement did not work and CARB should avoid pushing towards mandating a technology that is not ready. CARB responded the technology and costs have improved since the time we put this requirement on hold. SunLine¹ representative added ZEB is a proven technology and several transit agencies have already implemented ZEBs into daily service, and there is no long term empirical evidence that low NOx engines will perform as expected.

CTA proposal on performance based approach

CTA provided a high-level goal on performance based approach with following framework: broad implementation of ZEB technologies is feasible and desirable for some transit agencies, but it does not mean they can and should be aggressively implemented statewide. Investments in natural gas fleets and fueling infrastructure should be recognized and fleets should be encouraged to utilize this technology with the help of low NOx engines and renewable fuels to achieve higher emissions reductions. Electrified multi-modal operation must be counted towards a transit agency's achievement.² This proposal represents the broad overview of the framework. Details of how to measure and implement this concept are yet to be developed and discussed. CTA also described they would support a large zero emission bus demonstration program funded by CARB and could be monitored over a 5 to 10 year period. They would also like to see the State identify solutions to improve the cost of electricity for transit buses as is being considered in CARB coordination with the CPUC and utilities. The following are comments about a performance based approach:

- With this approach CARB would be technology neutral.
- ZEB may not be feasible for every transit agency. Transit agencies need flexibility of expanding their services and not being stuck in mandates. Strict mandate does not allow modernization of public transits.
- A multi-modal fleet concept may also be complicated. Transit agencies may not always be in control of other modes of transportation in their regions, e.g., they may not be the one operating the new zero emission driverless shuttles or have light rail within their purview.
- It can be more cost effective, and helps meet regional needs.
- Due to flexibility and cost effectiveness of this approach, the chance of cutting services during transition to cleaner technologies is lower.
- It helps with consideration of a multi-modal fleet.
- Performance based concept has the same issue as ZEB mandate in regards of information availability. Currently, there is no data available on low NOx engines.
- Electric drivetrain is more efficient than combustion engines. Battery electric buses combined with solar and energy storage can achieve real, 100% GHG and criteria pollutants reduction.

¹ SunLine Transit Agency has been operating zero emission buses since 2000. Currently, it operates five fuel cell electric buses and three battery electric buses.

² <https://caltransit.org/cta/assets/File/Proposed%20Alternative%20to%20ACT%20regulation.pdf>

- If we move our ZEB target far, we would never get there when we need it. We need to work towards availability of ZEB development.

Bus manufacturer sales requirements

This concept would require a percentage of bus manufacturer sales in California to be zero emissions and conventional buses would need to be equipped with low NOx engines if available. This approach was used in light duty zero emission vehicles regulation. A credit-and-deficit program similar to light duty (LD) would be the mechanism to implement the program. The following comments were made about this approach:

- Some environmental groups raised concerns that occurred with the same concept in the LD ZEV regulation and said they want to see more actual ZEBs in the market than credits being used by bus manufacturers to meet the compliance obligation. They also mentioned such approach has never been discussed for heavy duty sector and they would need more time to study it.
- LD vehicles and transit fleets are very different. This approach does not incentivize transit agencies and has no positive impacts.
- Gillig representative said bus building industry is very volatile and does not want CARB to put requirements on OEMs. It would be unfair to suggest minimum ZEB production or sale, if there is no market created for it.
- CARB staff indicated the ZEB market exists and is growing and there are some similarities between heavy duty and light duty markets.
- New Flyer mentioned they are technology neutral. They want to offer the best and most economical solution to their customers. This approach would change the way OEMs do business. In addition, manufactures have to deal with US EPA stringent requirements on Phase 2. Meeting these requirements means big investments.
- LA Metro representative expressed concerns about not getting the best bus prices when they procure buses from multiplatform bus OEMs (e.g. New Flyer and Gillig). Under this approach, some OEMs may be disadvantaged if they do not sell enough ZEBs in California and need to buy credits. This approach is a stick, not a carrot.
- Another transit agency mentioned this approach will increase the price of conventional buses and transit agencies would ultimately have to pay for it.
- This approach does not include infrastructure consideration, which is a main challenge in ZEB deployment and reduces the potential for transit agencies to address barriers and identify solutions.
- A sales requirement does not provide assurance buses would be located in disadvantaged communities or in regions that have the most severe air quality problems.

Voluntary Based Approach

This approach may allow transit agencies to set their own courses in bus procurement without a statewide direction. The focus would be on funding availability for zero-emission buses including coordination with other State agencies. This approach may follow by some regulatory backstops in case sufficient progress isn't being made. There would be similar questions to other approaches about how to encourage enhanced connectivity and mobility. The following comments were made about a voluntary approach:

- Gillig is a supporter of a voluntary approach and voluntarily entered the ZEB market and identified customers and partners.
- Foothill representative stated they are receiving numerous visitors on their facilities and seeing tremendous interests in zero emission technologies in other transit agencies. Information sharing is strong among transit agencies. Therefore, voluntary approach would work.
- Antelope Valley Transit representative confirmed interest is high for zero emission buses and added they also believe this technology is working and is adaptable by other transit agencies. They experience with ZEB reliability is higher than LA Metro for those 2 battery electric buses. They are supporting this approach and believe it encourages transit agencies.
- Incentive money has been over-subscribed. Voluntary approach would allow transit agencies continue receiving federal money. In addition, the State would be able to pick and choose funding that goes to disadvantage communities.
- Voluntary approach does not send a strong signal to OEMs to invest. Technology providers need forecasts in the market. A regulatory framework is needed to drive the price down.
- Small transit agencies do not have access to large funding like large agencies and can implement zero emissions technology only if funding is available.
- CARB should not take an approach that limits funding sources. Transit agencies assume any mandate will end some funding sources like federal grant money, and a voluntary approach keeps possibilities open. SunLine representative encouraged CARB to ensure funding is available with any approach, because funding is a very important part of this regulation.
- Transits always have to leverage funding. Transits never have big chunk of money to spend and have to take advantage of numerous small sources.
- CARB staff commented there is no evidence that federal programs will be affected by a regulatory approach and will seek to clarify any impacts on existing funding with any approach.
- Ballard representative mentioned voluntary approach does not provide long-term visibility and security for manufacturers to invest and focus on the market. It does not encourage competition between transit agencies and does not drive the price lower.
- BYD representative mentioned regulations provide certainty. They see ZEB demand because of regulations and directions from State.

- In contrast to purchase mandate, the voluntary approach would encourage competition spirits between transits and provide them flexibility to address challenges, such as ridership fluctuation.
- Voluntary approach gets transit agencies there, but maybe not as fast as mandate. Mandate may result in unintended consequences, such as service cut.
- Each transit agency is different and a voluntary approach might work very well.
- LA Metro is supporting this approach.
- The natural gas industry supported the voluntary approach and requested a matrix of different technologies to help with emissions reductions goals. It was also requested that funding to be allocated to near-zero technology as well.
- New Flyer representative mentioned, FTA has announced last year \$55 million in grants to put more zero-emission buses into service across America. This means fast move towards ZEB technologies. He also added ZEBs may become more affordable in the future, but access to funding remains an important aspect for transit agencies.
- This approach might work for transits, but its impacts and benefits are uncertain.
- This approach does not guaranty emissions reductions needed to meet State's goals and does not send a strong signal to transit agencies and manufacturers to create the economy of scale.
- Voluntary actions would be the first to cut if money becomes short. In addition, there is equity issue connected with this approach. Some transit agencies volunteer and implement the technology faster than others. In contrast, purchase mandate advances the market for everyone and is more equitable.
- Two ZEB advocates added voluntary approach does not create any demand for ZEBs. Without a regulation we would not have seen this interest in ZEBs and technology implementation among transit agencies and we would not have had this discussion. Regulations and investments are needed for advanced technologies that provide the most promises.

Combination of Approaches

This would be a hybrid path using multiple approaches mentioned above paired with incentives to meet range of objectives. Some of these hybrid approaches could be combination of manufacturer sales and transit purchase, manufacture sales and performance based, and a voluntary approach with regulatory backstop. There was little discussion of this concept.

Update on previous action items

- Gillig briefly went over current average prices of 40-foot buses of different propulsion systems, including diesel for \$450,000, CNG for \$500,000, CNG near zero for \$510,000, and hybrid for \$665,000. Gillig believes these buses are fairly well equipped. Gillig further states to calculate the basic bus price by deducting \$35,000 from these prices. Gillig also provided fuel efficiency and maintenance cost results from an anonymous fleet that has Gillig 2002, 2009, 2013, and 2015

model year (MY) diesel buses³. This data set does not contain detailed information about maintenance breakdown, drive condition, and average speed and not clarifying this information is based on empirical data or estimated ones.

- Ballard briefly talked about a report⁴ submitted to Fuel Cells and Hydrogen joint Undertaking (FCH:JU) for fuel cell bus call for the year 2016. This report provides information on deployment of 142 fuel cell buses under the 2016 call in Europe. Based on this report, Request for information (RFI) documents were received from UK and German clusters. The next step would be floating the tenders based on RFI. The most contracts under this call are expect to be in place by the end of 2016. The buses will then be deployed in 2017-18 timeframe. The target price for these buses is €650,000 (~\$730,000) and European Union is providing around €200,000 subsidy.
- CARB has not received any comments on the posted discussion documents other than some comments about fuel cell buses.⁵ CARB encouraged all stakeholders to submit them to CARB for consideration and plans to make updates if new information becomes available.

Update on Total Cost of Ownership

CARB staff made a presentation about the total cost of ownership (TCO) of individual fleets examples. The presentation is available at https://www.arb.ca.gov/msprog/bus/4thactwgmtng_costs.pdf. The presentation described key cost inputs and showed fleet examples for diesel fleets and CNG fleets in different electric utility areas. The selected fleet examples are Golden Gate Transit with diesel fleet in PG&E area, LA Metro with CNG fleet in Southern California Edison (SCE) and Los Angeles Department of Water and Power (LADWP) area, and San Diego MTS with CNG fleet in San Diego Gas & Electric Company (SDG&E) area. For the analysis, the presentation focused on a strategy of deploying battery electric buses (depot charging) for first 15 percent of the fleet. The analysis is predicated on a one for one replacement for buses that operate on shorter daily ranges of about 130 miles per day with buses that have a nominal range of about 150 miles between charges and is applicable to most fleet for a portion of their normal service. Only depot charging was used for the examples for simplification. Diesel and CNG costs were consistent with survey responses from transit fleets and future fuel cost projections were from the Energy Information Administration. Electricity rates for 2016 were based on charging in the depot overnight with sequential bus charging to manage demand charges for each utility and and projected consistent with EIA data. Staff also assumed the existing diesel and CNG infrastructure costs remain the same and showed the net fuel costs after LCFS credits assuming a value of \$100/credit. No incentive funding was included

³ In this set of data, fuel efficiency for MY 2002, 2009, 2013, and 2015 are 4.4, 4.9, 4.8, and 5.4 miles per gallon and maintenance costs per mile are \$0.31 to \$0.43, \$0.47 to \$0.48, \$0.51, and \$0.22 respectively. The maintenance costs include all parts, labor, rebuilds, and rehabs performed on buses and are year to date data.

⁴ http://www.fch.europa.eu/sites/default/files/Strategies%20for%20joint%20procurement%20of%20FC%20buses_0.pdf

⁵ Both discussion documents -Battery Cost for Heavy-Duty Electric Vehicles (https://www.arb.ca.gov/msprog/bus/battery_cost.pdf) and Literature Review on Transit Bus Maintenance Cost (https://www.arb.ca.gov/msprog/bus/maintenance_cost.pdf) are available for review and comment.

in the examples. The analysis showed that the total cost of ownership of a battery electric bus purchased in 2016 is lower than continuing diesel bus purchases in the PG&E service area and is comparable to CNG buses. Compared to CNG the costs are about the same. Slightly lower in all service areas except for the SDG&E area where electricity costs are higher. The same analysis with battery electric bus purchases starting in 2020 (when battery cost reductions lower the initial cost of the bus) the total cost of ownership results in a cost savings in all utility service areas for diesel and CNG fleets. The detailed cost assumptions are available with the meeting materials at https://www.arb.ca.gov/msprog/bus/tco_assumptions.xlsx. These assumptions will be updated as more information becomes available. Comments received on the presentation and cost inputs are summarized below. Infrastructure

- Fairfield representative mentioned non-monetary costs and barriers need to be considered as well, such as space limitation, noise, and public concerns with specific infrastructures.
- Antelope Valley Transit Authority (AVTA) full depot conversion costs about \$60,000 per bus including the cost of a backup generator to charge buses in the event of a power outage. Their utility line is about 800-ft from the property which added to the costs.
- Golden Gate Transit contracted for an engineering analysis and would be able to charge the first 2 battery electric buses without utility service upgrades, but the infrastructure and the charger would cost them around \$72,000 per bus. A ten bus deployment would require switchgear upgrades and a new transformer and would cost about \$500,000 for the engineer recommended option and up to \$1,000,000 for second installation option. However, the \$500,000 estimate is now off the table because PG&E does not agree with adding a second transformer on the property. Adding another transformer would have helped them to reduce their costs substantially. CARB said this would be a good topic to discuss with CPUC to receive their support in removing electrification's barriers under SB 350.
- LA Metro added their costs for having 5 chargers for their BYD buses was about \$10,000 each and they had to separately come up with over \$300,000 for infrastructure permits and trenching. The footprint for each charger is about 5 feet. Not all their facilities have such space availability.
- San Diego Airport Parking company representative added their level II 13kW charger costs \$10,000 in equipment and installation. The passenger vans they operate have a 100 miles range between charges and they operate them 200 miles per day. They operate most of the day and charging time at 13 kW is long and they need to charge during all times of the day during peak, mid-peak and off-peak hours. They are looking at solar and energy storage options to reduce electricity costs.
- CalSTART is evaluating seven fleets and believes the infrastructure costs and demand charges should be higher than \$50,000 per bus. CARB will follow up with CalSTART regarding this data evaluation.
- LA Metro representative mentioned they need 400 miles/vehicle/day and added CARB represented maintenance cost saving of \$10,000/bus/year is not realistic. They indicated that LA Metro's updated draft report also shows some

maintenance costs saving but not as much as CARB is using. LA Metro is going to share the updated draft on zero-emission bus study with CARB and the basis for the different assumptions.

- Steve Miller assumes costs of zero emission bus maintenance would be almost five times higher in short-run, but it is expected to see maintenance cost savings in the long-run. Service interruptions for maintenance cost money as well. He also cautioned about the inconsistency between fuel efficiency in NREL reports and NTD. As an example, Foothill transit fuel economy for the CNG buses that were evaluated in the in the NREL⁶ report is around 4.5 miles/DGE compared to 2.1 kWh/mile for the battery electric buses and the Foothill average fuel economy for their CNG fleet is about 3 miles/DGE in NTD⁷. Foothill transit confirms their fuel economy is over 2 kWh/mile. ARB staff indicated the differences can be partly explained by different average speeds and that the NREL data is for a small number of baseline CNG buses being monitored with an average higher speed than the fleet and the NTD shows data for the whole fleet.
- New Flyer representative said manufacturers believe \$0.25/mile maintenance cost saving is feasible and asked Steve Miller to include savings in his cost model.
- Some transit agencies mentioned more real life information about ZEB operation is needed. CARB and other agencies will continue to gather information from transits operating these technologies. CARB is also engaging with utilities on removing fleet electrification barriers.
- San Diego Airport Parking mentioned 6% of the electricity cost is tax and it should be considered.
- San Diego MTS commented on slide 22 of the cost presentation and mentioned their natural gas cost is considerable less than what is used in CARB slide example. They have shared the data with the cost subgroup previously and will share it with CARB. CARB believes the costs are consistent with the information received from MTS in the transit operations survey. If the information has changed CARB staff will adjust the value as needed to accurately reflect the costs.
- Various transit agencies mentioned LCFS should not be on the cost side of the cost model. LCFS should go to the funding side as a revenue source.⁸
- Participants requested CARB to show the LCFS value separate from the fuel costs in future presentations and in the cost model.

⁶ Foothill Transit's reported fuel efficiency in NREL report are 2.15 kwh/miles for the BEB fleet with average speed of 10.6 mph and 4.51 miles/DGE for the CNG fleet with average speed of 17.6 mph. The BEBs in this report operated primarily on a designated route (Line 291) as the CNG buses were randomly dispatched on all routes, including express and commuter routes, which have much higher average speeds. The Foothill Transit Battery Electric Bus Demonstration Results, January 2016 (<http://www.nrel.gov/docs/fy16osti/65274.pdf>).

⁷ With the help of NTD 2015 data report we can calculate only the fleet average fuel efficiency which is 2.91 miles/DGE with fleet average speed of 14.98 mph.

⁸ LCFS was previously discussed on August 29, 2016 Workgroup meeting: https://www.arb.ca.gov/msprog/bus/wg_summary_8_29.pdf

- Steve Miller mentioned he needs to analyze the TCO inputs further. CARB's data is different from his cost assumptions.
- CARB staff and the transit fleet cost subgroup should meet to clarify any remaining differences and to identify any new data sources.
- CARB should invite utility representatives to future cost discussions.
- New Flyer commented on the bus prices used by ARB and mentioned they are reasonable for 320 kwh battery capacity and the battery capacity is representative of 120 miles in Altoona testing.
- CARB should include fuel cell data in the cost assumptions sheet

Other Topics

Members discussed the role of renewables. When discussion came to criteria pollutant emissions reduction benefit, a transit agency representative commented that LCFS is just a credit and does not help solving local air pollution issues. He added in reality, fleets that state they are using renewable fuels are still burning conventional natural gas or a mixture of conventional and renewable natural gas. Natural gas industry representatives said the same argument is valid about renewable electricity. CARB staff confirmed that CARB analysis of emissions associated with electricity use is based on the average electricity grid mix. CARB staff added, that LCFS program and credit system does not assure that molecules of renewable fuels are burned in a given bus fleet. The current policy of LCFS program requires reduction of Carbon Intensity (CI) of California transportation fuel pool by 10 percent by 2020 and maintains such level post 2020 if there is no further amendment to the regulation. In addition, the supply of renewable fuel is finite; therefore, in developing long term strategies we have to make best use of renewable fuels in sectors that do not have other ways to increase efficiency and reduce their greenhouse gas emissions. Commenters explained that there are no other existing programs encouraging renewable fuel production for the use in other sectors at this time. This makes transportation as the only sector that use of renewable fuel is economically favorable.

Action items

- CARB is going to provide more information about potential effects of regulatory requirements on federal grants.
- CARB is requesting comments from all stakeholders on alternatives to Advanced Clean Transit and other topics represented at this meeting.
- CARB encourages all stakeholders to comment on posted discussion documents (Battery Cost for Heavy-Duty Electric Vehicles and Literature Review on Transit Bus Maintenance Cost) and submit them to CARB for consideration.
- LA Metro is going to share the updated draft on zero-emission bus study with CARB.
- CARB will revisit bus prices based on the Gillig information
- CARB will seek to determine if the fleet operational characteristics from Gillig, such as average speed, are consistent with prior findings where higher speed operations are expected to have higher fuel efficiency and lower maintenance costs due to lower brake repair costs.

- CARB is following up with CalSTART in regards of their recent analysis on seven transit fleets and data used for evaluation of infrastructure and charging costs.
- San Diego MTS is sharing their fuel and maintenance costs data.

Topics for next meeting

- Publish CARB fleet cost model for comment
- Update battery electric bus charging cost calculator
- Meet with individual fleets for case study and to discuss barriers, survey results, and cost information
- Have Transit Subcommittee meeting on October 26th